Multi-standard modem

Emulators

Computer cassette recorder

Cellular radio

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The new microprocessor controlled EP8000 Emulator Programmer will program and emulate all EPROMs up to 8k x 8 sizes, and can be extended to program other devices such as 16k x 8 EPROMs, Bipolar PROMs, single chip microprocessors with external modules. Personality cards and hardware changes are not required as the machine configures itself for the different devices. The EP4000 with 4k x 8 static RAM is still available with EPROM programming and emulation capacity up to 4k x 8 sizes.

FEATURES
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<table>
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<th>VA Size</th>
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<th>120 VA</th>
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Front cover illustrates some communications software and pages from Prestel, one of the databases which can be accessed through our modem design.

NEXT MONTH

Graphics display and up to 32 lines of 96 characters are provided by the v.d.u. circuit of John Adam’s microcomputer.

Two-metre transceivers for the radio amateur: as May’s RAE candidates await their pass slips, a survey of equipment for this popular band for the beginning.

Timebase correction for C-format vtrs is explained in the second installment of John Watkinson’s four-part series on variable speed video.

Multi-standard modem: details of the interface to the telephone line, plus suggestions for software and some databases to dial up.

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BC238 Planar BC108 58-00238 0.08
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Tri Colour LED
VS18 Orange-Green-Yellow 15-05180 0.60

Capacitors
Aluminium Electrolytics Radial PCB Mounting

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Tantalum Beads

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Monolayer Capacitors
Pack of 3

1n 04-10204 0.39
10n 04-10203 0.42
100n 04-10404 0.45

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Pack of 5

1n 04-10203 0.20
10n 04-10203 0.20

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Pack of 3

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CIRCLE 20 FOR FURTHER DETAILS.
COMMENT

Basic leap-frog

There is evidence that universities running courses for electronic engineers are playing leap-frog. Circuit design does not seem to be considered a vital part of the curriculum, perhaps because many of the circuit functions that used to be taught are now contained in integrated circuits. The effect of this, in recent times, is that new graduates are somewhat deficient in the basics of circuit design, though fully proficient in the development of i.c.s. "They all know how to shuffle little black bugs around on a board, but ask them to design a feedback amplifier and they want to go home" is how one manufacturer describes a recent influx of design staff. Clearly, education and training must move with the times, but such a policy of leap-frogging the basics of design to concentrate on using modules of other people's design does appear to be a little short-sighted. There is obviously a lower level of complexity below which one simply buys and fits — no one wants to make resistors and capacitors — but, since i.c.s now constitute the largest part of most designs, it surely makes sense to know enough circuit design to understand how they work. Not to do so is not to be an electronic engineer at all. It has always been the case in the past that an engineer should be familiar with the design and construction of components such as inductors and transformers, delay lines, power supplies and thermionic devices, even though they were usually bought 'off the peg' and fitted. Nothing has changed — but i.c.s are commonly connected together to form a highly complicated piece of equipment, the 'designer' having only a hazy notion of what the individual components are doing. Time now constitute the largest part of our industry is, and our industry has evolved so rapidly that a great deal of new technology must now be taught, but even so, to gloss over the rudiments of any subject is a practice fraught with danger. We may still see a generation of highly skilled designers who are unable to design.

Telephone hang-up

The home computer magazines are calling 1984 the year of the modem. As an entertainment medium. The modem has a lot to recommend it — certainly when you compare it with the handful of games cassettes you might get for the same money. So it's a pity that the majority of modems available to the impromptuous home user are (how can I put it?) illegal. Illegal to use, anyway.

The problem is that anything you connect to a telephone line has by law to be scrutinised by the British Approval Board for Telecommunications — Babtee to its intimates. But getting a device approved by BABT is a slow business, and not a course to embark upon unless you have kilopounds to spare. All right for commercial manufacturers, perhaps, but how about the poor home constructor?

BABT cannot vet a construction kit, still less a paper design. So anyone who wants to build our multi-standard modem may face the icy blast of official disapproval — along with all the other people using bootleg modems.

Most of these illicit modems are undoubtedly perfectly sanitary from a technical point of view. And BT's chances of catching people using them can hardly be very great. BT, who are probably more concerned about the menace of improvised cordless telephones, may even be happy to take the extra revenue.

Nobody stands to gain from doing damage to the telephone network, least of all the modem users themselves. Who are they harming? In some countries the telephone authorities can provide simple isolators for connecting subscribers' equipment to their lines. Would it be such a sacrifice to allow that in Britain?

Alternative energy

Did you know that on the larger wind generators, it's predicted that a broken blade could fly through the air for up to 2km? Imagine the devastation should such an object hit an unsuspecting bus queue from the back.

We're about to set up a campaign against these lethal devices before it's too late; electronic safety measures are fine but they can't hold back a broken blade once it has set off at around Mach 0.9. Current propaganda has convinced us that nuclear power stations are the only option for alternative energy, especially the extra safe ones that we use in the UK. The only slight reservation we still have is about the possible leakage of one of the massive chlorine tanks used for water purification, but we haven't found any figures on this subject yet, so our money is on nuclear energy.

After all, even when the dead weight of Britain's industry has been cleared — iron foundries, heavy engineering and the like — we'll still need a lot of electricity to power the computers used by the millions of retrained workers. And workers not prepared to retrain will lose lots of spare time in which they'll be using their electric-powered microwave ovens and dish washers. That is, when they realise that fish and chips with v.a.t. are a little over the top.
£10million Alvey contracts

Two contracts worth £10million in the Alvey Programme of advanced information technology placed last month are the first major contracts in the five year £350million collaborative project. Alvey (WW page 31 December 1982) was given the go-ahead a year ago and under it the Government will fund 50% of industrial costs and 100% of university costs. The first for what is called an 'integrated project support environment', is a multi-language advanced software tool that aims to support developers of real-time distributed computing systems at the centre of large complex systems such as industrial process control, avionics, and advanced communication systems. The £3.6million project, called Aspect, is a 'first-generation' IPSE led by Systems Designers who will use their IPSE 'Perspective' that supports production of Pascal programs for embedded applications. University of York who developed an Ada compiler, MARI with the 'Newcastle Connection' software for linking distributed Unix machines, as well as ICL with Perg expertise and GEC, with Series 63 computers. (A second generation IPSE will support distributed software development, and a third generation will contain knowledge-based tools to give 'intelligent' support to software developers, otherwise called an 'information systems factory'.)

Announcing the contract Kenneth Baker, minister for information technology, said Aspect will play a vital role in increasing productivity throughout the software engineering community: "The Alvey Programme aims to turn writing software from a craft into an engineering discipline" he said.

A consortium led by ICL has been awarded the second contract, worth £6.5million over five years, for a large scale demonstrator project to evaluate the role of new computing technologies in the formulation, interpretation and application of complex policies and rules. A team of DHSS officials will work with the consortium of ICL, Logica, Imperial College, Universities of Lancaster and Surrey. The project will cover investigations of intelligent knowledge-based systems and man-machine interfaces, as well as software engineering techniques.

Pointing a satellite

Ways of improving the orientation of satellites in space are to be investigated by Marconi Space and Defence on behalf of the European Space Agency. The study is to concentrate on the problems presented by large, flexible solar power panels which are to be used on the very large telecommunications satellites. Large satellites with high output powers need to be manoeuvred with a high degree of accuracy to ensure that their communications antennae are correctly oriented with respect to Earth receivers; even a tenth of a degree error in the direction of a communications beam can mean a serious loss of data. In addition some satellites use very narrow beams, making the need for accuracy even more important.

Greater precision has been achieved already in smaller craft where the solar energy panels are attached to the body of the craft. In the large craft however, the panels tend to flex under the impulses generated by correction thruster rockets. The flexing can introduce unwanted movement in the craft and further compensation is required, which in the extreme case can lead to a 'hunting' effect; wasteful in fuel and reducing the life of the satellite. The study is to take a mathematical approach to the problem. There is an algebraic theorem by Sturm, proposed in 1836, which may be used to calculate a correctly timed sequence of thruster commands. The commands should correct the pointing of the craft and take into account the vibration of any flexible parts at the same time. The research programme will also look at the modes of vibration of such flexible structures by using a single sensor, typically a gyroscope, attached to the spacecraft. By adopting these techniques it should be possible to improve the accuracy of pointing the satellite from the present 0.15° to better than 0.05°.

TV deliveries record

More than 4 million television sets were delivered to the trade in 1983, a record for the industry according to BREMA, and nearly 17% higher than the previous year. The trend toward portables increasing their share continued, with the small screen segment taking 36%, an increase of 16%. Both teletext and small-screen monochrome deliveries were 12% up on 1982. Surprisingly however deliveries of video recorders and of music centres, the other two main categories that Brema analyse, have levelled off and show no growth over the previous year. For video this was in some measure due to rising prices of the more 'sophisticated' machines coming onto the market, say Brema, together with a run-down of stocks in the wake of uncertainties relating to format trends and the level of Japanese imports following the recent MITI and EEC agreement.

Efp conferences

Electronics for Peace is organising three regional Saturday conferences this summer for electronics and computing engineers to meet and discuss the wider social and military implications of the electronics industry.

The dates and places are:
Saturday June 2nd, Sheffield
Saturday June 9th, Bristol
Saturday June 16th, London.
Details from Efp, 151 Courthouse Road, Maidenhead, Berks, or tel. (evenings) 0892-46354 or 0628-20225.

For Ambit read Cirkit

Following rapidly on the report that Ambit, the component distributors, were to move to Broxbourne, was another report that they have been sold to A.F. Bulgin & Co. Bulgin are to combine this company with others (Solent Component Supplies, Broxill Ltd and Projex Distribution) into a single company to be known as Cirkit. The new company will retain the policy of Ambit of selling components in small quantities to the home constructor as well as in bulk to industry. The catalogues of all the different companies listing over 10,000 different products are to be combined into a single consolidated catalogue later in the year. Cirkit commences trading from Broxbourne, Herts, from May 1st.

ELECTRONICS & WIRELESS WORLD JUNE 1984
Adaptive delta modulation for tv sound

With an eye to satellite and cable reception for tv sound, Dolby Laboratories have developed a digital encode-decode system that could also be used for terrestrial broadcasting of stereophonic tv. The new digital audio system — shown at Eurocast, Basel, in May — has already been licensed to General Instrument in the USA for use in its satellite tv plans. Under the terms of the licensing agreement, General Instrument will build subscriber decoders and Dolby will manufacture encoders for use at the up-link satellite station or at the cable system head-end.

The specifications of the process, a form of adaptive delta modulation, are comparable to those of the Compact Disc: 'The high cost of the CD process and of other promised home digital home media may well impede the growth of consumer acceptance of digital audio' say Dolby Labs. The Dolby/GO pact they say will allow tv audio to be the first to deliver digital audio quality to the regular consumer. Dolby aimed at a narrow bandwidth, around 200 to 350kbit/s, the exact rate being chosen to suit the transmission system, and chose delta modulation rather than p.c.m.

because of superior performance at low data rates and lower sensitivity to errors. No precision components are needed in the decoder, the performance and bandwidth advantages being gained by placing more complex circuitry in the transmission encoders. The system is said to be particularly useful for electronic delivery systems such as cable tv, satellite-delivered programmes and d.b.s. audio systems, where minimal error correction will lead to cheaper decoder designs.

Dolby Laboratories must be hoping to have more US interest in the BBC in this development than they did with the analogue Dolby f.m. scheme; the BBC have said they are now considering a digital system for stereophonic television.

New Research Head at BBC

Bruce Moffat has been appointed the new Head of BBC Engineering Research Department, where he has spent most of his working career. He has undertaken investigations into the causes and prevention of fleldclogging in tape recorders, and into the possible techniques for digital television recording. As Head of the baseband systems section he worked on the development of multi-channel digital audio transmission systems and near-instantaneous digital companding, the forerunner of Nicam, accepted by the CCIR as part of a system for satellite broadcasting. On transferring to the storage and recording section he worked on many projects including real-time digital audio signal processing, which has made feasible the development of a digital sound mixing desk. Another project was digital multi-image storing and animation. As head of the studio group he became responsible for the workings of several sections. Dr. Moffat has written or contributed to numerous papers, mostly on digital audio and video techniques. He also serves as chairman of the UK CCIR working group on high-definition tv.

934MHz Club UK

A club for users of 934MHz Citizens' Band has been formed to encourage and further the use of this band and to represent users to the official bodies concerned with radio communications. There will be a quarterly magazine to keep members informed of news and events with details of new equipment, letters and technical queries. Projected is a National QSL bureau for use by members, with club log books and QSL cards. The club organizers have already written to those users that they know of and have had a good response but they are aware that there is a large number of users that they haven't contacted but who might like to join. Details from the Honorary Secretary, 934MHz Club UK, Glenys Anthony, PO Box 424, Chelmsford, Essex CM6 3UR.

Optical data storage

Two agreements have been signed for the development of laser-read disc systems for the storage of computer data. The first is between Philips and the US Computer manufacturer, Control Data. They plan to extend their existing co-operation in optical disc storage development to also include the design, manufacture and marketing of optical recording peripherals and associated media for use with computers. The discs are likely to be only written on once to give a permanent record of up to a billion characters. The reading process will be similar to that used in Laservision and compact discs. The jointly owned company is to be known as Optical Storage International (OSI).

With a slight rearrangement of the initials we get OIS. Optical Information Systems, another joint company this time formed by an agreement between Acorn Computers and BSR International. They too intend to develop a new digital, optical data storage. BSR is to provide the high volume manufacturing facilities while Acorn uses their computer technology know-how. Their first joint product will be a compact laser disc drive with significantly greater storage capacity, and faster access time than presently available with conventional floppy discs.

6809 newsletter

First issue of the 6809 User Group Newsletter (March-April) is priced at 75 pence but subsequent issues will cost 50p, according to its editor Paul Hills, who also includes a free instruction card, "After long pauses and polite arguments" says Paul "we exist" and although only a small group he believes '6809' will stay alive because for every reader 90% of it is relevant. "Looking through another newsletter, I found only one out of 13 articles that were relevant to my interests." The first issue contains articles on an assembly course for upgrading from 6502, software for 6809 based microcomputer with normal memory-mapped screen, interfacing 76489 sound generator, and is available from Paul Hills at 28 Woburn Road, Launceston, Cornwall.

Electronics consultancy

John Woodgate, B.Sc (Eng), A.M.I.E.E., with over 25 years of product design and marketing experience, has left ITT Consumer Products (UK) as products manager to set up his own consultancy J.M. Woodgate & Associates. Currently specializing in standards advice, he is chairman of two BSI committees on electronic equipment for domestic and educational use, as well as being involved with international standards work. J. M. Woodgate also offers prototype design and evaluation of audio and video equipment, display equipment for exhibitions and consultancy in marketing. 3 Bramfield Road East, Rayleigh, Essex SS6 8RG.
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CIRCLE 202 FOR FURTHER DETAILS.
Stereo on tv

Some ten years ago, American television engineers put "stereo sound" at the top of those developments they expected to see introduced during the next decade. Sure enough, Japan has had some stereo tv for several years, the Federal Republic of Germany for rather fewer, using its own two-carrier system; the BBC has been experimenting with several systems, including digital stereo tests transmissions from Wenvoe and Crystal Palace. British hopes are also pinned on the multiplexed digital sound and data channels of the C-MAC/packet satellite transmission system that can provide up to about eight mono or four high-quality stereo channels per transmission. In the USA, the industry (EIA) has been attempting to evaluate three different systems for several years and has picked a Zenith f.m. system using a 31kHz subcarrier and with a 78kHz sub-carrier possible as a bilingual channel.

EIA also favours the use of dbx noise reduction to provide amplitude companding to reduce the dynamic range during transmission. It is claimed that suitable stereo decoding could be provided for $25 (plus the cost of the extra audio amplifier/sound system or however with the loss of the external amplifier). Stereo TV sets for this system are likely to appear in prototype form at the Chicago Consumer Electronics Show this June.

Broadcasters have been concerned that, as for medium-wave a.m. — stereo, the FCC would leave the systems decision to the marketplace. In fact. FCC has refused to come out in favour of a single system but has announced that it will enforce interference protection for Zenith-db extraction systems which, in effect, prevents rival systems using the same frequency, and makes Zenith-db virtually the American standard. So it is the green light for Zenith-db or still leaving at least three other systems in contention in Europe.

Meanwhile v.c.r. -type stereo TV sets being marketed in the UK, including those with pseudo-stereo circuitry for use on mono television broadcasts. Some broadcasters have been recording at least some programmes in stereo for several years, aided by the stereo tracks of the lin "A" format. While some programmes, such as stage opera, are natural for stereo, this is not true of many others, where we are used to subtle changes in stereo angles, etc. There are still some people who argue that you need a much wider and larger screen before stereo is effective — but the experience with simultacs has shown that this does not deter enthusiasts for a wider "sound stage".

Digital distortions

Chris Dillon, a lecturer in electronics at The Open University, agrees with some of the speakers at the research meeting organized last year by the Royal Society (Communications Commentary, October 1983) that the impact of digital techniques is tending to parallel the whole emphasis of formal electronic engineering training with many young engineers and others believing that "everything will be digital once the speed limitations of digital integrated circuits have been overcome." The result is that industry is finding it extremely difficult to recruit enough competent analogue engineers. As one recruiter put it: "They can all connect two boxes together and when we can't find enough people who understand how a simple emitter-follower works." In his own field of crystal filter design, manufacturers are facing a chronic shortage of design engineers, Chris Dillon believes. One also hears of trainee r.f. engineers being tempted into industry even before completing their training as broadcast field engineers.

The basic problem is partly that many of those who make decisions in government and education are profoundly dazzled by the euphoria surrounding "new technology" and "information technology" and fail to appreciate the skills really required from electronics engineers now and in the future. The way in which British and European firms are losing out in fields in which they were formerly up with the leaders was all too evident at a recent Royal Television Society meeting on electronic cameras. Although the world's first "automatic" camera was the Marconii Mark VIII a decade ago, a succession of cameras described recently installed computerized cameras in re-equipped British tv studios. Although cameras actually installed during the past two or three years appeared to be of American or Japanese manufacture.

NAB more technical

The character of the large annual shindig of the American National Association of Broadcasters (this year at Las Vegas, April 28 to May 2) appears to be changing. The "international" aspects are increasingly being emphasized and this year an extra full day of technical sessions on the Saturday was inserted into the programme as a sign that NAB is expanding beyond a trade show to the level of a full-blown technical conference. This year's technical talking points were multichannel TV sound; solid-state (c.c.d.) cameras; analogue "component" recording and cartridge machines; high-efficiency and computerized directional m.f. aerials; and the use of microprocessors in transmitters.

The United States Information Agency is seeking a large increase in funds for the financial years September with plans to spend a billion dollars over the next five years to modernize "Voice of America" equipment. USIA is currently busy establishing a "Worldnet" of TV circuits based on satellites; Euronet (linking Washington with European capitals became operational last October and has been followed by Arnet for South America. During 1985, TV circuits will be leased for up to three hours, five days a week, to the Pacific, Africa and the Middle East.

Multipath and radiodata

For many sub-carriers on v.h.f./i.m. broadcasts in the USA have been used to carry a second mono channel in the system known as SCA (subsidary communications authorization), or often called storecasting since its original use was to provide uninterrupted background music in department stores. More recently it has been deregulated by the FCC to permit its use for many applications, including a further sub-carrier that can be used for radiopaging.

SCHA has always been frowned upon in Europe on the grounds that in some circumstances, particularly under multipath conditions, the quality of the main stereo channel can be degraded by cross-talk. However, over the past few years, European broadcasters have been developing a radiodata system to carry identification, switching and information data signals, but not a mono audio channel, on v.h.f. broadcasts. There have been several field trials in various countries, including Sweden, whose system has continued to acceptance by EBU, and has recently been undergoing further field trials by the BBC at Wrotham, Kent.

The level of the data signals, it was thought, would be low enough to avoid interference with the stereo signal even under bad multipath conditions. This does not seem to have proved the case since there have been a few, but very vocal, complaints from listeners. Wrotham now uses "mixed" polarization which, in some terrains, can increase the amount of multipath. Now the EBU and BBC will have to decide whether the complaints are few enough to be ignored — or whether once again it is a question of back to the drawing board. Multiplexing works well when the radio path is good — but can prove a real problem in some circumstances. Even supersonic control signals can present difficulties.

Baird in history

One of the very few surviving 30-line televisions, made for the Baird company by Plessey around 1930, has been carefully restored by Ian Moth of Plessey Radar and loaned for exhibition at the Arreton Wireless Museum on the Isle of Wight, run by Douglas Byrne, G3KPO. As a matter of curiosity, 30-line televisions deserve to be carefully preserved. But I have been surprised to find how a number of people still resent any suggestion that Baird's low-definition TV system was barely "true television."
since, even in its final broadcast form, it contained no real sync. signals. The televisions, by the time they reached the market, included a phonic wheel system that had to depend upon the black edge of the picture, as a crude and most uncertain form of synchronization. The instructions recommended running the motor for some 15 minutes before attempting to lock the picture! There were no sync. pulses and these would have been virtually impossible to transmit on medium waves.

Logie Baird does deserve a firm place in the history of television but primarily for the interest he stirred up that led so quickly to the development of high-definition tv on v.h.f. In 1939, Peter Eckersley, as chief engineer of the BBC, recognized the futurity of the Baird 30-line system, wrote in Wireless World: "Baird stood above his contemporaries in imagination, but, as events proved, below them in knowledge...I was truly sorry for him. He was 'fooled to the top of his bent; told by a sensation-seeking press that he was the world's greatest technical genius, dazzled by the prospect of millions of money...how fatal to hopes are the brute facts of physics."

Yet there are still those who believe that he was the sole inventor of television and refuse to question the way in which his early demonstrations were 'contrived' (to quote Frank Haynes) or to realise that much of what was published about him was more a tribute to Baird's imagination than his actual results, innovative experimenter though he undoubtedly was. It is essentially a sad story but not one that should be buried in myths.

**Amateur Radio**

### Cable woes

The problems experienced by radio amateurs in the Milton Keynes area due to radiation of signals from the BT cable tv system within the amateur 144 MHz band has proved harder to overcome than originally appeared. Despite additional filtering interference to local amateurs continued and has led to the offending channel being taken out of service.

In the USA it is not only radio amateurs who are affected by wide-band cable distribution. During 1983, the FCC fined cable systems a total of more than $200,000 for violations of the rules under which channels within the aeronautical bands can be used; this is permitted subject to prior clearance and a specified maximum level of signal leakage. It would appear that some cable operators have infringed both these conditions, and a number have been ordered to cease using these frequencies.

Meanwhile throughout the world, the list of consumer appliances, car electronics etc. that have proved to be either susceptible to local transmitters or alternatively to radiate r.f. interference or electrical noise continues to grow. Electronic telephone handsets with c.r. sensors; cordless telephones; smoke detectors; v.c.r. machines; microwave ovens; microprocessor controls; home computers, etc., etc. Yet many of the problems could have been avoided if the designers had paid more attention to basic questions of electromagnetic compatibility and had some screening, by-pass capacitors, r.f. chokes, etc.

### 40 years on

With the approach of the 40th anniversary of D-Day, June 6, 1944, several groups of amateurs are planning to participate in events designed to mark that event. The G-QRP! Club, for instance, is organizing a contest in which its members will design and construct a modern 'suitcase' two-way h.f. set in recognition of the role played by such sets in 1944, including the use of the B2 hand, the B4.D bug and SSB groups who dropped by parachute into Normandy.

Sid Hall, G3BR (53 New Street Hill, Bromley, Kent) has been compiling lists of the radio amateurs who joined the Civilian Wireless Reserve in 1938-39 and subsequently served at the outbreak of war in the RAF in the W/T Emergency Fitting Parties, or with the Wireless Intelligence Screen which included the "Early Birds" who reached France on September 5, 1939. He has traced no less than 120 former C.W.R. members, most of them still active radio amateurs. Some 50 have joined in the s.s.b. nets he runs on 3760kHz at 10a.m. local time on the first Monday of each month or on the second Mondays on about 7050kHz.

The Emergency Fitting Parties, whose commanding officer was (the Rev.) H.A.M. Whyte, now VE3BYU but a leading pre-war dx operator as G6WY, absorbed more of the C.W.R. members than the Y service and were formed to install emergency radio equipment at RAF airfields. Some units helped install early radar equipment and also later helped jam and disrupt the German navigational aids.

### Silent Usos

Following a perfect launch on March 1, beacon signals from Surrey University's Usos-2 satellite were well received on 145.825MHz during the first three orbits, but then ceased. It was thought that a 30-day switching sequence written into the software would bring into the satellite back under control. Up to the time of writing, however, this has not happened and hopes are fading.

The RSGB has expressed concern that the intermediate frequencies being proposed for 12GHz DBS receivers could prove vulnerable to interference from strong local signals from transmitters working in either the 13GHz or 14GHz bands.

### Here and there

The Chinese Radio Sports Association has now applied to join the IARU as a further move towards restarting normal amateur radio in that country. In view of the continued use of frequencies in the 'exclusive amateur band between 7000 and 7100kHz by Chinese external-broadcast transmitters, as noted by R. E. Knowles, ZL1BAD, in the March Letters (my earlier report of the apparent reduction of this nuisance proved short-lived although spring 1983 did see a noticeable improvement in Europe) not every society may feel inclined to vote the Chinese in; others may hope that the Chinese could exert more influence on their broadcasting authorities from within IARU.

headquarters station, BY1PK, in Peking became active in March 1982 after 16 years of no amateur radio in China. But very few other stations have yet been permitted.

The British Amateur Radio Teleprinter Group has launched an ambitious new quarterly magazine called 'Datacom' replacing the former BARTG Newsletter. The first issue, which runs to 108 pages, includes a special feature on 'packet radio' and also information on the r. t. t. y. repeater located at Cambridge. Editor is Ian Wade, G3NRW, but for membership details contact John Beedie, G6MOK, 161 Tudor Road, Hayes, Middlesex (01-561 0010).

June mobile rallies include: June 3 Spalding (Springfields, Spalding), Welsh mobile rally at Barry Leisure Centre, Holton Road, Barry and RAIB Picnic, Broadlands, Romsey, Hants; June 10 Elvaston Castle Country Park, 5 miles south-east of Derby; June 17 RNARS rally at HMS Mercury, near Petersfield, Hants and Denby Dale rally at Shelley High School, nr Skelmanthorpe, Huddersfield; June 24 Longleat rally at Longleat Park, Warminster. A former Californian radio amateur, Richard Burton, is serving an 18-month prison sentence for continuing to operate his transmitter after his licence had been cancelled by the FCC for repeated use of obscene language.

At the Amberley Chalk Pits Museum and open-air industrial history centre, near Arundel, Ron Ham has recently completed the assembly of a "vintage amateur radio shack" in tribute to old-time radio amateurs including G2YL, G6YL and G2NM.

The RSGB National VHF Convention held at Esher at the end of March was attended by over 2500 people, considerably more than in 1983.

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Micro-controlled cassette recorder

Solenoid-operated cassette mechanism allows control of functions by push-button or microcomputer. Software to be described enables recorder to SAVE or LOAD automatically.

As a storage medium for microcomputer programs, the cassette tape-recorder is probably still the most widely used device, in spite of the falling prices of disc drives. Unless you are a Sinclair Spectrum owner, with a Microdrive, the cost of disc drives and controlling electronics is still very high. The storage capacity of a cassette tape is impressive; a C60 tape can store up to 750,000 bytes of data when recorded at a rate of 2400 baud — 1.5 Mbyte, if twin-channel recording is possible. However, cassette recorders cannot be used in an automatic SAVE and LOAD mode unless all the functions of the deck can be controlled by the microcomputer.

