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CIRCLE 45 FOR FURTHER DETAILS.
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This issue has been affected by the continuing dispute between members of the National Union of Journalists and Reed International. We apologize to readers and advertisers for its late appearance. The next issue of Electronics and Wireless World, cover dated August/September should be published on 15 August.
Music keys for the BBC microcomputer

Variable television reception with papaya tree antenna

Variable-speed video playback

Front cover pictures
David Read’s PAL colour TV enhancement board, also pictured on page 37, comprising PAL modifier and comb filter decoder.

NEXT MONTH

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CIRCLE 07 FOR FURTHER DETAILS.
Hyperthermia progress

Much attention in recent years has been focused on radiation hazards very close to high-power radio transmitters. Less notice has been taken of the advances being made in the medical use of r.f. heating by h.f., v.h.f. and microwave transmitters, particularly for hyperthermia treatment of malignant cancer tumours. Although hospitals have used heating by r.f. power (diathermy) for about 50 years, recent work has concentrated on the development of more effective coupling of the r.f. power into the affected part of the body by means of improved ‘applicators’.

A recent report from the Biomedical Engineering and Instrumentation Branch of the American National Institutes of Health in Bethesda, Maryland, notes that while hyperthermia offers promise as an adjuvant to cancer therapy, so far little success has been achieved in heating deep-seated tumours. A new design of helical coil applicator has been developed which in tests under simulated conditions of the fat-muscle-bone of a human arm or thigh appears to be both practically and theoretically capable of producing deep heating (IEEE Trans 1984 vol. BME-31, pp. 98-106 and Electronics Letters, 1984, vol. 20, pp. 337-8).

Hyperthermia uses r.f. power to raise the temperature of tumours to around 43-45°C instead of the normal body temperature of about 37°C. It has been known for over a century that some malignant tumours respond to localized but small elevation of temperature. The difficulty has been to heat the affected organ without overheating other parts of the body. The Bethesda work has used the industrial, scientific and medical frequencies of 13.56, 27.12 and 40.68 MHz.

Other workers have concentrated on microwave hyperthermia on 2450 and 915 MHz despite its limited depth of penetration of roughly 1 cm for loads of high water content, such as muscle, brain and organs. Design of applicators that can improve the heating of tumours deep within layers of fat or bone, with minimum absorption of energy elsewhere has proved difficult and the Bethesda work on helical coil applicators appears to be in the nature of a breakthrough.

A number of British hospitals are involved in hyperthermia experiments, some making use of obsolete 405-line v.h.f. television transmitters which can be modified for this type of work. IBA have already included several Band III equipment to hospitals in Aberdeen, Bristol and Cambridge and have earmarked further equipments for this purpose when Band III television is finally phased out in January 1985.

Telecommunications Act

The Telecommunications Act, 1984 received Royal Assent on 12 April, 1984 and Part VI - provisions relating to wireless telegraphy, including amendment and enforcement of the Wireless Telegraphy Acts - will shortly become law. The new Act appears to provide the DTI with the means of stamping out unauthorized and illegal use of transmitters of all types, provided always that sufficient effort is put into tracing them.

Manufacturing, selling, offering for sale or hire of 'restricted' apparatus becomes for the first time an offence. Having 'without reasonable excuse' such equipment in one's custody or control, or importing it, will also be an offence. Manufacturing includes assembly of component parts.

Immediate seizure of equipment under a search warrant becomes possible; if there is any doubt as to identity or address not even a warrant is necessary. Where such a warrant is later confirmed by the Court, the Secretary of State can, at present, dispose of it as he thinks fit.

The Act also makes provision for payment of the radio Interference Service from money provided by Parliament and operational responsibility for this service will be transferred from British Telecom to DTI.

The Act abolishes the advisory committee of the 1949 Act and strengthens the powers of the licensing authority in a number of ways including the ability at any time to revoke or vary the terms of any broadcasting or communications licence 'in the interests of national security or relations with the government of a country or territory outside the UK'.

Sending of false or misleading messages becomes an indictable offence. DTI have the right to prescribe technical requirements for services.

It remains to be seen how strictly the Courts will interpret the amended Wireless Telegraphy Acts and the effort that will be put into enforcing them. On the face of it it would seem to be an instrument capable of quickly putting off-air the broadcasting 'pirates' and the more numerous pseudo-amateurs such as the 'International C.B.' around 6.6MHz. Less easy to suppress will be the unlicensed 'amateurs' and 'c.b.' operators who may still find it possible to pass unnoticed for a time by operating in accordance with the licences they have omitted to obtain.

It seems likely that concessions will be made soon to small-time broadcasters by the introduction of some form of 'community radio' or 'special event' radio licence involving for example low-power transmitters at major outdoor and sports events. This may however be deferred until the end of the second session of the ITU Regional Administrative Conference at Geneva next October to December, when frequency assignments between 100-108MHz are expected to be agreed for the European region.

Vienna Convention

The events during April surrounding the 'sieg' of the Libyan People's Bureau were calculated to re-inforce the very worst fears of signals intelligence people. The American ABS network started the ball rolling by claiming that Libyan messages to London had been intercepted, deciphered but then not passed on to the police in time for them to take greater precautions during the morning of April 17.

Such a 'leak' apparently from American sources, if true, must rank alongside the three classic occasions in the 1920s when it was freely revealed in the British Parliament that Russian diplomatic traffic was being read. This led inevitably to the USSR introducing secure ciphers and the loss of a valuable source of information. As a result British Intelligence became very wary of passing sigint even to the Cabinet.

Today diplomatic traffic can be unconditionally secure (truly random : one-time keys) or more often 'computationally secure' requiring excessive computer time to crack. Clearly some of what can be plucked form the air can still be read, if only with difficulty, or signals intelligence would not have retained its importance. But the idea that almost all diplomatic traffic can be read immediately on receipt can serve only to encourage the Libyans (who know whether they sent such a message) and other countries to change to more secure ciphers.

The leak furthermore served no useful purpose. WPC Fletcher was already dead. If NSA or GCHQ are able to decipher such messages virtually without delay, it may indeed have been blame-worthy that a warning did not reach the Metropolitan Police before the shooting. But finding a scapegoat is a doubtful advantage if in the process a source is blown.

Diplomatic radio communications form one of the fixed services not entirely transferred to satellite. A stroll though Belgavria or other embassy districts of London reveals many h.f. aerials ranging from very large log-periodics to the barely visible compact transmitting loop aerial on the roof of the US embassy in Grosvenor Square. Diplomatic communications remain an important market for h.f. equipment.

Foreign embassies, however, do not have an automatic right to set up radio links. Paragraph 1 of Article 27 of the Vienna Convention on Diplomatic Relations, 1961 reads: 'The receiving state shall permit and protect free communication on the part of the mission for all official purposes. In communicating with the Government and the other missions and consulates of the sending State, wherever situated, the mission may employ all appropriate means, including diplomatic courtesies and messages in code or cipher. However the mission may install and use a wireless transmitter only with the consent of the receiving State.'
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ELECTRONICS & WIRELESS WORLD JULY 1984
**Amateur Radio**

**Moonbounced TV?**

Andrew Emmerson, G8PATH, has passed along news from Maurice Clot, F1FVX, of what promises to be a remarkable and unique experiment aimed at gaining a 'world first' in amateur television. French amateurs are attempting to moonbounce television signals transmitted on 1255 MHz using an aerial with a calculated gain of the order of 90 dB.

To make this possible, the French electricity authorities have granted permission for F9CH and F6BGR to use the 10,000 square-meter plane metal reflectors of the French experimental solar oven near Fontromue, East Pyrenees as an aerial, with a dipole element replacing the normal crucible and with the computer programmed to follow the moon instead of the sun.

It is planned to use frequency-modulated vision signals with a transmitter power of 140 watts during tests between July 9 and July 13 when the moon will be low enough on the horizon (20 to 24° at the meridian) to allow receiving stations to aim their aerials without the need for an elevation rotor. Further information on these experiments is to be distributed through French stations on 144.170 MHz ± 10 kHz and 3670 ± 10 kHz.

**Here and there**

The Australian society, WIA, has succeeded in persuading their Government to re-establish the special low import tariff (2%) on amateur transmitters and transceivers. This concession was lost in June 1983 when an Australian manufacturer of marine communications equipment complained that some imported amateur radio equipment had been modified and illegally sold for use in the maritime service. The low import tariff was granted on the basis that there is no Australian production of amateur h.f. transceivers.

The Olympic Games torch run that starts on the East Coast of the USA and will pass through all the 48 contiguous States before it ends at the Los Angeles venue on July 28 is being co-ordinated by amateur radio communicators travelling in the fleet of support vehicles, under the aegis of AT&T.

Several Australian amateurs have been granted experimental permits permitting transmission on 196 kHz (1830 meters) on condition that only 'backyard' aerials are used. With output powers of about 100 watts and fairly short aerials about 10m high, resulting in effective radiated powers of less than 0.5-watt, telegraphy contacts are being made over distances of several hundred miles.

A successful meeting of Dutch amateurs interested in narrow-band mechanical television was held last March in Eindhoven, attracting 50 to 60 visitors. Historic 30-line equipment was displayed by Kees Sanders, PaoDXY. A camera monitor by P. Walker was made from small lenses taken from a broken road sign and driven by a bicycle dynamo. Several British NBTV enthusiasts have been using silicon solar cells as pick-up devices for low-definition systems. A 96-mile mechanical system being developed by J.A. Short uses the old Baird techniques of obtaining sync signals by blanking off part of the picture (i.e. no blacker-than-black pulses) but uses a much more sophisticated form of sync-separator discriminator. Apparently it works, which is more than could always be said of the Baird phonic-wheel technique!

Wayne Green, W2NSO, editor of 73 Magazine, in a petition for rule-making submitted to the FCC has proposed that all American radio amateurs should be re-examined for more proficiency every two years with a requirement that they achieve a five-word-per-minute-up-grading each time, to a final level of 35 word/min. Failure to improve speed, he suggests, should result in loss of licence. However it seems highly unlikely that FCC would impose such a rule.

**Region 1 Conference**

At the 1984 IARU Region 1 Conference held at Cefalu, Sicily, Dr John Allaway, G3FKM, was elected as secretary of the Region 1 Executive Committee, the post held until his death in 1981 by Roy Stevens, G2BVN and since then by Eric Godsmark, G5CO. Region 1 conferences are held once every three years. At this year's conference, member societies were urged to seek from their national administrations a 50MHz amateur allocation and the removal of Syledis pulse transmissions from the 430 MHz band. The conference also recommended that no f.m. repeaters should operate between 144.8 and 145MHz and rejected proposals to allocate channels and repeater channels for narrow-band f.m. transmissions in the 29MHz band. It endorsed a provisional band-plan for 1296MHz and a new world-wide locator-squares system (from January 1, 1985). The IARU Medal was awarded to the Russian amateur N. Kazansky, USAAP. The conference also discussed the proposed new constitution for the International Amateur Radio Union.

Rather more success in dealing with interference from Syledis-type transmissions in the 430MHz band is reported from California where pulse transmitters on 433 and 437MHz have now been turned off.

**In brief**

A major solar flare, possibly the largest in Solar Cycle 21, was recorded at the end of April. The RSGB 1984 National Convention at NEC Birmingham attracted over 6000 people on Saturday 28 April and some 5000 on the Sunday. The 1985 Convention is to be held at the National Exhibition Centre on 13 and 14 April 1985. A postage stamp featuring the amateur radio station, H44ISL, of the Solomon Island amateur radio society was issued last December as one of a set of three forming a World Communications Year set. During early June, French amateurs operated a special station, TK6JUN, at Ste Marie-du-Mont (Utah Beach) to mark the 61st June, 1944 D-Day landings by Allied forces. On this side of the Channel, GB4BIC operated from the Royal British Legion centre at Nettle, Southampton as part of an 'Operation Overlord' project during the D-Day anniversary week. RSGB annual subscription is being increased by £2 to £16.50 from July 1. In a recent prosecution for the illegal use of a 6.3 MHz receiver, Robert Burwell was fined £250 with £50 costs. It was stated that French air traffic control had complained of interference to its operations caused by the transmitter. July mobile rallies include: Worcester club at Droitwich High School, Ombersley Road on July 1; West Manchester club at Burtonwood Motorway Service Area near the junction of M6 and M62 on 8 July; Cornish club at Camborne Technical College, Pool on 15 July; West Kent Radio and Electronic Fair at Royal Victoria Hall, Southborough on 21 July; Anglian rally at Stanway School, Colchester and McMichael rally at Bella Hills, Stoke Poges both on July 22; Rolls Royce rally at Sports & Social Club, Barnet and Scarborough rally at The Spa, Scarborough both on July 29.
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<table>
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<tr>
<th>V/A</th>
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<td>24.00</td>
<td>3.00</td>
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**Computer crashes**

No less than three different computer companies ceased trading in one week: Dragon Data, Tycom and Computas. The chief executive of Tycom is Sir John Clark, Conservative Member of the European Parliament. His major customer has been the Conservative party, who have installed the Microframe computer in a large number of constituency offices. The party is now looking for ways to provide services and hardware support to those constituencies. Brian More of Dragon Data feels that the buoyancy of the home computer market has been overestimated and that most people who get home computers do it purely and play games or because they are curious about computers. He is looking for a buyer, and one may be at hand. Tandy Corporation, whose Color Computer is very similar internally to the Dragon 32, has expressed an interest, initially in taking over the servicing and repair of the Dragon but possibly in continuing the manufacture as well. Computers, manufacturers of the Lynx computer which never really got off the ground, having sold only some 10,000 units, are also looking for a buyer.

The business computer market is now greatly influenced by the coming of the IBM personal computer. Such large corporations can use their capital and their marketing expertise to produce a machine that is easy to mass produce, and can provide full documentation and support in both hardware and software. The smaller companies such as Tycom find it difficult to compete with such powers.

**Software Key**

A fresh attempt to counter home software piracy has been launched by the Cornish company Microdeal, with the inclusion of the protection device with one of their latest computer games. Buzzard Bait, a game for the Dragon 32, comes with a small resin-encapsulated module which plugs into one of the computer’s joystick ports. This software key, as Microdeal call it, must be in place to enable the cassette to load properly. The company hopes the device will put an end to unauthorised tape-to-tape copying, since without it the cassette is useless. And Microdeal believe that copying the module itself would call for resources beyond those of the home user. The key, or dongle, was developed to Microdeal’s specification by Northern Software Consultants of Newcastle-upon-Tyne. It costs about £2, and can be applied to cassette or disc programs for almost any microcomputer. For business computers, a version can be made to interface with an RS232 port. A different key is required for each title.

Microdeal will be adding the key to several new programs on their Tom Mix Software label. They hope to discover whether increased sales to frustrated pirating pirates will outweigh those lost to schoolchildren who might otherwise have bought the game by pooping their pocket-money.

- Also fitting in to the RS232 port of a computer is the Sesame security key from Polytech Engineering Services Ltd. Without inhibiting the use of the port, any software used with the system interrogates the key which responds only if the correct password is used. Any copy of the software will only work on a computer fitted with the same key and as there are approximately 100 million possible codes, made up of ASCII control characters, in effect this means only one computer can use it. Each device is supplied with a randomly selected code, together with notes and a flow-chart on how to incorporate the interrogation routine into a program. It has been estimated that it would take a fast computer about 20 years to ‘crack’ the code. WW230

**Cell news**

Trials for Racal’s cellular radio-telephone system, to be known as Vodafone, are to start in December 1984, ahead of the original schedule, over a 150 square-mile area of London. The service will also start up before its schedule date of March 1985, initially covering London, cities in the south, Wales and the Midlands, and along several motorways. The second phase is to be an expansion into the north of England — plans for Scotland and Northern Ireland are to be announced later this year. Racal have also launched a new company, Racal-Vodac, to distribute, install and service subscriber equipment. Another company was necessary as the licencee for the system is not permitted under the terms of the licence from marketing the consumer equipment.