For some time now, Hart Electronics have been selling an entirely solenoid-controlled cassette deck of excellent quality. This series of articles describes the design of controlling electronics for this deck, enabling it to be operated by electrical push-buttons or direct from the 8-bit parallel output port of a microcomputer. Additionally, there is a design for a highly reliable f.s.k. system of electronics that enables the data from the microcomputer's serial line output (RS232 or t.t.l. level) to be recorded at a rate of 2400 baud. An electronic counter, clocked by the cassette deck's motion sensor, can be 'read' and 'reset' by the microcomputer via an additional 8-bit I/O port. This enables the tape to be wound or rewound to any desired position for the automatic SAVEing and LOADing of programs. The record/playback electronics are briefly discussed, since they are based on Linsley Hood's excellent design of a few years ago.*

Finally, examples of controlling software, developed on the author's UK101 microcomputer (a 6502 based machine) will be presented in a following article to illustrate how the various functions of the cassette deck may be automatically controlled. The program structure for the entirely automatic control of the cassette deck for SAVEing and LOADing of programs will also be discussed.

A block circuit diagram of the overall system is shown in Fig.1.

Control electronics

The solenoid-controlled cassette deck used in this design is the SF925F. Apart from its ability to be controlled electrically, it has all the usual specifications of a first-class cassette-deck mechanism: in particular a 12 volt motor with built-in electronic speed control and a wow and flutter figure of less than 0.08% weighted r.m.s. (0.2% DIN, r+p). Features which are specifically related to the design of the control electronics are micro switches to sense cassette-inplace and record prevention tab; a 3-digit memory counter with rotating magnet and Hall effect i.c. for motion sensing; and three solenoids which need an initial voltage of 15-24V, with a hold voltage of 7-10V. Current consumption per solenoid is 300mA at 12V.

Of the three solenoids, there are two main ones; one to control the fast forward, FF, function and one to control the rewind, R/W. The third allows the record/playback head to be lightly engaged during fast forward or backward winding. This is called the 'search' mode and the solenoid is referred to as the 'search' solenoid. For correct operation the deck, motor and solenoids must be operated in a particular sequence. For the record/playback sequence it is essential that the motor is switched on first and allowed to run up to speed before energizing the relevant solenoids. Although not essential in the fast-forward and rewind.


by A. J. Ewins

Fig.1. Block diagram of cassette recorder for data or program storage. Cassette deck is SF925F from Hart Electronics.
sequences it is good practice to do so. Assuming then that the motor is switched on first, the usual type functions are performed in the following ways:

1. Fast forward — energize the FF solenoid.
2. Rewind — energize the R/W solenoid.
3. Play/record — energize the FF and R/W solenoids simultaneously. (For this function the momentum of the motor is used to assist the raising of the head/pincher roller plate.)
4. Fast forward search — energize FF and R/W solenoids simultaneously and after a short delay (0.5s) energize the 'search' solenoid and de-energize the R/W solenoid.
5. Rewind search — as for F/F/S above, but in this case, after the short delay, energize the 'search' solenoid and de-energize the FF solenoid. (N.b., in this mode and the preceding one, the energizing of the 'search' solenoid may be carried out simultaneously with the de-energizing of the R/W or FF solenoids; the slightly 'slugged' response of the de-energized solenoids will ensure that they drop out after the 'search' solenoid has energized.)

It is possible to switch from one function to another directly, provided that the previous function is cancelled first.

The circuit of the control electronics required to perform all the above functions in the correct sequence of motor and solenoids is shown in Fig.2. It has been designed to be controlled by either push-button switches via diode-Or logic or by the correct selection of logic input lines from the 8-bit I/O port of a microcomputer. It is, of course, perfectly possible to control the energizing of the motor and solenoids in the correct order directly from the I/O lines of a microcomputer, letting the software within the computer determine the necessary sequence of events. The author chose to design the control circuitry specifically to allow manual operation so that the cassette deck could be operated in 'stand alone' mode and to allow its control to be overridden during software development.

To understand the operation of the control circuitry, consider its control via the six push-button switches. All the logic control elements are contained in c.mos digital i.cs, except for the six inverting input buffers, which are contained in a low powered t.t.l. logic circuit type 74108. These act as interfaces between the 12V logic levels of the control circuitry and the 5V t.t.l. levels from a microcomputer. The outputs of the six inverters are open-collectors, so 6k8 resistors are used as pull-ups to the 12V line. The inputs to the six inverters are normally open-circuit, and they are also pulled-up via 6k8 resistors, this time to the 5V rail. With the inputs to the six inverters at the logic 1 level, their outputs are at logic 0 and no functions will be operating. The 100nF capacitor

Fig. 2. Control circuitry for either push-button or computer-controlled operation.
in parallel with the 680k resistor and connected between the 12V rail and the reset, R, input of flip-flops B1 and B3 to B6 via a silicon diode ensure that all functions are held off during power-up.

Suppose that the fast-forward function is selected by pressing the FF push-button. This will energize inverter 2 and 3 will be grounded via the keypad diode-Or logic. Their outputs will thus go high to logic 1. A high on the set, S, input of B1 sets its Q output high and its Q output low. The motor is thus switched on and the stop led off. Simultaneously, a high on the set, S, input of B3 sets its Q output high. However, at the same time, the monostable, M2, has been triggered by the output of inverter 2 so that its Q output goes low. The output from And 1 thus stays low until Q of M2 goes high. When it does so, after the monostable, M2, delay period of about half-a-second, the FF sole-noid is energized and the cassette deck goes into the fast-forward function. The Q output of M2, which goes high when M2 is triggered, is used to clock all four flip-flops, B3 to B6, resetting to zero (via the logic 0 on their D inputs) all those whose set inputs are not simultaneously high. In this manner previous functions are automatically cancelled before the new one is selected.

The successful operation of any function depends on the operation of the push-buttons being momentary. This is because of the mode of operation of the motion sensing circuitry and the monostable, M1. When the cassette deck is running with a cassette in position, the output from the motion sensor is a train of positive pulses. This train of pulses is fed to the trigger input, +T, of M1 via the 100nF capacitor and associated diodes and 68k resistor. The monostable, M1, is operated in a retregibleger mode so that its Q output will remain low so long as it is continuously triggered. In the event of tape motion ceasing, the pulse train to the trigger input of M1 will also cease and its Q output will eventually go high (after a delay of about 2s). When it does, flip-flops B1 and B3 to B6 are reset and the function in operation is cancelled. Prior to the operation of a function the Q output of M1 is always high. For a function to operate it is therefore necessary to trigger the Q output of M1 low at the same time the function is selected. This is achieved by the diode link from the output of inverter 2 to the +T input of M1. If a push-button such as FF is held pressed, the output of inverter 2 remains high and so does the +T input of M1. M1 cannot be retriggered whilst +T remains high. Thus, at the end of the period of M1's temporary state, Q of M1 will again go high, cancelling the selected function. Thus no function button should be held pressed for more than about 2 seconds. It is perfectly normal to operate the push-buttons momentarily and this feature is of no consequence; in fact it can be used to cancel a function wrongly selected.

Selection and operation of the rewind function is carried out in a similar manner to the fast-forward function by pressing the R/W button. In this case the R/W solenoid is energized via inverter 4, flip-flop B4, and And 2. The function selection may also be readily understood as pressing the Play button merely energizes both FF and R/W solenoids simultaneously, after the motor run-up delay period of half a second. The record function is selected by pressing both Play and Record buttons together. The record button is linked to the Play button such that Record will only operate with the Play button and no other. The record function operates exactly as for Play but with the addition of energizing a record relay via logic signals from inverter 6 and flip-flop B6. No delay is imposed between pressing Record/Play and the operation of the record relay. This gives the Record electronics of the cassette deck time to settle before recording actually begins. The 'pre-recorded' tab microswitch is wired in series with the Q output of B6 and the record relay driver transistor, thus preventing a cassette from being recorded that has had its pre-recorded tab removed.

The remaining functions not so described, and involving a little more circuit sophistication, are those of the fast-forward and rewind search modes. The Stop function, it is hoped, speaks for itself and merely cancels all functions by resetting flip-flops B1 and B3 to B6. The Search functions are selected by pressing the Search button together with the desired FF or R/W button. The Search button only functions when pressed with FF or R/W, not on its own or with any other button. If all three buttons are pressed together the Play function results. When the search function is selected, the Q output of B5 is set high. A high output from And 3 occurs only after the usual delay period and only if the output from And 1 or And 2 is high; not if neither And 1 nor And 2 is high, nor if both are high. This logic is determined by the
CASSETTE RECORDER

cluded. The 2p2 capacitor, diode and 470k and 10k resistors debounce the memory switch contacts, so that reliable operation of the memory switch is achieved. When the memory switch contacts close, B2 is clocked. If the D input is high, then the Q output will go high, resetting flip-flops B3 to B6 and B1, cancelling the selected function. The D input is taken from the output of Nand 1, so that it is high for all functions except Play or Record. The forward function thus operates only when in the FF, R/W or two search modes.

In addition to operating the computer. The cassette-position microswitch is also connected to a 6k8 resistor from the 5V line to provide a logic signal that can be read by the microcomputer. The delay circuit, shown in Fig.3, is made up from the two remaining 2 i.p. Nand gates of a quad i.c., type 4093, which has Schmitt trigger inputs. Figure 4 shows the detailed circuit of the two monostables, M1 and M2, using an i.c. type 4098 or 4538. The motion sensor of the cassette deck makes the i.c. Hall-effect i.c. There are three connections to it; two are the supply rails, 0 and +12V and the third is the output

required solenoids for a particular function, the control circuitry provides logic signals to illuminate a number of leds to show the function in operation. The operation of the stop, search and record leads is straightforward and needs no further explanation. However, it is necessary to decode the FF and R/W logic signals to provide led indications for the FF, R/W and Play functions. The play led is illuminated when both FF and R/W solenoids are energized by a signal provided by Nand 1’s output inverted by Nand 2. The FF led needs to be illuminated when the FF solenoid is energized, but not when FF and R/W solenoids are energized; XOR 3 provides this signal. In a similar manner XOR 4 provides the signal for the R/W led.

The BC108 transistor and associated resistors converts the train of pulses from the motion sensor (at a 12V signal level) to a 5V level suitable for reading from the 8-bit I/O port of the micro

put to the control circuitry. The i.c. was found to operate better with the addition of the 2k2 pull-up resistor as shown in Fig. 2. Connection details to the i.c. are supplied with the deck.

To drive the motor and solenoids of the cassette deck and the record relay from the logic signals of the control circuitry, it is obviously necessary to provide suitable driver stages. A suitable circuit is shown in Fig. 5, together with a power supply to drive the cassette deck, control circuitry and solenoids. The i.c. ULN2001, contains seven stages of Darlington transistors capable of sinking up to 500mA each. It is therefore capable of driving the solenoids, motor and relay directly. B type c.mos devices are quite capable of delivering up to 10mA at a supply voltage of 12V. To achieve a high switch-on voltage for the solenoids, 2200uF capacitors are charged from a 20V supply through 220 ohm resistors. The supply side of the solenoids and capacitors is also connected, via diodes, to a 10V peak, unsmoothed, d.c. supply. Thus, at the instant of energizing, the initial voltage across a solenoid will be nearly 20V, and will fall to a 'holding'voltage of about 10V provided by the 10V unsmoothed d.c. supply. Since the voltage drop across a 220 ohm resistor is about 11V (when its solenoid is energized) it must be capable of dissipating (11/220) watts, i.e. just over 0.5W. 1 watt resistors should therefore be used. The value of the 220 ohm resistors is chosen to be low enough for the 2200uF capacitors to charge to a high voltage during the period of M2's 0.5 second delay. Thus no problems should occur when switching from one function to another when both use the same solenoid.

The motor of the cassette deck requires a stabilized voltage of 12V, which is supplied by the 1 amp regulator i.c., type 7812, fed from the 20V unregulated, d.c. supply. The c.mos logic circuitry is also supplied by this 12V source. 

Flip-flops, B1 to B6, are all halves of dual, D-type flip-flop i.c.s, type 4013. Thus three such i.cs are required. The three triple i.p. And gates are all contained in an i.c., type 4073. The four, 2 i.p. exclusive-Or gates are all contained in the 4070. Finally, the two, 2 i.p. Nand gates are the other half of a quad, 2 i.p. Nand gate i.c., type 4093, the first half being used by the delay circuit.

In the next part of the article, the f.s.k. modulator/demodulator, will be described.

Fig.5. Power supply for control circuitry.

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Fibre optic communications

Part 2 — optical sources, detectors and receivers

This second article looks at the different types of optical sources and detectors available and clarifies the best combinations for different types of system.

Optical sources for fibre transmission systems must be compatible with the fibre characteristics. They should be small, reliable, inexpensive and efficient in the conversion of electrical input power to optical power coupled into the fibre. In addition it must be possible to modulate them at high data rates, preferably directly. Two main candidates have emerged; light emitting diodes and injection laser diodes. Both devices operate in a forward-biased mode (low voltage, high current) and emit light as a result of hole-electron combination at the p-n junction. Direct modulation is possible for both l.e.ds and i.l.ds by varying the drive current, although there are certain complications for i.l.ds at very high data rates.

The early infrared gallium arsenide l.e.ds operating at 0.9µm are no longer used since their emission is too near to an OH water absorption peak to result in reliable low-loss transmission. They have been replaced by aluminium-gallium arsenide types with an output wavelength of 0.85µm. Because of the broad spectral width of l.e.ds (50-100nm being typical) and non-coherence they are best suited for applications in multimode fibre systems.

Longer wavelength operation at the 1.3µm dispersion minimum for optical fibres is made possible by InGaAsP heterostructure materials, allowing the use of l.e.ds in up-graded communication links. However, they have only recently become commercially available at the longer wavelength, in contrast to the 0.85µm AlGaAs l.e.ds that have been on the market for several years. The reliability of l.e.ds is extremely good with mean lifetimes in excess of 10³ hours being predicted from accelerated ageing tests.

The Burrus-type geometry has been the basic design over several years for the surface-emitting i.e.d.s specifically intended for coupling to optical fibres, Fig. 1. It is characterized by small contact area and an etched well for butt coupling to a fibre end. It is important that the etched well in the Burrus-fabricated i.e.d. does not reach down to the thin active layer or surface contamination can drastically reduce the servicable life of the device. A small emitting area is obtained by localizing the drive current by etching only a small contact on the underside of the device.

Depending on the core size and numerical aperture of the fibre used it is practical to launch optical powers of around 50 to 100µW into a fibre, although 25µW at an i.e.d. drive current of 100mA is more typical. Up to 300µW can be attained with specially optimized fibres. The Burres i.e.d. can be supplied with the attached fibre pigtail ready terminated in an SMA-style connector or left bare where direct low-loss fusion splices are intended. A variation on the basic Burres design is to locate a truncated glass microsphere lens in the etched well for increased optical coupling efficiency.

Mainly because of the lower current densities encountered, l.e.ds are more reliable than injection laser diodes and do not need output stabilization since their output power varies little with temperature. Direct drive current modulation up to about 150MHz is obtainable, higher in specially optimized devices, but at the expense of available optical power. Linear intensity modulation can be used for i.e.d.s in an analogue system because their input/output characteristics is substantially linear up to about 80% of their maximum light output, Fig. 3(a).

A new edge-emitting type of i.e.d. can ultimately couple more power into a fibre by virtue of a narrower light confinement angle, leading to better coupling efficiencies. In addition, it exhibits a narrower spectral width than the surface-emitting type of i.e.d., resulting in a greater maximum bandwidth-distance product through the restrictions of fibre material wavelength dispersion (discussed in Part 1).

The injection laser diode (i.l.d.) also relies on heterojunctions to confine injected carriers to the diode active layer with the attendant refractive-index steps forming a waveguide to confine light to the same active region, Fig. 2. Partially reflecting surfaces at the light emission faces are formed by the refractive-index difference between diode material and air. There are several alternative ways of producing confinement in the lateral direction, the earliest of which was the oxide-defined stripe of Fig. 2. When the injected current

Fig. 1. The most successful general-purpose l.e.d. for optical fibres in produced by permanently bonding a fibre 'pigtail' into the l.e.d. itself.

Fig. 2 An injection laser diode must have some method of containing the light within a narrow portion of the active layer between the end mirrors.

by Brett Wilson
Fig. 3. Injection lasers can launch more power into a fibre than an i.e.d. but their non-linear behaviour requires more complex drive circuits.

![Graph showing the relationship between current and launched power for injection lasers.]

Fig. 4. For a given wavelength and data rate there is a linear relationship between received power and signal to noise ratio.

![Graph showing the relationship between signal to noise ratio and detected power for injection lasers.]

density is sufficiently high to cause the necessary population inversion, gain rather than loss occurs in the active layer and coherent oscillations are produced in one or more cavity modes.

Early i.l.d. lifetimes were very short, but have been improved to around $10^6$ hours by paying close attention to processing and coating the mirror facets, along with the provision of adequate heat-sinking. Again AlGaAs formulations are used to produce continuous infra-red light at around 0.85µm but with a much narrower spectral width, typically 2nm. Unlike i.e.d.s, laser diode exhibit a threshold effect below which coherent light is not emitted. Injection lasers used with first-generation fibre optic systems usually exhibit a threshold around 150mA and are able to couple perhaps as much as 2mW of light into the fibre for an extra 100mA drive current, Fig. 3. The higher coupling efficiency is simply a result of the much narrower light confinement angle of the i.l.d. interfacing more effectively to the requirements of an optical fibre. For a similar drive power an i.l.d. can launch about 10 to 20dB more light power than an i.e.d. into a fibre.

The main research interest has now shifted to i.l.d.s fabricated from InGaAsP that emit at longer wavelengths (1.3µm), where the dispersion minimum of fibres allows a very high potential bandwidth-distance product. Various configurations are currently being tried to obtain the lowest lasing threshold and highest optical powers. The stripe geometry and the newer buried heterostructure devices, both emitting at 1.3µm, are commercially available and are currently used in the more demanding roles.

Multimode rather than monomode operation is most common for i.l.d.s with useful output power in the 2 to 10mW range. In fact, multimode lasers are preferred as sources for multimode fibres to reduce modal noise. Single-mode lasers are obviously required for ultra-high bit-rate systems using narrow monomode fibres. Unfortunately the lasing threshold of InGaAsP lasers is strongly temperature sensitive (much more so than the 0.85µm AlGaAs types) and, in common with most lasers, they tend to break into multimode operation when modulated rapidly. The effect is reduced by biasing the laser to just below its temperature-sensitive threshold, but at the expense of increased drive circuit complexity. Recently, stable single-mode operation in an InGaAsP laser has been demonstrated using a distributed feedback technique to enable modulation up to around 10GHz.

The decision to use an i.e.d. or an i.l.d. source will be made on grounds of intended repeater spacing, maximum modulation rate and system cost and reliability. Light emitting diodes are used almost exclusively in short-haul low-to-medium data rate systems, with i.l.d.s being chosen for the long-haul high data-rate links. Single-mode i.l.d.s would be used for the most demanding monomode fibre applications. There is however an overlapping range of distances and modulation rates in the middle ground where 1.3µm i.e.d.s and i.l.d.s compete, and the final choice in this area is often determined by reliability and commercial factors.

Optical detectors

An optical detector is essentially a photon to electron converter. The conversion is a statistical process and even with a noiseless amplifier connected to the detector there is a theoretical lower limit on detection sensitivity for specified error rates.

The consequence of this fundamental statistical sensitivity can be seen at work when considering detection of digital information with specified error rates. Information is transmitted in the form of 'marks' and 'spaces' and reaches the detector as pulses of energy E or 0. If no electrons are emitted from the photon detector in the appropriate time slot the assumption is that a space was received. Even if only one electron is emitted it must be assumed that a mark was intended since our idealized detector produces no electrons in the absence of an optical input pulse. However, even in the presence of a pulse of energy E it is still possible for the detector to emit no electrons at all and hence make an error by misdetecting a mark as a space. From the Poisson distribution that governs the behaviour of the detector it can be shown that even a perfect photodetector must sense at least 21 phonons for there to be a $10^{-9}$ probability of misinterpretation. ($10^{-9}$ is a common value for an acceptable bit-error rate in digital communication systems.) This lower limit on the sensitivity of a binary digital receiver is usually referred to as the quantum limit and is a convenient measure against which real digital detectors can be judged.

There is also a quantum limit for analogue systems, this time relating detector sensitivity to output signal to noise ratio, even assuming noiseless electronics. It turns out that the minimum detected optical pulse power is given by twice the product of the signal to noise ratio, the bandwidth and the photon energy. Fig.
4 illustrates this relationship for different bandwidths at the optical wavelength of 0.85 \mu m. This again is the quantum limit and real detectors, and receivers fall short of this limit.

The p-i-n diode, Fig. 5, is the simplest optical detector suitable for fibre optic systems. It is composed of an n^- substrate, a lightly doped intrinsic n-region i, and a thin p-zone. Operated with a reverse bias, mobile carriers leave the p-n junction producing a zone of moderate electric field on both sides of the junction into the i-region. Because it is only lightly doped this field extends deeply. Incident light power is mainly absorbed in the i-region (the p-region is extremely thin), causing electron-hole pairs to be generated. These carriers are separated by the influence of the electric field in the i-region and represent a reverse diode current that can be amplified.

For detectors operating at wavelengths shorter than 1\mu m the p-i-n diode material is silicon but at longer wavelengths, the popular 1.3\mu m window for example, other materials must be used because the quantum efficiency of silicon drops rapidly at around 1\mu m: it becomes transparent and fails to convert photons to electrons. Germanium is often used beyond 1\mu m, with complex materials such as InGaAs becoming increasingly popular. Unfortunately there is presently a penalty to be paid in the size of the residual dark current (<5nA for Si, maybe 5\mu A for InGaAs) currently setting a higher practical limit on the minimum incident optical power which the longer wavelength devices can be used to detect.

The second popular type of photodetector, the avalanche photodetector (a.p.d.) shown in Fig. 6, has the advantage of internally multiplying the primary detected photocurrent by an avalanche process, thus increasing the signal detection sensitivity. However, because the avalanche multiplication is statistical in nature some excess noise is generated.

The fabrication of an a.p.d., Fig. 6, is very similar to the p-i-n diode just discussed except that the high electric field region in the p-n junction produces the desired avalanche process to amplify the primary signal current. The signal multiplication of the a.p.d. depends on the applied reverse bias voltage and the temperature.

In contrast to p-i-n diodes where reverse bias voltages of around 10-20V are typical, an a.p.d. may require up to several hundred volts to produce an avalanche gain of 100. High performance systems normally require that the gain of the a.p.d. is temperature stabilized and will probably include a measure of automatic gain control operating via the reverse bias voltage.

The frequency response of p-i-n and a.p.d.s is similar, with transition times across the lightly doped intrinsic region less than 1ns, making them both usable up to around 1GHz. The main advantage of a.p.d.s over p-i-n diodes is simply greater gain-bandwidth product due to the inbuilt gain, permitting lower detected optical powers for the same error rate or signal-to-noise ratio.

Again silicon is the usual material for short wavelengths (<1\mu m), with Ge, InGaAsP and AlGaAsP becoming popular at the longer wavelengths around 1.3\mu m. Ultimately germanium will be superseded by the newer materials due to its poorer dark current (~500\mu A) and high excess noise.

**Practical optical receivers**

Because of the very small output signal available from a photodetector noise in the preamplifier input stage is a serious problem. For a real receiver this results in the required number of detected photons per data bit being much higher than the quantum limit of 21 photons for a 10^-9 error rate. Typical figures at 1.3\mu m are around 400 photons per bit with an a.p.d. and 1000 photons per bit with a p-i-n diode when both are used with optimized receiver preamplifiers at 100Mbit/s per second. That this ratio is not as large as might be expected, considering the inbuilt gain of the a.p.d., is mainly due to the higher dark current and the fact that the avalanche process itself contributes a certain amount of excess noise.

The most popular form of optical receiver front end is the simple trans-impedance amplifier configuration, Fig. 7(a), where the output voltage is given by the product of the input (photodetector) current and the feedback impedance. This approach to front-end design has supplanted the earlier high impedance integrating amplifier, (b), that suffered from problems of complex equalization to retrieve the pulse shape. But careful choice of values of feedback resistance for the transimpedance amplifier is still because of relative noise contributions and restricted phase margins arising from stray capacitance in the feedback loop. In general, an upper limit of around 5\Omega at low data rates (<1Mbit/s) decreasing to perhaps 10\Omega at 500Mbit/s is commonly encountered. Lower values also help to maintain receiver dynamic range. Calculations for optimum receiver sensitivity usually point to the importance of a restricted bandwidth to reduce various noise contributions, often resulting in the upper -3dB point being significantly less than the data rate used.

The transistor used as the first active device in the preamplifier obviously plays a major part in the performance of the receiver. It is here that rapid developments are occurring and most performance figures are soon improved on.

Gallium arsenide m.o.s. fets and silicon bipolar microwave transistors have probably been the most effective combination with the p-i-n photodiodes, although the silicon short-channel m.o.s. fet is showing promise. At lower data rates (<10Mbit/s) a silicon junction i.e.t. has a superior performance because it does not suffer from the 1/f noise associated with GaAs and Si i.e.t.s. Silicon **transimpedance amplifier is replacing the high impedance integrating amplifier as the preferred optical receiver preamp configuration.**
REFERENCES

Fig. 8. Choice between a p-i-n and a.p. detector for optimum receiver sensitivity depends on data rate.

devices posses the advantage over GaAs ones in that they can be integrated into a preamplifier chip with present silicon technology.

Performance zones of 1.3µm receivers based around p-i-n diodes and a.p.ds, followed by the best choice of the devices discussed above, are shown in Fig. 8. Even taking into account their higher dark current and excess noise a.p.ds will provide around 5dB higher sensitivity than the InGaAs p-i-n diode for data rates beyond about 100Mbit/s. At lower data rates p-i-n diodes display better sensitivities of their lower dark current.

At the longer wavelengths where experience of the technology is still limited no clear optimum choice has emerged that can satisfy all of the requirements for inexpensive fast and sensitive optical receivers.

Recent research has been stimulated in the area of coherent transmission and detection because of the promise of detection sensitivities approaching the quantum limit without using a high performance a.p. receiver. For these techniques of phase shift keying and frequency shift keying stabilized monochromatic sources with a high spectral purity are needed as transmitters and receiver local oscillators, ruling out the use of l.e.d.s. To achieve the best performance the carrier source and the local oscillator laser must operate in a single mode with their frequencies maintained to within a small fraction of the data rate. The behaviour of lasers under direct frequency modulation is complicated and investigations are still in their early stages for application of coherent transmission to fibre optic systems.

May 16 to 18
Communications 84
Telecommunications, radio and information technology. Exhibition and conference at the Metropolis Hotel and NEC, Birmingham. Industrial and Trade Fairs Ltd.
Tel: 021 705 6707.

May 21 to 24
European Telemetry Conference and Exhibition
Kongresshalle, Böblingen, Network Events Ltd.
Tel: 0260 851226

May 22 to 25
Communicasia 84 and Infotecasia
3rd Asian international electronic communications show and conference. World Trade Centre, Singapore. Overseas Exhibition Services Ltd. Tel: 01-486 1951.

May 24
Underwater Navigation
IEE (and others) colloquium. At the IEE, Savoy Place, London WC2R 0BL. Tel: 01 240 1971. Ext. 222

May 27 to 30
CETEX 84
Consumer electronics Trade exhibition. Earls Court, Montebuild Ltd. Tel: 01-486 1951.

May 31 to June 1
Videodisc and Digital Optical Disc Conference
Cunard International Hotel. London. Meckler Communications. Tel: 01-240 0856.

June 5 to 7
Scolex 84

June 5 to 7
Software 84
Professional and business software exhibition. Earls Court, London Reed Exhibitions, Tel: 01-643 8040.

June 6 to 7
Interconnection 84
Conference and exhibition Hilton Hotel, Park Lane, London. Benn Electronics Publications, Tel: 0582 417436.

June 12 to 14
IBM Computer User Show

June 19 to 22
Promecom C & I

June 23 to 24
Training for the Television Industry
Royal Television Society conference at the College of Ripon & York St John, Ripon, Yorks. Royal Television Society, Tel: 01 387 1970.

June 26 to 29
Transborder Dataflow Policies
Second international conference to be held in Rome. Intergovernmental Bureau for Informatics, PO Box 10283, 00144 Rome, Italy.

July 3 to 5
Networks 84

July 10 to 12
Cable 84

July 10 to 12
Development of Flexible Automation Systems
First international conference. IEE, Savoy Place, London WC2. Tel: 01-240 1871 Ext. 272 & 282.

July 15 to 17
ShowTech 84
Trade fair and congress for entertainment technology. AMK Berlin. Postfach 194740, Messdamm 22, D-1000 Berlin 19, Germany.
Cellular radio systems have their roots in the late 1960s, when proposals for such a service were made in the US by Bell Laboratories and others. The AMPS (Advanced Mobile Phone System) was developed by Motorola, Dynatac and AT&T, with trials taking place in 1982. The service was subsequently licensed by the FCC to undergo field trials: the Advanced Mobile Telephone System (AMPS) in Chicago and the American Radio Telephone Service (ARTS) in Washington DC.

Installed by Motorola using Dynatac equipment, ARTS currently covers an area some 80 miles long extending from the Northern Virginia suburbs of Washington to the city of Baltimore in Maryland. Initially the area was divided into eight cells, each one being allocated three 16-channel and 12-channel allocations for each. The base stations, with an e.r.p. of 100 watts, covered a radius of some 11 miles with minimal interference. In the final designs for the area, aerial height was reduced from 150 to 60-70 metres above sea level to reduce interference. Lineal lines have not been used to link the base stations, but microwave links are to replace the cables.

Unlike the Chicago system, ARTS was designed to serve portable units as well as car telephones, and special attention was given to the problem of providing good performance inside buildings. By the end of 1984, cellular radio networks are expected to be in service in 24 US cities, some of which will have more than one system. Specifications of the subscriber's equipment for ARTS and AMPS have been standardized by the USEC of the US, with the same telephones should be usable on any network in the US.

Canada
Canada's Department of Communications policy is to encourage growth of the service on a competitive basis with a minimum of government regulation. Two contrasting cellular radio systems have been licensed, and the first to enter service is Aurora, an automatic roaming radio system from Novatel Communications Ltd.

Instead of the large central switching centres favoured by other systems for linking cells to the public telephone network, Aurora is based on distributed switching nodes with interconnections at local telephone exchanges. This avoids the expense of installing dedicated trunk cables and greatly reduces starting up cost. Aurora is therefore suited to serving rural areas as well as big cities. Although a cell could be set up to cover an area as small as say, an hotel or even an airport departure lounge, there would be a risk that a well-situated caller within that building might unwittingly access distant base stations as well as the local one.

To be attractive to the potential subscriber, a cellular radio telephone must feel just like an ordinary wired telephone. The user, whether in a car or on foot, must be able to dial outgoing calls direct and to receive incoming dialed calls. The cellular radio system offers the full range of services available on the public network and often more. As neither party to a call can be expected to know precisely where the mobile user is, the call must be routed through the appropriate base station automatically. Moreover, the mobile user is liable to wander out of one cell and into another as the call progresses. To cope with this, the system must route the call through the new base station, switching the call to new radio channels without interrupting it. This procedure, known in the jargon of 'hand-off', is one of the distinguishing features of cellular systems.

The cellular radio systems now in service are expensive to the user both in call charges and in the price of the mobile equipment. The cost of establishing a network is heavy, and it may seem unlikely that cellular radio will replace the ordinary wired telephone, at least in urban areas. But to business users who can justify it, cellular radio offers some attractive prospects: the 'carry anywhere' pocket telephone, for example.
CELLULAR RADIO

The system began field trials in Alberta in 1981 and entered commercial service in mid-1983. By the end of the year it is expected to cover three quarters of the province using 123 cell sites. The frequencies used are in the 400MHz region.

Canada's other cellular system, now being installed in Montreal and Toronto, will likely be ready for business in September. This 800MHz system has a centralized architecture, with a 'mobile telephone exchange' acting as a control and switching node to connect mobile subscribers to the public switched telephone network.

Problems have been encountered with wired links in the system: among them echo, noise and signal loss. According to Bell Canada, echo-cancellation equipment is now included to improve transmission performance with the aim of providing a sound quality not worse than on the ordinary telephone network.

The service is designed to emulate the public facilities such as call forwarding and conference calls. Services are available to roaming subscribers as well.

United Kingdom

The system adopted for use in Britain, TACS, is modelled on the Chicago AMPS. Two companies have been licensed to provide a service: Racal Millicom and Telecom-Securior Cellular Radio. As it stands, AMPS is unsuitable for direct application in Britain because of differing frequency allocations and channel spacings in the two sides of the Atlantic. In addition, there is a need for a nationwide roaming capacity, a facility not required in the US.

The British network also has to allow for inter-systems roaming, so that a Telecom-Securior subscriber can wander into Racal's areas vice versa.

TACS (it stands for 'total access communications system') is due to begin operations in 1985. It will use the band 890-960MHz. (The network then knows whether an individual subscriber is available and where he is to be found. When the mobile subscriber is called, or when he initiates a call, a suitable pair of speech channels is allocated by the computer and the connection made. This procedure avoids ineffective use of radio channels and guarantees that when both parties are ready to speak: according to Siemens it saves about 30% of channel capacity.

To make features such as inter-cell hand-off possible, data communications are maintained even during the call. The speech is time-compressed, each 12.5ms segment being squeezed into 0.25ms to make room for a 5.28kbit/s f.s.k. data burst.

A dynamic four-band scrambling procedure is applied to the speech signals, with 256 possible key combinations. The correct key is selected automatically when the call is set up and different keys are used for subsequent calls.

System architecture is decentralized, and the moduler switching equipment can be expanded to match traffic requirements. C-900 is due to be introduced in Germany in 1987.

Scandinavia

If you disregard a small system installed by Cable and Wireless in Qatar in 1978, the cellular network longest established in public service is the Nordic Mobile Telephone System (NMT). Opened in Sweden in 1981 this 450MHz network now covers large parts of Sweden, Norway, Finland and Denmark, and with the addition of Finland is now being installed over 75 000 subscribers. The system is also in operation in Spain, Tunisia and Saudi Arabia, and has lately been selected by the Netherlands, Austria and Ireland.

Each cluster of base stations is linked to a 'mobile telephone exchange' (MTX), a standard AXE-10 digital exchange, which provides interfacing with the public switched telephone network. One channel at each base station is designated a calling channel; and when someone dials the number of mobile sub-
scriber, a calling signal is broadcast over all the calling channels in the traffic area. When the mobile detects this call, it returns an acknowledgement on the same frequency. Speech channels are then assigned by the MTX.

When the mobile subscriber initiates a call, the equipment hunts for a clear traffic channel on which to reach the base station. On receiving the signal the MTX checks the number dialled and the category of the subscriber and sets up the call.

Transmission quality of every call is monitored by means of a 4kHz pilot tone which is added to the speech channel by the base station and looped back by the mobile. If reception deteriorates the mobile transmits a hand-off request to the MTX, which then attempts to find a more suitable routing for the call. Adjacent base stations may make field-strength measurements on the traffic channel, and if one of them is able to offer better transmission quality, and has a free channel, the call is switched over.

Each mobile is registered on one particular MTX, the 'home exchange'. If it moves into the area of another MTX, any calls are automatically re-routed. The system permits subscribers to roam without restriction throughout the four Nordic countries, thus avoiding the problems of 'country' switches that the subscriber is forced to use a number of different frequency bands.

NMT's 180-channel allocation was thought very generous at the time the network was being planned, according to Christina Calmer of Ericsson Radio Systems. However, full capacity is likely to be reached much sooner than had been expected and plans for a 900 MHz version were now being finalized.

**France**

The move towards cellular radio has taken France in a rather different direction. Matra Radiocommunications is now installing a national radiotelephone network which combines a public telephone service with private business communications.

The RTA system is founded upon cellular principles, but seems to place more restrictions on the user than other systems. Subscribers can access only the repeater stations with which they are registered. There is a three-tier service: access to one station only, up to ten stations (which need not be adjacent) or, for certain users, nationwide coverage.

RTA offers business users the option of a private communication system using push-to-talk simplex operation; this is available as well as or instead of the ordinary car telephone service. These closed user groups use the same technical facilities as the public service.

With some other cellular systems, RTA can give certain users priority when there is a queue of calls waiting to be set up. At busy times, however, station call attempts may invoke an automatic time limit facility which informs users that the call may be cut short: the limit is programmable between 30 seconds and 16 minutes.

Frequencies assigned to the RTA network are 173-223 MHz and 406-430 MHz, with 12.5kHz channel spacing. Repeater stations have a transmitter power of 50W and a coverage radius of 20-30 km. Connections between them are via the existing public switched telephone network and this, according to Michel Canitrot of Matra, has helped to make RTA significantly cheaper to set up than other cellular systems. The network is modular in form, with no centralized control.

**The user's view**

In Britain, the Mobile Radio Users' Association has encouraged the development of the new services and technology, particularly cellular radio for its effective use of frequencies. Nevertheless, according to Walter Stevenson of the MRUA, there is still a requirement for conventional mobile networks in paging systems, at least in the short term. Most vehicles operate within a limited area and are unlikely to need a nationwide roaming facility.

But Mr Stevenson is nervous that the Government is trying to force cellular radio as the sole solution to the mobile user's problems. Additional frequencies are urgently needed as well.

**The future**

The next two or three years will see the introduction of a patchwork of mutually incompatible cellular systems all over Western Europe; only Italy, Portugal and Switzerland have not yet made a choice. Some countries will have more than one system.

However, one market analyst, Malcolm Ross of Arthur D. Little International, thinks that there is no need for a European standard in the short term since the market for mobile radio on a national basis is so big that it should be dealt with first. Quoting statistics to the effect that only 25% of telephone calls to offices reach the right person, Mr Ross predicts a big demand for pocket telephones for businessmen. And he suggests that before the end of the decade a mobile telephone may become cheaper than a wired line, costing perhaps as little as £120 for a consumer model.

Nevertheless, steps are being taken to overcome the present lack of standardization. A working party under the CEPT is discussing the possibility of a pan-European mobile telephone system, and it is probable that this will be a 900 MHz cellular system. The total bandwidth for cellular radio in Europe will eventually be 50 MHz and of this only 15 MHz has so far been released in Britain.

**Fig. 2. The German C system has separate data links for setting up speech channels at the start of each cell. As the call proceeds it is controlled and monitored by another data signal multiplexed with the speech.**

**Fig. 3. Call set-up procedure with the Scandinavian NMT system. Signalling takes place on a calling channel and a speech channel is then allocated by mobile telephone exchange.**
The information society

2 - Politics of telecommunications

The growth of infrastructure services and the influence of politics on British Telecom and its operations.

Political, technical, and economic factors impede the formation of a unified network in the foreseeable future.

Private industry is unlikely to introduce networks or services unless it considers that the market will return an adequate short or medium term profit. For PTT monopolies this aspect is less important, consequently marketing skills are also of less importance to them.

The PTTs possessed the cables, and with EEC backing, added the facilities to provide the Euronet network. Upon it ride the home computers, mainly privately owned, which provide services for a fee. Consequently the desirable objectives of providing scientific information services, and encouraging the generation of European-compiled databases has been achieved.

However the absence of a market-driven approach can be disadvantageous. The Prestel service would have been long since shut down had it been a commercial system.

In the United States, a range of new services is gradually appearing in consequence of market forces. The country also possesses a strong electronics industry, a propensity to innovate, and a large number of people with some disposable income. I was able to observe the market-driven entrepreneurial approach at work during a visit in 1981.

Communication networks for home computers were being operated by two companies, The Source and Compuserve. Compuserve's Micronet was gatewayed to Tymnet. Charges were $5 per hour plus $2 for Tymnet. The Source and Compuserve then had about 8000 subscribers, mainly with TRS80s or Apple 2s. Compuserve offered Micronet terminal programs for both machines and a videotex program for TRS80s.

The Source and Compuserve are also information providers. Compuserve provided a range of services included with its $5/hour fee — for instance an electronic mail service for all listed users — but charged extra for special services like access to 32,000 continuously updated stocks in its Microquote service. A set of detailed information about a stock cost 5 cents.

Perceiving that it might have a customer base, a bank in Knoxville concluded an agreement with Compuserve and Radio Shack who supplied TRS80 microcomputers, and offered banking services for viewing statements, paying bills etc., by the page (videotex) at $5 per hour. Users also required the TRS80's videotex program. The service included the provision of a special modem for use with a TRS80 into which a magnetic card carrying an encryption key had to be inserted. At that time about 300 people used this service.

It was not clear whether prices for domestic users had dropped to a level which made success probable. The fact is that a structure has been gradually assembled in which operational costs were shared by many. Consequently an information provider or customer could join at a low incremental cost. There was no public financial burden. The foundation of the undertaking was the existence of a corps of people with a common self-interest — they were computer buffs. However there is no reason why business and professional users could not use the common resource and some did.

This kind of approach seems to be prospering according to a September 1983 article. The Source, now owned by Reader's Digest, has expanded greatly and Compuserve, a subsidiary of H & R Block, has over 20,000 subscribers.

The politics of telecommunications

The fusion, usefulness, modification, or convergence of the networks shown in Fig. 1 will obviously be affected by control, administration, and investment.

The best way of administering the UK telephone system, currently being modified into a digital telephone/data system, is controversial. The consensus of opinion was, and still is, in countries where information technology is less advanced, that a regulated monopoly is the best way to run a national telephone system.

The classic case for monopolies is set out in references 25 and 26. A 'natural monopoly' is a service or industry in which it assumed that economies of scale make it cheaper for one organization to produce a product or provide a service than for two or more to do so. Regulations can be imposed by the government to set prices which are in line with costs. The result, says the conventional wisdom, is a service provided at relatively low cost, obtained by regulating the prices charged by a single organization...
which is able to operate at the scale needed to achieve maximum economies.

'cream-skimming' is one of the major factors used in monopoly arguments. Competitors could provide new profitable business services, eroding the incumbent's (British Telecom's in the UK) revenues needed to fulfill its social obligation to provide loss-making rural telephone services.

In the 1960s the US telephone network started to be pressed into service for data transmission, since it was the only ubiquitous network available. It became very tempting to see if the telecommunication systems could themselves be used to provide some new, useful services. New requirements prompted the following questions: would consumer's needs be best fulfilled by entrusting all services to the traditional carriers? Was it rational to extend the monopolistic structure to control the other associated technology and processing involving modems, terminals, private line and microwave facilities, special data services, communication satellites, etc.

The British Post Office depreciates plant and equipment over 25 years. The organization's finances and price structures are arranged accordingly. But in the computer/data processing industry, obsolescence proceeds on five-year or less cycle, not because equipment has by then come to the end of its useful life, but because it is replaced by something better and cheaper.

The wind of change which first blew in the United States was not generated so much because the regulated monopoly for the telephone network was found wanting. Although it had its critics, but because the telephone system, once a definable entity, was becoming the major component in a total information system.

One of British Telecom's (then the Post Office) strategy directors said in 1977: "The absence of competition removes information about markets which could otherwise be inferred from competitors. Changing government policies influence the amount of investment, borrowing, and the levels of tariffs. The UK Post Office 'lays down prices and pays itself its 270,000 staff, whose working lives are spent usually in a single organization, in 122,000 separate instructions varying from 1 to 100 pages in length. Size, complexity, plant life of 40 years etc., all militate against rapid change'.

Egalitarianism requires the generation of wealth to support it. Wealthy companies have to compete internationally, and for them a poor telecommunications system is an expensive overhead.

"The competitiveness of UK industry depends in part on the efficiency and related costs of the telecommunications services, especially compared with the USA and Japan. The UK and European computer, telecommunications and electronics industries need to expand at a rate at least commensurate with world demand so as to provide substitute jobs for those being abolished in declining industries."

In a recent press release, BT claimed "Major achievements including... a reduction in the line waiting list from 122,000 to 20,000... a net growth of 5.6% despite the long recession radiopaging... new electronic mail system... lowest failed calls on record - local 1.3%, trunk 2.7%... lowest fibre-optic cable in the world... etc., etc.

One critic disagrees, using the standard anti-monopoly argument; "I love to see people making profits, but monopoly profits are something else. A monopoly profit is the difference between how much they can get away with charging and how much they can get away with wasting. If you can't take your business elsewhere then there is no market, no competition, no price mechanism."

Various criticisms have been levelled at BT. Its charges for telephone services have consistently been near the top of international comparison tables. Its differential pricing policy has been questioned; according to reference the cost of a PABX per extension in London was £650, but £196 in Dublin for a similar PABX. It was suggested that this was because BT's specifications for home suppliers are unnecessarily tight. In the same article some calculations were made showing that a London-New York private satellite link, if it was allowed, would cost £53,000 a year, compared with the BT tariff of £565 000 for a similar link. The BT price for a single-circuit leased link between London and New York was £49,000 a year, while a coast-to-coast link of about the same length in the USA cost £4500 a year. In a recent letter to the Financial Times, a reader complained that increases of 27% and 7% announced by BT in the last two years were misleading. Charges in the writer's company increased from £80,000 in 1980 to £150,000 in 1982.

Government policies for the Post Office 'protect inefficiency, remove incentives to self-improvement, penalise consumers and lower the gross national product' according to a well known authority writing in 1975. BT added a high surcharge to certain services provided via Tymnet, an efficient US network with a London node (access point). Tymnet would not agree to it, so users had to dial the Tymnet node in Paris at a cost almost as great.

A better way of doing it?

A Conservative government was returned to power in May 1979, having released a document proposing policies for information technology in the previous month. It presented the British Telecommunications Bill in November 1980, proposing to split Postal and Telecommunications services as recommended in the earlier Carter report and to allow competition controlled by the Department of Trade and Industry (DTI). Connection to the BT network would be allowed by others who could set up their own telecommunications systems.

BT would retain its monopoly over the Public Switched Telephone Network (PSTN). The government would dispose of its shares in Cable and Wireless.

In the Beesley report of April 1981 it was said that the consumer benefits of allowing competition would outweigh any BT loss of revenue. BT should be free to set prices and compete for non-voice services, subject to DTI regulation. It seemed likely that cream-skimming and leased line price increases would follow. The bill became the British Telecommunications Act on October 1st 1981. The Labour opposition stated that it would repossess BT assets without compensation if it returned to power.

![Fig. 1. Project Mercury's proposed trunk network, which is intended to employ optical fibres, microwave and cellular radio and satellite communications.](image-url)
THE INFORMATION SOCIETY

Mercury

In June 1981, a consortium set up by Barclays Bank, Cable and Wireless and British Petroleum sought permission to set up a communications network to be called Mercury, in the first instance to link up a limited number of UK cities. High capacity optical-fibre cables would be laid alongside British Rail lines, and the system would include microwave and satellite communications with satellite extensions to other parts of the country. The government granted a 25 year licence to Mercury in February 1982.

Mercury started preliminary operation in the City of London during April 1983 with a point to point microwave service. Its proposed network is shown in Fig. 2. Later, Mercury announced that it would establish a transatlantic link via a spur from its network to an earth station in the London docks and an Intelsat satellite.£637M and net profit down from £458M to £365M, a return on capital of 5.8%.

The threat of deregulation and then privatisation produced an optimistic effect. BT concluded an agreement with Satellite Business Systems for a transatlantic business service, and joined in with a UK private initiative through a joint venture to provide a direct broadcast satellite (DBS). The 18 month waiting time for services in the City of London has been cut to 3 months.

In October 1982 BT took three full pages in the Financial Times to advertise Teletex, satellite, facsimile, business systems, Prestel, and digital overlay services. It will offer complete packages to companies for external and internal private services, the latter using Local Area Networks (LANs) — a strong competition for Mercury.

Also in October government announced that BT’s operating licence would include obligations to provide General Telephone services, kiosks, and emergency services, which are loss makers. Competitors would have no such obligations. On the other hand an organisation which has for so long not needed to take much account of its customers will take time to reorient itself. The intent is there, but the proof of ability to sell into a competitive market is awaited.

To be continued

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25. McIlroy, John. Computer Weekly. March 31st 1983. We can show the world that we can lead.

The 1982 Bill

A new Telecommunications Bill was introduced in October 1982. Its main purpose is to sell 51% of British Telecom — in other words to ‘privatise’ it. The government also proposed to set up an Office of Telecommunications (OFTEL) early in 1984, and to grant an operating license to BT as its first act. The Bill was lost in the general election of June 1983, re-introduced when the Conservatives were returned to power, and received its second reading in July 1983.

Also in 1983, Professor Littlechild, an advocate of free markets, reported as requested to the DTI. In responding to terms of reference including ‘regulation with a light rein’ he said that new competitors should be encouraged, and that for five years after privatisation BT should be required to keep its price increases below the rise in the retail price index.

Opinions have been expressed about the timing of liberalisation, a relatively non-controversial issue, and privatisation, a controversial separate issue, but linked with or merged into liberalisation in the minds of many people. Perhaps it would have been better to let the liberalisation dust settle before risking general mudliness produced by the rain of privatization. The case against privatization has been well presented by BT’s management trade union — the Association of Telecom Executives. BT’s 1982/83 results showed the replacement cost of net assets at over £16 000M, income at

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SC84 Microcomputer

This second section of the SC84 professional microcomputer for engineers and enthusiasts — the input/output interface — provides control for any floppy-disc drive, three parallel ports, an RS232 serial port and more.

As well as providing basic serial, parallel, keyboard and disc input/output, this board also provides some system control and special facilities. At its heart is the Mostek STI, the MK801N-6. This device is one of several types recently introduced which provide a set of peripheral facilities; for those familiar with Z80 peripherals, it combines a CTC, a PIO, an SIO and an interrupt controller. As benefits the complexity of most Z80 peripherals, it has 24 internal registers, 16 of which are directly addressable and eight of which are indirectly addressable, and 16 sources of interrupts.

The STI comprises an eight-bit parallel port, a universal synchronous/asynchronous receiver transmitter (uart) for serial i/o, and four counter/timers, two of which are able to provide delays, count events and measure pulse widths, and two of which are only capable of providing delays. In delay mode, each timer switches the state of an individual output pin at precise intervals so the generators may be used to generate accurate frequency signals up to 500kHz — even four-part music. The two limited capability timers provide internal timing and/or determine uart bit rates.

The parallel i/o port has three features. It can be used just as an i/o port and as such each line may be configured as an input or output. Alternatively, some pins have special functions. Two are event and pulse-measurement inputs for the timers and two are 'handshake' lines for the uart. Thirdly, each line of the port may be used as a Z80 interrupt line. This is especially useful as the Z80 interrupt system is excellent but difficult to use with non-Z80 i.e.s, a good example of this being control of a floppy disc drive. There is no Z80 disc controller and yet interrupts are really useful in a disc interface because of high data-transfer rates. The STI is the answer to this, providing 16 distinct interrupts each with its own priority. These could be integrated into a larger system, but the STI is so versatile that it is the only Z80 peripheral i.e. in the basic computer. If there is a blemish in the STI design it is that uart receiver and transmitter handshake lines are both outputs, presumably for compatibility with another rather odd Z80 device. This is unfortunate as logic would dictate that handshaking signals pass in the opposite direction to the data they are controlling, but the STI signals indicate that either the receiver or transmitter in the uart is empty. The former signal correctly warns external devices that the receiver is not ready but the latter is the wrong way round, the handshake being required from the external device to the STI and not away from it. As a result, these signals are disabled in this design and their i/o port lines provide handshaking in the conventional manner. It's a pity that this option was not designed into the chip.

Floppy-disc drive interfacing is handled by a Fujitsu MB8877A which is an improved and yet cheaper version of the common 1793 controller. The Fujitsu device only requires a ±5V supply but for readers with a 1793 to hand, +12V is available on the p.c.b. so either part may be used. To the Z80, the controller looks like a specialized microcontroller with its own instruction set, comprising instructions to reset the system (i.e. move the head of the selected drive to the outermost track, track zero, as a means of getting the head over a known track), move the head to a particular track on the disc, and read or write one or more sectors or a complete track. Inside the con-

by J.H. Adams

Table 1. Signal connections for typical drives.

<table>
<thead>
<tr>
<th>Signal</th>
<th>Sony D32</th>
<th>Std 34 way for 5.25in</th>
<th>Std 50 way for 8in</th>
</tr>
</thead>
<tbody>
<tr>
<td>READY</td>
<td>26</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>RDDATA</td>
<td>24</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>WPRT</td>
<td>22</td>
<td>28</td>
<td>44</td>
</tr>
<tr>
<td>TR0</td>
<td>20</td>
<td>26</td>
<td>42</td>
</tr>
<tr>
<td>INDEX</td>
<td>18</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>SIDE</td>
<td>16</td>
<td>32</td>
<td>14</td>
</tr>
<tr>
<td>HLD</td>
<td>14, 1</td>
<td>16, 2</td>
<td>18</td>
</tr>
<tr>
<td>WG</td>
<td>12</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>WD</td>
<td>10</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>LC</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>STEP</td>
<td>8</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>DIRC</td>
<td>6</td>
<td>18</td>
<td>34</td>
</tr>
<tr>
<td>SEL1</td>
<td>4</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>SEL0</td>
<td>2</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>GND</td>
<td>7-25</td>
<td>1-33</td>
<td>1-49</td>
</tr>
</tbody>
</table>

The 5.25in pattern is used on BASF, Canon, Shugart and Tandon drives and the 8in pattern is used on DRE 7100 and 7200 types. Many other drives conform to these standards, but connections should be confirmed before the drive is used. Ground connections are joined over the range of odd-numbered pins indicated.
Fig. 1. The only requirements on disc data pulses are that they should not start within 40ns of a clock edge and that they must be entirely within one clock half cycle or must not be longer than 300ns for 8in double density or 600ns for 8in single density. This gives a wide margin of error in data recovery.

Fig. 2. Floppy-disc, serial and parallel input/output are provided by this section (far right). Heart of the circuit is the 3801, containing a parallel port, a usurat for serial communications, four counter/timers and an interrupt controller. The controller there are several parameter registers which are loaded with the track and sector numbers required before a command is executed and read from or written to during data transfers between disc and 280. The controller has two interrupt channels to the 280 through the STI. One, DRK, indicates that the controller is ready for data transfer, the other, INTRQ, that the controller has completed a command. In response to the second type, the system can read a status register within the controller to determine whether or not command execution ended satisfactorily, or whether an error pre-empted the command, e.g. the sector could not be found, or a write operation was attempted on a protected disc. The circuit handles both single and double density for all sizes of floppy disc. Switch S1m selects double density when closed and S2m is shown in the 5.25in, 3.5in and 3.5in/8in/300rev/min drive position (the other is for 3.5in/600rev/min and 8in.

The MB8877A does not provide all of the facilities required for interfacing disc drives to a system. Data separation and regeneration of the data clocking signal is achieved by the SMC9216B (the B version, which is more expensive, only being required for double density) and write precompensation by the 74LS195. It is possible to get all of these facilities in one i.c. but at considerably greater expense and complexity.