Consumer equipment for the BT/Securicor Cellnet system is to be manufactured in Japan by NEC. After a world-wide search for a manufacturer to these products, BT decided that NEC were the only people with the facilities and expertise to provide the system. The equipment will include both car-mounted mobile radiophones and hand-held portables. The mobile sets will be available in December this year with the portables following later in 1985. If the cellular system is as successful and popular as both BT and NEC think it will be then there is a chance of manufacturing facilities being transferred to the UK. The first working pilot system of Cellnet was to be demonstrated in London early in June to cover 3,000 square miles and give continuous coverage over central London, extending to Heathrow and Gatwick Airports.

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###野村}
**Usat 2 not dead but poorly**

Usat-2, the Surrey University satellite which ceased to transmit beacon signals after the first three orbits, has now been traced. (Communications Commentary, last month) The giant SRI dish in Greenland managed to detect the 1.2GHz local oscillator which pin-pointed the exact orbit of the craft. Surrey engineers were gratified to have confirmed that the satellite was where they expected it to be. They managed to turn on the 2MHz beacon to discover that the satellite was undergoing a weekly temperature cycle and that there were major problems with the 2MHz beacon system. Now they have managed to bypass the problem by using the on-board computer and have been able to send commands on the command uplink. It is still necessary to stabilize the craft to prevent the temperature cycling and to get the main antenna pointing earthwards. Then it will be possible to have a complete system check-out and find out how many of Usat-2’s functions are still working. Even if everything else functions properly, it will not all be able to be used because of the use of the computer to bypass the 2MHz problems.

**OED on computer**

The compilers of the new edition of the Oxford English Dictionary have decided to commit it to a computer. This will enable the original 13 volumes to be expanded by the four supplement volumes and any new words can be easily inserted right up to the moment that the edition is prepared for printing. There are over half-a-million entries which include over two million illustrative quotations giving a total of over 80 million characters. In addition there is a variety of typefaces including Greek, phonetic characters, mathematical symbols and scientific formulae.

The system is to be based around an IBM 4341 central processor with both tape and disc storage, printers and over 20 v.d.u.s. Under IBM’s scheme for support for academic institutions they are sending two data-processing specialists to the OUP to assist the dictionary editors with the task of updating.

**Communications in the air**

British Telecom persuaded British Caledonian to run part of its Gatwick operation from Birmingham. (Communications 84) They did this to demonstrate the capabilities of Touchdown, a communications link between the aircraft, controllers and groundstaff which allows for the arrangement of schedules for refuelling and repairs, check destination and time, book crews and aircraft, check passenger loads and the provision of on-flight catering. All this is done from a touch-screen terminal. By touching squares on the screen operators can answer incoming calls, display background information, make internal and external calls (all regular numbers are stored and dialled automatically), and send or receive telexes. The link from Gatwick to old Birmingham was for two of the 12 terminals in use at Gatwick.

Another communications system, installed by BT at Gatwick, is for the air traffic controllers. Through ADEKS, Advanced Design Electronic Key System, allows control and display information to be input to a central computer, which in turn provides the output. It is used for air traffic control at Gatwick.

**Expanding American teletext**

The National Association of Broadcasters has joined the FCC in its proposals to authorise American tv stations to provide paging and a variety of data transmission services in the tv signal vertical blanking interval. The services should include video games and computer programs, and other ‘interactive’ services. The decision to provide these services should be left to the market place. In its submission, the NAB said that the system was technically sound, promoted competition and conducive to spectrum efficiency. It also said that the services should not be subject to common carrier regulation. Cable services which are obliged to carry certain network services should not be permitted to ‘strip’ the new offerings from the tv signals.

**One network not two in UK**

Britain is urged not to follow the American example and have separate telephone and tv networks. In an article in the Sunday Times of June 4th, Warren Partridge an American lawyer and telecommunications business consultant, points out that with the denationalization of British Telecom, Britain is heading toward the same system that the US has developed in the 70s: one that has a private telephone monoply, underfunded cable tv and unnecessary investment in all sorts of services to be carried into homes on several wvrs. Now is the time, he maintains, for all these services to be combined into one network.

The American experience is the development of two separate, and inadequate, systems. The telephone network is neither designed for local transmission of high speed data nor tv pictures; the other, a cable tv system is not designed to provide telephone services. Both systems suffer from not getting the income that could accrue from the services provided by the other.

Mr Partridge suggests that Britain’s cable tv franchising process could be used as the mechanism for privatizing BT. Britain could be divided into a few large combined telephone and cable services. The condition attached to awarding a franchise should be the acquisition of BT’s present telephone system assets. This would privatize BT geographically, piece by piece, with the licensee operating a single system for telephones and tv. Those awarded franchises should offer a common carrier service only and lease capacity for tv channels or other services to programming and marketing companies. Control of such entertainment channels could be through the proposed cable authority.

These proposals would counter the problems found in the US, where it has been found that cable tv only provides more channels if those channels are also available over the air then the cable systems begin to founder. Only in Washington DC has the telephone company proposed that they provide the cable system to be leased to cable tv companies. That should be the way forward for Britain, says Mr Partridge, if it wants to learn from US mistakes and take its telecoms into the future.
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Digital stereophony with television

Tests on digital four-phase d.p.s.k. technique of transmitting additional sound information for TV stereophony show the system to be more rugged than for either teletext or colour television pictures.

A single high-quality broadcast audio channel requires a bandwidth of at least 15kHz. Simple linear quantization of an audio signal results at least 13 bits per sample for acceptable broadcast quality. Near-instantaneous digital companding*, however, enables the number of transmitted bits per sample to be reduced to ten with negligible degradation in quality. Assuming a 15kHz audio bandwidth, a sampling rate of about 32kHz is required to satisfy the Nyquist criterion** and thus avoid unwanted alias effects. The minimum bit-rate for a single high-quality audio channel is therefore about 320kbit/s. To this must be added the bit-rate needed to transmit additional data such as framing words, parity bits for error detection, and the scale factor words associated with near-instantaneous companding. Two such channels, therefore require a bit-rate of something in excess of 640kbit/s.

A system has been devised based on earlier work at the BBC Research Department* and its outline parameters are given in Table 1. The proposed system, which is still under development, was not used in the South Wales tests, a pseudo-random binary sequence generator being used instead. However, the important factor was to test the modulation system employed and this is discussed next. The proposed system employs a bit-rate of 704kbit/s, chosen because it is a multiple (22) of the sampling frequency which could lead to simplification of the decoder, and it provides a few kbit/s spare data capacity for supplementary purposes.

Choice of modulation techniques

The choice of a modulation technique for any digital transmission system results from a compromise between the required bandwidth, the signal-to-noise ratio required to achieve an acceptably low received bit-error rate (this

Table 1. Proposed baseband coding for experimental digital stereo sound with terrestrial television.

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<th>Parameter</th>
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<td>Pre-emphasis</td>
<td>CCITT</td>
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<tr>
<td>Audio sampling rate</td>
<td>32kHz</td>
</tr>
<tr>
<td>Samples per block</td>
<td>32</td>
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<tr>
<td>Audio coding</td>
<td>14/10-bit near-instantaneous companding</td>
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<tr>
<td>Scale factor bits</td>
<td>3 per block per Channel 6kbit/s</td>
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<td>Error protection for sample words</td>
<td>32kbit/s</td>
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<td>Error protection for scale factor bits</td>
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<td>Framing</td>
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<td>Available for further development</td>
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<td>Overall bit rate</td>
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</tbody>
</table>

*In near-instantaneous digital companding the analogue input signal is sampled and digitally coded to an accuracy of 14 bits per sample. Only ten of these 14 bits are actually transmitted, the ten 'bit window' moving up and down the 14-bit range according to the peak signal level occurring during a block of 32 samples. The receiver decoder is instructed on the correct placement of the 'window' by a three-bit scale factor word sent with each successive 32-sample block. By this method, low-level programme signals are transmitted with 14-bit accuracy. The accuracy progressively decreases down to ten bits per sample for the higher signal levels, but the consequently increased quantization noise is masked by the higher level of programme.

**The sampling frequency must be at least twice the highest modulating frequency.

by E. H. Hartwell
BBC Research Department

Ted Hartwell joined the BBC in 1963 after serving four years as a design and development engineer in industry. Most of his time in the BBC has been spent in the studio engineering department at the Television Centre in West London where he worked as an engineer and, more recently, as a technical writer. He became Research Author at the BBC's Research Department last year.

Receiving, demodulating and measuring equipment inside a BBC survey vehicle.

Electronics & Wireless World July 1984
already been gained in the use of this method.

Four-phase p.s.k. is a digital modulation technique in which the carrier adopts one of four possible phase states dependent on the two-bit pattern occurring at any instant, i.e. 00, 01, 11 and 10. Carrier amplitude remains constant except during phase transitions.

Simple four-phase p.s.k. requires the transmission of an additional phase reference signal for correct decoding and this can only be achieved at the expense of increased carrier power or bandwidth, neither of which is desirable. However, if the p.s.k. signal is differentially coded (d.p.s.k.), no additional information is required. Instead, the transmitted message is coded into carrier phase changes between one bit pair and the next, which the decoder does not need a phase reference to detect, Fig.1. Briefly, the modulation system works as follows.

The changes of carrier phase which correspond to the four possible bit pairs 00, 01, 11 and 10 are respectively 0, —90, 180 and —270°, Fig.1(a). The carrier phase itself can dwell in one of four rest states 90° apart, as depicted in (b). An input bit-pair shifts the carrier phase into a different rest state by the amount assigned to that particular pair. The transmitted phase changes and subsequent carrier rest states for the input bit-pair sequence 00, 10, 11 and 01 are illustrated in (c).

Choice of second sound carrier

The relative levels of the vision and sound carriers, and the frequency-spacing between the main and second sound carriers, have to be chosen to give good compatibility with existing receivers, whereby interference to the picture or main sound channel is kept to a minimum. The frequency and level of the second sound carrier must also be chosen so that the digital system works reliably throughout the service area of normal television reception. A third requirement is that the second sound carrier must not interfere with transmitters operating on adjacent television channels. The first and third requirements have been investigated in the laboratory, and the second during the field tests in South Wales. Inevitably, these requirements conflict and a compromise has had to be sought.

Theory and laboratory tests indicate that, to avoid interference to or from the main frequency-modulated sound signal, the additional digitally-modulated sound carrier would need to be spaced 6.5MHz or more above the vision carrier (i.e. 0.5MHz above the rest frequency of the main sound signal), and at an amplitude of between 20 to 25dB below it.* This is a larger frequency spacing than that used in the earlier BBC tests on the analogue two-carrier system, where a spacing of about 6.3MHz was best, because of the greater bandwidth (about 700kHz) of the digitally-modulated signal compared with that of the f.m. signal.

The upper limit on the spacing of the second carrier from the vision carrier was determined by adjacent-channel interference, both from the viewpoint of interference from the digitally-modulated signal into the vestigial sideband of the upper adjacent channel, and vice versa.

Laboratory tests indicate that with the second sound carrier at a level of 20dB below the vision carrier level, interference from the digitally-modulated second sound carrier into the upper adjacent channel is not a problem and complies with the CCIR recommended protection ratio. In fact the main sound carrier is the limiting factor for interference into the upper adjacent channel; this remains true even when the main sound carrier is reduced by 3 to 10dB below the vision carrier. Interference from the upper adjacent channel into the digital sound channel seems more likely because the CCIR recommended protection ratio in this direction is much more tolerant.

Any interference to the digital sound channel from the vestigial sidebands of the upper adjacent channel vision signal is picture dependent, which meant detailed

---

*Fig.1. In the differential coding process four bit-pair combinations which modulate the carrier cause it to change phase by the amount shown in the table (a). Carrier has four possible rest states 90° apart (b). An example of carrier rest states adopted for the input bit-pair sequence 00, 10, 11 and 01 is shown in (c).

Table 2. Modulation system for experimental digital stereo sound with terrestrial television.

| Frequency of second sound carrier | 6.55MHz above vision carrier |
| Level of second sound carrier | —20dB with respect to peak vision carrier |
| Modulation of the second sound carrier | 4-phase d.p.s.k. |
| Overall bandwidth (to —30dB) of transmitted d.p.s.k. signal | 700kHz |
| Level of main sound carrier | —10dB with respect to peak vision carrier |
studies of the power-density spectrum with a variety of picture signals. As expected from the vestigial sideband shaping, the power density spectrum falling into the digital channel is triangular, power-density decreasing with increasing spacing from the interfering vision carrier. This indicates that the frequency of the second sound carrier should be kept as close as possible to that of its parent vision carrier.

These conflicting requirements lead to a frequency spacing for the digital sound channel of 6.55MHz above the wanted vision carrier, i.e. 0.55MHz above the main f.m. sound carrier, Fig.2.

Parameters of the modulation system adopted for the experimental equipment are given in Table 2.

Conclusions

The South Wales tests show that the experimental digital system is adequately resistant to impairments to digital sound signal reception arising from low field strength, multipath propagation, ignition interference, and distortions in a long chain of transposers.

The results clearly show that when receiving low field-strength signals directly from the main transmitter (at Wenov) the digital sound signal will not, on average, fail before the picture became unacceptably noisy; when receiving signals via a re-broadcast relay station (transposer) the average failure point occurring at a field strength well below the nominal service area limits for Band IV and V transmissions. The system is more rugged than either colour television pictures or teletext with regard to multipath propagation effects (ghosting).

In May, with Home Office agreement, the BBC conducted similar tests from the BBC2 transmitter at Crystal Palace, to confirm that the experimental system is compatible with the widest possible range of domestic receivers. In May, test transmissions were made of a television programme with stereophonic sound using the experimental system described. The results of both series of tests are very encouraging: the BBC is presently having discussions with the IBA and the receiver industry to establish an agreed UK Standard.

Background to BBC experiments

For many years there has been interest in the possibility of adding stereophonic sound to existing television services and the BBC has investigated a number of possible methods. In all cases an additional sound signal is required to carry the stereo information and, in some cases, the additional signal is suitable for the transmission of independent sound signals as may be required, for example, to provide a bilingual service. Methods investigated include the pilot-tone system as used for stereo radio broadcasting in the UK, the Japanese f.m.-f.m. system and the German two-carrier system, all of which employ an analogue second sound signal; and digital sound similar to that proposed for direct broadcasting by satellite television.

The first two methods have certain limitations in this context and were not pursued as serious contenders. The German method, (WW November 1981, Page 40) in use on a limited basis in that country, appeared more promising and engineers at the BBC Research Department devised a variant of this method adapted to the PAL System I as used in the UK.

Towards the end of 1982, the BBC conducted over-air compatibility tests of this variant from the BBC transmitter at Crystal Palace outside normal broadcasting hours. The tests indicated that the system was only marginally compatible; interference between the additional sound carrier and the main sound carrier gave rise to picture pattering, which, to avoid, required reduction of the main sound carrier. However, reduction of the main sound carrier to 13dB below the vision carrier as in Germany caused increased buzz-on-sound in some existing receivers.

During the period that various options for analogue stereo sound with television were being assessed, the status of digital techniques in domestic equipment had changed considerably and consumer products, such as the digital audio disc with its attendant high quality sound, had become available. Also, the BBC proposes using an internationally agreed system of digitally coded sound for d.b.s. These advances led to the consideration of a digitally modulated second sound carrier to convey the stereo signal.