Data is recorded on disc by converting the stream of data bytes into serial form and recording the occurrence of binary 'ones' by reversing the sense of the flux recorded on the disc. The rate at which these flux reversals are made, and hence the amount of data stored, is limited by the calibre of the disc and recording head in the same way that higher frequencies are limited in audio systems. On playback these transitions are sensed, amplified and returned to digital form. Different systems have drives running at different speeds; disc change shape and data may consist of long strings of binary zeros, leaving long intervals where no transitions come from the disc. Thus additional and more regular information must be written on the disc to keep the playback process in step with the original recording rate. For this reason, extra flux transitions are inserted into the recording; for single-density recording an extra transition is inserted between every data bit period, making sure that there is a lot of synchronizing information available during playback but reducing the amount of data transferred by half. In double density recording, extra transitions are only inserted between bit periods corresponding to two adjacent zeros in the data bit stream, ensuring that an all-zeros sequence still contains some synchronizing data but, by being inserted in a natural gap in the bit stream, retaining the speed of the ideal system and not asking for a recording density, i.e. a frequency response, greater than that needed for single density. One method gives easier decoding at the expense of storage capacity, the other optimises storage at the expense of decoding complexity. Note that the physical requirement on the drive is the same for both methods so descriptions of some drives as being 'suitable for double density' — and the price premium — can be misleading.

Two data input signals are required on the controller. One is raw data from the disc drive, the other a clock signal derived from the data. The relationship between these two is that each half cycle of the clock signal is a window in which a data pulse must lie. There are two approaches to recovering the original clock signal — analogue and digital. The analogue technique uses a phase-locked loop with a fast lock-up time. This is an effective technique but requires adjustment of components for correct working and a fair amount of circuitry, not the least because the recovered frequency differs between densities and disc size. The digital technique used here requires just one, albeit rather expensive, eight-pin i.c. which extracts the clock signal from all perturbations of density and disc size without adjustment. It works by dividing an 8MHz signal to the nominal clock rate — 125kHz for 5in single density up to 500kHz for 3.5in/8in double density — and adding or dropping a divider count to keep incoming data pulses two counts short of the maximum divider count. This roughly phase-locks data pulses to the counter rate, i.e. data pulses definitely fall within a window framed by the state of the most-significant counter bit. The data pulse is not centralized within the window as it would be ideally, but more than adequately meets controller-input specifications.

As hinted earlier, to get more data on a disc requires better and hence more expensive discs and drive heads. In practice the head in particular will not be grossly over-specified. Adjacent flux changes interact. As flux changes become closer together, the effect of this interference becomes more noticeable and transitions appear to be displaced on the disc and hence in time. Fortunately, the sense of the error is predictable, although its magnitude varies from drive type to type, so a correction — write precompensation — can be made before data is written on the disc. The algorithm sensing whether a pulse should be written late, on time or early is implemented in the controller, and the 74LS195 parallel-loading shift register produces a compensation of 250ns, 0 or —250ns, these being values shown to suit most drives. Again, the digital solution is preferred, the write pulse loading a single bit into a shift register being clocked every 250ns. The bit lines come from the controller EARLY and LATE pins and from a gate which derives a NOMINAL signal (logically not early or late). At the output of the register a bit appears for one clock period, 250ns, which is either late, 250ns later or 250ns later.

**Table 2. Formatted capacities for single-sided drives.**

<table>
<thead>
<tr>
<th>Disc size</th>
<th>Tracks</th>
<th>Single density</th>
<th>Double density</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5&quot;</td>
<td>70</td>
<td>140K</td>
<td>350K</td>
</tr>
<tr>
<td>3.5&quot;</td>
<td>80</td>
<td>160K</td>
<td>330K</td>
</tr>
<tr>
<td>5.25&quot;</td>
<td>35</td>
<td>70K</td>
<td>175K</td>
</tr>
<tr>
<td>5.25&quot;</td>
<td>40</td>
<td>80K</td>
<td>200K</td>
</tr>
<tr>
<td>5.25&quot;</td>
<td>80</td>
<td>180K</td>
<td>400K</td>
</tr>
<tr>
<td>8&quot;</td>
<td>77</td>
<td>250K</td>
<td>610K</td>
</tr>
</tbody>
</table>

40
I/O board specification

Serial I/O
- Speed: 1 to 38,400 baud, separate receiver and transmitter clocks
  - Format: synchronous 5-8 bit, auto-search and sync.
  - asynchronous 5-8 bit, 1.5 or 2 stop bits
- Control: RTS (ready to send) and CTS (clear to send)
- System: RS-232C, +12V and -12V levels

Parallel I/O
- Input: 8-bit port, 1 low-power Schottky TTL input, schmitt buffered
- Output: 8-bit port, TTL compatible, 5.1t1 loads

Special I/O
- 3 mos I/O lines operating event counters, pulse timers and Z80 interrupts.

Disc I/O
- Output lines can sink 40mA. Input lines terminated with 220 ohm + 5V.
  - Bus lines are active low but have the following specification.

Signal Direction Function

READY Input
- Implies disk in drive and rotating at correct speed

RDDATA Input
- Raw data consisting of (nominally) 250na pulses

WRPRT Input
- Indicates disk in drive is write protected

INDEX Input
- Pulses once every disc revolution

TR00 Input
- Indicates that head is over the outermost track

WG Output
- Enables disc write circuitry

WD Output
- Data to be written to disc

LC Output
- Indicates that the write current should be reduced

HLD Output
- Loads drive head against disc

DIRC Output
- Sets direction of head stepping. Active means step in

STEP Output
- Steps head one track in direction set by DIRC

SEL0 Output
- Selects Drive 0

SEL1 Output
- Selects Drive 1

SIDE Output
- Selects Side 1

A listing of SC84's machine-code operating system — MCOS — can be obtained by sending an s.a.e. to Wireless World SC84, Room L305, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Details of how to obtain other software including the disc operating-system and Basic were given last month together with a source of p.c.b.s and newsletter information.

John Adams has recently designed a switch-regulated p.s.u. for SC84 and we hope to publish its design in the near future. He also plans to provide SC84's two eproms ready programmed; for details send an s.a.e. to the author at 5 The Close, Radlett, Herts.

V.D.U. interfacing, memory and control are detailed in the next article following a description of parallel I/O options and keyboard input.

*or permanently — Ed.

SPECIAL FEATURE

Command in this system the drive motor is turned on by the HLD signal, drive connections labelled Head load and Motor on, or the like, being connected together. READY being inactive does not abort the command; the controller simply starts the drive and waits for READY. What of the time delay between sensible data coming from the disc and the missing pulse normally inserted by the monostable device to give the head time to load, and is it a good idea to accelerate the disc with the head already loaded against it? Some drives such as the Tandon TM100 do not have a separate head-loading mechanism and those machines that do usually gate READY with the loading signal within drive so the head is not loaded until the disc is up to speed. Head loading and settling delay and the time taken to get up to speed amount to less than one revolution, and as the controller has to have counted five revolutions before it gives up attempting a command, this system optimizes the delay between a command being issued and its completion while using the barest minimum of hardware and software. As an example, the disc operating system loads and the directory is scanned and noted in just over 1s when using double density.

Some drives do not give a READY signal, if so, leave the READY input to the computer open or wire it to the 5V supply. Also, some drives have optional links on their circuit boards, one of which offers the choice of head loading being solely controlled by the drive-select line or by a combination of drive select and head load inputs. If so, use the latter option. Advice on using different types of drive will be available through the users' group.

Nominal allocation of drives is that there are two drives designated A and B by the disc operating system, dos, hardware selection being by control lines SEL0 and SEL1 respectively. If double-sided drives are used, the reverse side of drive A will be designated C and that of drive B, D. This is nominal as the selection of each logical drive surface can be altered temporarily. Open-collector drivers are used between the interface and drive. It is important that the total length of the cable does not exceed 3m (less for the 3.5in drives) and preferably as short as possible. Where more than one drive is used, drive-signal connectors are wired in parallel, from the computer to the nearest drive, then from this drive to the next etc. The only exceptions to this are the SEL signals which are individual to each drive although possibly connected by the same cable. You will find that 5.25in and 8in drives contain a pack of resistors usually in a dual-in-line package plugged into an i.c. socket wired to the signal connectors and probably labelled 220/330Ω. These packs must be removed from all but the physically furthest drive from the computer. It is good practice to provide a separate, well-rated, power supply for the drives. Disc drives tend to take large amounts of current when the drive motor starts and when the head loads. This can momentarily overload the supply with devastating results if the computer shares the same power source. Also the ground lead between the drive and interface, which should be substantial, is happier when it only carries signals.

Table 1 gives connections to widely used disc drives. There are many second-hand drives around at the moment; buying such drives is rather like buying a second-hand car — there are bargains but there is also rubbish. In particular, I would advise personal inspection and that you watch out for incomplete drives (large areas of p.c.b. with no components) unless they are a bargain and information on the missing parts is available, worn down head pads (the pad that pushes the disc onto the head) and, at least in the U.K., for drives with 110V and/or 60Hz motors. Caveat emptor. I would recommend that you obtain a drive with a distinct head-loading mechanism (usually a solenoid) rather than one that puts the head to the disc as soon as the door of the drive is closed. As to the choice between two single-sided drives and one double-sided, there are many advantages to using two drives, such as the ease with which back-up copies of discs can be made, reduced head replacement costs and that the computer remains useful when one drive is out of action. Many types of drive — Sony, Canon/ BASF, DRE, Shugart and CDC — have been used with the computer and the names given in the table are not intended as an indication of merit. Table 2 gives some typical capacities for drives used in single and double density modes.

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<tbody>
<tr>
<td>Medium Resolution Colour Monitor(s) at £179.95 each (ex VAT)</td>
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<td>Connection lead(s) at £6.00 each</td>
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CIRCLE 18 FOR FURTHER DETAILS.
Multi-standard modem

Circuit details of an f.s.k. modem suitable for any microcomputer with an RS232-compatible serial port

Since the Am7910 i.c. is billed as a single-chip modem, you may wonder at the number of additional components it takes to make it work.

It is certainly possible to connect the device direct to a uart with the addition of little more than the interface to the telephone line. But the circuit of Fig.1 is for a stand-alone modem, and as such it has to be able to drive an RS232 line and receive from it. In addition, switching is needed to select the various modes of operation, and gating of the data and handshake signals may be necessary. Nevertheless, in many applications it will be possible to omit some of the components shown.

Selection of the signalling mode of the Am 7910 (IC) is by way of the five inputs MC₀ to MC₁. Of the 32 possible configurations only 19 are available to the user, the others being reserved by the manufacturer. The ten-way switch suggested for the mode selector S₁ reduces the user’s chances of stumbling upon the one of the reserved modes (see table 1). The Am7910 makes extensive use of digital signal processing and there are no external filters to adjust, which simplifies greatly this part of the circuit.

Between S₁ and the control inputs of the Am7910 is a t.t.l. priority encoder IC₁. The circuit diagram shows pull-up resistors R₁₁-₁₄ at its outputs to ensure that the encoder will drive the cmos logic reliably; but if a 74C series device is used instead (74HC147 or 74HCT147) the resistors should be omitted.

The use of a priority encoder may seem a little untidy here, since it would have been possible to use a b.c.d. switch and connect it direct to the 7910. However, it is difficult to specify a b.c.d. switch which every constructor can be certain of obtaining. The cheapest sort is a printed-circuit mounting rotary type which stands upright on the board; but this would mean having the controls sticking out of the top of the box. The alternative, fitting the controls to a second p.c.b. would involve additional wiring and extra cost. An edge-wise thumb-wheel switch would have been neat, but difficult to interpret unless you had a look-up table constantly to hand.

In any case, gating is needed to control the operation of the modem, and the arrangement shown here simplifies it a little. For example, position 9 of S₂, which is used solely to provide a means of testing the narrow-band back channel in the CCITT V.23 mode, gives automatic selection of the test mode. This loops the output of the Am7910’s transmitter back to the input of its receiver and at the same time inhibits the line-sense relay RL₂, if fitted. Decoding of the select lines would otherwise be needed to achieve this.

For other signalling standards, the test mode is selected by S₄, which can be a double-pole double-throw toggle switch with a centre-off position. In the test position, S₅ causes the output of the Am7910 to be looped back and it adjusts the device’s transmit and receive filters to the same setting. This allows the user to test the modem off-line.

A further possibility here is remote-testing of the modem. Data received by the Am7910 can be connected straight into its transmit input and so looped back along the telephone line for tests by the computer at the other end; but the value of this to the private user seems relatively small and so the facility has not been implemented.

RS232 interface

Some microcomputers have a full RS232 interface brought out to a 25-way D-connector, and the circuit board designed for this project has space for a corresponding socket. The RS232 interface includes data and handshake lines for both the main channel and the back channel (secondary transmit data, secondary clear-

by Richard Lambley

A ready-made printed circuit board for this project will be available shortly. The board, measuring 200mm x 160mm, will be double-sided, with plated-through holes to allow the use of i.c. sockets and to avoid the need for the through-the-board links seen in this prototype. Details next month.
to-send and so on); and with an arrangement of this sort the RS232 drivers and receivers on the board can be linked direct to the corresponding pins on the Am7910. These links are shown dotted in Fig. 1.

However, the contractor may wish to connect the modem to a computer with a less comprehensive serial interface. The BBC Microcomputer, for example, has an RS423 serial port. This is compatible electrically with the RS232 standard but has its connections brought out to a five-pin domino (reversible DIN) connector. Here the only lines available are a data line in each direction and the associated clear-to-send and request-to-send lines. In the 300 baud modes, these lines must be linked to the main channel connections of the Am7910; but in the CCITT V.23 and Bell 202 modes, it is necessary to switch some of them to the corresponding back-channel pins.

Thus, for accessing Viewdata systems such as Prestel, data to be sent back to the Viewdata computer must be applied to the BTD input, and the clear-to-send signal taken from the BRD pins. Wide-band data from Prestel appears on the RD pin as does received data in the 300 baud modes.

Normally the RTS output from the local computer would be wired to the RTS input of the modem, and the CTS output of the modem to the CTS input of the computer. However, this may not always give the right results, and some experiment may be required. One possibility might be to connect RTS from the computer to DTR on the modem. With some low-cost commercial Viewdata modems the RTS connection is omitted and the input of the modem is wired so that RTS is asserted whenever the device is powered.

A feature of this design is that it allows the user to operate the asymmetrical V.23 and Bell 202 standards in the reverse direction, sending 1200 baud signals while receiving on the back-channel. This makes it possible to communicate with the many individuals who have standard 1200/75 baud Prestel modems. This mode is entered by switching S2 to the 'reverse' position. The same result can be effected by applying a high level to the free end of R3. With suitable software, both computers could send at 1200 baud alternately.

The switching logic is complicated slightly by the fact that the Bell 202 mode does not allow duplex communication in the sense that the V.23 modes do. The back channel carrier, instead of being modulated with ASCII data by frequency-shift keying, is merely keyed on and off by the BTD line. When BTD is low in the Bell 202 mode, a 387Hz tone appears at the Am7910's TC output. The BTD input is therefore without a function to perform in this mode and is fixed at +5V by a section of IC4. In the same way, the BCTS and BRD pins carry meaningful signals only in the V.23 mode.

Managing the Bell half-duplex mode is likely to be a complicated business for most home computers. The low signalling rate in the back channel (not more than 5 bit/s) is outside the scope of a simple serial interface and will entail the use of some other I/O port. Fortunately I have not yet come across any U.K. systems which follow this standard.

The RD and BRD outputs, carrying received data in the main and back channels respectively can be gated together at the RS232 driver (part of IC3c). Internal logic in the Am7910 ensures that in normal use only one is active at a time.

Capacitors can be connected across the outputs of the line-drivers (IC6,7) and to the response control pins of the receiver (IC5) for adjusting the signal rise and fall times. Ideally these should be restricted to conform with the

Using the modem board (bottom) in the 1200/75 baud mode; two frames from Prestel.
MULTI-STANDARD MODEM

Table 1: mode selection using switches $S_1$ and $S_2$. An equaliser is available in the 1200 baud modes to compensate for poor high-frequency performance over long lines.

<table>
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<tr>
<th>$S_n$ signalling mode</th>
<th>normal</th>
<th>test</th>
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<tbody>
<tr>
<td>0 Bell 103 300 baud</td>
<td>originate</td>
<td>originate loopback</td>
</tr>
<tr>
<td>1 Bell 103 300 baud</td>
<td>answer</td>
<td>answer loopback</td>
</tr>
<tr>
<td>2 Bell 202 1200 baud</td>
<td>half-duplex with equaliser</td>
<td>loopback with equaliser</td>
</tr>
<tr>
<td>3 Bell 202 1200 baud</td>
<td>originate</td>
<td>originate loopback</td>
</tr>
<tr>
<td>4 CCITT V.21 300 baud</td>
<td>answer</td>
<td>answer loopback</td>
</tr>
<tr>
<td>5 CCITT V.21 300 baud</td>
<td>1200/75 baud</td>
<td>main channel loopback</td>
</tr>
<tr>
<td>6 CCITT V.23 mode 1</td>
<td>1200/75 with eq</td>
<td>main channel loopback with eq.</td>
</tr>
<tr>
<td>7 CCITT V.23 mode 2</td>
<td>600/75 baud (reserved)</td>
<td>main channel loopback</td>
</tr>
<tr>
<td>8 CCITT V.23 (test)</td>
<td>back channel loopback</td>
<td></td>
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</table>

In other modes, it is probably useful to have the relay enabled whenever the modem is in a normal transmission mode and switched on-line. This would allow user-to-user communication where the connection is first established in voice. Further conversation might be necessary after the exchange of data, and the operator could thus avoid accidentally dropping the line on switching back to the telephone receiver.

A position of carrier is indicated by ledS, one for the main channel and one for the back channel. The receiver in the Am7910 is more than adequate: its sensitivity is good enough to cope with signals of —43dBm and below.

The line connection can be broken at any time by switching $S_2$ to its centre position or $S_3$ to ‘test’. This will disable the Am7910 (its DTR terminal acts as a chip-select) and, via IC17, cause RL1 to drop out. Automatic answering is possible with the Am7910 if a suitable line interface is connected. When pin 3 is taken low by a ringing detector, an auto-answer sequence is activated. The modem sends a period of silence followed by an answer tone for the calling modem to detect and so to complete the setting up of the call. In this design, the RINE signal is stretched by a monostable IC10 in the line interface section (to be described later) and used to hold RL1 until an incoming carrier signal is available to take over. It does not matter that the RING input remains low while the call proceeds as it has no further effect.

The auto-answer mode can be enabled only when a suitable signalling standard has been selected by $S_3$ that is, in one of the 300 baud answer modes or in a reverse half-duplex mode.

Component notes

The following notes relate mainly to the ready-made printed circuit board for this project, details of which will appear in the next part.

Switch $S_1$ is a miniature printed circuit-mounting switch wafer — RS Components type 327-591 is suitable. For the other switches, double-throw centre-off toggle switches can be used. $S_2$ should be a double-pole type, $S_3$ single-pole.

Relay RL1 is miniature p.c.-mounting telecommunications type, such as RS Components’ 345-845 or Farnell Electronic Components’ 170-529. Other miniature relays may not have contacts suitable for the voltages encountered across telephone lines.

There will be space on the p.c.b. for two additional relays of the same type, RL2 and RL3; these are for an optional auto-dialling facility. Drivers are provided in the ULN2003 and the connections brought out to the terminals marked IMP and DON.

The D-connector for the R232 line is a 25-way socket. The printed circuit will accept a p.c.-mounting version, RS Components’ 125-856 or equivalent. If a full RS232 interface is not required one of the MC1488 line drivers may be omitted and a cheaper connector used. Some low-cost Prestel modems use a 6-pin DIN socket. The reversible domino connector fitted to the BBC Micro might appear to have the advantage that it could be turned round if the RS423 connections happened to be back-to-front; but as it is, it has unfortunately not been wired symmetrically.

The transistors are general-purpose small-signal silicon types: the p.c.b. will take BC183L and BC223L, and are BAW62 or other silicon signal diodes, except where indicated otherwise. The crystal is a standard-value parallel resonance type and should be available at low cost.

Details of the interface to the telephone line will follow next month.

Further reading


The chip heard around the world: application note on the Am7910 published by Advanced Micro Devices.


RS32 specifications, although for driving short lines they can probably be omitted. Unused inputs of the MC1488s should be connected to the +5V line.

For normal transmission in, say, one of the 300 baud modes, $S_3$ would be in its centre (off) position and $S_2$ in the on-line position. In this condition, the Am7910 would be enabled by DTR and the line-seize relay RL2 would be closed. For accessing Prestel, however, it is desirable that the relay remain closed only so long as the incoming carrier is being received. This allows the user to disconnect in the conventional way by sending *90*, which causes the Prestel computer to send its sign-off page and then drop carrier.

When the call is first set up, the relay closes for a brief period as $S_2$ is switched on-line. The Am7910 should detect the carrier within about 15ms. Its CD output will go low and via $R_D$ and $D_A$ will maintain the relay for the rest of the call.

In 1982, theTel: 04862-22121.

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ELECTRONICS & WIRELESS WORLD JUNE 1984
**POWER UP/DOWN RESET**

Power failure in microprocessor systems causes spurious operation. This circuit was devised to prevent pulses being sent to an eprom programmer on such occasions by initiating a microprocessor -reset signal when the supply falls below about 6.5V; it also provides power-on reset for about 100ms depending on the power-supply rise time.

Two spare RS232 line receivers are main elements of the circuit. If a stepless transition is required, add the capacitor shown in broken lines. Threshold voltage is varied by connecting a resistor between the first receiver's response control input and ground or +5V. Values will need to be changed if the 1489A receiver is used since this version has different thresholds.

E. Wagner
London

---

**INSTRUMENTATION AMPLIFIER HAS DIFFERENTIAL OUTPUT**

Combining a TL072C i.c. and an XR 13600 transconductance op-amp produces an instrumentation amplifier with differential input and output. The transconductance of the op-amp is \( V_{out} = g_m V_{in} \), and threshold voltage \( V_{out} \) is given by \( g_m = I_R/V_r \) where \( V_r = 26\,\text{mV} \). So gain of the amplifier may be set by varying bias current \( I_R \) to pins one and 16 only. For simplicity, only control voltage \( V_c \) is shown. The circuit may be useful in applications where \( V_{out} \) is above or below zero.

Kamil Kraus
Rokycany
Czechoslovakia

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**FORWARD/REVERSE MOTOR CONTROL**

Designed for use in a solar tracking system, this forward or reverse motor controller has three advantages over conventional circuits — only an a.c. supply is required, one signal determines forward or reverse, and only four transistors are used. Polarity of the input signal determines direction of rotation and it is impossible to switch both Darlington pairs on together. Zener diodes are included for larger motors to prevent overvoltage damage during fast commutation.

J.A. Maldonado de la Fuente
Valparaiso
Chile
MULTI-CHANNEL A-TO-D CONVERSION

Excluding address decoding, this four channel analogue-to-digital converter for connecting to a computer requires only five inexpensive ICs. One more 324 input comparator allows eight analogue channels to be monitored. Further, the circuit needs only one 5V supply and is quite fast when the computer software is designed to determine the input value using successive approximation. Within the limits of the ZN425 output capability, expansion requires only further input comparators and 74LS44 buffers. K.P. Tibbetts Preston Lancashire.

PROPORTIONAL TEMPERATURE CONTROLLER

In this simple proportional temperature controller designed for photographic processing, none of the transistors saturates so the circuit should be capable of functioning at high frequencies in other applications.

Transistors Tr1,2 form an emitter-coupled multivibrator whose period is approximately 4RC — 4 seconds for values shown. Mark-space ratio is controlled by the voltage difference between bases of Tr3,4; plus and minus 20mV give about 25% and 75% respectively which corresponds to a proportional band of about 1K.

With these component values, C is never reverse biased. A differential output of ±500mV is available between points A and B, or a 1V output can be obtained from a 10kΩ resistor in the collector of Tr2. Thermistor characteristics over the range 15 to 45°C are linearized by the 4.7kΩ resistor. J.R. Hunt Doncaster Yorkshire.
In-circuit emulation

John Ferguson discusses the principle of emulators and illustrates their use by reference to several commercial units.

The technique of in-circuit emulation (i.c.e.) provides the engineer with a simple, yet effective means of testing hardware and evaluating software in a microcomputer system. Figure 1 illustrates the principle. The microprocessor is removed from the unit under test (target) and connection made to a second computer system (host) through a dual-in-line plug and ribbon cable. Normally the host computer uses a similar microprocessor to that removed from the target, to imitate or emulate the original processor. At first glance it might seem pointless to remove the original to have it replaced by another in the host, but the technique allows the host to get between the target system and its microprocessor, enabling it to monitor bus activity or to inject signals into the target system.

The technique was first introduced by Intel on their microprocessor development system (MDS) to help debug hardware and software problems encountered during the development phase of a project. Early development systems were essentially software orientated, providing editors, assemblers, linkers, and, to a limited extent, some facility to execute and debug the final machine code. However, to test hardware and software effectively it was necessary to commit the final code to eprom before transferring it to the unit under development. Any further debugging that was required was now carried out using a logic analyser. If faults were discovered the engineer returned to the development system to update the software before programming a new eprom.

The introduction of i.c.e. shortly after this time-consuming procedure, allowing the design engineer to run the system under development directly from the MDS, thus eliminating the need to use eproms as a means of transporting software into the target system. Further, since the emulator has access to the target system's buses during program execution, it can also be used as a debugging tool. To help with this task most emulators also provide on-board logic analyser functions.

In-circuit emulation is now a standard feature on development systems with some manufacturers, including Hewlett Packard, Genrad and Tektronix, providing a range of emulators covering a variety of 8 bit and 16 bit microprocessors. However, all of these systems are well outside the budget of most individuals or small companies involved in microprocessor system development. To fill this need several manufacturers, notably Microtek, are producing a range of low cost stand-alone emulators that can be driven through an RS232 interface from either a v.d.u. or any popular microcomputer with a serial port.

The value of in-circuit emulation has also been acknowledged by those involved in microcomputer servicing, offering a simple method of injecting test or stimulus programs into a defective board. This can prove an essential facility if the unit under test does not respond to normal keyboard operation or, perhaps, as in the case of some controllers, does not contain a keyboard. Many manufacturers, including Hewlett Packard, the John Fluke Co. with their 9010 Troubleshooter and Solartron with their range of Micropods, are now producing...

*Microelectronics Educational Development Centre.

Fig. 1. Attaching a target system.

Fig. 2. Simplified emulator architecture.

Fig. 3. Mapping — constructing memory map for emulation. In this example, 'user rom' overwritten by emulation ram, allowing software to be loaded and tested by host system.

by John D. Ferguson

ELECTRONICS & WIRELESS WORLD JUNE 1984
EMULATORS

Fig. 4. HP64000 development system — an example of universal system supporting a range of microprocessor families.

Fig. 5. Example trace specifications on HP64000.

TRACING SPECIFICATION
trace after address = 8000H

CONTENTS OF TRACE BUFFER
ADDRESS, DATA, STATUS
0080 0100 0101 0102 0103 0104 0105 0106 0107 0108
00B0 00B1 00B2 00B3 00B4 00B5 00B6 00B7 00B8 00B9

Using address alone to trigger the analyzer

TRACING SPECIFICATION
trace only address = 8000H or address = 8100H

CONTENTS OF TRACE BUFFER
ADDRESS, DATA, STATUS
0080 0100 0101 0102 0103 0104 0105 0106 0107 0108
00B0 00B1 00B2 00B3 00B4 00B5 00B6 00B7 00B8 00B9

Looking for a sequence on a data bus before triggering and capturing bus details after address 8000H

TRACING SPECIFICATION
trace in sequence data = 8000H range

CONTENTS OF TRACE BUFFER
ADDRESS, DATA, STATUS
0280 0281 0282 0283 0284 0285 0286 0287 0288 0289
02B0 02B1 02B2 02B3 02B4 02B5 02B6 02B7 02B8 02B9

Looking for a sequence on a data bus before triggering and capturing bus details after address 8000H

test instruments in which emula-
tion is an essential ingredient.