A digitally-coded signal is more rugged than its analogue counterpart and may therefore be transmitted at a lower level. This reduces the level of any interference between the main sound carrier and the added digitally-modulated carrier. Also, because of the more noise-like nature of a digital signal, the visibility of any interference patterns is reduced further, which enables the main sound carrier to be maintained at near its full level, avoiding the increased buzz-on-sound problems found with the analogue two-carrier system.

A thorough investigation of the digital option carried out at the Research Department led to over-air tests of an experimental system, conducted outside normal broadcasting hours from the BBC2 transmitter at Wenov in South Wales and its associated rebroadcast relay stations during the autumn of 1983 [ref.1]. This particular area was chosen because the terrain is hilly and multipath propagation of normal television signals very evident. The area contains a large concentration of rebroadcast relay stations which enabled assessment of the digital sound signal when subjected to the cumulative effects of distortions in a long chain of such stations.

This article discusses the reasons behind the choice of parameters used for the experimental systems, together with a summary of the test results.

References


*The vision carrier level is taken as the peak vision carrier power at the tips of the sync pulses, and levels of the main and second sound carriers refer to the respective levels of the unmodulated carriers.
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CIRCLE 26 FOR FURTHER DETAILS.
Music keys for the BBC microcomputer

Using the computer's sound unit or external generators, this economical polyphonic keyboard interface makes a musical instrument and an educational tool for storage, analysis and display of music.

Potential of the microcomputer as a tool for teaching, editing and perhaps even composing music is great, as the amount of music-related software currently available will testify. This software however suffers from one serious drawback — the means of entering musical information into the computer. These means include the computer's typewriter-layout keyboard and sometimes games paddles or joysticks but all are clumsy, slow and error prone which is a great discouragement to the musician (as opposed to the computer enthusiast) attempting to use the computer creatively.

There are systems that include the natural input device for a musician — a music keyboard — but they are mainly intended for computer-based synthesizer applications. Best known of these are probably the Fairlight Computer Musical Instrument costing around £20,000 and the Alpha Syntauri add-on for the Apple computer costing around £2,500. The Alpha Syntauri is intended for use as a synthesizer but there is now some elementary teaching software available for use with it.

Some other (mainly American) music teaching systems were recently reviewed by David Ellis.*

Lancaster University's music department is studying possible uses of microcomputers in aspects of its work including the training of musicians, music editing and research into music analysis. We felt from the outset that a 'musician friendly' input device was essential for acceptance by potential users and given the cost of commercial systems — not to mention their shortcomings — we decided to develop a straightforward and cheap keyboard interface for the BBC microcomputer. The outcome is a keyboard and interface costing around £50 in components and drawing about 60mA from the computer's 5V supply, which hasn't caused problems even while two disc drives are powered from the same source.

Design considerations

Synthesizer applications were not considered a prime objective although the design can be used to play the computer's own sound generator or external units. No attempt was made to make the keyboard touch sensitive to measure the speed of key depression; simple on/off key switches will suffice. Uses envisaged for the interface suggested that it should be fully polyphonic, i.e. should accept chords and should not be restricted to the one-note-at-a-time characteristic of typewriter-style keyboards designed for computer input. Finally, rapid response was required and in some circumstances the computer might be processing input

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information in real time, suggesting that time should not be wasted by scanning the keyboard unnecessarily.

These conditions were met by making the system interrupt driven and bit mapped. This means that any change in keyboard status due to a key being pressed or released produces an interrupt signal causing the computer to read the status of all the notes on the keyboard. On reading the keyboard, the computer stores a bit-mapped image (zero for an unpressed key, one for a pressed key) of the current keyboard status for subsequent analysis, display, sound generation, etc.

Hardware

A four octave C-C (49 note) keyboard is used. Initially, the 49th note proved a minor nuisance since 48 notes can be neatly mapped into six bytes. However, in the final design it turned out to be convenient to read the keyboard in eight bytes so the system can accommodate a five-octave keyboard. One byte is used to check that spurious noise pulses have not sent the interface byte counter out of step with the reading software.

Keyboard and key switches used are those sold by Maplin Electronic Supplies as the basis of their ‘Spectrum Synthesizer’ (no connection with the well known microcomputer). The key switches are unusual in that they are simply coiled springs soldered to a p.c.b. at one end and touching a bus bar on the p.c.b. at the other end when the key is pressed (the p.c.b. is also supplied). This seemingly effective keyboard is easy to assemble and much cheaper than using conventional organ key switches. Some initial problems were experienced due to key bounce caused by spring vibration but these were solved by inserting lengths of soft foam plastic at the edge of the p.c.b. where the switches are soldered to damp the vibrations.

The BBC microcomputer user port is connected to the B lines of a 6522 versatile interface adapter, v.i.a. It carries eight data lines, D0-D7, two handshaking lines, CB, R, a number of ground lines and the computer 5V supply. Through programming, the v.i.a. can be made to generate an interrupt signal when CB, changes from high to low or alternatively low to high — but not both. For a response to be detected, it is required when any key is pressed, or released, and even if a number of other keys are already held down, so a means producing a suitable interrupt signal is needed.

Figure 1 shows basic key connections in which two equal resistors, Rp, establish a steady-state voltage of 2.5V on the strobe rail. Each key switch is connected to a network made up of Rp and C. Initially, C, has a potential difference of 2.5V across it (lower plate 5V, upper plate 2.5V). When the switch is closed, the lower plate potential falls initially by 5V and as the capacitor’s charge cannot change instantaneously, so does the upper plate’s potential i.e., the strobe potential drops to 2.5V.

In due course, C, discharges through Rp then recharges with reverse polarity through R, and the strobe returns to 2.5V. When the switch is opened, C tries to discharge through R, and R, and in doing so pulls the strobe line above 2.5V by an amount depending on the values of the resistors. The capacitor now discharges and recharges to the original steady-state voltage through R, and R, so key status can be read at point S.

If several keys are connected to the strobe rail each with their own RC networks, their behaviour will be similar but step magnitudes and associated time constants will depend on how many keys are pressed. For example, if 48 keys are pressed — a tricky feat even using arms instead of hands — pressing the 49th key places the last C, in parallel with the 48 others and limits the step size to about 100mV. However, as long as the system can detect the smallest possible step and react to the minimum time constant while the maximum time constant is short enough to ensure that recovery occurs before one has a chance to press the next key, all is well. Component values shown allow the keyboard to respond to chords of any number of notes that I have managed to reach over and to trills and glissandi without problem.

Negative-going interrupts can be produced by taking the strobe line to the non-inverting input of a comparator whose input is biased just below 2.5V so that it responds only to negative-going pulses, and to the inverting input of a further comparator, whose non-inverting input is at just above 2.5V, which responds only to positive-going pulses. The LM393 dual comparator is ideal for this purpose since it works with a 5V supply and has open-collector outputs which can be wired together to produce OR gating.

Figure 2 is the final circuit. Resistors R1, provide bias for the strobe rail and R, and C, are R, and C, for each key. Also, Fig.1. Resistors R, provide bias for the comparators, IC. Resistor R, forms collector load and resistors R, and C, provide some hysteresis — usually a good policy when using comparators to improve noise immunity and switching times and to reduce tendency to spurious oscillations. The input voltage on IC must not be allowed to fall below ground and it can be seen from Fig.1 that the strobe rail can do this — hence Continued on page 29

![Diagram](image-url)

Fig. 1. Outline of the keyboard's interrupt generator. Closing or opening the switch causes the voltage on the strobe rail to act as shown. Each pulse causes an interrupt.

At switch on, the counter is set to zero and its synchronism is checked each time the keyboard is read. The delay allows for key bounce and for the fact that is impossible to play all the notes of a chord simultaneously.

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24 ELECTRONICS & WIRELESS WORLD JULY 1984

www.americanradiohistory.com
Television reception with papaya tree antenna

Novel technique couples r.f. energy from vegetation canopy to receive tv signals.

Back in 1979 we conceived of using green vegetation canopy as an r.f. antenna and conducted feasibility studies with a live cypress plant and freshly cut date palm leaf branch at 1000MHz to successfully demonstrate it. Later, we conducted experimental studies to use vegetation canopy (leaves and branches of gulmohr, canna, bottle brush, coconut, date palm, fern, etc) as electromagnetic antennae structures at microwave frequencies. These studies reveal that certain geometrically-shaped vegetation, due to water and chlorophyll content vis-a-vis their dynamic complex dielectric properties can sustain, propagate and radiate electromagnetic waves from their structure if suitably excited. A gain varying from 2 to 5dB over an exciter probe antenna from selected vegetation canopies at 1000, 3000 and 4000MHz has been achieved with satisfactory impedance-matching characteristics. (The radiation pattern of the exciter probe antenna be shaped with increased its gain axially when it excited an e.m. wave on vegetation cover structure.) A range of branches from a single tree branch to a bunch of a few branches (kept in a plastics cone to maintain a dielectric-rod antenna configuration of the bunch) were used to achieve better radiation pattern characteristics with a gain of around 5dB over that of the exciter probe antenna.

In all these studies a probe helix at the end of a vegetation branch was used to excite an e.m. wave on the vegetation structure. The radiation characteristics so observed were found to remain so long as the vegetation structure is fresh, and start to deteriorate with increase in dryness.

We further reported experimental studies to receive Band 3 television signals from the Bangalor transmitter (radiating 1kW) by using freshly-cut date palm and coconut branches, of length 1.5 and 3 metres respectively. The vegetation cover with reasonably good signal-to-noise ratio. A new simple method to tap the r.f. energy captured by the leaves branch was reported at the same time.

And most recently, we received signals from the Bangalore tv transmitter using a few live papaya trees (one at a time only) of height around 3 to 5m in length and located firstly at 12km and later 25km away from the transmitting tower.

Experimental set up

In this last experiment a few papaya trees (used one at a time), of height around 3 to 5m were

Fig.1. Field receiving site

The authors are with ISRO Satellite Centre, Bangalore, India, except S.P. Kosta who is studying at the National College, Jayanagar, Bangalore.

ELECTRONICS & WIRELESS WORLD JULY 1984

by S.P. Kosta
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K.S.
Dayashankara
B.
Rudralingappa
V.R. Katti
Y.P. Kosta

Dr Shiv Prasad Kosta graduated from Jabalpur University and took his Ph.D. in Telecom engineering in 1969 at the same university.

Dr Kosta is a specialist on antenna and transmission line systems and has more than 120 research and technical papers to his credit. He takes keen interest in basic research problems relating to electromagnetics, antenna and micro-waves and has guided students for M.Tech and Ph.D. degrees.

Recently, Dr Kosta conceived of using trees and salt solutions as tv and radio antennas for very high and microwave frequencies.

Presently, Dr Kosta is working as head of systems integration, at the ground checkout and test division of ISRO Satellite Centre, Penny, Bangalore.
The maximum signal tapping point was found after many trials, from which we found that the piercing end of the inner conductor should touch the moist/wet portions of the tree (xylem, phloem, chlorenchyma, etc.). The other end of the coaxial cable was connected to a Sony portable receiver model CVM-111E. The BNC connector is not necessary to tap the r.f. energy. The signal received from the papaya tree trunk, its one green leaf and the dipole antenna at 12km and 25km distance, were of good readable quality. The v.s.w.r. under best conditions of reception was around 1.5. Only the leaves pointing clearly toward the TV transmitting tower without obstruction received good television pictures. To achieve higher gain (better s/n ratio of the received tv picture), standard antenna array techniques using a few suitably located papaya trees or a few suitably oriented leaves need to be studied in depth.

Under average conditions (slow breeze and feeble rain) the observed tv picture quality was fairly satisfactory.

**Theoretical model**

To a first order of approximation one may simulate either

- suitable symmetrical and geometrically-shaped fresh-cut or live vegetation branch or a bunch of branches (like fern, date palm, bottle brush) as a standard well-known dielectric rod antenna configuration; or
- papaya, coconut, banana-type live branch leaf as a thin dielectric sheet aperture antenna.

The exact constitutive parameters of a green leaf are not well-known. Because of the very large static dielectric constant of water one can well expect that the moisture content of the leaf will have a predominating influence. A reasonable estimate of the complex dielectric constant of green foliage (Du and Peake) can be made from the following equation:

\[ \varepsilon_r - \varepsilon_f = \frac{g}{\omega \varepsilon_0} - \frac{75}{1 + \frac{1}{G}} \]

where \( g \) is the ionic conductivity due to dissolved salts of the fluid in the leaf, \( G \) is the fraction of water content, \( \omega \) is 160Hz, and \( \varepsilon_f \) have the usual meanings, and the conductivity of the dissolved salt may vary widely but is assumed here to be 0.2 to 0.4 x 10^{-4}mho/m. Further, the effective relative dielectric constant of the medium can also be written as

\[ \varepsilon_i = \varepsilon_f + \frac{g}{\omega \varepsilon_0} \]

where \( \varepsilon_i \) is the effective dielectric constant, and \( g \) the effective conductivity.

Du and Peake measured values of the relative dielectric constant (\( \varepsilon_r = 1.01 \) to 1.04) and effective conductivity (\( g = 0.2 \) to \( 0.4 \times 10^{-4} \)mho/m) of the green leaves with varying percentage of water content (10 to 50%) and the volume concentration of the leaves (in the range of 0.0003 to 0.001) at v.h.f. They have also found that dielectric constant is nearly independent of frequency in the v.h.f. band. Spence and Heisler have reported dielectric constant of grassy jungle environment as \( \varepsilon_i = 1.02 \) and conductivity \( g = 10^{-4} \)mho/m. It is also known that

Continued on page 29

**REFERENCES**


**Fig. 2. Probe coupling configuration**
Variable-speed video playback

Using C-format video recorders over a wide speed range. Discussion continues with a description of the effect of the recording process on video waveforms.

At +2X and at 0, a single-track jump is required every drum revolution, whereas at -1X and +3X, a two-track jump is required. At intermediate speeds, a sequence of single and two-track jumps is made. A single-track jump will always be made, but if the bimorph displacement exceeds one track at the end of a field, a two-track jump is needed. This process can be extrapolated up to any speed as necessary until the travel of the bimorph caters for complete tracks. In this extreme case, a maximum size jump will take place whenever the travel limit is approached.

The head jump must take place during the vertical interval in order that it shall not occur in a visible part of the picture. There is, however, a further difficulty. In C-format, vertical interval storage is optional and vertical detection is done by locating the equalising pulses which are at the end of the main field track. These pulses are relatively narrow, and could be missed in the case of dropout. They are thus predicted and validated by counting lines along the field track. The 3/2 line timing shift between adjacent fields has been mentioned: if a jump takes place, this shift has to be taken into account in order to locate the equalising pulses correctly.

When the tape speed is varied, the head-to-tape speed changes, causing the off-tape H sync. pulses to change frequency. As the head—tape contact is not continuous, the machine has to maintain sync. from track to track by counting extrapolated H sync. pulses at the same frequency as they are coming off the tape. A circuit is incorporated which measures the off-tape line period in cycles of a reference clock, and which can generate H pulses separated by that period during the vertical interval. By counting these H pulses, and modifying the count by 3J lines for every track jumped, the machine can always know where it is in a field, and generate convincing vertical pulses which it has not played back. The drum servo will use these corrected vertical signals in order to maintain correct drum phase in the presence of head jumping. It is important that the off-tape field rate should always equal reference field rate: the reason for this will become clear when the timebase corrector is discussed.