Basic principles

Figure 2 shows a simplified diagram of an emulator's internal architecture. Control circuitry is used to allow either the host computer or the emulation processor to gain access to the target system's buses.

Most emulators are equipped with random-access memory (emulation memory) that can be used to add to, or take the place of memory on the target board (user memory). This extra ram can often prove useful during program development, providing workspace for software before it is finally committed to rom.

The procedure of establishing a memory layout for the combination of emulator and target is called mapping. In microprocessor development systems this is normally accomplished from the keyboard during a configuration phase prior to emulation. Simpler systems (e.g. Microtek's MICE) use small in-line switches on the emulator's main printed circuit board.

An example of mapping is shown in Fig 3. In this arrangement the memory space occupied by user rom has been overwritten with emulation memory allowing the engineer to load and test different versions of software. After mapping has been decided, control circuitry ensures that all addresses established by the processor or host system are directed to the selected memory devices i.e. emulation or user memory.

Normally the target system's own clock would be used to run the emulator's microprocessor in 'real-time', thus ensuring that any critical timing of the target system hardware is maintained. If, however, the emulator is used without prototype hardware it can make use of an internal clock option.

Once configuration is complete the operator can then load the machine code into either emulation or user memory before running or single-stepping the program. As all designers are aware, prototypes seldom work first time and most projects would now enter a testing phase in which the engineer would call on the debugging capabilities of the emulator, which can be divided into four areas:

memory/register display and modification
— single step, single cycling
— software breakpoints
— trace analysis.

The first three features are common to those found in most software debugging packages, e.g. DDT, ZSID. Trace analysis, however, is often enhanced by the inclusion of a logic analyser, allowing the operator to capture bus activity, about some trigger event, in a trace buffer.

Emulation on the HP64000 development system

For ease of use and versatility, Hewlett Packard's 64000 development system, shown in Fig. 4, sets a high standard. The system offers a variety of options ranging from a stand-alone portable station, for use in the field, to a multi-user, hard-disc based network capable of supporting a wide spectrum of microprocessor families. Multi-user capability greatly eases the problem of integrating software produced by a team of engineers, allowing different areas of a project to be developed independently and yet allowing them to be easily shared between members of the team.

Hardware options available for the 64000 include

— a wide range of 8 and 16 bit emulators
— a user-configurable emulator (a novel idea allowing customers to 'build' an emulator for any processor not supported by HP)
— state and timing analysis
— a range of empor programmers.

In common with other systems the operator is provided with a wide range of debugging features for use under emulation. Symbolic debugging, where the operator can refer to program locations using labels defined in the source code, greatly eases use, especially when tracing routines generated by compiling high level language programs written in PASCAL or C.

Depending on your needs (and assets) such a system offers many analysis options starting with a software logic analyser (not real-time) and progressing to plug-in cards that perform state and timing analysis on the emulation subsystem. Fault location with a logic analyser demands flexibility when defining the trigger event, or more completely the 'trace specification'. Figure 5 shows a variety of possible trace specifications highlighting the power of the analyser.

The systems have been on the market now for several years and most of the bugs have been removed. However, a few rough edges still remain, and some typical examples again from the HP 64000 include arithmetic problems evaluating relative jumps when disassembling 280 code and a rather messy approach to...
emulating the 8088/8086, where an emulation monitor program has to be linked to and loaded with the user program. Of the other development systems two families can be identified.

**Manufacture Specific:** This includes the INTEL MDS and the Motorola EXORmcs development system. Each system will normally deal with all that manufacture microprocessors often including devices not yet covered by the 'Universal' systems.

*Universal:* examples include the Futuredata and Philips systems as well as the HP 640000 detailed above. While covering a wider range of processors from different manufacturers, they are less likely to cope with the latest and fastest from any given supplier.

**Low-Cost Solution - Microtek MICE**

Microtek's 'Micro-In-Circuit Emulator' (MICE) shown in Fig. 6 performs many of the functions found on a development system at a fraction of the cost. A range of personality cards allow MICE to emulate most industry standard microprocessors, including the 8088/8086, 68000, 8095, 6809 and the popular domestic processor, the 6502. Two models are available, differing in the size of the emulation ram and the trace facilities.

**MICE I 8KBytes emulation memory — not real-time trace.**

**MICE II 32K bytes emulation memory, expandable in blocks of 32Kbytes — real-time trace.**

Both models are controlled via an RS232 interface, enabling either a display terminal or a computer system with a compatible port.

Driving a stand-alone emulator from VDU would only be satisfactory for a small development environment or when used in a servicing role (e.g. to check memory or form signatures of ROM using its on-board test routines). The list commands, Fig. 7, includes a line assembler, useful for small routines or when patching a larger piece of software and two-pass disassembler that generates labels for all subroutine and jump instructions - a nice touch not found even in expensive systems, Fig. 8.

Serious applications, however, would utilise a host computer system allowing code generated by assemblers or compilers to be downloaded, in either Intel or Tektronix format, to the target system. When a host system is used it requires a driver program to communicate with the emulator. A range of routines is available for some popular systems:

- **Apple**
- **any CP/M machine**
- **Digital Equipment minicomputers**

**Sharp Personal Computer Guidelines included in the manual should allow anyone with a reasonable skill in interface programming to generate a driver routine for their machine.**

Trace facilities are good, allowing the operator to perform a real-time forward or backward trace capturing address, data and processor status information in a massive 2048 word buffer. However, there are limitations on the sophistication of the trigger event which is limited primarily to address and status, Fig. 9.

To summarize, in-circuit emulation has been available on a range of development systems for several years, where it has proven its usefulness as part of the product development cycle. The appearance of low-cost stand-alone emulators should widen the appeal of the technique. A list of suppliers follows.

---

**Fig. 7. MICE command summary.**

**Adding an 'S' to the L command, displays the contents of the trace buffer in hex.**

**Fig. 8. Two-pass disassembler on MICE.**

**Fig. 6. MICE can be operated from a VDU or, as shown, from a computer system running a driver routine.**

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<td>TW3 6HP</td>
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<td>TX3 1PD</td>
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<td>Rosemont Tower</td>
<td>EN6 5BU</td>
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<td>S31 1PD</td>
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**EMULATOR SUPPLIERS**

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<td>Computech Systems</td>
<td>168 Finchley Road</td>
<td>N13 1LY</td>
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<tr>
<td>Dapple Electronics (Cranfield) Ltd</td>
<td>Wood End Road</td>
<td>MK4 0ED</td>
</tr>
<tr>
<td>Data Applications (UK) Ltd</td>
<td>168 Dyer Road</td>
<td>GL7 2PF</td>
</tr>
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<td>Eagle Controls (England) Ltd</td>
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**RCS Microsystems Ltd**

- Cumnor House
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- Middlesex
- TW13 6HA

**Rockwell International Inc.**

- Heathrow House
- Bath Road
- Hounslow
- Middlesex
- TW3 9QW

**Sintrom Electronics Ltd**

- 14 Arkwright Road
- Reading
- RG2 6LS

**Spectra-Tek (UK) Ltd**

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- Malton
- N. Yorks.
- YO17 0QR

**Systek Inc.**

- Honeywell House
- Charles Square
- Bracknell
- Berks.
- RG2 1EB

**Texas Instruments, Semiconductors Div.**

- Manton Lane
- Bedford
- MK4 1TA

**Vale Electronics Ltd**

- Pass Street
- Wemeth
- Gifford
- OL9 6HZ

**Zilog (UK) Ltd**

- Zilog House
- Monday Road
- Maidenhead
- Berks.
- SL6 8PL

**MICE details**

- ARS Computers
- Doman Road
- Cambridge
- Surrey

**Hewlett Packard**

- South Queensferry
- West Lothian
- EH30 9TG

**Solartron Electronics Group**

- Farmborough
- Hampshire
- GU14 7PF

**Philips Electronics Instruments**

- York Street
- Cambridge
- CB1 2PS

**INTEL Co (Ltd)**

- Piper's Way
- Swindon
- Wiltshire
- SN3 1RJ

**GenRad Ltd**

- Norreys Drive
- Maidenhead
- Berks.
- SL6 4BP

**Motorola Ltd**

- York House
- Empire Way
- Wembley
- Middlesex
Improving colour television decoding

This article details the performance and setting up of the filters used in the add-on enhancement boards in Figs. 34 & 36 (March). It leads onto passive filter circuits that can be placed between tuner i.f. and PAL decoder circuits as an alternative to the add-on board, includes analysis of filter networks used in current receivers, and surveys suitable delay lines.

The three filters used in the extra board circuits shown in Figs. 34 and 36 have the following characteristics to suit the signal filtering requirements.

**Chroma band-pass filter.** The chroma is filtered by $L_1$, $L_2$, and $L_3$ with capacitors $C_1$, $C_2$, and $C_6$ (Fig. 34, March), and the insertion loss is shown to be approximately a gaussian band-pass response. If the bandwidth of this filter is narrow, it will result in: reduced chroma risetimes (up to 1µs), reduced cross-colour because wide-band luminance reaching U and V chroma demodulations is reduced, and a lower noise spectrum in the displayed chroma. However, with a very high order element aerial and steering guy-wires through the roofs of neighbouring houses, a good signal-to-noise ratio was obtained. Hence, the decision was made to filter the chroma resolution (decreased risetimes) was required and that the resulting cross-colour increase could be tolerated.

**Post-modifier low-pass filter.** The modified output chrominance (V-axis switched) signals cancel chroma from the composite video present at the $T_4$ summing point to provide clean luminance (Fig. 34, March). A low-pass filter is required to remove other frequency products around $2f_c$ and $3f_c$, (as shown in the spectral energy diagram of Fig. 19, January) to obtain a clean 0-5.5MHz baseband signal. Components $C_{13}$, $C_{14}$, $C_{15}$, and $C_{16}$, with $L_1$ and $L_2$ form this filter and the group-delay phase equalizer is formed by $C_{15}$, $C_7$, $C_9$ with $L_1$, $L_2$, and $L_3$. Figure 44 shows the insertion loss of the filter which is flat between 0-5.5MHz and is more than 35dB down at 2$f_c$ (8.866MHz); $L_1$ and $C_2$ are in parallel resonance at $2f_c$ to provide a part of the characteristic, $L_2$ and the associated capacitors response remains greater than 35dB in the stop band. Figure 55 is the group delay characteristic of the filter plus equalizer; the delay delay of 275ns is used to obtain the correct chrominance-to-luminance timing as required by the decoder chip inputs, i.e. to ensure chroma/luminance alignment.

The response is theoretically flat but because all the capacitor values have been rounded to preferred values and the adaptive $I_{bc}$ notch added, the group delay is not as flat as it could be. However testing with a pulse and step signal, see Fig. 56, shows that the overall performance is good.

To set up this filter, it is best to use a 0-10MHz sweep with markers although a generator with set frequencies can be used. If there is difficulty in setting up it may be necessary to isolate the phase equalizer and obtain the correct performance from the filter and

---

**Figure 52. Amplitude response of chroma band-pass filter used in the circuit of Fig. 34 (March issue). Lower trace shows the 0-6dB area.**

**Figure 53. Group delay response of the chroma band-pass filter.**

**Figure 54. Insertion loss performance of the post modifier/modulator low-pass filter $L_1$ to $L_{30}$ (Fig. 34 March issue).**

---

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

These six installments of 'Improving colour tv decoding' have been the result of the gathering of information and investigation followed by the collection of much valued advice on how to knock the ideas into shape. I particularly wish to thank Dr. Mino Gobetti, for keeping a fatherly theoretical eye on the planning; John Nash of ITCA, for patiently checking and adjusting the worst of the grammatical gaffs, and Cliff White of the BBC for invaluable help on practical aspects of design and construction.
Fig. 55. Group delay response of Fig. 34 low-pass filter.

The network used by the Thorn (Ferguson TX10) 26in. receiver in Fig. 59 has the amplitude performance shown in Fig. 60. At first sight, it appears that the insertion loss curve indicates a good response, but the group delay curve, Fig. 61, shows a rise of delay to 320ns as the amplitude falls to 3dB.

As a result of the colour (f_c) notch and (6MHz) sound trap not being group-delay equalized (giving a rising delay with increasing frequency), the luminance signal has asymmetrical rings, as the pulse and step waveform in Fig. 62 shows. Since the pulse has a half-amplitude duration of 200ns its spectral bandwidth is within 5MHz. Hence, a notch at 4.43MHz will cause ringing. If the circuit is equalized, the rings will be halved in amplitude and distributed symmetrically about the pulse or step. The asymmetrical rings on a television screen appear as shown in Fig. 63, and will mar all the picture detail in a similar way to multipath ghosting with short delays involved.

Analyzing the chroma path, Fig. 64 shows the insertion loss characteristic. The rising response being on the chroma bandwidth (f_c+1MHz) is shaped to provide a high-pass response, such that, with the i.f. s.a.w. low-pass filter, a bandpass response is formed for the chroma modulation. Many s.a.w. filters are 3-6dB down as f_c, and the rate of fall is similar to the rising response shown in Fig. 64. The result is a somewhat narrow bandwidth, which is good for giving low cross-colour (little luminance energy reaching the chroma de-modulator), but is at the expense of very poor chroma risetimes resulting in limited chroma detail (the f_c+1MHz points are approximately 12dB down). The group delay curve (Fig. 65) shows delay asymmetry about f_c. In the range f_c+1MHz, the insertion delay with increasing frequency has a high rate of change and reverses in slope with a peak-to-peak delay of 300ns. This is a delay comparable to the period of f_c (225.5ns), these sidebands will, after passing through the R-Y and B-Y demodulators, result in chroma rise and fall times being between pre- or post-overshoots; depending on the sideband distribution. There will also be visible moving Hanover-bar effects at the chroma transitions.

**Line up of post modifier low-pass filter**

The sweep or spot frequency generator can be applied to the powered board (Fig. 34, 35) at its normal video input with the appropriate resistor connected at R_1 as input termination. The filter should then be fed from and terminated in the correct resistances. If the input signal is driving a 75Ω load, temporarily add 1kHz across R_14 and 100μF (6V) across C_30, plus a series resistor of 75Ω in the output to suit the input impedance of the test generator. Lift one end of each of C_18 and C_19, first adjust L_19 for a minimum output at 4.07MHz, then adjust L_18 for a maximum output at 4.07MHz. Reconnect C_18 and adjust L_19 for a maximum output at 4.07MHz. Insertion loss response of the equalizer should be flat to within 0.5dB. Lift one end of C_30, short together the collector and emitter of T_5, reconnect L_19 for a minimum value at f_c' (4.333MHz).

The remaining inductor, L_50, may be adjusted using a return loss bridge (being set for a minimum at 2.93MHz). Alternatively, isolate the output of this equalizer and connect an oscilloscope to the input, and adjust for a minimum at 2.93MHz. In practice it is easier to use a pulse and bar waveform or i.t.s. off air and adjust L_50 for best bar corner shape (squareness). Remove the collector/base short on T_5, and, if used, the 1kΩ across R_14 and the 100μF in parallel with C_30. Reconnect C_13.

**Pre-sync filter**, Figs 57, 58

The pre-sync filter is required to improve the performance of the sync separator and obtain the correct relative timing of video and 'sandcastle' pulse at the decoder chip blanking/clamping operations. To do this, in order not to produce pre- or post-transition overshoots on the filtered signal, the filter is designed to rolloff in such a way that the group delay response is flat to the 3dB down point so that the sync separator chip then operates with clean input signals. The filter operates from 1kHz and corrects the 'sandcastle' pulse at the decoder chip blanking/clamping operations. To do this, in order not to produce pre- or post-transition overshoots on the filtered signal, the filter is designed to rolloff in such a way that the group delay response is flat to the 3dB down point so that the sync separator chip then operates with clean input signals.

The filter operates from 1kHz and corrects the 'sandcastle' pulse at the decoder chip blanking/clamping operations. To do this, in order not to produce pre- or post-transition overshoots on the filtered signal, the filter is designed to rolloff in such a way that the group delay response is flat to the 3dB down point so that the sync separator chip then operates with clean input signals.
source impedance, is terminated in a high impedance and achieves a minimum insertion loss of less than 1dB. No setting up is needed provided that the correct components have been used.

**Philips filter circuit**

The circuit of luminance and chrominance filter derived from a Mullard network is shown in Fig. 66 with the luminance amplitude performance in Fig. 67. The offset tapping of the 66μH coil was not made clear in the Mullard book. The luminance insertion-loss curve shows a rising response over the range 1.5 to 2.5MHz and a smooth fall to the 4.433MHz trap. The 3-4dB rise provides an aperture-correction effect and the smooth fall of the trap minimizes the group-delay distortion as shown in Fig.68. This is readily equalized by one A’ trap in the next section.

The overall effect of the notch and the equalizer results in overshoots and symmetrical rings. The overshoots occur because of the rising amplitude response; both the rings and overshoots are made symmetrical by having adequate group delay equalization. The pulse and step waveforms are shown in Fig.69. The size of the symmetrical overshoots provides horizontal aperture correction (by operating along the tv line to enhance the horizontal detail of the picture i.e. vertical edges are sharper). The width of these overshoots is such that, when added to the broadcasters aperture-corrected pictures, they appear as a rather heavy thick outline — typically seen at the sides of faces or dark to bright clothing boundaries. For pictures that are not good initially and for smaller screens (less than 20in) this size of overshoot is beneficial; it would also help receivers that are operating at the end of a long transmission chain.

The chroma-patch circuit is shown in the lower part of Fig. 66, with its insertion loss characteristics in Fig. 67. The near symmetrical amplitude response (to 6 dB points) about f₀ is suitable for a flat amplitude response video source.

If the video signal is fed from a typical domestic receiver i.f. then, if the centre frequency tuning point of the circuit is raised (so that the i.f. and filter responses together provide a symmetrical bandwidth), the 7.8kHz twitter at chroma transitions will be minimized. Fig. 70 (s.a.w. filter) and Fig. 64 (TX10

![Fig. 61. Group delay response of the luminance path between i.f. output and colour-decoder input.](image1)

![Fig. 62. 2T pulse and step waveforms having passed through the luminance path of i.f. output and decoder input.](image2)

![Fig. 63. Television screen display shows asymmetrical rings due to the lack of group-delay equalization in the f₀ notch or sound traps used between i.f. and colour decoder.](image3)

![Fig. 64. Chroma path insertion loss characteristic for the network between the i.f. and chroma demodulation (Ferguson TX10 receiver).](image4)

![Fig. 65. Group delay response for the chroma output shown in the circuit of Fig. 59.](image5)

![Fig. 66. Circuit taken from the Mullard book on consumer i.cs, March 1979. This 'application circuit' is fed with 2.7V pk-pk composite video from the i.f. stage and supplies 0.45V (sync bottom to white level) to the luminance input on pin 10.](image6)

The chroma circuit (showing these high-pass and low-pass cut off are nearly the same. Hence, since these responses are effectively in tandem a chroma bandpass results, albeit a somewhat narrow one.

The group-delay curve of Fig. 71 shows that both the upper and lower sidebands occurring at chroma transitions are time advanced with respect to the centre frequency f₀; the resulting amplitude and/or error is illustrated by the vector diagrams in Fig. 72.

**Alternative filters designed as second option to comb filter circuit of Fig. 34**

As a starting point it is assumed that all recently-designed receivers will use s.a.w. filters with the subcarrier down by between 2 and 6dB. This is equivalent to 35MHz in the i.f. bandpass as shown in Fig. 73 and represents a typical s.a.w. filter. Components such as RW 153P SY 153A (SW155 with f₀, 1dB down should be available later this year from SignalTech.) are designed for the UK PAL system I. With the comb filter replaced by an f₀ notch, and assuming a s.a.w. i.f. filter is in use, there will be no useful luminance energy above 4.1MHz. Fig. 74 shows the insertion loss of the notch which has a width and depth chosen as a compromise between conflicting picture effects. A narrow shallow notch would provide greater luminance resolution, because less luminance spectrum is removed, but would allow more of the sidebands generated at chroma transition through; a sharp cornered cut-off would result in rings being added to the luminance pulse and step components.

After subjective tests viewing differently shaped notches and with good quality live studio programmes, it was decided that a gentle roll off +650kHz 3dB points, 16-18dB deep seemed a good compromise. The equalized group delay curve of the notch in Fig.74 is shown in Fig. 75. The 100ns in the group delay curve near to 4MHz can readily be equalised as shown in Fig.76. The circuit of the filter and equalizer is shown in Fig.77. The insertion delay of the filter is 290ns and the filter was equalized up to this to suit the luminance/chrominance timing requirement of the decoder chip, i.e., for theTDA 3561A or 3560, this is the delay between pin 10 lumin-
A postscript article will introduce an up-dated approach to the tuner/i.f. section of a home receiver, introducing recent i.f. surface-wave filters and the necessary adjustments to the i.f. output and decoder input filtering. It will briefly outline a TV tuner/i.f. demodulator marketed by SPT Video and built to

BBC design RC1/511 (about £1,000 to buy). And other methods of picture enhancement will be included, for instance scan/velocity modulation (turbo-scan is the Sony name for it), and use of a controlled switched equalizer with the signal taken from taps on a delay line.
ance input and pin 3 chroma input. No luminance delay line is therefore required. The 2T pulse step performance of this equalized Chroma filter is shown in Fig.78. The overshoots of 2.1% for the pulse and 0.3% for the step are only visible when viewing electronically-generated test waveforms. This is because the group delay response is flat within a few nanoseconds up to 4MHz the amplitude response has fallen by 5dB, and continues to fall steeply. The group delay performance is therefore not important beyond this point. A suitable filter for the chroma path is an adaptation of the TX10 circuit. The width of the 6MHz trap can be reduced by increasing the capacitor values and reducing the inductors from 4.264 to 0.6µH. More importantly, this modification minimizes the group-delay effects in subcarrier area. Comparison of Fig.64 and 65 with 79 and 80 shows the modification. In the important area f1 40.5MHz there is now no group-delay reversal and a reasonable degree of symmetry exists. This improves the quality of the chroma waveform (after demodulation) at the chroma transition points. The revised circuit is shown in Fig.81. The chroma band-pass characteristic is determined by the s.a.w. filter response (Fig.73) as it falls to the 'sound shell', and by the high-pass response of the network between the i.f. and PAL decoder (Fig.79) if the additional circuit board of Fig.34 is used it will be further modified by the gaussian band-pass response (Fig.52) which has a reasonably symmetrical group delay response between the 0 to 6MHz down point. The sidebands of the chroma signal at the input of the demodulator have a fair degree of both phase and amplitude symmetry. Fig.82 shows the filter and the high-pass responses together representing the first two chroma-shaping components; the gaussian band-pass maintains the amplitude symmetry. The phase symmetry of the chroma sidebands is mainly determined by the two LC networks because the group delay response of the s.a.w. while mostly at low level (typically ±10 ns), shows a number of high rate-of-change spikes. The phase response is mainly determined by the filter group delay curve, Fig.80, which shows that the sidebands are similarly leading and lagging either side of subcarrier f,. (Note: amplitude modulation, as used for chroma signals, generates symmetrical sidebands.) Where the receiver has a good tuner and i.f. response, or uses a s.a.w. filter which is of the order of the 1dB down at f1, then the extra board containing the circuit of Fig.34 (WW March issue) will result in the gaussian band-pass characteristic also affecting the chroma response. The lower trace of Fig.52 (WW April issue) shows that the amplitude symmetry of this band-pass filter is adequate. The group delay response, Fig.53, when added to the group delay response of the high-pass network (Fig.80 WW April issue), results in a reduced overall group delay error as shown in Fig.83.

Luminance delay lines

These should ideally be flat from 0-5.5 MHz and have zero group delay error. The performance of a selection of delay lines taken from receivers, professional monitors and video recorders is shown in Fig.84. The performance of these delay lines is adequate for the video recorders, where the bandwidth is of the order of 1.5 to 2.5 MHz, but in the application of an improved PAL colour decoder only the fourth delay line illustrated (using a glass tube) was worth considering. The order of delay required at the DL1 position in Fig.34 (March) is 240ns. By dismantling a tube delay line to adjust the turns (removing deliberately about 20% of the 2 thou/48swg/0.04mm wire), a fair performance was obtained as shown in Fig.85 (delay line E). Delay line D would be adequate for the DL2 position in Fig.34.

A 240ns version of the delay line is made by Sprague part no. W3600.Z.145, colour-coded purple body with black rings and has a Z0 of 1kΩ. However these are difficult to acquire. Sprague say a minimum order of a 1000 is required, they want a turnover of £15,000 p.a., and that no UK distributor has the product! From Mullard/Valvo, however, a 340ns undipped delay line was obtained. After removing a proportionate number of turns to obtain the required delay (fr = f/N) i.e. x = 42 mm, the results shown in Fig.85 (delay line E) were obtained. If this modified delay line is used, the chroma cancellation at Tr emitter is less effective than for a perfect delay. This is so because,
TELEVISION

Fig. 83. Chroma path group delay resulting from the high-pass network with 6MHz sound trap, Fig. 81, and the gaussian filter of Fig. 79.

Fig. 84. Performance of four video delay lines (A, B, C and D) used in receivers, colour monitors or video recorders.

Fig. 87 (above right). Two type B group delay sections providing 200 to 240ns of insertion delay, the value required in delay line position DL1, Fig. 34, March issue.

Fig. 85. Rewound delay line (E), from which turns were removed until the correct delay value was obtained.

over the range ±1MHz about f, the delay line tranverses from -8 to +14 ns whereas the gaussian filter performance (Fig. 53) is +20 to -20 ns. Thus, the error is in the opposite direction. Adding 15 pH Painton/Sigma/KS chokes at each end of the delay line will redistribute the delay ripple and could change the shape across the chroma band to advantage as shown in lower traces of Fig. 85.

More luminance delay line options

In the prototype, two Matthey or Bal video delay lines are used each programmable in 5 ns steps up to a total of 155 ns because these give the best performance. An internal amplitude equalizer results in 1.8 kΩ appearing to the signal earth across the line. So as to minimize d.c. disturbance if using these components, balance this by adding 1.8 kΩ to the +12v raise for each line used. From agents or distributors the Matthey lines cost up to £36 each; if winding coils is possible the delay line can instead be constructed with discrete L and C components. From a past project a 200 ns delay circuit was utilised, giving performance as shown in Fig. 86. By suitable scaling for 240 ns, L and C values are multiplied by 1.2 to divide the frequencies by the same factor. The original (200 ns) and the modified (240 ns) circuits are given in Fig. 87 with the bottom circuit showing capacitors as preferred values. Insertion loss response is within 0.2 dB to 10MHz but the delay ripple, with the preferred C values, causes a slight loss in performance of the pulse-and-step test.

The 75 ohm characteristic impedance of the delay line matches most test equipment. However, the delay network can be tested within the circuit of Fig. 34 as was the output filter connected between R23 and R6. The components can again be scaled to give a characteristic impedance (Z0) of 220 Ω; then R23 and C6 in Fig. 34 would not be required. R8 and R9, should each then be replaced by 440Ω (or pairs of 220 Ω). To scale Z0, L values are multiplied by and C values by (using the values from the middle circuit of Fig. 87) before rounding the results to preferred values. (i.e. C is set to preferred values and L is then adjusted to return to the resonant frequencies.)

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On reaching retirement I thought that I would like to undertake some electronic projects to keep me alert and active, so I set about getting information and components.