**Effect of the v.t.r. on video waveform**

Mixing and editing in PAL video is only possible provided that all sources are synchronised to within about 5 degrees of subcarrier, which is approximately 3 nano-seconds. A field in PAL has a duration of 20 milliseconds, so the stability demanded is:

\[
3 \times 10^{-9} \times 20 \times 10^{-6} \times 100\% = 0.000015\% 
\]

As no mechanism can approach such a tolerance, timebase correction is mandatory even at normal speed.

Video tape, like all magnetic tape, has a plastics backing, which has a relatively high temperature-coefficient of linear expansion, and can also change its dimensions as a function of ambient humidity. It is also flexible. The length of a field track on the tape can be altered by temperature, humidity or tension changes, and timing errors will be caused.

When tapes are interchanged between machines, mechanical tolerances on drum diameter and tape tension will change playback timing. The impact of the rotating heads striking the tape and leaving again creates shock waves which travel along the tape, causing jitter.

Where portable recorders are carried whilst recording, inertial effects can cause timing shifts of several lines. The drum attempts to rotate at constant speed with respect to the earth, owing to its inertia, and if the v.t.r. is turned about the drum axis, the drum phase will change until the drum servo can correct it. This is often erroneously referred to as 'gyroscopic error'.

Video tape is also subject to dropout, where the playback r.f. level is too low to resolve the frequency. Although the mechanism of dropout cannot in itself change

---

**FIG. 10. In PAL, subcarrier must be at odd multiple of one quarter line rate for U and V spectral peaks to interleave with luminance (Y). Unlike NTSC, there is no dominant component at 1/2fₚ points.**

**FIG. 11. Quarter-cycle subcarrier/H relationship and burst swing combine to give four-line sequence — normal and inverted pairs which is not absolutely defined.**

---

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

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**ELECTRONICS & WIRELESS WORLD JULY 1984**
VARIABLE-SPEED VIDEO

Appendix

PAL structure

The broadcasting of colour television is done in such a way that the bandwidth of the signal is no greater than that of a monochrome signal equal resolution, and that a monochrome receiver can display a good picture from a colour broadcast without modification. Without these constraints, NTSC could never have been introduced, since every monochrome set in the United States would have been made obsolete overnight by a non-compatible system.

The bandwidth constraint was achieved by choosing a subcarrier whose sidebands were interleaved with those of the monochrome signal, and monochrome compatibility was achieved by encoding colour difference signals into the subcarrier which a colour receiver could use to convert the monochrome signal into a colour picture. The subcarrier would be virtually invisible to a monochrome receiver. The only problem was that the original design of the 525 line monochrome system had very wisely placed the sound carrier at an odd multiple of half line rate, to give maximum immunity to video sidebands. This became, however, precisely the frequency in an odd multiple of one quarter-line rate. A solution involving a change of sound carrier frequency would have meant re-aligning the coils in every TV set in the United States, so the only alternative was to shift the video/subcarrier spectrum by changing the entire picture rate.

NTSC field rate is thus 59.94 Hz, a change of 0.1%. A direct consequence of this was the development of a drop-frame time code to permit resynchronisation of this strange frequency.

Experience of broadcasting NTSC led the PAL system, whose well-known characteristics of colour broadcast are one of the reasons why colour difference signals on alternate lines had some further constraints. The first, and intended, consequence is that by line averaging, hue errors caused by phase errors under different reception conditions were converted to saturation errors, much more acceptable subjectively, and the hue control was eliminated from the receiver. The frequency in PAL is, however, more complex than in NTSC because of the V switch: the effect of the V switch is to shift the V spectrum up and down by ±1/2 f, at half-line rate. The unswitched U signal is at the centre of the ±1/2 f swing of the V energy.

The subcarrier (U) frequency were chosen at an odd multiple of half line rate, this would make V sidebands coincide with U. Therefore, U and V, it is mandatory that the subcarrier frequency is an odd multiple of one quarter-line rate. The odd multiple chosen is 1535, but 1535 ±1/2 f might have worked just as well. Figure 10 shows that, using this frequency, perfect interleaving of U and V is achieved. Note also that there is no spectral component at half line frequencies, a fundamental difference from NTSC.

Table 1

<table>
<thead>
<tr>
<th>Line</th>
<th>Line period</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>64 usec</td>
<td>15.75 MHz</td>
</tr>
<tr>
<td>X2</td>
<td>64 usec</td>
<td>15.75 MHz</td>
</tr>
<tr>
<td>X3</td>
<td>64 usec</td>
<td>15.75 MHz</td>
</tr>
</tbody>
</table>

video timing, the consequence of dropout can. For example, the destruction of a burst by dropout renders the following chroma information meaningless, since the timing of the suppressed carrier is lost. Dropout compensation is thus a major function of timebase correctors.

If the variable-speed playback is employed, the effect is to change the line period from the standard 64 microseconds. It is possible to calculate the line period for any speed. As the track angle in C-format is so small, the error caused by assuming it is zero is of the order of 0.1%, which can be neglected. The line period in inversely proportional to the head/tape speed. At X1 forward, the tape speed is 239.8mm/s, and the head to tape speed is 21.39m/s. If the tape is run at +2X normal speed, the head/ tape speed will now be 239.8 + 2.2389m/s and the line period will be

\[ t_n = \frac{239.8 + 2.2389}{63.29} \mu s = 3.5 \mu s \]

a change of about 1.1%.

It is important to remember that, although the line period becomes smaller, the field rate remains constant owing to the constant drum speed. The visible part of the picture is thus time-compressed into a shorter part of the field period, and the interval where the head is between tracks will be extended. Owing to the horizontal alignment condition, this extension will be 3] off-tape lines at +2X as there is a one-track jump at every drum revolution. There are normally 32] lines in a field, but at +2X speed, an extra 3] can be added into the same field period. This holds the key to a much simpler way of calculating the line period, which is

\[ t_n = \frac{64 \times 312.5}{312.5 + 3.5} \mu s = 63.29 \mu s \]

This can easily be generalised if the specific speed S is unity at normal speed

\[ t_n = \frac{64 \times 312.5}{312.5 + (S-1) \times 3.5} \mu s \]

This equation is to be preferred, since no approximation has been made, and no knowledge of drum dimensions or tape format is needed except the size of the video offset of 3Jh. It is very easy to arrive at the equation for other standards. For example, in 525/60 NTSC C-format, the video offset is 2H. The equation follows from that. Table 1 shows the effect of applying a variety of speeds to the equation. Interestingly, in reverse, the field tracks are stretched in time, the backwards head jumps lose 3Jh for each track jumped and the vertical interval is encroached upon.

The change in head/tape speed also changes the apparent frequency range of the f.m. carrier, and consequently the levels and amplitude of the playback video. The percentage change can be derived from the equation for change in line rate, since both are controlled by the same phenomenon.

Jumping performed in variable speed causes fields to be omitted or repeated, which destroys the odd/even field structure. The recreation of the eight-field sequence, the correction of the time compression or expansion of fields, and restoration of video levels are the major additional actions of a variable speed time-base corrector.

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The subcarrier frequency in PAL is thus fixed at 283 l/fms line rate, but with offset of 25 Hz, which causes residual subcarrier on luminance signals to be out of phase on alternate lines, helping to make the subcarrier invisible to the viewer.

Subcarrier frequency is defined as:

\[ f_s = f_l - 25 \text{ Hz} \]

The V signal can only be decoded properly if the receiver knows the sense of the switch. This information is conveyed by swinging the burst phase relative to continuous subcarrier. In a well-damped phase-locked loop in the receiver will run at the average phase of successive bursts, but the sense of the phase error in the loop will follow the burst swing and reveal the sense of the V switch to the decoder. The swing could not be ±90°, because there would be ambiguity about the average phase. A swing of ±135° corresponds to 90° between the lines.

Spectrum interleaving demands a quarter cycle offset between subcarrier and line frequencies, to avoid the direct result of using PAL V switch. Burst swing is another direct result of using V switch. The combination of these two gives rise to interesting results.

The quarter-cycle shift means that subcarrier phase advances by 90° from the start of one line to the next. Burst swing is 90° from line to line, but alternately advanced and retarded. On some lines then, the 90° advancement of the subcarrier cancels the 90° retarded burst, giving no change, whereas on others, the 90° subcarrier advance adds to the 90° advanced burst, causing a 180° change. The result of this is a four-line sequence, containing, relative to H pulses, two identically phased bursts and two identically inverted bursts. Figure 1 shows these effects.

The two bursts, normal and inverted, are determined by the state of a squarewave of 1/4 line rate. As 625 will not divide by four, it takes four frames before a given relationship between the burst phase control signal and the vertical pulse repeats. The 2500-line sequence is divided into the four-line sequence described, but it causes the four-line sequence to contain 2500 unique lines.

This extremely long sequence must never be broken if the signal is to be broadcast, and this adds to the complexity of videotape editors and timebase correctors.

The relative permittivity of water alone, which is the dominant content of the green vegetation foliage, is around 80 at microwave frequencies.

In the literature, low-loss dielectric-loaded aperture antennas and dielectric rod antennas are well-known for their directional beam-mode antenna radiation pattern. Low-loss dielectric rods have been used in practice, with Teflon, polystyrene (ε=2.5).

Thus, after carrying out indepth studies of the dielectric data cited above, and the works of Zicker, King, Ulaby, Anderson, James et al., we conceived, intuitively, of the idea to use the green vegetation canopy as an antenna structure.

We concluded that a suitably located Papaya tree of height between 3 and 5 metres (at 10 to 25 km distance) has the properties to pick up Band 3 TV signals from the TV tower, which can be easily tapped by a suitable feeder line probe to the TV set.

However, no attempt was made to optimize the quality of the TV picture received by the organic antenna structure, either by developing more efficient antenna designs or by adopting antenna arraying techniques. In-depth studies are called for to overcome the effects of hostile environments (wind, rain, snow) and to improve the s/n ratio of the received TV signals before any commercial venture can be thought of.

Continued from page 23
SC84 Microcomputer

The third module of John Adams’ disc-based professional microcomputer for engineers and enthusiasts provides a c.r.t. display of more than 3000 text characters, 36000 picture elements, or a mixture of text and graphics.

by J. H. Adams

John Adams, with a B.Sc and M.Sc. from University College of North Wales, is head of the microprocessor division of Graseby Dynamics Ltd. Prior to working in industry he held various educational posts during which he initiated the teaching package ‘Starting microelectronics’. This, his second series of articles for Electronics and Wireless World, combines his interests in education and engineering.

In his spare time, John is a keen classical organist.
Designed chiefly for fast clear high-density text display, the SC84 is memory mapped and uses the pipelining technique. Output is separate video and sync. signals in either polarity. Fig.1. SC84's monochrome v.d.u. circuit, right, uses an enhanced version of the 6845 c.r.t. controller with light-pen register and interfaced video facility to give 32 lines of 96 characters and up to 192 by 192 pixels for graphics. Using an eprom character generator is cheaper than using a proprietary rom and allows reprogramming. Switching is included to relocate the v.d.u. section for experimentation.

monochrome one for dense character display, where typically close-up use renders a colour monitor tiresome to read unless perfectly adjusted, and a full colour output with the option of character formation.

Controllers

The Hitachi HD6845S used in this design (until recently numbered HD465065S) is a developed form of the popular 6845 v.d.u. controller. Its advantage to the computer designer is flexibility, virtually all design parameters (e.g. characters per line, lines per screen, sync. pulse length etc.) being stored in registers loaded by the c.p.u. rather than being fixed. In the Hitachi version capabilities of these registers are extended; these capabilities are used in this design so it is important to use the specified device. While it can be used for graphic displays, its primary intent is as a character-display controller and to this end it has control lines which can be fed to a character generator (a rom which produces dot patterns corresponding to characters placed in the v.d.u. memory), and skewed video control lines, i.e. signals which can be delayed internally by one or two character periods to allow a technique called 'pipelining' to be used. 'Pipelining' is a technique used in complex v.d.u. whereby v.d.u. memory and character generator outputs are latched in synchronism with the character display rate. Whatever the speed of memory accesses, providing they are each shorter than one character display period (500ns in this system), data passes, or is 'piped' synchronously through the v.d.u. Being able to skew the display and cursor enabling systems means that it is easier to ensure that control and data information appear together at the end of the 'pipeline' (see the timing diagram). The controller provides a register for positioning a cursor which can be made to flash, a register for use with a light pen and a facility for interlaced video. Together with multi-

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plexers selecting memory, c.p.u. or controller lines, some high-speed logic too fast to build into the nmos controller, and memory it forms the character v.d.u.

The NEC µPD7220 is one of a new generation of graphics controller designed for i/o mapping but offering a degree of internal complexity which overcomes many of the objections to i/o mapping. Designed to control up to 256K words (1 word = 16 bits) of dynamic memory, it appears to the c.p.u. as two i/o ports and optionally a d.m.a. channel. Using i/o ports for commands and d.m.a. for data, rapid access to v.d.u. memory is possible. For graphic functions such as shape drawing or filling areas, the 7220 can be given parameters and then commanded to draw - which it can do at over one million picture elements (pixels) per second without further c.p.u. involvement. Other internal features are full refresh, zooming (expansion of one part of the display to fill the entire screen) and the option of flash-free memory update (i.e. memory access during flyback period only). Details of the graphics display and of programming techniques for both controllers will appear in a later article.

Figure 1 shows the character v.d.u. circuit. At most c.r.t. controllers, the HD6845S is designed for use in raster-scanning systems, i.e. with a normal, television-like display where the cathode-ray tube spot writes lines across the screen from left to right while being progressively swept down the screen. This means that one character is not completely drawn on the screen before the next. As the spot moves across the screen, successive character codes are taken from v.d.u. memory and just one row of dots from each of the corresponding character pattern is taken from the character generator rom and displayed on the v.d.u. At the start of the next c.r.t. line the v.d.u. memory address reverts to the same value as that of the start of the line but a different row of dots is selected from the character generator. Only when the last dot row has been drawn is the memory address allowed to step to the next area of v.d.u. memory. The number of characters on line and the number of dot rows, or rasters, is given by four binary bits. The rasters are used to constructing dynamic memory, 256K words (128K rows) being used to store a normal 32x32 character set. The counter is a programmable counter. It provides a 'carry' pulse at pin 15 as it passes through its maximum count value - binary 1111 - and this signal loads the binary value on pins six to three into a counter to count on to zero on the next clock pulse. This value is binary 1010 - denary 10 - so the counter counts through six states, binary 1010 to 1111, before repeating. Divider output C provides the character clock signal fed to the controller. An inverted carry pulse is used to provide a clocking and/or loading signal throughout the logic outside the controller.

Synchronization is extremely important. As one can see from the timing diagram there are many delays between the rising edge of the character clock initiating the addressing sequence and the production of a dot pattern at the output of the character generator, and between this point and the coming of those dots and control signals for display blanking, etc., from the controller. The timing diagram is to scale and incorporates the worst-case delays specified for the i.cs. Two signals used to synchronize the system are rising edges of dot clock and carry signal. To cope with delays between the controller generating an M-line address and the output of v.d.u. memory settling - a process which might take up to two-thirds of a character period - memory Continued on page 64

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  - 30dB.

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Improving colour television decoding

Viewing tv pictures at work and at home over several years using various decoding methods, David Read found the comb filter method an undoubted improvement with a 26in screen. But improvements to other video processing blocks are needed to fully appreciate the picture. This postscript recommends an acoustic surface wave filter for i.f. use and discusses other picture enhancement techniques.