In the last two months I have sent for catalogues, perused them carefully and then ordered successively as plans matured and I discovered further suppliers. Although I have ordered from fourteen component suppliers advertising in a variety of journals, many of them four or five times, with individual orders worth from just over £4 to £126.

I am sorry for industry and can understand some of their poor performance if they have the same sort of experiences that I have had, as well as for other hobbyists who are treated as I have been. Only two of the firms were fully efficient (E&T) and always sent a correct order — the others all exhibited one or more of the following, often more than once.

1. Wrong items sent.
2. Items sent not as described in advertisement or catalogue.
3. Items sent short.
4. Items not of the quality advertised.
5. Items not of the value ordered.
6. Items out of tolerance — the classic case was one order of metal film 1% resistors which, when measured, were not even within 2% tolerance! What of those items the amateur cannot check, such as complex i.c.s.
7. Despite phoning, items out of stock by the time the order reached the supplier.
8. Suppliers offering data do not send full information.

Manufacturers' data is very slow, sometimes not sent at all, even if s.a.c. is sent, as I nearly always do — do they want orders?

9. Catalogues have misleading, downright misleading and clearly wrong information yet most distasteful is the responsibility if this results in damage — I wonder whether their disclaimer would stand up in law?

10. Some firms pack individual items and groups of like items: one just bundled the goods together in one jiffy bag.
11. Few firms send with the goods an invoice listing the items sent, a few send receipts and some send nothing of this sort.
12. Despatch is always promised the same day as receipt of order.

Despite being on the western fringe of the country I have overnight first-class post to and from most parts, yet only one firm has actually got goods back to me on the third day — the time for the majority from posting here is six days, why advertise same day despatch? A moderately fast, reliable service would be more acceptable than a very fast unreliable one!

If this is the sort of thing that is going on throughout the industry and commerce on this scale then I think we as a nation have no future, for it is adding unnecessarily to costs and wasting time for productive work. This we certainly cannot afford in the present economic climate of the world and of our country.

D. S. White
Gwynedd

DOMESTIC EMC

The RSGB's 56th a.g.m. which was reported in the November 1983 issue of the Society's journal, Radio Communication, contained a number of references to the proposed new Telecommunications Bill. Similar to the Australian Radiocommunications Bill (Act), it replaces the old Wireless Telegraphy Act. However, unlike the Australian Act, the UK Bill seems to contain little or no legislation to cover the EMC problems with domestic electronic and entertainment equipment. When asked why this was not covered, the RSGB President replied that he considered this to be a most difficult area and that the Bill would prove unworkable if extended into this area.

Considering many European countries, the USA and Australia are addressing themselves very positively toward the effective EMC control needed to allow the complex electronic communications and control equipment, which will take us into the 21st century, to function correctly and efficiently: And, the constant flow of reports from the UK which indicate the EMC problems with domestic electronic and entertainment equipment is increasing at an alarming rate. It is therefore, indeed, most surprising to see that the RSGB taking such a negative attitude towards a problem which has given UK amateurs such a headache for so many years.

No such difficulty or concern was expressed, or is considered, by the world's most senior amateur radio society — The Wireless Institute of Australia. The WIA worked in close cooperation, as always, with the Australian Department of Communications in the production of the new Radiocommunications Bill. Indeed, the DOC and the WIA gave very special consideration and attention to the extensive and extremely comprehensive EMC section of the new Act.

A.D. Tregale, VK3QQ
ARTAC International
Watsonia
Australia

LICENCE REGULATIONS

There can be few British radio amateurs who have not, at some time, been in a situation where they would have dearly liked to ask the station to whom they were communicating, for example, send a short greetings message to a friend or relation whom they haven't seen for years or, just ask simple route directions for a friend. For British amateurs this is designated, by the licensing authorities, as 'third-party' and is, in general, forbidden! Any sensible reason for these medieval and totally unnecessary restrictions, remains a mystery!

British amateurs, for years, have had to remember to be extremely careful to avoid mentioning, over-the-air, anything which could, even remotely, be considered 'third-party'. Not only for fear of repercussions from the authorities, but in consideration of the other station, who also has to live under these austere and antiquated regulations. It appears that the British licensing authorities consider the Amateur Radio Service has progressed little since the days of Marconi, and spark transmitters.

Members of the Amateur Radio Service did, in the old days, a great deal of home construction and experimentation. There were two main reasons for this; the only radio equipment available was built by amateurs and enthusiasts and there was an obvious need to do extensive research into the basic concepts of our primary radio communication modes.

With modern communications technology we are, in the main, addressing ourselves to the more detailed and specialized areas.

Our previously developed primary communications systems allow us to communicate ideas and information about these specialised subjects, thereby promoting higher levels of national and international technological development.

Equally important, in these days of world tension, is the development of national and international friendship, through communications. Fortunately, this latter area has been especially cared for by many of the new members of our service. Unlike the old days, when it was of prime importance to place great emphasis on the technical aspects of our primary communications systems, there is today a leaning towards communicating for friendship, with experimentation and research as closely related secondary subjects.

Modern economic trends are towards shorter working weeks, more leisure time, and increasing psychological pressure during the time at the work place: therefore, a greater number of people are looking for suitable relaxing hobbies and, amateur radio is indeed most suitable. Consequently, the obvious and simple extension for members of the British Amateur Radio Service would be the lifting of the third-party restrictions.

Australian amateurs shook off the third-party restriction shackles some three years ago, took a breath of the fresh air, and never looked back. It is indeed most refreshing not to need a barrister in the shack!

A.R.T.A.C. International would like to hear from anyone interested in the removal of this totally unnecessary restriction on the British Amateur Radio Service.

A.D. Tregale, VK3QQ
ARTAC International
Watsonia
Australia
FEEDBACK

ELECTRIC CHARGE FROM A RADIO WAVE

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

Is it not true that the velocity in space of a guided electromagnetic wave is independent of the motion of the conductors that do the guiding? In other words, even in principle we cannot drive a waveguide backward so that the wave it carries is arrested in space. Now this objection does not apply to the discrete component machine described in the article. The waves associated with such a machine are not electromagnetic waves in space, but as I said in my earlier letter, more like the waves we find on a polyphase machine. As such they have a velocity relative to the hardware of the machine. Perhaps Mr Hesketh has raised unwittingly a more serious objection to Professor Jennison's demonstration than at first occurred to me. We cannot use a machine that generates waves having a velocity which can be vectorially combined with the velocity of the machine to explain phenomenon where the waves have a velocity that is independent of the machine velocity.

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

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

ENERGY SAVING

Mr Cummins states that he uses no supplementary heating and implies that for this reason he does not need thermostats in individual rooms.

I would applaud his basic design approach but should be very interested to know how in practice it copes it copes with three unavoidable sources of supplementary heat: (a) solar radiation, (b) people and (c) their reading lights and televisions. I find that the first alone, here in the north of Scotland at any rate, can entirely obviate the need for heat from the radiators. In South-facing rooms even on cold days, and in specifying my central heating installation I considered room thermostats to be essential in South-facing rooms and highly desirable in other rooms whose occupancy was liable to vary much during heating hours.

Ian Leslie
London N 10

PROBLEMS IN SPECIAL RELATIVITY

I am sorry that Professor McCausland found my simple arithmetic derivation somewhat obscure. Had he persevered he would have discovered that C.F. Coleman was quite right. Dingell was, and McCausland is still, confused over the distinction between simultaneity and synchronicity, as the latter's comments on Coleman's letter now make clear.

McCausland states, correctly, that Einstein's procedure for synchronising clocks was based upon the out and return journey of a light beam between clocks A and B. McCausland, (not Einstein) then adds, 'If the reading on B at the moment of reflection is halfway between the readings of A at emission and return of the flash, the clocks are synchronised'. Not true, as my worked example shows. This requirement actually means that clocks A and B both reach time, say 1200h simultaneously. He has tried to smuggle in simultaneity under the guise of synchronicity, and it need not be done. This is the advantage of a worked example -- it uncovers the verbal ambiguities.

Let me spell it out. There is no observational procedure which will enable clock B to show the same time simultaneously with A for a moving clock. In a vicious circle in the procedure I challenge McCausland, or anybody, to produce one. McCausland's error is fundamental and the remainder of his argument now fails.

Statements involving the expression 'real effect' need clarifying. If observed a physical phenomenon using the best instruments, the best scientific procedures, and after repeated measurements arrived at a result, I should be somewhat surprised if somebody said that my results were only an observational effect and that the real effect was something different. I should conclude that the someday either knew something that I did not, or was indulging in metaphysics. In either case I should ask for observational evidence.

J.C. Laine
Lymington.
Hants.

POWER OSCILLATOR

In the 1970 September and October issues of Wireless World you were good enough to publish details of my new 13 Watt sine wave oscillator, which resulted in some adverse comments from Thomas Roddam, one being about the cores used. In order to cut down on the number of cores used it was decided to try using a pair of E cores (Mullard FX1818) with the emitter and collector coils on the outer limbs. This arrangement works very well in practice as well as being much cheaper. The phase shift coil was also made using a pair of E cores (Mullard FX1652) and the final design resulted in a unit 4in long by 1in wide and 3in thick, weighing 4 ounces. The oscillator in this form was used to drive a 13 Watt fluorescent 21 inch tube. A large number of these were used to provide lighting in a factory during the power cuts of the early 70s. A car ignition unit was also built and tested in a Fiat car on a tour of Europe. I still have the original unit and demonstrate it to those who show interest.

The oscillator was invented in 1959 to provide the bias and erase for a small high quality tape recorder for use in the news gathering business. The circuit was given the final patent in 1962 and also patented in Germany, Japan and America. I am the sole inventor of the oscillator as can be verified by the Patents Office. I must admit to being puzzled by the lack of interest and discussion about the oscillator which is quite a breakthrough in sine wave power oscillators. The fact that the transistor does not need a heat sink and will continue to operate in temperatures up to 1200C thought would have aroused some interest, particularly as the current falls with an increasing temperature. I also have a short circuit of the output indefinitely if capacitively coupled to the load, there being no current flow when oscillation ceases.

I am enclosing photographs of the fluorescent lighting unit and the ignition unit to show the coil assembly used for the emitter and collector coils.

H.L. Armer
Alvaston
Derby

THE MIND-FORG'D MANACLES

I'm pleased to see you quoting from Blake in your April editorial. Perhaps I could answer with another quotation:

Now I a fourfold vision see,
And a fourfold vision is given to me;
'Tis fourfold in my supreme delight
And threefold in soft Beulah's night;
And twofold Always. May God us keep
From Single vision and
Newton's sleep!

The single vision which Blake so feared corresponds exactly to what you call the 'technicization of society'. Many people outside of technology have noted the acceleration of this process but, lacking inside knowledge, have been unable to challenge it at its base. Their impotence has resulted in a blind despair of technology, a sort of modern-day Luddism, whose danger is that it could lead to the formation of a dual society: technocratic and desperate on the one hand, anarchic and desperate on the other.

It is left up to engineers and technologists themselves to awake from Newton's sleep and, taking control of the process, direct it back towards the humanization of technology. The 'characteristic mode of thinking and feeling that determines the way machines and systems are designed and interact with people' must be consciously recognised and modified if there is to be a human future.

Tim Williams
Tunbridge Wells
Kent.
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These precision box jointed pliers and cutters are manufactured in West Germany and are of extremely high quality. They are supplied to and used by the electronics industry. They all have double leaf springs, moulded on PVC grips and polished heads. The cutters have induction hardened cutting edges.

As a little test of the quality and the squareness and fit of the jaws we tried holding pieces of paper with the pliers and cutting the paper with the cutters— we were extremely impressed. Naturally we also tested them with wire and were equally pleased with the results.

We decided to offer readers the alternative of a set of the three most vital tools, comprising top cutters, side cutters and snipe nose pliers (smooth inside jaws). All are approximately 4½” long. In shops this set (Set A) would cost about £29.70, but our price to readers is £19.50 incl VAT and UK p&p.

Our alternative choice is the above set plus a pair of round nose pliers which are extremely useful for shaping wires, etc. This set (Set B) comprising the four too’s would normally cost £38 but we are offering it at only £24.75 incl VAT and UK p&p.

We regret the tools are not available separately— only the sets as offered.

To order either of the above, use coupon or photocopy or on plain paper and send with crossed cheque/PO made out to Wireless World Offers. Send to Pliers Offer, 48 Beauchamp Place, London SW3 1NX. Allow up to 28 days for delivery, UK addresses only. Closing date July 31st 1984. VAT receipt will be supplied if SAE is enclosed with order.

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Automatic speech recognition

Speaking communication between man and machine is needed for many applications—in military use, where hands are otherwise occupied, where the communicator is disabled or where it is simply more convenient. Tom Ivall reports on two recent meetings.

Machines are needed to wreck a nice beach...... If you have read that sentence purely visually, as most people do, you will be somewhat puzzled. If, however, you heard it being read aloud, fairly quickly, you probably would have interpreted the last part of the continuous stream of sound as the entirely appropriate words "...recognize speech."

This rather artificial example illustrates one of the characteristic problems in the automatic recognition of speech by electronic systems. Electronics can analyse the acoustic speech signal perfectly well in terms of amplitude, frequency, time and other such parameters, but how does it translate the result into a correct message—either in printed words or merely as data for controlling a machine—when such ambiguities are possible?

According to J. S. Bridle of the Joint Speech Research Unit (JSRU), who supplied this example, aural ambiguity is the most difficult problem of all. Another is the problem of continuity. In normal speech the words run together into a continuous stream of sound, as shown by the spectrogram of the two words "go away" in Fig. 1, so how does a machine find the linguistic and semantic boundaries? In any case, the mouth movements required by particular junctions between spoken words modify the sounds of the syllables on either side of these boundaries.

Then there is the problem of variability of pronunciation—for example, in utterances of the same word by different speakers, or in different rates of speaking, even by the same person. Finally, there is a big problem in the sheer complexity of the different levels of meaning in spoken language (e.g. if you say to a machine "Can you tell me the time?" you don't want it to just answer "Yes").

Mr Bridle was one of the speakers at a recent IERE colloquium on "Speech Input/Speech Output" held at the Royal Institution in London. This followed shortly after a similar London meeting, an IEE/IERE lecture on "Man-Machine Speech Interface" given by Dr J. Laver, a phonetician from Edinburgh University. Together these two meetings gave a useful picture of current activities and achievements in what is now called speech technology—mainly speech synthesis and speech recognition.

But why do we want this particular kind of man-machine interface? What is wrong with the established m.m.i. techniques using keyboards, v.d.u. screens, printers and the like? The most general answer seems to be that in some jobs the operator's hands and eyes are already heavily occupied, sometimes with multiple tasks. They should be kept as free as possible to concentrate on procedures that are more important than data input/output.

One group of speech interface applications is where technical solutions are being sought for very pressing reasons, such as helping the pilots of fighter aircraft to operate systems so that they can concentrate their main attention on tactics. Here, plenty of money is available. Dr Laver remarked, in a regretful tone, that "the military market constitutes the major driving force behind this technology."

A second, less pressing group of applications are the "hands busy" tasks in industry that require data entry—inspection, quality control, package sorting, office machinery, computerised map-making, handling very dirty materials—where operating a keyboard can be very inconvenient. Japanese banks have been using speech recognition for some years to help counter staff deal with customers' enquiries, and now a Japanese ship-building firm is trying it for engine control in a coal-carrying vessel.

Aids for the disabled, such as voice control of wheelchairs, are a socially useful group of applications (see, for example, April 1984 issues, News, p.59). Finally, there are those applications which are not really necessary in any urgent sense but exploit the wide availability of the ordinary telephone as a cheap form of speech input/output. Of course, this has a mass-market potential for the electronics manufacturers. New automated services now being tried out include telephone directory and train timetable enquiries, telephone banking, voice activated dialling using keywords like "Mother", and voice activation of telephone switchboards for disabled operators.

Much of the current commercial equipment for speech recog-

Fig. 1. Spectrogram of spoken phrase "go away", showing formants. In some speech recognizers, spectrum analysis by filter banks provides acoustic information which subsequently has to be translated into linguistic/semantic data. (Horizontal scale is time; recording density is proportional to acoustic energy.)
Fig. 2. The SR-128 connected-speech recognition system made by Marconi Space & Defence Systems uses a template-matching principle and has a maximum vocabulary of 240 words. Syntax can be applied to isolated keywords. Utterances can be up to 8s long and recognition response time is 50ms.

Vocabulary is limited, to perhaps several hundred words rather than the several thousand desirable. Some recognizers will work only on isolated words, with pauses separating them from the preceding and following words. Most commercial recognizers are 'speaker dependent': they can be calibrated with one particular voice, the one that has been used to 'train' them. The spoken words must be carefully enunciated and acoustic background noise must not be allowed to interfere — a real problem in aircraft cockpits, for example.

Thus the ambiguity problem discussed above is just sidestepped: the words can have only one prescribed meaning, or nothing at all. Overall the result, in the words of Dr J. N. Holmes of the JSRU, is that "communication with machines by speech is at present pathetically trivial compared with speech communication between humans." And Dr M. J. Underwood, of the Alvey Directorate, argued that "the difficulties arising from the fact that the systems do not necessarily match the users' jobs, skill or experience."

Dr Underwood was issuing a general warning against the "fable argument" that, because speech is man's most natural form of communication, spoken communication with computers and other machines must be worth doing. And J. Paterson of Logica joined him in the view that the problems of matching systems to applications were now more pressing than the purely technological problems of equipment design. Mr Paterson felt that a major goal, in this applications task was minimizing access or transaction time, which was influenced by both the type of transaction and the error rate.

**Technology**

Most speech recognizers start with a signal processing section, which analyses the acoustic waveform of the spoken words. This is followed by a digital information processing section, basically programmed logic, which makes decisions about the linguistic/semantic meanings of the parameters presented to it, on the basis of some algorithm.

Dr Laver referred to a distinction that is often made, between systems based on the principle of 'template matching' and systems that extract specific phonetic features from the acoustic information. The important point here is that template matching — trying each input acoustic pattern, typically a whole word, against a vocabulary of stored reference patterns — does not have to depend on any explicit theory of speech. The process would work just the same if the input and reference patterns were sound of dogs barking, whistles blowing or anything else that makes a noise. The basic simplicity of this template-matching principle — and the fact that it can be used on continuous sequences of connected words as well as an isolated single word — makes it very attractive for use in commercial equipment. Its main drawbacks are that it tends to be speaker-dependent and limited in vocabulary. Dr Laver agreed with an American opinion that "template matching will not be able to attain human levels of performance."

The alternative principle, of extracting phonetic features, does, however, depend on explicit theories of speech. In general it uses phonemes — the smallest elements in speech sounds capable of meaning — as speech units. The differences, mentioned by Dr Holmes as a particular problem in speech synthesis, are due to coarticulation: the sound of a driven vowel or consonant depends on the articulatory movements necessary to form the vowels and consonants immediately before or after it.

The use of phonemes, as against whole words, allows great flexibility and a high level of performance, but it also introduces considerable difficulties. Basically, how are phonemes identified from the extracted acoustic features? To begin with, only some of the information in the speech signal is relevant to the recognition process. Parameters that are in fact relevant can include peak values, frequency of zero crossings, times between prominent peaks, the sum of squares of waveforms over a period of time and so on.

Time varying patterns of local peaks in power spectra — the forms in Fig.1 — are important clues to recognizing phonemes, especially their dynamic properties. Various electronic techniques being used include spectrum and cepstrum analysis, Fast Fourier Transforms, autocorrelation, and autoregression or linear
prediction. (See, for example, recent issues of *IEEE Trans. on Acoustics, Speech and Signal Processing.*)

Several lecturers agreed that the information processing stage, following feature extraction, will need much more research on how to use artificial intelligence in this field. Dr Laver pointed out that the Japanese were employing multi-disciplinary methods involving signal processing, computer technology, phonetics, linguistics, artificial intelligence and ergonomics to achieve very ambitious goals in a 100M dollar project up to the end of 1993. This would involve parallel processing at speeds of 40 million instructions per second in 1986 and 500 m.i.p.s. by 1989.

As an example of what is needed, Dr S.J. Young described work at Manchester University aimed at finding better forms of man-machine dialogue than those controlled by the rather rigid and artificial 'menu' type of interaction. He recommended a "data driven" dialogue control and described a prototype system in which knowledge necessary to run an intelligent and flexible dialogue is encoded in special kinds of data structures.

The two meetings, however, revealed rather more about the technology of current template-matching systems. These have achieved good results mainly through the use of a very powerful algorithm based on dynamic programming. J. Wilson demonstrated the Marconi SR-128 speech recognizer using this technique and J. S. Bridle explained the broad principle. The Logica system shown in Fig.3 is based on dynamic programming and this algorithm is programmed into some i.c. chip sets.

In this method, matching between an input pattern and a stored reference pattern is achieved by an optimisation technique, while time-normalisation copes with one of the oldest problems in automatic speech recognition: the variability of speaking rate. This amounts to a non-linear variation of the timing of the input pattern for a word, or sequence of words, relative to the time-scale of the reference pattern. With the dynamic programming algorithm, the timing differences between the two patterns are eliminated by dynamically distorting the time-scale of one to obtain maximum co-incidence with the other.

Dynamic programming — not to be confused with any kind of computer programming — is a mathematical technique used in optimisation problems and is useful where time-dependence and non-linearities are involved. For example, the control problem of steering a vessel to reach a desired destination by the optimum path (shortest or quickest) can be seen as a multi-stage decision process, in which the steering has to be repeatedly re-decided along the route to counteract the non-linearities introduced by currents, wind and other perturbations.

Inventory control in a factory is another example of a multi-stage decision process. The inventory of a particular item depends on the previous day's inventory, the production quantity decision in the factory, and the random demand from customers. In general at each stage of a multi-stage decision process the current state or result is a function of (a) the state at the previous stage, (b) any action made by a decision, and (c) any random event that occurs.

In the template-matching speech recognizer, the two patterns, input and reference, are typically spectrum analyses produced by filter banks. The Fig.3 system, for example, uses a bank of 20 bandpass filters. The information produced has the parameters shown in Fig.1: energy/frequency with time.

Analogue digital conversion produces two patterns of stored digital data, which are compared. In Fig.4 these two patterns, input (A) and reference (b), are shown in relation to each other as sequences of units called 'frames' (a1, a2, ... etc. and b1, b2, ... etc.). Each frame is a digital 'cross-section' of the spectrum analysis corresponding to a particular instant of time. If the A and B patterns are identical the curve relating them would be a straight line (a = b). In reality, the timing non-linearities make the curve a crooked one, such as the one shown, with its sequence of points, c1, c2, ... etc., indicating the timing differences between the patterns.

This curve is a function which maps the pattern A time-scale onto the pattern B time-scale — a 'time-scale distortion' function. The dynamic programming algo-

![Fig.3. This continuous-speech recognition system made by Logica is based on techniques developed at the JSRU. Using a template-matching dynamic programming algorithm, it has a vocabulary of 120 words expandable by extra storage to about 2000 words. Syntax and error correction strategies can be programmed in.](image)
SPEECH RECOGNITION

Fig. 4. In the dynamic programming algorithm for speech recognition, timing non-linearities in the input speech pattern relative to the reference (template) pattern are eliminated by distorting the time-scale of one relative to the other. In this graph, input and reference patterns consisting of spectrum analysis 'frames' are related to each other by a 'time-scale distortion' function.

A company has been formed to offer a mail-order catalogue service for test and measuring instruments, with cables, connectors, kits and accessories. There is no minimum order and the catalogue is aimed at the small business and home constructor. Supercor Electronics Ltd, PO Box 201, St. Albans, Herts AL1 4EN. EWW 258

Over 1300 new products are included in the latest edition of the Verospeed catalogue, which in its 400 pages covers a total of 7500 products, telephone and computer connectors and cables, keyboards, proximity and microswitches, a wide range of test equipment and many tools and accessories. Verospeed, Stansted Road, Boyatt Wood, Eastleigh, Hants SO5 2ZV. EWW 259

Weir Electronics have published an introductory leaflet outlining the capabilities of their display division which specializes in the design and manufacture of data display monitors. Described is a wide range of mono-chrome and colour video display modules with brief performance specifications. Weir Display Division, Durban Road, Bognor Regis PO22 9RW. EWW 260

Texas Instruments has published a Master selection guide on its semiconductor ranges. The 14-page guide gives outline data and packaging information on all TI components including memories, logic arrays, digital products, linear products, telecommunications circuits, opto-electronics, and power and small signal devices. Included are details of TI's latest products. Copies available free from any TI distributor or by phoning TI at Bedford (0234) 223000. EWW 250

The extensive 'C' range of Eurocards, rack-mounted computers and peripherals has been described in detail with extensive illustrations specifications and technical information in a 150-page catalogue. Development systems based on Eurocards are a specialty of the company and they produce direct, and often enhanced replacements for the Acom range. A new range of Delegate/Unicube modules are designed for industrial and laboratory control. There is also an extensive range of add-ons for the BBC microcomputer. Ferranti Electronics Ltd, Unit 2, Anderson's Court, Newnham Road, Cambridge CB3 9E2. EWW 251

The specialist computer company, Unit C, has published a useful pocket-sized guide to its range of 68000 VME and Pascal-2 products. The guide describes the 68000 VME and Q-Bus hardware together with the Unix system III operating system and Pascal-2 supporting software. Development software is available for Unix/68000, DEC RSX/ PDP or DEC VMS/VAX hosts. Stand-alone 68000 target support can also be provided by means of the y-SoS real time executive. Unit C Ltd, Dominion Way West, Broadwater, Worthing, West Sussex. EWW 253

A catalogue lists software available for Torch computers, from Torch themselves and from other software houses. Over 140 programs are listed for the computers which are networked Unix and CP/M compatible operating systems. By purchasing the Torch add-on, the programs are also available to users of the BBC micro/Torch Computers Ltd, Abberley House, Great Shelford, Cambridge CB2 5LQ. EWW 254

Ferranti Electronics has issued a colour brochure highlighting their new generation of power mosfets. The mosfets are suited to a wide range of switching and amplifying applications where high input impedance, high gain and fast switching is desired. The brochure gives basic mosfet information with the aid of clear diagrams, and there is a tabular selectors guide giving the range of devices on offer. Ferranti Electronics Ltd. Fields New Road, Chadderton, Oldham, Lancs OL9 8NP. EWW 255

A 16-page colour brochure gives full technical details of the recently-introduced Gould 5110 intelligent 100MHz oscilloscope system. The 5110 automates many oscilloscope measurements and has a built-in IEEE interface for use in automatic test systems. It is controlled by a keyboard/menu system. Numerous application examples are given and the instrument's operating modes and controls are clearly illustrated. Gould Design and Test Systems Division, 40 North Road, Haydon, Ilford, Essex IG6 3UE. EWW 256

LITERATURE RECEIVED

The specialist computer company, Unit C, has published a useful pocket-sized guide to its range of 68000 VME and Pascal-2 products. The guide describes the 68000 VME and Q-Bus hardware together with the Unix system III operating system and Pascal-2 supporting software. Development software is available for Unix/68000, DEC RSX/ PDP or DEC VMS/VAX hosts. Stand-alone 68000 target support can also be provided by means of the y-SoS real time executive. Unit C Ltd, Dominion Way West, Broadwater, Worthing, West Sussex. EWW 253

A catalogue lists software available for Torch computers, from Torch themselves and from other software houses. Over 140 programs are listed for the computers which are networked Unix and CP/M compatible operating systems. By purchasing the Torch add-on, the programs are also available to users of the BBC micro/Torch Computers Ltd, Abberley House, Great Shelford, Cambridge CB2 5LQ. EWW 254

Ferranti Electronics has issued a colour brochure highlighting their new generation of power mosfets. The mosfets are suited to a wide range of switching and amplifying applications where high input impedance, high gain and fast switching is desired. The brochure gives basic mosfet information with the aid of clear diagrams, and there is a tabular selectors guide giving the range of devices on offer. Ferranti Electronics Ltd. Fields New Road, Chadderton, Oldham, Lancs OL9 8NP. EWW 255

A 16-page colour brochure gives full technical details of the recently-introduced Gould 5110 intelligent 100MHz oscilloscope system. The 5110 automates many oscilloscope measurements and has a built-in IEEE interface for use in automatic test systems. It is controlled by a keyboard/menu system. Numerous application examples are given and the instrument's operating modes and controls are clearly illustrated. Gould Design and Test Systems Division, 40 North Road, Haydon, Ilford, Essex IG6 3UE. EWW 256

ELECTRONICS & WIRELESS WORLD JUNE 1984
function generator
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<table>
<thead>
<tr>
<th>Valve Code</th>
<th>Description</th>
<th>Price</th>
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The proven upgrade for the BBC Micro. Comprising 2 X 400K disc drive, 260 processor with 64K of memory, and a CP/M compatible operating system, it opens up the vast range of CP/M software, including advanced languages, scientific and business applications. The software comes with the PROPER software range, including PROPER WRITER, PROPER SPEAKER, PROPER CALCULATOR etc. The whole TORCH Z80 programme is supplied allowing access to information, and communication, between a multitude of BBCs.

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- Personality selection is simplified by a single rotary switch.

- Programmable socket selection.

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The programmer comes complete with cables, software & operation manual £125.00a £9.75e. Software on disk £12.00e.

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**TEXT CLIPS**

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NEW LIGHT ON MULTIMETER

An optional feature of the new Philips PM 2518 Multimeter is a low-power electroluminescent strip which acts as a backlight for the large l.c.d. The display is automatically illuminated when the ambient light level is too low. This enables the use of the meter in dark and awkward places such as testing equipment on site and in photographic darkrooms. The backlight also switches itself off automatically if no reading has been taken for 30s. With the back light illuminated, the meter still has a battery life of some 200 hours.

The meter uses a microprocessor linked to other i.c.s internally by the Philips/Intel I'C (inter integrated circuit) bus. An I'C adaptor will be offered as an option which will allow users of the meters to carry out maintenance and calibration tests with the meter interfaced to a computer.

Facilities offered by the meter are claimed to match those of many bench multimeters. It is autoranging and offers a basic d.c. accuracy to within 0.1%. Alternating voltage and current measurements are true r.m.s. Voltage measurements are up to 1kV and (with a special high current probe) current measurements are up to 30A. Resistance range is between 1kΩ and 100MΩ with a resolution in the 1kΩ range of 100mΩ. There is also a diode test facility, a dB scale, a bleeper output for continuity testing which also acts as a warning if any range is exceeded. Temperature readings between -60 and 200°C are possible with an optical temperature probe. There is very little bandwidth (10Hz to 10kHz) for a.c. measurement which combined with the true r.m.s. reading is very suitable for audio measurement. Bandwidth may be increased further with h.f. probes, up to 1GHz. Safety test leads are provided which are unaffected by, for example, burning with a soldering iron. A wide range of optional accessories are available including the various probes mentioned above. The basic costs £165; with back light it comes to £199. Pye Unicam Ltd, York Street, Cambridge CB1 2PX.

EW210

INDUSTRIAL CONTROLLER

A single board computer based around a 6809 processor has been especially produced to suit the needs of the engineer and process designer. The 6809 has a wealth of readily available software and programs may be developed quite easily for a particular application. This single Eurocard may be interfaced with the Acorn/BBC computer, which may then be used as a development system for the software that will run on the controller. The system may be used to write programs in the control language PL9, or any of a number of languages including BCPL, Pascal, C or assembler. The use of the board is very flexible and the memory map of the system can be redefined to any preferred configuration. The control board can address up to 64K of read/write memory, ideal for applications where real-time data storage is required. The board incorporates battery back-up circuitry and there are two sockets for eight-bit memories such as eproms up to 16K, or 8K c.mos or n.mos read/write memories.

Thus its capabilities range from a device with 32K of rom and 32K of ram or just 4K of rom and 56K of ram or in a minimal configuration of 4K rom and 2K of ram. So superficially functions may be removed, thus cutting the cost of the controller card. The on-board versatile interface adator provides two 8-bit parallel t.t.l.-level i/o ports with protocol control lines and there are a pair of interval timers for real-time interrupts. The v.i.a. communicates with the outside world through a 26-way connector. Microprocessor control, data and address lines are available through a 64-way edge connector and not only will this connect to a host computer but may also be used to connect other cards such as extra digital i/o, a-t-o and d-to-a converters, opto-isolated mains switches and any other Acorn- bus compatible circuits. The board may also be used as a second processor for the Acorn/BBC computer by way of an interface board and may then be used to run Flex software. The basic price for the 6809 board is £229, another £20 will get you the 68090-to-BBC interface, software on floppy disc to link the BBC and 6809 is £10 and also on disc is an unconfigured Flex with assembler and editor and full operational manual for £130. Cambridge Microprocessor Systems Ltd, 11 St. Margarets Road, Girton, Cambridge CB3 0LT.

EW212

EPROM ERASERS

Three new low-cost eprom erasers have been designed for use in the laboratory, classroom and by the hobbyist. All three versions use a simple drawer construction for easy access. The drawer is lined with high-density anti-static foam to hold (depending on the model) 20 or 40 devices to be erased at one time. A low-power light source has been selected to keep the unit cool while emitting the correct level to the eproms. The tube is fully enclosed. Unit 82 for 20 devices costs £31.25, 84 takes 40 devices and costs £44.95 and for a further £10, Unit 84T may be purchased and this includes a timeswitch to prevent over-cooking the chips. Time is variable between 10 and 30 minutes. An l.e.d. indicates when the unit is working. J. P. Designs, 37 Oyster Row, Cambridge CB5 8LJ.
LOW-COST OSCILLOSCOPE

This general purpose, dual-trace oscilloscope costs £225 and is made by Bridge, in Skipton, N. Yorkshire. The DB242 has been specially developed to cater to the needs of educational and industrial laboratories, and test and service bays. Small in size and portable, the oscilloscope is also suitable for radio, tv and hi-fi maintenance. Ease and speed of use have been considered important in producing an instrument which the makers claim is easy to understand and yet versatile. The display has a medium-persistence phosphor on a 60 by 50mm screen which has a calibrated graticule. There is a trace location button and an auto brightline triggering system. Sensitivity can be varied from 50mV/cm in independent switched sequences for each channel. Sweep speeds can be varied from 1µs/cm to 0.25s/cm using a calibrated switch. The scope complies with British and EEC safety standards and has been made with safety in mind. A cheaper single-trace version with the same general specification costs £195. Bridge: Scientific Instruments Ltd, 63 High Street, Skipton, North Yorks. BD23 1EF.

EWW 231

LOGIC ANALYSER FOR HOME MICRO

An add-on unit which turns the Acorn/BBC computer into a logic analyser is available. The Hawk 3210S is controlled from the computer's keyboard and provides 32 t. i. 1. or variable threshold input channels. The computer with disc drives, monitor and printer is used to provide diagnostic processing, display, recording and hard copy facilities. Once data has been recorded on disc it can be processed by the computer as the requires.

Each channel captures 1024 samples, including any glitches, timed by an internal clock programmed to run at 10MHz, or by an external clock. Triggers may be programmed in binary, octal, hex, decimal or ASCII for each channel and pre or post triggering can be varied by up to 1024 samples delay.

In timing mode the system can display 16 out of the 32 channels concurrently for comparison, while in parallel mode all 32 channels can be displayed in the chosen format. Glitches are detectable to 30MHz and their display is optional, as an overlay to other data. The unit is menu driven, with on-screen prompts and a 'help' display page. Most programming selections are made by a single key input.

Another version of the unit is available for use with Apple II and Ile computers. Hawk Electronic Test Equipment, Bircholt Park Industrial Estate, Maidstone, Kent ME15 9XT. EWW 232

BUILD A 16-BIT CONTROLLER

A microcomputer dual-processor controller card is built around the Motorola 68000 and 68701 processors. It feature on-card eprom (up to 32Kbytes) and ram (16Kbytes), a real-time clock, serial RS232 interface and a parallel printer port. The card is designed to the G64 bus specification and comes on an extended Eurocard. This card may be combined with a 256Kbyte memory card and a dual-density disc controller to form the SAT-16 computer system. The control system gives four selectable data transmission rates, an on-card self test that is carried out each time there is a power reset, direct memory access operation and is easily expandable. Interfacing to the G64 bus is provided by tri-state buffers, data transfers are asynchronous for off-card memory and on-card resources but synchronous for peripherals. Any existing eight-bit peripheral which is G64 compatible may be used directly with the Sat-16 card.

The 68701 contains software programmed within it that provides the user with the normal communications dialogue with its co-processor the 68000 and a number of user commands. The software is installed within the 68701 at manufacture but may be modified, although a 68701 programmer is needed for this. The system is aimed at giving would-be 16-bit users a system at a reasonable cost which can be for single-board applications or expanded as required.

Built and tested the c.p.u. card costs £299; in kit form its £280, and a starter kit which includes the bare p.c.b., p.a.l. devices, 68701, i/o software and full documentation is £150. Built modules, kit or bare boards are available for the RS232/printer adapter, a six-slot back board and a bus terminator board. Satellite Services Ltd, 9 King Street, Sileby, Leics LE12 7LZ. EWW 230
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<tr>
<th>Type</th>
<th>Output Power</th>
<th>Load Impedance</th>
<th>Price</th>
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<td>1.6 - 8</td>
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<td>HY60</td>
<td>3.0 - 8</td>
<td>1.5Ω</td>
<td>£29.95</td>
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</table>

MOSFET MODULES
Ideal for Disco's, public address and applications with complex loads (line transformers etc.). Integral heatsink slew rate 20v/µs distortion less than 0.01%

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<thead>
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POWER SUPPLY UNITS

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PREAMPLIFIER MODULES
All modules are supplied with in line connectors but require potentiometers, switches etc. If used with our power amps they are powered from the appropriate Power Supply.

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<th>Type</th>
<th>Application</th>
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<td>HY6</td>
<td>Mono Pre Amp</td>
<td>Full Hi Freqs</td>
<td>£7.95</td>
</tr>
<tr>
<td>HY6B</td>
<td>Stereo Pre Amp</td>
<td>Full Hi Freqs</td>
<td>£4.95</td>
</tr>
<tr>
<td>HY7</td>
<td>Guitar Pre Amp</td>
<td>Two Guitars plus Microphone</td>
<td>£15.95</td>
</tr>
</tbody>
</table>

MOUNTING BOARDS: For ease of construction we recommend the 66 for HY8 £0.95 B66 for HY86-78 £1.45.

FOR FREE DATA PACK PLEASE WRITE TO OUR SALES DEPT.
Post to: ILP Electronics Ltd., Dept. 6
Graham Bell House, Roper Close,
Canterbury, Kent. CT2 7EP
Tel: (0227) 54776 Telex: 965780

Happy Memories

<table>
<thead>
<tr>
<th>Part type</th>
<th>1 off</th>
<th>25-99</th>
<th>100 up</th>
</tr>
</thead>
<tbody>
<tr>
<td>4116 200ns</td>
<td>1.25</td>
<td>1.15</td>
<td>1.10</td>
</tr>
<tr>
<td>4164 200ns</td>
<td>4.95</td>
<td>4.40</td>
<td>4.20</td>
</tr>
<tr>
<td>2016 150ns</td>
<td>4.75</td>
<td>4.25</td>
<td>4.05</td>
</tr>
<tr>
<td>6116 150ns Low power</td>
<td>3.85</td>
<td>3.45</td>
<td>3.30</td>
</tr>
<tr>
<td>2716 450ns 5 volt</td>
<td>4.20</td>
<td>3.75</td>
<td>3.60</td>
</tr>
<tr>
<td>2722 450ns Intel type</td>
<td>3.85</td>
<td>3.45</td>
<td>3.30</td>
</tr>
</tbody>
</table>

Soft-sectored floppy discs per 10 in plastic library case:
5 inch SSDS £17.00
5 inch SSDS £19.25
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5 inch SSDS £23.95
5 inch SSDD £26.35

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Tel: (054 422) 618 or 628

CIRCLE 65 FOR FURTHER DETAILS.

CIRCLE 58 FOR FURTHER DETAILS.
ELECTRONICS & WIRELESS WORLD JUNE 1984
6VA MINIATURE TX 240V AC Input 12-0-12V Output P.C. Mounting + Internal thermal overload protection. £25 for 10+ VAT £115 for 50+ VAT, £210 for 100+ VAT, £950 for 500+ VAT. Sample sent for £3 + 75p P and £ (4.30 inc vat).

MINIATURE SKELETON Preset horizontal mounting 220R @ 0.1W ±1.5% x 10 2MM pitch, £35 for 1000+ VAT.

BERG LOW PROFILE 14-PIN DUAL IN-LINE IC SOCKET manufactured from glass filled polyester to UL94V-0. £7 for 100, £31 for 500, £56 for 1000, £295 for 5000, £460 for 10,000 £2,100 for 50,000. Sample 10 sent for £1.20 + 30p P and £ (£1.72 inc VAT).

BERG LOW PROFILE 16-PIN DUAL IN-LINE IC SOCKET as above £8 per 100, £316 for 500, £655 for 1000, £895 for 5000, £1,350 for 10,000, £2,390 for 50,000, £4,300 for 100,000. Sample 10 sent for £1.40 + 30p P and £ (£1.96 inc VAT).

125MA 32mm QUICK BLOW GLASS FUSE £5 for 100, £48 for 1000. TO3 HEAT SINK. Efficient space saving to 03 Heat Sink. Suitable for on-board mounting. Flat surfaces ensure high thermal conductivity. Pre-drilled to accept any standard TO3 device. Height 12mm, width 36mm, length 47mm black anodised finish. £20 for 100 + VAT, £150 for 1,000 + VAT, sample sent for £2.50 + VAT and p&p.

HIGH POWER SILICON BRIDGE RECTIFIER. 25 amp 600V single hole fixing. 250 (1/4) push on connector terminals, manufactured by TI. £20 for 10, £90 for 50, £175 for 100, £800 for 500, £1,450 for 1,000. Special quotations for larger quantities. Sample sent for £2.50 + 25p P and £ (£3.16 inc VAT).

METAL FILM RESISTOR TYPE FZ4. Manufactured by C.G.S. Semi precision with a standard tolerance of ±2% and a temperature coefficient of better than 100ppm/°C. We have a full range in stock from 100R to 1MO. All bandoliered. £2.50 per 1,000 any one value.

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STEREO CASSETTE FRONT LOADING REPLAY MECHANISM for in-car entertainment complete with motor and pre-amplifier. Manufactured in UK under licence of Staar S.A. £45 for 10 + VAT £205 for 50 + VAT £395 for 100 + VAT. Sample sent for £5 + 15p P&P (£5.15 inc VAT).

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Telephone: 01-249 5177
Telex: 982996 EECO G

Circle 52 for further details.

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Electronics & Wireless World June 1984
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WINCHESTER/ FLOPPY DISC CONTROLLER

Compatible with the VME bus, the Force disc drive controller features user-programmable d.m.a. channels, up to 16Kbytes of dual-port ram, and double Eurocard sized p.c.b. with DIN 41612 connectors.

The board is capable of supporting up to a video floppy-disc drives and up to three hard-disc 5in drives. It generates interrupts with user-selectable interrupt levels, and auto interrupt vectors. The SY568K/WFC-1, allows a programmable sector size up to 1Kbyte, and provides automatic track formatting for hard discs. The data transfer rate is up to 5Mbits/s. Available from Microsystem Services, PO Box 37, Lincoln Road, Cresssex Industrial Estate, High Wycombe, Bucks. HP12 3XJ. EWW 213

SWITCHING MULTIPLEXER FOR NETWORKS

A solution to the problems of interconnecting dispersed multi-terminal data processors is offered by Babynet, a switching multipoint multiplexer. It combines switching (port selection and contention) with multipoint multiplexing. The switching capability allows dynamic mapping of connections between remote terminals to a computer. Remote ports can be permanently mapped to a particular computer port, mapped on terminal connection to one of a predetermined group of computer ports, or routed to one port of a user specified group. All port groups are designated by alphanumeric strings so that the terminal user could specify, for example, 'PDP11', 'VAX' or 'Accounting' on connection. This allows a large number of terminals to use a small number of computer ports, and also allows one terminal to be connected to a number of computer systems.

The multiplexer used a single communications line with its own polling method called 'Adaptive Polling Technique'. With APT, Babynet continually monitors remote station activity and polls active stations at a much higher rate than inactive ones. This results in a faster response time for terminal users.

Babynet is an expandable system with three functions (master, master expansion and node) all in the same piece of hardware. All units start as two channels and may be upgraded in increments of three channels. A master can have up to 22 ports and up to eight nodes, each with eight ports.

The configuration of each Babynet is a simple matter of pushing the right buttons on the front panel. A control console may also be used, if needed. Each Babynet also contains self-testing, terminal testing and diagnostic fuctions. The system is transparent to the user; no systems or applications programming is necessary. It works not only with v.d.u. terminals but also with virtually any asynchronous RS232 device including printers and bar-code readers. Error detection and correction is built in to the system and is completely automatic. The Babynet system is designed for unattended operation. Start-up is completely automatic and preprogrammed configurations are retained even when the power is off. Network Products Ltd, 387 Sykes Road, Slough Trading Estate, Slough, Berks. EWW 215

VIDEO SYNCHRONIZER FOR THE BEEB

A device to synchronize the RGB output of the Acorn/BBC computer to a video signal allows it to be used as a low cost alternative to professional tv caption and graphics generators. The Beeb-Lock is housed in a small case and is connected to the computer's p.c.b. with a few simple connections. The unit includes a PAL colour encoder and colour genlock system to convert the RGB output from the computer into a synchronous PAL colour signal which can be combined with a video signal through a vision mixer. One version, BL.2K, includes a mix/key circuit and provides a complete system for those users who require a basic title and caption insertion or fade facility. Another model, BL.3 is fitted with a Micropal board instead of the PAL encoder. This decodes the reference video signal into RGB components prior to combining them with the RGB output taken directly from the computer. The final output is a linear RGB signal which can be displayed directly on a colour monitor.

A future enhancement, available toward the end of the year, is to be a colour mapping board which will be able to select eight colours from several million variations. This makes possible the selection of several shades of the same colour for use in shadow and modelling effects.

The price of the basic Beeb-Lock, which is powered from the computer's auxiliary socket, is £185. An enhanced version, BL.2 may be expanded by the addition of optional p.c.b.s and includes a mains power supply for £240. Models BL.2K and BL.3 mentioned above are £330 and £260 respectively. Two-channel video mixers are available from the same designer/manufacturers: Video Electronics Ltd, Wigan Road, Atherton, Manchester M29 0RH. EWW 214

MINIATURE SOCKET

The high-profile version of the Harwin sub-miniature socket is designed to give a maximum protrusion below a p.c.b. of less than 1mm. This means that the socket's tail will be untouched by any conventional lead cropping process. Inside the socket is a four-leaf beryllium copper contact designed to accept the leg of any standard i.c. Use of the socket allows high density packing of i.c.s and offers lower than average insertion/withdrawal force. Harwin Engineers SA, Fitzherberts Road, Farlington, Portsmouth, Hants PO6 1RT EWW 216
D.I.L. LINKS

Programmable links offer a low-cost alternative to d.i.p. switches for many applications where frequent changes are not necessary. The Series 680 programmable headers from Aries can be operated by simply severing the links between pins. One style of header can be used to program connections between both adjacent and opposite pins. It has a plain cover through which opposite links may be broken. A hand tool is available for small production runs or an arbour press for bulk programming. The headers may also be bought pre-programmed. Aries Electronics Ltd, Alfred House, 127 Oatlands Drive, Weybridge, Surrey KT13 9LB.

WW 227

Extending their horizons from the purely photographic to other images, Kodak have produced a home video system. The core element is a video camera/recorder (Camcorder) which uses 8mm wide tape in cassettes about the same size as audio compact cassettes and lasting for 60 minutes for PAL signals or 90 minutes with NTSC. The Camcorder is no larger than an average amateur movie camera and weighs 2.4kg, yet a similar quality to the average video cassette recorder is claimed. This has been achieved, says Kodak, through the use of cobalt-nickel metal tapes, amorphous metal recording heads in the helical scan recorder and the development of a new 0.3in (85mm) Newvicon tube. For display on a domestic TV, the Camcorder fits into a 'cradle' which provides the electronics and also acts as a battery charger for the camera. The camera has all the moving parts and so acts as the heart of the system. The cradle may be fitted optionally with a tuner/timer for the recording of programmes off-air. Soon to be launched in the US, the UK version may be available towards the end of the year.

BORROW AN OSCILLOSCOPE

If you have sudden need of an oscilloscope, perhaps for prototype testing, you can hire one from Microlease. For example they now have the latest Nicolet 3091 portable digital oscilloscope which uses 12-bit digitizing and is claimed to be ten times more accurate than analogue instruments. It may be used for field calibration, fault diagnosis, or transient analysis, in mechanical, electrical, acoustical and biological applications. It may be linked to a computer by way of an RS232 interface, and to plotters and chart recorders for waveform printouts. Weekly rental is from £70, including bubble memory cassette. Microlease plc, Forbes House, Whitefriars Estate, Tudor Road, Harrow, Middlesex HA3 5SS. WW 226

WIREWRAP TOOL

This bit and sleeve combination is able to cut off excess wire for cable, wire harness or reel, strip the proper length of insulation, and wrap the correct number of turns onto the terminal. This eliminates the need for pre-cutting or pre-stripping the wire. Used in the same way as conventional wire wrapping tool bits and sleeves, the CSW sets are available for 0.50, 0.40 and 0.25mm wire and a wide range of terminal sizes. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA. WW 229

ANTI-STATIC CARPET SPRAY

An anti-static aerosol spray, ASP 40, has been designed for use on carpets and/or video screens in static-sensitive environments. A walk across a carpet can generate a charge of up to 10 000V, according to the spray manufacturers. This can damage electronic components or cause data glitches in computer equipment. A single canister of the spray can treat up to 20 square metres of carpet. The treatment lasts for two to three months and during this time the carpet has the additional property of being dirt repelling. A video screen will remain clean and static-free for six to eight weeks. £4.20 for a single can, £3.90 each for a pack of six. Technofrend Ltd, The Town House, Chobham, Surrey GU24 6AF. WW 228

If you would like more information on any of the items featured here, enter the appropriate WW reference number(s) on the reply-paid card bound in this issue. Overseas cards require a stamp.
AMAZED FUSED LOGIC

A software package for designing integrated fuse logic from Mullard is called AMAZE, which stands for automated map and zap entry. Another acronym involved is BLAST for Boolean logic and state transfer, the first package within Amaze which also includes a device programmer interface and a simulator.

Blast allows the designer to assign pin mnemonics and functions, and to write Boolean equations which are compiled into programming table. Data entry is by way of a menu screen display and the data is checked for consistency and legality before progress to subsequent screens is allowed. Complex functions are reduced to a sum of products by a resident logic processing program.

The DFI (device programmer interface) can download compiled program tables in selected formats. It can also 'upload' the tables from existing devices for editing and simulation.

The simulator can be run manually or automatically. In manual mode the operator can assign input vector and then observe the resulting output; in automatic mode the simulator creates a test vector file for production testing of the programmed device.

The first release of AMAZE contains the Blast and DFI modules for 82S153 and 82S159 devices and is suitable for use on VAX, VM53.2 or later computers. Personal computer versions will be released later in the year along with the rest of the integrated fuse logic range including the simulator module.

Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.

EWW 222

MEASUREMENT AND CONTROL INTERFACE

A complete interface system in a single compact package can provide a link between any GPIB controller and the sensors and actuators of laboratory and process automation systems. A single p.c. motherboard accepts plug-in modules which may be configured to provide conditioning and conversion for any combination of analogue and digital input or output signals. Functions currently available include digital input and output; pulse, event and up/down counting; frequency measurement; real-time clock; and thermocouple, strain gauge and real-time display inputs.

Fully compatible with IEEE 488 and IEC625-1 specifications, the Di-An DMS550 is designed to operate with eight-bit binary characters and enables the transmission and receipt of GPIB data at a maximum rate of 250kHz.

Available from STC Instrument Services, Edinburgh Way, Harlow, Essex CM20 2DF.

EWW 223

HEAR AUNTIE FROM ANYWHERE

 Specifically designed for the reception of the BBC World Service, the LiniPLEX F1 h.f. receiver has nine fixed crystal-controlled channels tuned to the frequencies most used by the BBC in various locations around the world. The 5 to 26.5MHz band is also tunable for reception of other s.w. stations. Crystals may be easily changed if a different frequency is required on any of the pre-set channels.

The receiver incorporates a patented a.m. phase-locked demodulator which uses a phase-error signal to control a voltage-controlled oscillator and the set stays tuned even during a temporary loss of a pilot carrier signal. This is especially useful in areas of multi-path reception and also helps cut out distortion caused by fading signals. Double or single sideband reception is possible and upper, lower or both sidebands may be selected at will. This facility offers the choice of least interference from transmitters at adjacent frequencies. The ability to use a balanced antenna indoors also helps to reduce local interference. Despite its die-cast aluminium case, which is strong and offers electromagnetic shielding, the LiniPLEX F1 weighs only 1.85kg and is small enough to be slipped into a briefcase.

Phase Track Ltd., 132 Queens Road, Reading, Berks RG1 4DG.

EWW 224

FAST PROMS

Two 2048-byte, edge-triggered, D-type registered proms are claimed to be 20% faster than comparable devices. These bipolar devices consume half the power of a standard prom with an external register. The RA1681 and RA1681A are available with synchronous or asynchronous operation and have maximum clock-to-output response times of 20 and 15ns respectively. They feature a flexible initialization scheme which offers a start-up and time-out sequencing of 16 programmable words to provide controlled systems start-up.

The proms are designed to hold microprogrammable control storage, state sequencers, next-address generation and mapping other proms in a wide range of computer systems. The synchronous devices may be used when multiple registered proms are bussed together to provide increased word length. Asynchronous versions are used when multiple gates are not in use or when the outputs are to be gated onto a data bus. The devices are available with a variety of access modes, refresh modes and setup modes. Both types include two externally controlled modes, one access and one refresh. The two auto-access modes of 1681A operate in 130ns, worst case and thus eliminate the wait states usually encountered in fast microprocessor systems.

Monolithic Memories Ltd., 1 Queens Road, Farnborough, Hants GU14 6DJ.

EWW 225
BENCH POWER AMPS

Two power amplifiers, a 200W stereo and a 300W mono, are presented in open frame form for o.e.m. and hobby use. S200 the stereo module consists of two completely independent amplifiers which may be operated with separate power supplies, and at different frequencies. The amplifiers may be used for bench testing of equipment and one example has been the amplification of outputs from accelerometers in vibration analysis. With bench use in mind, all connections use screws so that different power supplies or inputs and outputs may be quickly connected. The open metal frame provides a very large external heatsink.

Both the S200 and the M300 amplifiers although rated at their maximum powers may, of course be used at lower power ratings by reducing power supply voltages. In addition the M300 includes preset potentiometers to adjust the gain, allowing ratings to be set precisely. S200 costs £48.50 and M300, £43.50. There is in addition an amplifier drive board which is a complete amplifier without the output power transistors. These may be selected to build amplifiers designs from 60 to 250W into 8Ω or 100 to 300W into 4Ω. This module, D100, costs £23.50.