Most of the signal-processing improvements that the home viewer can make — to PAL decoding, RGB drive, and wideband comb filtering — have been covered in this series of articles. One remaining area for investigation is the tuner/i.f. strip. Although the ten-years old design originally described in these pages (1975, Oct-Dec) is still in use and gives good results, particularly with extended comb filter methods of PAL decoding, it is felt that the design and circuit board cannot be recommended for building today with discrete components. The i.f. bandwidth shaping and post-demodulator group-delay equalization. It has been remarked that the board looks more like a Manhattan sky line! There is also a daunting setup procedure.

Recently, both Signal Technology and Mullard have been manufacturing some excellent surface acoustic wave i.f. filters. The SD155 from Signal Technology is flat at frequencies above f_s and has a sound shell of —16dB though probably not sufficiently down for a single-chip demodulator e.g. TDA 3541, though an LC trap to provide an extra 10dB could readily be added. Over the retailers’ counter this could cost £40 to £50 currently, but it is hoped that cable-head companies and set manufacturers will start to use these better quality filters and the price will reduce.

Some of the better filters, for example Signal Technology’s SY155 and RW153P have the subcarrier equivalent frequency (vi-sion carrier minus subcarrier, 35.07mHz), only 0.5 to 2dB down. These will provide the best overall performance with modified LC filters used before the chroma decoder. However, the performance is not good enough to justify the Fig.34 comb filter circuit approach although a much improved picture can be obtained with the alternative LC networks shown last month. This is achieved by using the Fig.77 circuit for the luminance path (Figs 74 and 76 show amplitude and group-delay performance) and the Fig.81 circuit for the chroma path (Figs 79 and 86 give amplitude and delay performance). The chroma circuit can be modified to advantage as shown in Fig.93 (See Figs 94 and 95 for amplitude and delay performance). The modified chroma filter will offer a better chroma bandwidth and reduced 7.5kHz twitter at the chroma transitions if it is adjusted to match the s.a.w. filter response (chroma sideband symmetry optimized), as was similarly indicated in Fig.82.

When the s.a.w. filter with the performance of Fig.96 is in use, e.g. the SD155, the best chroma filter is the gaussian band-pass filter of Fig.34. For this Fig.52 shows the amplitude response and Fig.53 the group delay performance, with Fig.52(b) indicating the clean chroma transitions that can be obtained.

Mullard are expected to introduce two new tuners later this year, the U343 for potentiometer tuning and the U344 for use with a frequency synthesizer. These use low noise, high dynamic range mosfet stages and include the first i.f. bandpass coupling stage and driver amplifier for the s.a.w. filter. The tuner i.f. board then need only comprise a front-end tuner, s.a.w. filter and the integrated i.f. amplifier demodulator TDA3541 together with a few discrete components (ref.11).

Design of high-grade receiver

For really high quality sound and vision to feed into a comb-type decode, the B.B.C. have designed a u.h.f. tv receiver type RC351L, being manufactured under licence by SPT Video.
Errors caused by rounding components of Fig.87 (bottom circuit) to preferred values are shown by the group delay response above (Fig.88).

Group delay ripple and other losses in performance caused by using preferred capacitor values are shown in these pulse-and-step test results (Fig.89).

Fig.91. Alternative self-contained decoder board (Fig. 34 & 36 circuits not used) incorporates TDA3561A with the luminance notch filter of Fig.77 and the chroma high-pass filter of Fig.81, hard-wired at the p.c. board edges. Board also has copper tracks laid out for RGB output stages, if needed for video processing improvement, similar to that in the TX10 receiver (Fig. 41, May issue). Boards available from?

Fig.92. Component location for PAL modifier comb filter board. It is useful to check the coil bases with the board before winding any coils, particularly the center-tapped ones. Chip provides additionally the 2p feed required by the PAL modifier in Fig.34. The sandcastle pulse to the TDA3561A can be supplied from the TDA2591/2/3. These two signals may already be available in existing receiver designs, but check that it is a 2p locked oscillator if this signal is to be extracted.

There are excellent picture enhancers that rely on picture storage and can provide both horizontal and vertical aperture correction. By recycling the information taken from the picture store with new pictures as they arrive, noise reduction is achieved. But on movement, zonal adaptive techniques are needed to stop cumulative recycling and thus prevent excessive blur.

For the domestic receiver, a simple enhancement technique is to modulate the line scan velocity.
Fig. 96. Amplitude and group delay performance of s.a.w. filter recently introduced by Signal Technology.

Fig. 97. Block diagram of the BBC-designed u.h.f. tv receiver, RC1/511, giving outputs of 1 volt composite video and good quality sound.
Readers of this series puzzled by the numbering of component references on page 33 of the May installment may be reassured to know that it originated from the maker's service sheet and were not shown on the circuit diagram. The BC337's of Fig.41 are transistors 653, 652 & 651 in the text, the BF392's are 659, 658 & 657, and resistors 665, 664 & 663 are the 22k pull-up components at the BF392 bases. Also on that page, the resistor referred to in line three, column three, should be 2.7k not 2.7Ω In Fig.42, the annotation 'Fig.34' should have read Fig.41. The author also asks us to point out that in Fig.40 the chroma input burst should be 150mV rather than the 250mV shown at pin3 of the i.c. The right-hand ordinate on Fig.66 (page 62, June) was inadvertently croppped, and should of course be labelled with attenuation in dB. Observant readers will have noticed that Fig.60 was a repeat of Fig.69; the correct figure appears in this article. In Fig.24 (page 56, January) please substitute 200ns for the 200µs shown.

## Component suppliers

1. **Surface wave filters**
   - Signal Technology Ltd, Crompton Road, Groundwell Industrial Estate, Swindon, Wilts. Tel: 0793-726666 ex.220.
   - Mullard Ltd., Torrington Place, London WC2. Tel: 580-6633.

2. **Delay lines**
   - Manor Supplies, 172 West End Lane, London NW3. Tel: 794-8751.
   - Coil formers
     - Cirkit (Ambit), 200 N.Service Road, Brentwood, Essex. Tel: 0277 231616.

## Parts list for Fig.34, 36 one-line comb filter circuits.

<table>
<thead>
<tr>
<th>Value</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitors, Polyestrene ±2% 125V (Suffex, Salford, Lemco)</td>
<td></td>
</tr>
<tr>
<td>Value (F) Circuit reference</td>
<td>220p</td>
</tr>
<tr>
<td>Disc ceramic or red/blue cap.</td>
<td>1n</td>
</tr>
<tr>
<td>Polyester metallized ±10% 100 or 250V (Mullard type 344)</td>
<td>6.8n</td>
</tr>
<tr>
<td>Tantalum: 20% (Union Carbide or Composants)</td>
<td></td>
</tr>
<tr>
<td>33p</td>
<td>10.5p</td>
</tr>
<tr>
<td>Electrolytic (Eire, Mullard or equivalent)</td>
<td>1m 6.3V</td>
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<tr>
<td>Transistors Type and Circuit reference</td>
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<tr>
<td>2N3904/2BG239</td>
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<td>2N3906</td>
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<tr>
<td>2N3908</td>
<td>10, 11, 5, 18</td>
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<tr>
<td>2N8110L</td>
<td>(reference missing from the circuit: transistor with R36, 38, 13, 14, 15, 17)</td>
</tr>
<tr>
<td>or 2N8112L</td>
<td>or M9191D/C, or 116THG</td>
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</table>

## Integrated circuits

- MC796, MC1496 or MC1596
- I.C.
- TDA2590/1/2/3
- IC

## Circuit reference and Value

<table>
<thead>
<tr>
<th>Value</th>
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<td>271µ</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14.3</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>16</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

## Delay lines

- DL, Best to make the discrete LC network. Through see test for alteration.
- DL, DL60 or DL700 not critical. Observe R6 and R10 built X0 of line. See table

## Resistors, Mullard MR25 metal film ±2% or equivalent metal film ±5% 0.2W

<table>
<thead>
<tr>
<th>Value</th>
<th>Circuit reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.7k</td>
<td>1, 3, 57</td>
</tr>
<tr>
<td>470k</td>
<td>12, 16, 31, 33, 81</td>
</tr>
<tr>
<td>13k</td>
<td>10</td>
</tr>
<tr>
<td>10k</td>
<td>13, 15, 47, 63, 74</td>
</tr>
<tr>
<td>560k</td>
<td>21, 18, 28</td>
</tr>
<tr>
<td>150µ</td>
<td>23, 37</td>
</tr>
<tr>
<td>1k</td>
<td>22, 4, 5, 66</td>
</tr>
<tr>
<td>820k</td>
<td>8, 7, 36</td>
</tr>
<tr>
<td>27k</td>
<td>14, 25</td>
</tr>
<tr>
<td>100Ω</td>
<td>30, 34, 64, 65</td>
</tr>
<tr>
<td>3.3k</td>
<td>82, 38, 68, 88, 90, 66, 79</td>
</tr>
<tr>
<td>100k</td>
<td>26, 40</td>
</tr>
<tr>
<td>33k</td>
<td>25, 30, 54, 75 (note: R6 was 22k, R10 was 18k using 33k) improves modulator balance</td>
</tr>
</tbody>
</table>

## Potentiometers (Cermets)

<table>
<thead>
<tr>
<th>Value</th>
<th>Circuit reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>500Ω</td>
<td>24</td>
</tr>
<tr>
<td>1k</td>
<td>32</td>
</tr>
<tr>
<td>5k</td>
<td>42, 89</td>
</tr>
<tr>
<td>10k</td>
<td>87</td>
</tr>
<tr>
<td>100k</td>
<td>76</td>
</tr>
<tr>
<td>50k</td>
<td>71</td>
</tr>
</tbody>
</table>

## Values determined by DL1 Impedance

<table>
<thead>
<tr>
<th>Zo</th>
<th>75Ω</th>
<th>800-1kΩ using LC network</th>
</tr>
</thead>
<tbody>
<tr>
<td>R6</td>
<td>1500</td>
<td>1.6kΩ</td>
</tr>
<tr>
<td>R7</td>
<td>1500</td>
<td>1.6kΩ</td>
</tr>
<tr>
<td>R8</td>
<td>1250</td>
<td>1.6kΩ</td>
</tr>
<tr>
<td>R9</td>
<td>2200</td>
<td>820Ω</td>
</tr>
<tr>
<td>R10</td>
<td>682</td>
<td>682Ω</td>
</tr>
<tr>
<td>R11</td>
<td>1972</td>
<td>1972Ω</td>
</tr>
<tr>
<td>R12</td>
<td>5100</td>
<td>1.5kΩ</td>
</tr>
<tr>
<td>C9</td>
<td>1mF</td>
<td>—</td>
</tr>
</tbody>
</table>

*It is best to set up A and B group-delay equalizer sectors in isolation, i.e. no other equalizer or filter in the circuit; thus check each stage of the filter and equalizer section at a time. L6 and L6 are measured across outer pins i.e. total inductance.*
in relation to transitions in the increasing video signal. A pair of four-turn coils built into the scanning yoke and placed in the line-scan coil plane provides line aperture modulation of the scanning field. A restricted spectrum of the luminance signal (in the range 2 to 3.5MHz) is amplified, amplitude-limited and used to drive the extra coils in the scan yoke. The block diagram is shown in Fig.98. The additional circuit feeding these coils need only consist of a simple CR differentiator, back-to-back diode limiter and class B output amplifying transistors. The waveforms of the system are as shown in Fig.99 and the display picture shown in Fig.100 illustrates 'before and after' the application (screen photograph taken from a Mullard publication).

**Picture enhancement with colour-transient improvement**

It is possible to improve the RGB signal where the chroma bandwidth has been restricted to suppress crosscolour, resulting in risetimes in excess of 500ns on improving (speeding up) the risetimes, care has to be taken not to exaggerate the crosstalk (e.g. increased U/V 12.5Hz flicker).

By using a switched equalizer under the control of the differentiated luminance signal (to minimize cross-colour increase), the U and V i.e. B-Y and R-Y chrominance steps can be improved. This is possible because of the good correlation between the luminance and chrominance picture information. An i.c. to improve colour transients is the Mullard TDA4560, shown in Fig.101. This uses the differentiating input R-Y and B-Y chroma to control and chroma delay switching. The effect of using such techniques is for a chroma positive-going transition as seen in

---

**REFERENCES**


---

**Fig. 98.** Block diagram describing a method of scan-velocity modulation to improve picture sharpness.

**Fig. 99.** Example of waveforms occurring in a scan-velocity modulation circuit.

**Fig. 101.** Functional block diagram of an available i.e. for colour transient improvement (taken from the data sheets for the TDA4560).
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CIRCLE 52 FOR FURTHER DETAILS.

CIRCLE 6 FOR FURTHER DETAILS.
ELECTRONICS & WIRELESS WORLD JULY 1984

www.americanradiohistory.com
Multi-standard modem

Details of the line interface and software requirements, plus some telephone numbers to dial

The line interface follows the pattern shown in Fig.3 of the article in the May issue. In the direct-connect version of the modem, op-amp IC1o duplexes the transmitted and received carriers. Resistor R4o is the terminating resistor for the telephone line. An analog circuit switch IC6 provides loopback of the transmitted signal to the receiver input when S2 is in test position; but in a direct-connect modem, this i.e. and its associated components (TR5 and TR6 etc.) should be omitted, since there will be sufficient coupling around the duplexer. If IC6 is not fitted, a link must be wired between pins 8 and 9 of its location on the p.c.b.

When a call is in progress, the modem holds the telephone line by means of the gyrator network around TR5 and TR6. This arrangement is taken from a Mullard circuit widely used in commercial modems. No heat-sink is required for TR5. The capacitors in the line interface may have to withstand ringing voltages and transients on the line, and so it is important to fit suitably rated types: for the prototypes, 250V metalized film capacitors were chosen.

If the constructor does not intend to add an auto-dialer, there is no need for RL2, RL3 or their associated components R39, R31 and C38; but a wire link should be added in place of the contacts of RL2.

The spark gap across the telephone line is included for safety, although some commercial modems do without. It should be able to withstand the voltages developed during ringing without breaking down. Suitable types are available from Electrovalue Ltd.

The auto-answer circuit is isolated from the line by an optocoupler IC9. The zener diodes are to protect IC9 against damage by over-voltages and to define a threshold level below which it will not respond. An a.c. ringing voltage causes the level on pin 3 of the zener diode (IC9d) to fall, triggering the monostable. The telephone will continue to ring for a few seconds until the second monostable is triggered by the rising edge at IC9e pin 4.

At this point, pin 1 of the Am7910 is pulled low, causing it to begin its answering sequence, and the line-seize relay RL4 closes. The time constant of the second monostable is about 30 seconds, which should allow enough time for the calling modem to establish communication. Control of RL4 then passes to the CD/BCD outputs of IC8, if the incoming carrier is lost the relay will be released and the call terminated.

To enable auto-answering, it is necessary to disable RTS until the answer sequence of IC8 is complete. For this reason the amendments shown in Fig.3 should be made to the computer interface section of the modem. The additional connection to pin 16 of IC7 is to ensure that the DTR signal is removed briefly between auto-answered calls. Without this, the modem will not generate its burst of answer tone.

However, a problem may arise if a large transient occurs on the line as S2 is moved. The first monostable in IC12 may be triggered, removing DTR temporarily. If this happens, a way of dealing with it is to inhibit the monostable except when auto-answering is enabled. Omit C33 and R33, but connect pin 6 of IC10 to pins 3 and 11 of IC9. If the components of the auto-answer section are omitted entirely, a 47k2 resistor must be inserted between pins 12 and 16 of the IC8 position to ensure that pin 1 of the Am7910 is tied high.

Note also that the dotted links LK2 and LK3 in last month’s circuit diagram are shown reversed; if a full RS232 interface is required, the RTS input of IC8 should be linked to pin 11 of IC5 and the BRTS input to pin 8 of IC5.