XTR Electronics, 335 Holdenhurst Road, Bournemouth, Dorset BH8 8BT. EWW 217

SOLID-STATE RELAYS

Housed in standard 14 and 16-pin d.i.l. packages, the range of MSI solid-state relays use thick-film hybrid circuits to combine the handling of high power in a physically small volume. There are three d.c. relays and seven a.c. types with a wide choice of current and voltage ratings, optical or transformer isolation and synchronous or zero-voltage switching.

One of the range is the E24E-2H which has 1A current rating and is housed in a 16-pin package. Input/output isolation is 400V r.m.s. and the use of anti-parallel s.c.rs in the power switch ensures enhanced rise time, surge current and thermal characteristics. The device switches at zero volts and requires an input signal of 8mA at 5V. The output switch has a peak voltage rating of 600V and is therefore safe to use with 240V a.c. supplies. Others in the range include the E40-1 which will switch a.c. or d.c. up to 80mA at 60V, E41-2H is rated 1A and has a trac output up to 600V; E43-1 for d.c. switching of 50mA, 60V and E43-2 also for d.c. at 200mA, 250V. The use of ceramic sealed packages ensures that they are hermetically sealed. They are good conductors of heat and maintain a good safety margin on junction operating temperatures. Elyon Electronics Ltd, 23 Croydon Road, Reigate, Surrey. RH2 0LY. EWW 219

DIGITAL TIMESWITCH

A digital electronic time switch can provide up to 84 separate on or off settings in a week — 12 settings for each day. The program may be set for each individual day or a group of up to six setting may be repeated automatically every day. The current time is shown on a display which can also indicate the status of any function or program. A built in battery can retain the program. A built in battery can retain the program and clock time during a power failure and the battery is automatically recharged when the power is restored. The program may be easily overridden at any time without affecting the memory and operation will revert to the program when the next switch is reached. Applications include the switching of heating or air conditioning plant, or manufacturing processes up to a rating of 220V, 10A a.c.

Highland Electronics Ltd, 8 Old Stones, Brighton East Sussex BN1 1BZ. EWW 221
An experienced Test Engineer required for safety testing laboratory in London SW2 area.

The successful candidate will be fully conversant with BS 415 1979 and have a good knowledge of other standards relating to domestic electronic equipment.

Excellent working conditions and rates of pay for an engineer with the relevant experience.

If interested in the above post, please contact:

Bill Jeanes - Technical Director
Tech-Semco Limited
Telephone No: 01 733 5588

(2605)

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Royal Devon and Exeter Hospital (Wonford), Barrack Road, Exeter
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Applications are invited from suitably qualified and experienced persons for the above post in the Physics department. The successful applicant will work with two other technicians responsible for the development and maintenance of equipment used in the fields of radiation physics, radiotherapy, nuclear medicine, ultrasound imaging and pathology. Experience of, and interest in, the applications of microprocessors will be particularly valuable.

Job Description and application form from the Administration Department, tel Exeter (0392) 77863 ext 2007. Closing date for applications 1 June.

(1589)

Bloombery Health Authority
DEPARTMENT OF MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING UNIVERSITY COLLEGE HOSPITAL, LONDON

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Applications are invited from experienced service engineers for the post of Medical Physics Technician in the Department's Electro-mechanical Unit. The work, under the discretion of the physicist in charge, includes servicing of a wide range of monitoring equipment. Acceptance testing and equipment calibration is also carried out.

The applicant must be prepared to work in a clinical environment, contact with patients may be necessary.

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Further details and job description from Mr C. Hamsley, 01 636 5152.

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Job Title/Description

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UNIVERSITY OF BIRMINGHAM
DEPARTMENT OF ELECTRONICS
AND ELECTRICAL ENGINEERING
Postgraduate Research Fellowship
Applications are invited for the above post which is funded by the MOD. The work is concerned with signal handling in high frequency receivers using digital techniques for filtering and demodulation. There are prospects for a wide range of work and also collaboration with other establishments. Both theoretical and practical skills are required and an ability to direct and to liaise with other staff will be important.

The post is available for up to one year from the earliest possible date.

The salary is on the Research Fellow 1A scale £7390 + £1165 plus superannuation. For further particulars telephone 021-472 1301 ext. 2599, quoting reference 53.

No formal application form. Three copies of application, including full Curriculum Vitae and naming three referees to Assistant Registrar, (Science and Engineering), P. O. Box 30, BIRMINGHAM, B15 2TT by 4 June 1984.

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The minute your profile form arrives at Lansdowne all these people and more will be actively searching for vacancies that suit you. Searching day in, day out.

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The Lansdowne service is absolutely free to job-seekers.

Now shortlisting
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All posts are open to men and women and our service is completely confidential for companies and job-seekers.

SATELLITE TVRO ELECTRONICS

The expansion of our Development operation has created the requirement for an additional Engineer to work on the design and production development of a new range of satellite television receiving equipment for both professional and consumer applications.

Suitable candidates would preferably hold a relevant degree or HND and have several years experience in commercial product design and development. More important, they should be able to demonstrate aptitude and flair, a genuine interest in the technology of RF, logic and baseband circuitry, and the ability to work without supervision.

Satellite TV Antenna Systems Limited is a small and highly professional British Company with strong prospects of fast growth in this emerging technology and is located in new facilities in Wales.

Salary and benefits are negotiable.

Applications in writing please, together with a current C.V. to Mr. P.M. Gray, Managing Director, Satellite TV Antenna Systems Ltd.,

10 Market Square, STAINES TW18 4RH, Middx.
TEST PLANNING TRIALS SUPPORT INTEGRATION & TEST

Are you ready for a commitment to Engineering Excellence?

STC Defence Systems has one of the most impressive growth records in the international defence market. In the short space of 3 years we have more than doubled in size — in both turnover and manpower. Major development projects currently in hand are the direct result of solving technical problems through a commitment to engineering excellence increased activity in a wide range of advanced technology fields, such as specialist communications equipment, guidance and control systems and general data communications systems is continuing our record of expansion and has now created the following positions for experienced Electronics Professionals at our Basildon location.

**Test Planning**
Senior Engineers (up to £13k pa)
We’re looking for Senior Engineers to plan a major role in the preparation and planning of test programmes. Working closely with prototype manufacturers and external suppliers, you’ll develop stringent test specifications and schedules — from single modules through to complete systems. You’ll be involved in extensive customer contact and maintain close liaison with internal trial’s support teams. The positions call for the highest standards of professionalism. A degree or HNC level qualification is essential, coupled with at least 4 years’ relevant experience in an electronics environment or technical support role.

**Trials Support**
We are looking for Engineers at all levels to play a key role in conducting acceptance trials pre- and post-product handover, providing a complete testing service to Project Leaders and other Departments as required.

Senior Engineer (£12-£13k pa)
You should be qualified to degree level or equivalent with around 5-7 years’ experience in operational test or in the evaluation of electronic equipment in an operational environment.

Engineer (£8-£9k pa)
Aged 23 years +, you’ll be qualified to at least HNC level with at least 3 years’ relevant experience, possibly gained in an installation or commissioning role with a major user or supplier of electronic equipment.

**Systems Integration & Test**
We’re looking for people from Section Head to Engineer level to be responsible for the integration of the hardware and software elements of complex high technology systems. You will be involved in producing proposals on software simulation and hardware modelling to meet stringent product requirements for harsh environments and for identifying and conducting test programmes.

Section Head (£13-£14k pa)
Qualified to degree level or equivalent, you should have 5-7 years’ proven experience including a sound background in both hardware and software.

Senior Engineers (£12-£13k pa)
Aged 25 years + you’ll be qualified to degree/HNC level with around 3 years’ sound relevant experience.

We would like to discuss all these key positions with Engineers who are looking for their next challenge in Electronics. Necessary personal qualities include the ability to work to deadlines and under pressures, with the minimum of supervision. Working with STC Defence Systems will bring you exceptional opportunity to grow within a young, dynamic environment and share in the company’s success. Very competitive salaries are offered together with an attractive range of benefits including an exceptional relocation package where appropriate.

Please send your c.v. to our consultant, John Faith at Cambridge Recruitment Consultants, 1a Rose Crescent, Cambridge CB2 3LL quoting reference TP/TS/TC or telephone Cambridge (0223) 311316 for an application form. These positions are open to both men and women.

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**STC TELECOMMUNICATIONS**

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ELECTRONICS & WIRELESS WORLD JUNE 1984
Dedication to engineering excellence and technical innovation has established our client as one of the world’s leaders in the design, development and manufacture of TV Studio equipments and systems for a wide range of applications within the broadcast industry. Continued expansion and total commitment to an exciting and dynamic development programme has created unique career opportunities for a small number of engineering professionals to play major roles in the conception, design and development of new broadcast systems or equipment for the future. This will require an interest and awareness of the latest technologies and state-of-the-art in one or more of the following areas:

- **HIGH SPEED DIGITAL PROCESSING AND WIDE BAND ANALOGUE TECHNIQUES IN AUDIO AND VIDEO APPLICATIONS**
- **MICROPROCESSOR INTERFACING & CONTROL TECHNOLOGY**
- **DECODERS AND SYNCHRONISERS**
- **NEW DIGITAL TV PROCESSING EQUIPMENT, VIDEO DISTRIBUTION**

If you are well qualified technically with extensive relevant project management or design experience within the professional broadcast, studio equipment or closely related communications systems industry fields, this is an opportunity to attain the highest level of professionalism and responsibility.

Our clients offer top negotiable salaries and benefits including generous relocation in the Home Counties, excellent technical facilities and a green fields working environment second to none.

For an informal and confidential discussion please call Alan Newman on (0494) 30517 or write to him in the strictest confidence quoting ref. no. 8/84.

Datton Recruitment Limited
23 Eastgate Street, High Wycombe
Buckinghamshire HP11 1NY

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**The SNV Group**

**Soundcraft Network Video Ltd.**

**SALES MANAGER**
(SNV London)

Challenging opportunity in the fastest growing video communications company in the U.K. Based in Charlotte Street, the successful applicant will have a proven record of sales and managerial success in the professional video world and will be seeking responsibility and involvement in SNV’s expansion. Car, attractive salary and benefits.

**FACILITIES and HIRE TECHNICIAN**
(SNV North East)

All rounder required to provide a fully integrated Facility and Hire service to our clients in the North East. Good understanding of video equipment as well as an ability to edit (might suit an experienced AV technician or corporate one man band). Progress to full time editor envisaged as department expands. Good salary and use of company vehicle.

Applications in writing with C.V. please to The National Facilities Director, The SNV Group, c/o SNV London, 50-51 Charlotte Street, London W1P 1LW. Salaries will conform to the Company Staff Grading System currently under review. Company BUPA scheme.

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**THE SNV GROUP**

The Very Best in Video

**TECHNICAL ENGINEERING MANAGER-FACILITIES**
(SNV London)

Responsible for the day to day operation of the edit suites and technical areas at our Charlotte Street premises. The successful applicant will have practical hands on engineering knowledge of VTR’s (including 1" BVU and LB), editing control systems and broadcast cameras, and will be capable of supervising and training staff as well as handling future planning and development. Working closely with the Facilities and Hire Manager and reporting to the National Facilities Director, this is a challenging position with good potential for personal development. Salary by negotiation.

**VIDEO EDITOR**
(SNV London)

Top notch personality required, with proven editing ability, to take charge of Edit Suite 1, our computer assisted multitrack edit suite. This position might suit a really good ‘Number Two’ looking for a break! Good salary, plus bonus geared to success.

**REGIONAL FACILITY/HIRE MANAGERS**

With the expansion of our Facility and Hire departments throughout the U.K., applications are invited from experienced managers seeking to broaden their careers by becoming involved in developing and promoting video facilities to a wider market. The SNV Group has offices in every part of the country and provides a co-ordinated and comprehensive nationwide service. Successful applicants will enjoy a challenging and responsible position and will play a key role in SNV’s expansion. Company car, salary by negotiation.

**BENCH and FIELD ENGINEERS**
(SNV London, South, West, North and North East)

Due to an ever increasing number of varied commercial and industrial contacts, the SNV Group requires yet more Engineers, with at least 3 years practical video experience to carry out bench and field servicing. Must be conversant with client requirements. Salary based on experience. Performance bonus. Company vehicle available for field use.
At H.M. Government Communications Centre we're using the very latest ideas in electronics technology to design and develop sophisticated communications systems and installations for special Government needs at home and overseas.

With full technical support facilities on hand, it's an environment where you can see your ideas progress from initial concepts through prototype construction, tests and evaluation, to the pre-production phase, with a chance to influence every stage. Working conditions are pleasant, the surroundings are attractive, and the career prospects are excellent.

Ideally we're looking for men and women who have studied electronics to degree level or equivalent and have had some experience of design, whether obtained at work or through hobby activities. Appointments will be made as Higher Scientific Officer (£7149-£9561) or Scientific Officer (£5892-£7765) according to qualifications and experience.

For further details please write to the address given below. As our careful selection process takes some time, it would be particularly helpful if you could detail your qualifications, your personal fields of interest and practical experience, and describe the type of working environment most suited to your career plans.

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

COMMUNICATIONS ENGINEERS AND TECHNICIANS

Join the UK's leading communications system house where recent success has created the following opportunities. Can you meet these needs?

**Systems and Project Engineers**

Engineers who have a broad experience of single channel, microwave and multiplex equipment and can understand the parameters of these systems.

Vacancies exist both at Great Yarmouth and Aberdeen with opportunities for occasional overseas travel. You will be involved in the design and planning of complete communications systems, and as well as their implementation.

We offer an attractive salary, full pension scheme and BUPA membership. Assistance with relocation if necessary.

**Engineers and Technicians for UK and Overseas**

For on-going projects in the UK and overseas, we require engineers and technicians able to install and maintain a wide range of communications equipment from microwave and multiplex, to VHF, HF and UHF systems and probably some PABX knowledge.

Whether you are working in the North Sea or the Middle East, you can expect to receive a competitive salary plus allowances and attractive work/leave cycles.

We also have vacancies for radio operators, qualified to M.R.G.C., preferably with oil related experience.

Please apply in writing to: R. D. Elliott, Group Personnel Director, Inspectorate EaE Group Limited, 284/5 Southtown Road, Great Yarmouth, Norfolk NR31 0JB.

ELECTRONICS ENGINEERS for MARINE SYSTEMS

Hunting Surveys & Consultants Limited requires Electronics Engineers to work on both the theoretical and practical aspects of Marine Survey Instrumentation Systems.

They must be qualified to degree level with a broad electronics experience but having an emphasis on digital circuitry, computing and microprocessing techniques. Software experience will be necessary.

Applicants (preferred age 23-30) will need to be physically fit and prepared to undertake periods of operational work in the North Sea and Overseas. Engineers appointed must be capable of working with minimum supervision to take overall responsibility for initial circuit design, prototype building and testing, layout diagrams and documentation. This work often involves the production of working prototypes to be used in the field within days.

If you believe that you are suitably qualified and could be happy working under these demanding but stimulating conditions, please apply in writing to——

The Personnel Manager

HUNTING SURVEYS & CONSULTANTS LTD

Elstree Way, Borehamwood, Herts WD6 1SB

ELECTRONICS & WIRELESS WORLD JUNE 1984
Regional Sales Manager (Export)

Racal Dana Instruments Ltd. is a major manufacturer of sophisticated electronic test and measurement instrumentation for the radio communications and ATE industries.

The potential for expansion in the export markets for our products means that we need to recruit a Regional Sales Manager to realise this targeted increase in exports. Applicants must have a technical qualification in electronics with a background in the radio communications industry. We also require a minimum of two years experience of technical selling in either the U.K. or export markets with a track record that testifies to the ability to achieve targets in a highly competitive industry. A second language (French or Spanish) would be an advantage.

We offer an attractive salary package including company car, over five weeks annual leave, staff pension and free life assurance scheme. Assistance with relocation is available in appropriate cases.

This is an excellent opportunity for an ambitious professional to develop his/her career in export selling.

If you have the drive and enthusiasm to join Britain's fastest growing electronics group then please contact:-

The Personnel Officer,
Racal Dana Instruments Ltd., Duke Street, Windsor, Berks. Tel: Windsor (07535) 68101

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DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

LECTURERS IN ELECTRONIC/ELECTRICAL ENGINEERING

Applications are invited from those holding appropriate qualifications, preferably with industrial experience, to teach to BTECH HND level in one or more of the following areas:

1. Electronics and Electrical Power.
2. Microprocessors and their applications.

Salary within the range: £5,649 - £9,735 plus £987 p.a. London Allowance.

Application forms and further details may be obtained by writing to the Vice-Principal enclosing a self-addressed envelope. Completed forms should be returned within 14 days of the appearance of this advertisement.

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ELECTRONICS & WIRELESS WORLD JUNE 1984
**PRINCIPLE DESIGN ENG. to £17.5K**

**PRINCIPLE QUALITY ENG. to £15K**

**Analogue/Digital Technology**

A world leader in the innovative design of future electronic equipment, offering you an opportunity to meet the challenge of stretching the capability of present technology and its principles to resolve the most exacting Signal Processing and Analogue circuit design requirements for future systems development.

You will be part of a professional team of engineers, managers, systems analysts and modelling consultants. You will help to maintain our client's position as world leader in their field by successfully dealing with a continuous influx of new projects. These future developments will offer you considerable opportunities to exercise your personal initiative, innovative, technical and managerial skills from the product's conception through to customer acceptance. As a candidate you will have a degree in electronics and experience in one or more of the following:

DIGITAL SIGNAL PROCESSING, SPREAD SPECTRUM TECHNIQUES, COMMUNICATIONS PROCESSING, WIDEBAND ANALOGUE CIRCUIT TECHNIQUES with LSI, VLSI and HYBRID DESIGN TECHNIQUES.

**Our client also requires:**

- **DESIGN AND DEVELOPMENT ENGINEERS**
- **SYSTEMS AND SCIENTIFIC ANALYSTS**
- **SYSTEMS MODELLING CONSULTANT**
- **PROJECT MANAGEMENT**

And opportunities also exist for candidates with HVCH Tech qualifications or graduates yet to gain experience.

These important positions present a major opportunity for the professional engineer serious to establish himself in future electronic circuit and systems design and development. Our client provides the most modern accommodation and engineering facilities including the latest VAX System, an attractive salary package, full company benefits, five weeks holiday and generous relocation package to S.E. England.

To find out more and to obtain an early interview please telephone Mr. Jacobsen in complete confidence on Hemel Hempstead (0442) 47311 during office hours or one of our duty consultants on Hemel Hempstead (0442) 212650 evenings or weekends.

Alternatively write to him at the address below.

---

**ELECTROSONIC**

**SYSTEMS AND DESIGN ENGINEERS**

**£28K — £12K PLUS CAR**

ELECTROSONIC, a well established International Company with subsidiaries in Europe and America, designs, manufactures and commissions a wide range of control systems for the entertainment and commercial markets.

Although the Company's main strengths lie in the areas of audio, lighting and associated control systems, much of its work is best categorised as 'imagineering' with the only thing more diverse than its client list, being the range of technologies and solutions used to solve their problems.

A project Engineer/Manager is required to augment the existing technical team. The successful candidate should have experience in one or more of the above fields, as well as an in-depth knowledge of video systems.

The position carries the benefits of a Company car, participation in the Company's pension and bonus schemes and offers the opportunity for overseas travel.

A Development Engineer is also required to augment a multi-disciplined team of audio, lighting, control hardware and software engineers. Our preference is for an Engineer with a video design background, but with a willingness to expand his/her experience by carrying our work in some of the other fields listed. The successful candidate will be an experienced Development Engineer possessing the drive necessary to contribute to both the specification and implementation of the designs for both the project solutions and standard products.

**Applications in writing to:**

R.L.C. STINTON
Director of engineering
Electrosonic Ltd.,
815 Wongli Road, London SE7 8LT

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**Brompton Hospital**

**Medical Physics Technician III**

**Electronics**

A vacancy exists for a technician with hospital experience to join the team of technicians in the Department of Medical Electronics. The Department provides a comprehensive maintenance and development service to two busy cardiac/haemodynamometric hospitals. The technician will be based initially at the Brompton Hospital, SW3, but he/she must be willing to also work at London Chest Hospital, E2.

For further information contact Mr. Butler, Chief Technician 01-980 4433 Ext. 340.

For a job description and application form contact Mrs. J Walton, Assistant Personnel Manager, Brompton Hospital, Fulham Road, London SW3 6HP. Tel: 01-352 8121 Ext. 4357.

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**ELECTRONICS & WIRELESS WORLD JUNE 1984**

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Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £5000-£15000.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you. All applications are treated in strict confidence and there is no question of your present employer (or other companies you specify) being made aware of your application.

TJB ELECTROTECHNICAL PERSONNEL SERVICES,
12 Mount Ephraim,
Tunbridge Wells,
Kent. TN4 8AS.
Tel: 0892 39388 (24 Hour Answering Service)

Please send me a TJB Appointments Registration form:

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

(86U)

Have you a flair for Electronics? c.£11,000

Schlumberger Cambridge Research, part of a highly successful multinational organisation, is a research centre recently established to investigate topics of central importance to Schlumberger's oilfield drilling and production services.

Expansion of our research activities has created posts for two Electronics specialists. Both positions offer opportunity to work with first-class equipment including a major flow loop facility and a wellbore simulator in an exceptionally modern working environment. The job details and requirements are as follows:-

Fluid Mechanics

Projects in this department include the development of flow measurement techniques and a general instrumentation system. We require someone with a thorough knowledge of both digital and analog circuits and preferably possessing experience on microprocessors for on-line data acquisition and analysis.

Wellbore Physics

The post here offers the opportunity to exercise practical skills in electronics (especially digital electronics), measurement, the construction of prototype instruments and interfacing instrumentation with computer hardware, both in the laboratory and on a large-scale wellbore simulator, hence, a flair for software application is desirable.

Both appointments require an honours degree in HNC in electronics or electrical and electronic engineering preferably supported by 2-5 years' experience in a research or an R&D environment.

Salary is negotiable around £11,000 p.a. and the general conditions of service are excellent including a non-contributory pension scheme and considerable scope for career development exists with Schlumberger, which has very wide interests in instrumentation, measurement, control and other areas of electronics.

Please send your curriculum vitae, quoting reference RA-FLM/WBP to: Mrs. Jacqueline Barr, Personnel Manager, Schlumberger Cambridge Research, PO Box 153, Cambridge CB2 8BE. Telephone 0223 315576.
Technical Manager
Medical Electronics

To £15K

Oxfordshire

With the retirement of its Technical Director due within the next two years our client, a market leader in the manufacture, development and marketing of electronic phototherapy equipment, is seeking to recruit an experienced Technical Manager.

Reporting initially to the Technical Director and later direct to the Managing Director your role will embrace all aspects of the technical development of new and existing products from inception through manufacture to after sales service. In addition to total responsibility for the day to day running of the Design and Development department you, as the company's technical specialist, will be responsible for providing technical advice to customers and sales engineers and technical support to the manufacturing and sales/service engineering functions.

To fully succeed and develop this role candidates should:-

- be aged 30-45
- be qualified to degree level in electronics
- have design and development experience with RF equipment, power amplifiers or similar equipment using mainly digital techniques.

In addition the ability to manage in a technical setting and communicate effectively both within the company and to customers at all levels is essential.

In addition to the salary the company offers a package of benefits including relocation assistance in appropriate cases. For the right person there is the prospect of promotion to Technical Director on retirement of the current post holder.

For an initial and confidential discussion please call
Newbury (0635) 48709 or write in strict confidence quoting ref: 949/MM to:-
Larkfield Personnel Selection,
Mill Reef House, 9-14 Cheap Street,
Newbury, Berkshire RG14 5DD.
TELE-CINE LTD.

have a number of immediate vacancies for:

VTR AND TELECINE OPERATORS/ENGINEERS

Essential requirements include a suitable technical qualification, (HNC, Higher Tec, or equivalent), and some experience working in a broadcast television environment. Applicants will ideally be in their mid to late twenties and should be capable of motivating both themselves and others when working with a small operational group within an interesting shift system. Salaries are negotiable and will be commensurate with experience. For full details, please write, enclosing full c.v. to

J Rowland
Tele-Cine Ltd.,
109/110 Bolsover Street, London W1P 7HF

(25/73)

ENGINEERING OPPORTUNITIES

Bell & Howell, recognised as an international leader in audio visual and video equipment have, since the creation of the new Bell & Howell television Division, experienced significant success which will assure our future throughout the 80s and beyond, in the highly competitive world of broadcast level equipment.

A major factor in our success has been the contribution made by our Engineering team. This success lends itself to recruit further experienced engineers.

Broadcast Engineers:

To provide technical support to our Sales team and assist our design, test and end users. This will involve working both in house and on client sites throughout the U.K. — a company car will be provided!

You will be aged 25+ and should have HND/HNC in electronics engineering and have 2/3 years experience of broadcast level equipment.

Professional Video Engineers:

To service a wide range of video equipment up to broadcast level hardware at our workshop in Alperton, Middlesex. Aged 25+, male or female, and likely to be qualified to HND/HNC in electrical or electronics engineering, with at least 3 years experience in a similar or related environment. You should also be able to demonstrate good communications skills since a part of your role will be assisting our customers with their technical needs.

In both cases you will be joining small but efficient and highly professional teams. You will be self motivated as well as possess good written and oral skills and have the ability to work within an ever changing technical environment.

In return both these positions carry an excellent salary with a realistic benefits package and the opportunity to advance your career within a new division of a large and progressive company.

To apply for these exciting opportunities write or telephone for an application form to: Jennifer Coomings, Personnel Manager, Bell & Howell Ltd., Alperton House, Bridgewater Road, Wembley, Middlesex. HAO 1EG. Telephone: 01 902 8612.
Technical Training
Professional Broadcast Equipment

As an essential part of a comprehensive service to the Broadcasting industry, the training Department of Sony Broadcast Ltd provides in-depth product courses on an extensive range of professional broadcast video and audio equipment. Two excellent opportunities have now arisen on our lecturing staff who are responsible for conceiving and conducting theoretical and practical courses.

Lecturer – Digital Audio Products
We are at the forefront of the Digital Audio revolution and our products include a Multi-track Digital Recorder, Digital Mastering System and a professional Compact Disc Player. In addition to lecturing on Audio products the successful applicant will also have an opportunity to become involved with our Video equipment.

Video Products
Our world renowned range of professional video equipment includes cameras, C-format and U-matic Video tape recorders, Betacam systems, Time Base Correctors and a range of computerised editor systems.

Applicants for both positions should ideally be educated to degree level or equivalent in electronics and should have a sound understanding of the theory and practice of analogue and digital techniques, together with an appreciation of Video and Audio principles. Experience should have been gained in the broadcast, computer or telecommunications industry.

The ability to communicate knowledge clearly and concisely on both theoretical and practical levels is essential.

Training on our range of products will be given where appropriate. Some overseas travel will be involved and we offer attractive salaries together with first class conditions of employment, and relocation assistance will be given where appropriate.

If you are interested, please contact Mike Jones, Senior Personnel Officer, Sony Broadcast Limited, City Wall House, Basing View, Basingstoke, Hampshire. RG21 2LA. Telephone (0256) 55011.

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke
Hampshire RG21 2LA
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DESIGN AND CONSULTANCY of microwave, digital and analogue equipment. Complete service from feasibility and design to prototype and commissioning. Advice on test and design of dedicated test equipment or ATE. LPA Electronics, 24 Timbermans View, Basildon, Essex. Tel: 060 085431 (1269).

TUNING YOUR SURPLUS – in transistors etc. into cash, immediate settlement. We also welcome the opportunity to quote for complete factory clearance. Contact: EDO-EDISON & CO, 103 South Brisk, Welwyn. Herts. Tel: 541 6488 (1069).

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