Components

The Am7910 integrated circuit is stocked by AMD distributors, including Quarndon Electronics and Hawke Electronics; the unit price is £32.80 excluding VAT. This and other semiconductor devices for the project together with the crystal, the relays and the connectors are available from Technomatic Ltd (see address list). The Am7910 is also stocked by Maplin Electronics. The two transformers can be supplied for £5.70 the pair, including inland postage and VAT, by Barrie Electronics.

A printed circuit measuring 160 by 200mm will be available from July 10 from Combe Martin Electronics, for £16 inclusive. The board, a prototype of which was shown in last month’s article, is double sided with plated-through holes.

Software

To control the modem, a suitable communications program is needed. In its simplest form, this would configure the serial port to transmit and receive at the required rate. It would then route data arriving from the modem to the screen, and direct data from the keyboard to the modem.

In a practical program there would also be facilities for selecting the data word length, parity and stop bits, for controlling the display format and for transferring disk or cassette files to and from the modem.

The start of a program in Apple Basic, in Prestel telesoftware format. With the help of suitable communications software, a complete program can be downloaded automatically in about the time it would take to load from tape.
Other useful options include the ability to send Xon and Xoff commands to halt temporarily the output from the distant computer, and to echo incoming characters back to it: this allows the other operator to see what he is typing. There may be some advantage too in redefining the output of certain keys on the keyboard. In particular, the effect of the delete key seems to vary from one computer to another. For Viewdata systems such as Prestel it is convenient to have the return key send a # character.

Some of the bulletin board systems listed here have adopted the so-called Christensen or Xmodem protocol for file handing.

This protocol allows virtually error-free transfer of Ascii text or program files over event the poorest lines. The file to be sent is transmitted in 128-byte blocks, with error-checking on each block. If an error arises, the receiving computer asks for the block to be sent once more. Error-checking is used also in viewdata terminal programs for telesoftware file downloading.

Viewdata software for a variety of home and business computers is available from Micronet 800. For the 300 baud modes, Maplin Electronics can provide modem interfaces and software for the ZX81, Spectrum, Dragon, Oric, VIC 20 and Commodore 64.

For the BBC Microcomputer there is a wide choice of software, including packages in eprom. Computer Concepts' communicator (36Kbyte) provides emulation of a DEC VT100 terminal. It gives very extensive control of transmission mode and display format and includes such features as storage of telephone numbers for an auto-dialler. Communicator costs £59.

A rom of especial interest to bulletin-board users is Pace Software's Commstar (8Kbyte). This provides software handshaking, file transfer facilities using the Christensen Xmodem protocols and numerous other features. Current versions have a Prestel mode which supports colour Viewdata graphics (including double-height characters) and can download telesoftware. The price is £34 including v.a.t.

Software for the TRS-80 is available from Molimerx Ltd, who offer two communications packages: Smart Terminal at £25.30 and Modem 80 at £30.48.

A communications program to run under CP/M-80 is available to members of the CP/M User's Group. Details, in return for a stamped addressed envelope, from the group at 72 Mill Road, Hawley, Dartford, Kent. Individual membership costs £7.50 per year.

Logging on

First select the appropriate signalling standard and mode using S1 and S2. At this stage S2 should be in the centre off-line position. Dial up the computer of interest; and when its answering tone is heard move S2 to the on-line position. This will establish communication, disconnecting the tele-
phone handset at the same time. With some of the bulletin board systems listed in the box, it may then be necessary to type a few carriage returns to start things off.

At the end of the call, S2 should be moved back to the centre position to break the connection. In the Viewdata mode, disconnection occurs automatically when the Prestel computer drops its carrier. This may happen prematurely if the RTS signal is removed: as this may occur momentarily while files are being saved to cassette or disc, it may be best to fix RTS permanently on in the modem. This can be done by linking pins 13 and 14 of IC5; it may then be wise to cut the link between pin 13 and the 25-way socket to avoid contention when the full RS232 interface is used.

The third position of S2 allows the modem to auto-answer calls from other computers. This facility is allowed only in the 300 baud 'answer' modes and in V.23 mode with S2 set to 'reverse'.

Acquisition of a carrier in the back channel is indicated by LED2, and in the main channel by LED1. LED1 lights when the circuit is powered and flickers during transmission of outgoing data. When a call is autoanswered, LED1 lights; and LED2, comes on when the modem is indicating a line.

To test the modem off-line, set S1 to the test position. The modem should then echo characters typed at the keyboard back to the screen. Note that this test may not work in the V.23 mode, since the Viewdata terminal software will set the RS232 driver and receiver to different data rates.

Some databases to try

The following 'bulletin board' systems are run by private individuals on a voluntary basis. No charges are made for use of their facilities, which include message handling, software downloading and news. Forum-80 systems use a seven-bit word with even parity and one stop bit; others have an eight-bit word with one stop bit and no parity bit.

Beware of 1200/75 system: some use the same data format as on their 300 baud modems, and may not be compatible with Prestel terminal software.

CBBS Chiltern: 0703-28273, 0703-39241, 18.30-22.30h, Monday and Wednesday.

CBBS Cumbria: 069-92314*, 1800-2200 daily, V.21, Bell 103 and 1200/75 baud V.23.

CBBS Southampton: 0472-899014, 24 hours, V.21 and 1200/75 baud V.23.

CBBS Surrey (Woking): 04862-25174, 24 hours.

MG: NET CBBS (London): 01-3992136, Sunday only, 17.00-22.00h.

CABB, Computer Answers bulletin board (London): 01-631 9076, 24 hours. Also weekdays on 1200/75 baud V.23.

Forum-80 (Hull): 0482-85916, Tuesday and Thursday, 19.00-22.00h; Saturday and Sunday, 13.00-22.00h. Night-time service for U.S.A. using Bell 103 tones, 00.00-08.00h.

Forum-80 (London): 01-9022546, evenings and weekends.

Mailbox-80 (Liverpool): 051-428824, 24 hours.

Mailbox-83 (West Midlands): 0384-63536*, 17.30-08.00h daily and all day Sunday.

Manchester BB: 061-4273711.

Sunday-Thursday 22.30-00.00h, Friday 13.30-02.00h, Saturday 22.30-02.00h.

Microweb (Stockport): 061-4564157, 24 hours. For users of the BBC Micro.

TBBS City (London): 01-6064194, 24 hours. 1200/75 on Wednesdays.

TBBS London: 01-3499400, 09.00-08.00h with CCITT V.21 tones, 01.00-09.00h with Bell 103 tones.

TBBS Southampton: 0703-437200, 17.00-08.00h weekdays, all day at weekends.

North Birmingham BBS: 0287-2888*10, 24 hours.

Blandford Board: 0258-544949, 24 hours.

Stoke ITC7 BB: 0728-265078, 24 hours.

Southern Bulletin Board: 0243-510777, 24 hours.

BASUG (British Apple Systems User Group board): 0742-667983, 24 hours.

The following commercial systems, operated by electronic component suppliers make no charge to users except where shown:

Distel (Display Electronics Ltd, London SE19): 01-6791888 (V.21). A 1200/75 baud service is to be added: test port on 01-6791883.

Estelle (STC Electronics Ltd, 3D, Essex): 0279-443511 (V.21), 0279-443511 (V.23), business hours.

Rewtel (Gritkit, formerly ITI International, Brentwood, Essex): 0277-232928. Some facilities are available only to subscribers.

Maptel (Maptel Electronics Ltd, Southend-on-Sea): 0702-559241.

Fig.3. Disabling RTS and DTR during the auto-answer sequence. This addition has been incorporated in the p.c.b. for this project.

Fig.2. Space for this power supply is provided on the p.c.b.
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**CIRCULAR 14 FOR FURTHER DETAILS.**
**RS422/RS232 converter**

RS422 is a half-duplex data-link standard and, being balanced, allows greater distances to be covered and higher data rates than are possible using RS232. It can also be used with one transmitter and several receivers ('multi-drop'). This circuit provides RS422 and line monitoring using an RS232 v.d.u. or computer.

Normally, the circuit is in receive mode and the v.d.u. monitors the line. When a key is pressed, line four on the RS232 interface is inverted and the 75176 transmits the character. Receive mode is resumed on key release. Line five provides information on the direction of the line and may be omitted. Essentially, the circuit is a level converter and therefore independent of data rates. Note that direction reversal time on an RS422 line can be far shorter than that of a simple v.d.u., which can lead to apparent loss of characters. A twisted pair should be used for the 422 line as the 75176 is very sensitive, and care should be taken with layout.

L. Smith
Blackford
Perthshire

---

**Isolated video driver**

Designed for connecting computer video output to a non-isolated domestic TV, this circuit uses a readily available 6N139 optical coupler (RS Components) operating at 1:1 current-transfer ratio. Positive video modulation is assumed and, for the UK, a composite video-signal bandwidth requirement of 6MHz.

Voltage gain of the fet stage is about four. The source is directly coupled to the next stage, which approximates a current drive for the coupler led. Bias current of around 9mA, determined by the fet drain/source resistors and supply voltage, keeps the optical-coupler transfer characteristic in its linear region. Capacitor C1 negates the effect of Miller capacitance in the driver transistor and C2 extends frequency response to above about 800kHz by quickly removing stored charge in the transistor emitter during voltage transitions. Resistor R5 is set for optimum rise and fall times.

Collector current in the opto-coupler is about 7mA, allowing low resistor values to be used to shunt Miller capacitance so that the transistors can operate at maximum speed. Direct-current supply for this stage may come from the TV; in valve sets, the sound output-valve cathode might be used.

The prototype gave rise and fall times of 200ns corresponding to a bandwidth of 5MHz which should be sufficient for most home computers. Bandwidth is mainly limited by the opto-coupler and faster devices should work with only minor modifications since the driver bandwidth is about 20MHz. Layout is critical — all TV circuit tracks should be separated from the grounded side by at least 4mm for insulation, and signal paths should have minimum stray capacitance. Video signal from 75Ω coaxial cable is terminated and should be about 1V pk at the input and large values of C3 are required for faithful reproduction of frame-sync. pulses. Output is about 4V pk and may need to be divided for some sets.

J. A. McEwan
Ballincollig
Co. Cork
Ireland

---

**DON'T WASTE GOOD IDEAS**

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

Loud regular pips — clearly audible even above my attempts to master the guitar — are generated by this metronome. Each pulse from $IC_{1a}$ triggers a fixed-duration pulse from $IC_{10}$ which drives the loudspeaker through $Tr_{13}$. Normally, common collectors of $Tr_{3,6}$ are approximately at ground potential but counting and decoding circuits around $IC_{2}$ cause $Tr_{3,6}$ to be driven in opposition to $Tr_{13}$ on the first beat of each bar to give an accentuated pip. Time signatures of $2/4$, $3/4$ or $4/4$ are selected by a switch. Supplies of between 5 and 18V may be used. I used two PP3 batteries to give 18V in the prototype.

Steve Kirby
East Molesey
Surrey

**Microprocessor teaching aid**

Using the WAIT command, the Z80 microprocessor can be made to execute one instruction at a time under control of a manual switch. If all the address, data and control lines are monitored, the processor can be seen fetching/storing information and carrying out commands.

While the switch is open, WAIT is low. When the switch is closed, the upper bistable device is clocked and WAIT goes high. Simultaneously, pulses from the processor clock feed the lower bistable i.e. and after two rising edges, the output of the lower device goes low and resets the upper one. Thus WAIT returns low after one or two clock cycles and sets the lower bistable i.e.

Note that dynamic memory content will be lost since the memory-refresh circuit cannot operate. The circuit has been used with a Z81 (no ram expansion), connected through the 23-row connector to make internal soldering unnecessary. A binary-to-hexadecimal converter and display on the data lines is a useful addition.

Peter Hall
University College London

**Simple clipping detector**

No setting up is required on this simple clipping detector for audio power amplifiers. When positive output swing exceeds $V_{b1}+V_{b2}+V_{b3}+V_{b4}$ the led lights. Values shown are for a 34–0–34V supply and switch the led on at 64V pk-pk, but they may be altered to suit any single or dual-rail power amplifier.

Tolerance on the switching point is about 0.5V due to junction effects. Resistor $R_5$ and the diode protect $Tr_3$ during negative swing.

M. J. Conduit
Farnham
Surrey

ELECTRONICS & WIRELESS WORLD JULY 1984
Artificial daylight

For applications including tropical fish-tank lighting, this circuit gradually changes lamp brightness from off to full-on in 25 minutes, or vice versa depending on the switch position. A bridge rectifier and shunt zener diode provide mains synchronized d.c. pulses. Triac firing, through an opto-coupler, is from a unijunction transistor whose time constant is determined by a fet acting as a variable resistor. The capacitor which biases the fet, is charged or discharged depending on the switch position. If R2 is disconnected, brightness remains constant for at least 24h through charge in C1.

J. Clegg
Doncaster
Yorkshire

Accurate switched-gain for op-amps

Using a cheap array of seven equal resistors provides accurate switched op-amp gains of one, two, five and ten times. Resistance ratios for these gains in a non-inverting amplifier are 0.2, 1.2, 2.2 and 3.2 respectively so the input resistor may be made from zero, one, two or three resistors in parallel, and the feedback resistor form the same number of resistors in series.

B. P. Cowan
Bedford College
University of London

Current limiting for 317 regulators

Addition of an opto-isolator to a 317-based variable-voltage power supply allows precise current limiting. I have used this circuit to protect transistors during development of r.f. output stages of uncertain behaviour and it should be possible to apply this idea to simpler power supplies using power-transistor/zener-diode combinations.

When voltage across the series-pass resistor exceeds around 1V the isolator photodiode starts to emit, turning on the phototransistor and reducing control voltage to the regulator. Output diodes keep regulator output voltage at 1.5V above control voltage to limit output current under a dead short. Power and resistance ratings of the series resistor are chosen to suit the required current limit and the diodes must be able to carry more than the current limit value.

Lionel Sear
Truro
Cornwall

Combination lock with deterrent

In this idea in the May issue, IC1 should have been a 74148, E0 of IC2 is not connected to E of IC1, the transistor shown should have a base resistor and ICQ72 is the left-hand section. On IC1, Q and Q should be transposed. We apologise for these errors.
Remote volume control

Heart of this circuit, which requires only contact closures for volume increase/decrease, is a 4051 eight-channel multiplexer operating in analogue mode. The setting of this variable attenuator depends on output states of a 4029 up/down counter which is stepped through on contact closures under control of a buffered clock signal from pin eight of the 4069 inverter.

Frequency of the clock is RC/2.2 and a 555 timer ensures that the volume level is low when the circuit is switched on.

One 4051 is required for each further audio channel, the maximum number of channels only being limited by 4029 drive capability.

Dennis J. Eichenberg
Ohio
USA

Three-channel light dimmer

Using a non-linear ramp to linearize power output, this light dimmer with three channels requires few components and allows triacs to be fired remotely through non-mains carrying cable. Remote firing also means that the triacs can be mounted next to the load which simplifies mains filtering. Channels may be added by using further comparators, isolators and triacs.

Advantage is taken of the LM339 open-collector outputs to eliminate series resistors at the three phase-control sections and directly discharge the ramp capacitor. Transformer output should not exceed about 6V to prevent excessive dissipation in the LM339.

Tim Williams
Tunbridge Wells
Kent
Cool and calculating.
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<table>
<thead>
<tr>
<th>PART</th>
<th>DESCRIPTION</th>
<th>REPLACES</th>
<th>POWER (W)</th>
<th>SPEED (ns) @</th>
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<td>ADSP 1080</td>
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<td>MY 12JU</td>
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<td>ADSP 1010</td>
<td>16 x 16 MULT/ACC</td>
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<td>ADSP 1110</td>
<td>16 x 16 SINGLE PORT MAC</td>
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<td>ADSP 1024</td>
<td>24 x 24 MULTIP/ACC</td>
<td>PROPRIETARY</td>
<td>0.25</td>
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CIRCLE 21 FOR FURTHER DETAILS.

CIRCLE 11 FOR FURTHER DETAILS.

CIRCLE 32 FOR FURTHER DETAILS.
ELECTRONICS & WIRELESS WORLD JULY 1984
In view of the very low energy levels involved in fibre optic transmission they are best suited to the transfer of information rather than power. It is in this area that they are making a major impact, even at this relatively early stage of their development. Indeed, British Telecom has recently announced that it will be ordering no more coaxial cable after 1985 for the telephone network, due to their growing commitment to fibre optics. It has been predicted that over half of all trunk telephone traffic will be carried on optical fibres by 1991.

There is no difficulty in principle in substituting optical fibres for copper cables in the majority of data transmission applications. After multiplexing the data in the normal manner the electronic modulator drives a light emitting or laser diode rather than a coaxial line amplifier, Fig.1. At the receiving end the signal can be treated again in the conventional manner once it is beyond the detector preamplifier. In small systems the additional complexity is minimal, whilst complex data systems such as telephone trunk routes can actually be simplified by adopting optical fibres as the transmission medium.

The range of telecommunications applications for fibre optics can be conveniently divided into three areas:
- Public telephone network
- Broadband entertainment and information services
- Computer local area networks

### Public telephone network
Because of the very low bandwidth required for each telephone handset, it is doubtful if there will ever be an economic need to replace the usual copper wire pairs with an optical fibre. This position changes of course when considering an integrated data network including telephony, television and data link. The major fibre application is in the area of junction and trunk telephone transmission where the traffic has been concentrated and multiplexed to a much higher data rate. Here experience has shown that the first generation systems have fallen into several broad performance areas, as we would expect from the previous look at fibres, sources and detectors.

The majority of installations have operated at a wavelength of around 0.85µm using medium performance graded index fibre with silicon avalanche photo-detector receivers, Fig.2. Where the main consideration was not maximum repeater spacing, i.e. ds have normally been used because of their lower cost, resulting in repeater separations of around 6km in the 30-45Mbit/s and 7km in the 100-140Mbit/s range. The latest phase of the first generation systems has seen the use of the dispersion null at 1.3µm with low attenuation fibres resulting in even greater spacings for medium data rates.

An additional advantage arising from the increased repeater spacings is that well over 50% of the connections between major switching centres within cities can now be made repeaterless, with an increase in reliability and decrease in cost. This has also been the pattern of experience in N. America, Europe and Japan.

Optical fibres are not usually laid as a single fibre. Instead a number of them, eight being common, are made up into a cable around a steel strength member.

After a postdoctoral fellowship at Manchester University, and a year teaching in Baghdad, Brett Wilson returned to Manchester to work on optical position detectors and sensitive non-contact current measurement. He then lectured at Nottingham University, where he's been concerned with novel uses of op-amps in addition to fibre optics, and is now back in Manchester, this time at UMIST. His Ph.D. was on a high-speed laser stroboscope for magnetic bubble research.
Most of the cables are installed in existing ducts where their small size is a great advantage in an already crowded environment. Lengths around 1km of optical cable are usually pulled through the ducts before being jointed using V-groove or arc-fusion techniques.

For second generation systems effort is being concentrated on long-haul high-speed communications where the cost is affected strongly by repeater spacings. Hence it is natural to use laser driven monomode fibres in their minimum dispersion region at 1.3μm. Repeater spacings of 20km are typical with data rates of 400Mbit/s being employed (NTT, Japan) over routes eventually several thousand kilometres in length. Most field trials, however, have been conducted with shorter routes of around 100km.

The promise of low-loss transmission with high data rates is obviously of great importance in the area of underwater telephone cables. In addition, the lower weight and smaller size of optical fibres compared to copper coaxial cables is of great economic and handling importance considering the long lengths of cabling, approximately 6500km, involved in a transatlantic crossing. The various agencies concerned have mapped out the nature of the first optical fibre transatlantic telephone cable, TAT 8, to be installed in 1988.

It is intended to operate multiple optical fibre pairs at 280Mbit/s, equivalent to 35,000 two-way voice channels, with repeater spacings of more than 35km. Monomode fibre will be used excited by 1.3μm injection laser diodes. Strength is provided by the usual arrangement of central and peripheral steel elements with cushioning from interstitial elastomer and an external polyethylene coating. Water resistance and electrical power in the form of a constant current for the repeater electronics is obtained via a continuously welded copper cylinder jacket. The overall diameter of the completed cable will be just over 20mm; under half the diameter of the previous copper coaxial TAT 7 cable.

The underwater repeaters, which have not yet been finalised, will probably use up to four laser transmitters, one actively employed and the other three as standby units. This is thought to be necessary because of the limited lifetimes so far achieved with i.l.ds coupled with the enormous cost of underwater repairs. Optical detection is performed by an InGaAs p-i-n diode rather than an a.p.d. because of the complexity of providing a high voltage supply to an a.p.d. A silicon bipolar transistor preamplifier is used in preference to a GaAs unit because as yet silicon fabrication technology is more proven than that required for GaAs. Active waveform retiming is carried out at each repeater by clock extraction circuitry. Various monitoring circuits transmit operational information back to the shore based stations.

**Broadband information services**

The use of optical fibre technology has been much discussed with respect to the re-cabling of Britain, where a single unit on the customer's premises would provide access to a wide range of TV channels and interactive information services. Connections between the customer's unit and the distribution centre can obviously be of the ordinary copper coaxial cable type or by optical fibres, either of which could be arranged as a tree and branch, or switched star topology, both of which are shown in Fig.3. The switched star system is currently favoured as offering the greatest future potential for system expansion. In contrast, over 80% of all American coaxial cable systems use a tree and branch topology.

Owing to the inherent difficulties and signal losses involved in splitting the signal in an optical fibre, it is likely that its use in a tree and branch network would be restricted to the main trunk. In a switched star network, however, the signal paths are a series of point to point transmissions ideally suited to the characteristics of optical fibre technology.

Most of the field trials that have been conducted around the world (UK, USA, Canada, Germany and Japan) to assess the potential of fibre optic transmission links have relied somewhat on some form of analogue intensity modulation of the light source. The reason is simply that frequency division multiplexing onto ever higher frequency carriers has been the traditional manner in which to multiplex telephone, and by extension, television channels. Analogue intensity modulation performs satisfactorily with coaxial cable techniques but does not ideally suit optical sources since in general they are non-linear unless pre-biasing techniques are employed. Even then circuit complexities arise because the lasing threshold of a semiconductor injection laser is temperature sensitive. The best properties of the optical transmission systems discussed in the previous articles are brought out by binary intensity modulation, i.e. on or off. For a fully integrated data network this is obviously the best form of modulation as it renders unnecessary any form of modulation change between the computing section and the distribution section.

However, there are certain bandwidth penalties to be paid when attempting to encode TV channels in a completely digital format. In an analogue format a PAL colour signal will occupy a bandwidth of 6MHz, but with eight-bit p.c.m. digital encoding this increases to around 120MHz to satisfy sampling requirements at an appropriate multiple of the colour sub-carrier. In other words a single digital TV channel would occupy the equivalent of a 140MHz optical fibre telephone trunk circuit! Even with bandwidth compression techniques this figure is only reduced to approximately 70MHz. Clearly there is a problem in providing every user in a tree and branch network with an optical fibre and receiver electronics with sufficient bandwidth at an affordable price, capable of bringing in perhaps 10 or 20 simultaneous TV channels and ancillary services.

A switched star network overcomes many of these problems by employing upstream spread signalling, so that customers may indicate to the star switching centre which service or channel they want at any given time.

**Fig.2.** Longer wavelength laser systems offer the best combination of repeater spacing and data rate, but shorter wavelength i.l.d. systems are less costly.

**Fig.3.** Tree and branch topology is best suited to broadband broadcast distribution in contrast to the star configuration which permits much easier installation of up-stream selection signalling.
switching centre then routes the required signal down the customer's line, which obviously only need sufficient bandwidth for one service at a time. The primary routes from the main control centre to each of the switched star centres must of course be able to carry the full range of services simultaneously.

British Telecom has gained valuable experience in this field with their Milton Keynes 'Fibrevision' experiment in which 18 houses received a full range of services via optical fibres. Based on this experience, BT are proposing a 'Multi-star Wideband Network' offering:

- broadcast tv, d.b.s. tv
- subscription tv
- videotex, alphanumeric and photographic
- individual video, e.g. library discs
- home data services.

The proposed topology of the network is shown in Fig.4. The originating site, or super headend, would house the data library as well as the off-air tv and video equipment. This site would be connected by optical fibre 'primary links' up to approximately 20km in length with no repeaters, to a number of hub sites. Each of these hub sites would simply regenerate and distribute the information over 'primary links' to a maximum of 120 wideband switching points where the real intelligence and flexibility of the system resides. The full range of services is available to all the switching points, but programmes are only transmitted down the 'secondary links' to each customer when they demand a specific tv channel or service.

It is envisaged that each wideband switching point will be able to service up to 300 customers with cable runs up to 500m. Even though the Fibrevision trial used optical fibres for these secondary links it is considered that cost still favours small bore coaxial cables, at least for the next few years. Eventually the secondary links will also be optical fibres. Each customer will be able to receive two simultaneous tv channels and a range of f.m. stereo sound encoded by frequency division multiplex on their 120MHz bandwidth secondary link. A customer/termination unit, a small set-top u.h.f. converter and a remote control handset completes the information/control chain.

Where a super primary link to the super head end is relatively short it is intended to utilise 50µm graded index fibre driven by a 0.85µm semiconductor laser. On the longer super primary links it may be necessary to use 1.3µm monomode fibre. Each link will be composed of ten fibres. There will be five fibres for a full range of off-air and subscription television, with each fibre carrying four frequency multiplexed frequency modulated tv channels, resulting in a total of 20 broadcast channels.

Of the remaining five optical fibres constituting the 10 fibre link, three will be for dedicated tv bandwidth channels such as on-demand video library and videotex, again multiplexed four per fibre. Each fibre will be optically modulated by analogue intensity modulation. The remaining two fibres will carry switching and control signals—one upstream and one downstream.

At a hub site the optical signals are simply regenerated and relayed out to the wideband switching points. A firm decision does not seem to have been taken whether to use an injection laser diode along with an avalanche photo detector at 0.85µm on a graded index fibre for the primary links, or whether to upgrade an i.d.d. or i.e.d. at 1.3µm with a p-i-n fet receiver, again using graded-index fibre. What is certain is that in the primary links the five fibres containing the 20 broadcast tv channels will be optically tapped to serve several switching points. The primary links between hub sites and switching points will be less than 5km in length.

Within each wideband switching point a microprocessor-controlled matrix type of routing switch will route the 20 broadcast tv channels as demanded by each of up to 300 customers. Each customer will be able to receive two channels simultaneously. Requests for individual video programmes in the form of discs will be relayed up through the system to the super head end, which will then replay on one of the dedicated channels back down through the hub site and the customer's own switching point and on out to the customer's own secondary link.

Local area networks

A lan is a communications network connecting a number of users within a local geographical area to shared computing resources. The two most common topologies have been the contended bus with collision detection (Ethernet) and the ring structure, as in the Cambridge ring, Fig.5. Many of the features of optical fibres make them attractive for use in lan but usually only after some modification from a coaxial cable design has been implemented.

In the Ethernet system each station is connected to the coaxial bus via a bidirectional passive tap, making insertion of a new workstation a relatively simple matter. Each station attempts to transmit its message when the bus is quiet. If a message collision is detected transmission is stopped and retried a short time later. With fibre optic technology it is relatively difficult to make passive couplers without an unacceptably high loss, thus restricting severely the number of users that may be attached to the bus. To overcome this, Fibernet, the optical version of Ethernet, uses a central passive star coupler to enable 16 users to com-
Optical modulation and detection schemes, as classified in an informative survey of fibre-optic transducers (ref.5).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mechanism</th>
<th>Detection</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence</td>
<td>Interference between signal and reference fibre, or different propagation modes in multimode fibres.</td>
<td>Fringe counting or phase shift detection.</td>
<td>Fibre gyroscope, hydrophone multimode gauge for dynamic strain measurement.</td>
</tr>
<tr>
<td>Amplitude</td>
<td>Modulation of transmitted light by absorption, emission or refractive index change.</td>
<td>Analogue or digital.</td>
<td>Strain/pressure gauge using modulated micro-bending loss. Optical encoders.</td>
</tr>
<tr>
<td>Wavelength</td>
<td>Spectral dependent variations of absorption, emission and refractive index.</td>
<td>Amplitude comparison at two fixed wavelengths, or analogue signal for scanned wavelength.</td>
<td>Temp. measurement by • variable Fabry-Perot cavity • birefringent crystal • semiconductor bendergap shift</td>
</tr>
<tr>
<td>Time Received</td>
<td>Transient absorption or emission behaviour.</td>
<td>Time-delay pulse analysis.</td>
<td>Temperature gauge by time decay of rare earth ion fluorescence. Nuclear radiation diagnostics using Cerenkov light.</td>
</tr>
<tr>
<td>Polarization</td>
<td>Changes in the gyrotary optical tensor.</td>
<td>Polarization analyser and amplitude comparison.</td>
<td>Faraday rotation magnetic field transducer for non-contact current measurements.</td>
</tr>
</tbody>
</table>

At each station a message packet may be attached to the appropriately numbered 'wagon' slot after the locomotive has passed. Because the locomotive is a synchronized event, re-triggered by reception of a previous locomotive back at the terminus R, the message delay through the system is tightly bound.

At the far end of the highway, the star coupler distributes the trains of information back to the receive terminals of all the stations. Just as there can be more than one train on the line between Manchester and London, so will D-Net support more than one train at a time, given a detailed knowledge of the maximum propagation time, bit slot lengths and number of stations. This configuration seems especially attractive at very high speeds beyond 100Mbit/s because it retains a higher efficiency than a passive bus arrangement.

Fibre-optic sensors

One of the aims of research workers in the field of fibre optics has been to stabilize the transmission of information along an optical fibre against commonly encountered environmental changes, for example; pressure, temperature, strain, etc. they have succeeded to an extent where, in many applications, fibre optics is, or will soon be, the preferred transmission medium. In contrast, at the opposite end of the applications spectrum, there have been efforts to exploit variations in the same transmission parameters with respect to environmental disturbances in order to produce a range of fibre optic sensors.

Such sensors would exhibit many potential advantages, usually for the same reasons as in communications, namely; electrical isolation, freedom from electromagnetic interference and the lack of fire risk in sensitive areas.

The range of parameters that can be measured can conveniently be classified into

- mechanical (force, pressure, deformation)
- electrical (field strength, polarization, current)
- magnetic (field strength, polarization)
- temperature.

In most cases these measurands produce changes in the refractive index or in the absorption of the fibre, but some of them will modulate luminescence effects. The table presents information on the categories of modulation and detection that may be used with each of the five different optical parameters.

Some of the most sensitive fibre sensors constructed use an interferometric technique in which the optical phase shift produced by pressure changes on the fibre, resulting in acoustic hydrophone sensors with higher sensitivities than piezoelectric types. Magnetic fields can also be detected by phase techniques if the optical fibre is coated with a magneto restrictive material.

Mechanical displacement can be measured by several arrangements of intensity sensing between movable fibre ends, either with an orthogonal or a slant cut. Vibration detection of a movable membrane from reflected light is also popular. One of the most widespread uses of amplitude detection is the sensing of a Gray code from an encoded disc or shutter, with resolutions available down to 10 μm. Finally, modulated microbending loss can be used by clamping a fibre between two plates with a periodic mechanical grating. In general amplitude detection methods are less sensitive than phase modulated sensors and in addition suffer from unwanted and variable signal attenuation and temperature problems.
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<table>
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<th></th>
<th>Single Density</th>
<th>Double Density</th>
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<tr>
<td>Capacity</td>
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<td>500K Bytes</td>
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<td>9,830 BPI</td>
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<td>Track den.</td>
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<td>100 TPI</td>
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<tr>
<td>Num. tracks</td>
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<td>40 (each side)</td>
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<td>Rec. method</td>
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<td>MFM</td>
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<tr>
<td>Rota. speed</td>
<td>400 RPM</td>
<td>500 RPM</td>
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<tr>
<td>Transfer rate</td>
<td>125K Bits/Sec</td>
<td>250K Bits/Sec</td>
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<tr>
<td>Access time to track</td>
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<td>3 ms</td>
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<td>Access time settling</td>
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<td>20 ms</td>
</tr>
<tr>
<td>Motor start time</td>
<td>0.5 sec</td>
<td>0.5 sec</td>
</tr>
</tbody>
</table>

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<th>Description</th>
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<td></td>
<td>Single drive</td>
<td>£229.95</td>
</tr>
<tr>
<td></td>
<td>Dual drive</td>
<td>£469.95</td>
</tr>
</tbody>
</table>

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--- | --- | --- | --- | --- | --- | ---

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3000:1, 60 amp, 12V, £1500.00**

**HIGH VOLTAGE ELECTRICITY**

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2500:1, 60 amp, 12V, £600.00

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Micro-controlled cassette recorder -2

Description of cassette recorder for use with microcomputer continues with description of f.s.k. modulator and demodulator.

The main criteria for choosing a suitable encoding technique for recording serial data from the output of a microcomputer (RS232 or t.t.l. levels) are, in my opinion, reliability, circuit simplicity and, perhaps most importantly, the ability to be used with any good set of recording/playback electronics. The microcomputer user is primarily concerned with reliability and ease of use of any encoding technique. He is not interested in very high speed techniques if half the time the data is recorded or played back incorrectly; or if the tape-recorder settings need constant adjustment.

There have been a number of designs in various electronic magazines for 'high' speed recording techniques. The fastest of these, of which I am aware, was for 4800 baud. I also have had some experience of designing suitable encoding techniques for high speed serial data recording and am therefore very aware of the problems. Readers may recall the series of articles, in this magazine, on a digital multichannel tape recorder. In this design I achieved a rate of 22,000 baud using complex, but well known, techniques called Miller or delay modulation. However, all these very high speed designs, including my own, rely on the ability to record single high/low or low/high signal transitions. The success or otherwise of the technique depends not only on getting the 'electronics' right but also on tape quality and the mechanical operation of the cassette deck. It is very sensitive to imperfections in the tape quality, dirty tape-heads and indifferent transport of the tape across the head. In my opinion the techniques are unlikely to be successful unless only the best tapes are used, the cassette deck is of the highest quality, and the tape-heads are regularly cleaned.

A technique that is far less sensitive to these three sources of error is frequency shift keying. Using a few modern i.c.s, a voltage-controlled oscillator and a phase-locked loop, a modulator and demodulator are easily designed that are easy to set up and reliable in use. In f.s.k., the output of an oscillator is simply switched between two frequencies; to represent the low and high logic states. There is a maximum rate at which the switching between the two frequencies can take place; somewhere between a fifth and a tenth of the mean of the two frequencies is a good rule-of-thumb. Using a good set of record/playback electronics I set my sights cautiously on a mean frequency of 10kHz, i.e. 9kHz and 11kHz for the 'low' and 'high' frequencies. A bit rate of 2400 has a highest frequency content of 1200Hz when a train of successive ones and zeros are being transmitted. Thus this figure was taken as the highest rate that could be easily be transmitted using the two nominal frequencies of 9kHz and 11kHz. (Actually, by pushing the mean f.s.k. frequency up to 12kHz and careful design of the demodulator stage, it should be possible to record at 4800 baud. Alternatively, it should be possible to drop the mean frequency to 6kHz and still be able to record at 2400 baud.)

F.s.k. modulator & demodulator circuits

The circuits of the f.s.k. modulator and demodulator are shown in Figs 6 and 7. I claim no originality.

Fig.6. F.s.k. modulator, based on Signetics circuits but with triangle to sine converter for greater flexibility in choice of record/playback circuitry.
Fig. 8. Internal layout of 565 p.1.1.

Fig. 7. F.s.k. demodulator, using Signetics 565 phase-locked loop.

The heart of the f.s.k. modulator (Fig.5) is the voltage controlled oscillator i.e. the 566. These i.c's are designed to operate with a nominal voltage on their modulation input, pin 5, of \( V_{c/8} \) below the positive supply rail, i.e. \( 7V \) to \( 8 \). A modulation of this voltage by \( \pm 10\% \) produces a modulation of the frequency output by the same amount. For a \( V_m \) of 15\( V \), \( V_{c/8} \) is 1.875\( V \). Plus and minus 10\% of this value gives voltages of approximately 1.69 \( V \) and 2.06\( V \) below the positive supply rail, i.e. actual voltages on pin 5 of 13.31 and 12.94\( V \). The 15k\( \Omega \) and 12k\( \Omega \) resistors produce a nominal voltage on pin 5 of 13.33\( V \). When the transistor is conducting the 39k\( \Omega \) resistor is effectively in parallel with the 12k\( \Omega \), reducing the effective resistance to about 9.2kohms. The voltage on pin 5, when the transistor is conducting, is thus reduced to a nominal value of 12.90\( V \). Thus by switching the transistor on and off the voltage on pin 5 is modulated by \( \pm 10\% \) about its centre value of 13.125\( V \). The input stage to the transistor has been designed for either t.t.l. levels (between 0 and 5\( V \)) or RS232 type signals (\( \pm 3 \) to \( \pm 15\)\( V \)). If both types of input are required there is no reason why two transistors should not be used with their collectors sharing a common 39k\( \Omega \) resistor. It is, of course, important that the transistor of the unused input be in its off-state, i.e. non-conducting.

Apart from the voltage on pin 5, the frequency-determining components of the 566 i.c. are the 9.1k ohm resistor on pin 6 and the 3.3nF capacitor on pin 7. With these chosen values, the output frequency for a voltage of 7\( V \) on pin 5 is \( f=1.2/(4RC) \), i.e. 9990Hz. Thus, when the logic level on the input varies between low and high, the frequency output of the 566 i.c. varies between about 9 and 11kHz.

The output from pin 4 of the 566 i.c. is a symmetrical triangular waveform of about 3\( V \) pk-pk with a positive d.c. bias voltage. The triangle-to-sine wave converter needs quite a large voltage drive and the variable gain stage is included for this purpose. The triangle-to-sine wave converter uses the non-linear \( I_{DS} \)-\( V_{DS} \) transfer characteristic of a p-channel j-fet to shape the triangular waveform. The output from it is a little less than 1\( V \), r.m.s. with a distortion factor of less than 1\% when the input amplitude is correctly adjusted. A distortion meter is the only proper way of achieving the minimum distortion figure, but visual inspection using an oscilloscope can produce a good enough result. A variable or fixed attenuator is used to reduce the sinewave output voltage to a level suitable for recording on the cassette deck's record/playback electronics.

The circuit of the f.s.k. demodulator is shown in Fig.7, the heart of which is the 566 phase-locked loop. There is nothing unusual about its design but a few comments will be made so that its operation may be understood. The phase-locked loop consists of a voltage-controlled oscillator (an identical v.c.o. to that used in the 566 i.c.), a phase-sensitive detector and an amplifier with a single stage of low-pass filtering. The interconnection between the various elements of the p.l.l. is shown in Fig.8. When the frequency of the v.c.o. is locked to that of the incoming signal, the output from the phase detector (amplified and filtered) applied to the input of the v.c.o. is that voltage which the v.c.o. requires to produce the particular frequency. The voltage applied to the input of the v.c.o. is also the demodulated output signal that we require. For the v.c.o. to produce a different frequency output, the voltage on its input will have to change. This is exactly what the p.l.l. achieves; when a signal of a different frequency is applied to the input of the.
"There is no doubt that the JVC range of ECM colour monitors is excellent value for money ... there is no loss in quality of picture after long periods ... and remember, as more and more resolution is available with new micros, the need for a better display will be that much greater."

High resolution indeed from Personal Computer News. Meanwhile Acorn User said:

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---

**Model Reference**

<table>
<thead>
<tr>
<th>Model Reference</th>
<th>1502.2</th>
<th>High Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>580 x 470 Pixels</td>
<td></td>
</tr>
<tr>
<td>C.R.T.</td>
<td>14&quot;</td>
<td></td>
</tr>
<tr>
<td>Supply</td>
<td>220-240V 50/60Hz</td>
<td></td>
</tr>
<tr>
<td>E.H.T.</td>
<td>Minimum 19kV Maximum 22kV</td>
<td></td>
</tr>
<tr>
<td>Video Band Width</td>
<td>10MHz</td>
<td></td>
</tr>
<tr>
<td>Display</td>
<td>80 characters by 25 lines</td>
<td></td>
</tr>
<tr>
<td>Slot Pitch</td>
<td>0.41mm</td>
<td></td>
</tr>
<tr>
<td>Input Video</td>
<td>R.G.B. Analogue/TTL Input</td>
<td></td>
</tr>
<tr>
<td>Sync</td>
<td>Separate Sync on R.G.B. Positive or Negative</td>
<td></td>
</tr>
<tr>
<td>External Controls</td>
<td>On/off switch and brightness control</td>
<td></td>
</tr>
</tbody>
</table>

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Please state the make of your computer.

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Opus Supplies Ltd.
SC84 microcomputer
continued from page 34

output is captured in an eight-bit latch IC205, by the trailing edge of the next carry pulse and held during the next memory cycle. This allows the eprom to produce the dot pattern for character zero while character one is being brought from memory. The trailing edge of the next carry pulse occurring 500ns later allows plenty of time for the eprom to submit a dot pattern. This pulse enables parallel loading of the shift register IC207 used to convert the dot pattern from eprom into a serial stream of pixels. Being synchronous, the shift register does not load the dot pattern until the rising edge of the dot clock, which occurs while the load input is low. This edge occurs just before the end of the carry pulse and might not, at first, appear to be consistent with the synchronous philosophy propounded earlier as there is an undefined delay between this clock edge and ending of the carry pulse. Note though that it is this same clocking edge which advances the synchronous counter and thus ends the carry pulse, which must therefore change after the rising edge of the clock. Also, the required holding time for the loading signal after shift register clocking is zero and the clocking signal is from a Schottky gate with a very fast rise time, so the loading of data is assured. With this data stored in the shift register the trailing edge of the carry pulse loads a new value from v.d.u. memory into IC205 and the cycle repeats. This means that pixel output begins two character periods after the start of a scanning period. As mentioned earlier, the controller also supplies some direct video-control signals, one to enable the display (so that the screen may be blanked during non-display periods such as during flyback) and a second to indicate when the character position being accessed corresponds to the setting of the controller cursor register. As with M lines, these signals will be delayed and, taking the example of the display-enabling signal, they must be delayed by one and a bit character periods if they are to become active just as pixels for the first character on the line are clocked out of the shift register. One enhancement made to the Hitachi 6845 is that it is possible to delay the output of these two control signals by one or two character periods, which saves on i.c.s. These signals are given a one character-period delay and synchronized by a two-bit latch, IC315, which is also clocked by the carry signal.

At the other end of the system, the 74LS85 four-bit comparator produces a signal at pin 6 when A3h and VDUSEL are low and A2P is high, i.e. an address on the address bus is in the range 08000 to 09FFFF and the v.d.u. memory is switched into the memory. Note that the four matching comparator inputs are switched so it is possible to relocate the area in memory at which the v.d.u. appears (switch on=low). The address is set up before MREQ by the Z80 so the comparator signal can activate MEMDIS to inhibit a system-memory cycle. Further decoding is necessary though to ensure that this is a memory cycle; MREQ is gated so that the v.d.u. memory decoder and, during a true v.d.u. memory access, select signal SEL does several things. It switches the four 74LS157 multiplexers so that they direct bus address lines into the v.d.u. memory and connect the system WR signal to the memory and HD6845S. The v.d.u. memory and the 6845 are always selected so they would be incorrectly written to if WR wasn’t gated. It also enables the data-bus buffer and clocks a set/reset latch made from half of an 74LS00. When set, this latch clears the 74LS273, forcing a display of one dot-row of the character generator corresponding to code 000 — which happens to be blank. The latch is reset by the character clock. This latch suppresses the speckling effect mentioned earlier, the algorithm being 'any c.p.u. access during the fetching of a character code to the character latch forces character code to zero'. While it might seem simpler to gate SEL directly with the video output to produce blanking, due to the pipelining technique SEL would blank the display between one and two characters too early.

The v.d.u. memory consists of 6Kbytes of static memory. Address and data lines to the v.d.u. memory i.c.s do not correspond to their specified 'A' or 'D' numbers but this doesn't matter. The order used was chosen to ease p.c.b. layout. After all, if a data byte is written into memory with a particular addressing pattern but not be accessed when the same address is applied. The lower 11 bits of the address supplied by the multiplexers are fed to all three memories in parallel. The next two most-significant bits of the address feed a decoder which activates one of four output lines. The four lines pass to the memory i.e., enable inputs and the 6845 so that within the addressing range 08000 to 09FFFF for which SEL is active, the memory is mapped at addresses 08800 to 09FFFF and the 6845 control registers from 08000 to 087FFFF. Effectively the 6845 only needs two locations, one to receive the number of the internal register that the c.p.u. wants to access and one which appears as that register. The fact that it has been allocated another 2046 in the rather coarse decoding is not a loss though, and it simplifies both hardware and software. The standard rom supplied programs the system for standard timing signals and a display consisting of 32 rows of 96 characters each. This means that only 32 by 96, or 3Kbytes, of v.d.u. memory is required and, for the basic system IC305 may be omitted. 6Kbytes of memory is needed though to work with the higher resolution graph plotting mode provided in Basic which reprograms the 6845 to scan twice as much memory and produce a display of 64 rows of 96 characters. In graph plotting with the character v.d.u., the split-screen plotting area is 192 by 180.

Fig.2. A monitor is best for high density text display but a monochrome tv set with minor alterations can give satisfactory results. This modification for Ferguson/Ultro 3840, 3845, 3847, 3848, 6840 and 6845 tvs allows the set to be switched between computer input or broadcasts. Numbers in circles refer to pins on the cathode-ray-tube controller socket. The tv circuit must be isolated from the mains (see text).
Connecting a monitor

A 30cm-screen monitor is about optimum. Synchronizing and video signals may be inverted to suit your requirements. For the switches controlling the sync. signals, S98 and S390 on provides negative-going sync., whereas switch sections S59 and S102 select either positive or negative-going video; note that these two switches must not be on at the same time. The dense display makes a stringent requirement on the monitor but standard types with bandwidths of 15MHz or more should be satisfactory. As a cheaper alternative, a television may be modified. This does not stop the set being used as a tv but does require some simple internal modifications. Following details show how to adapt a Ferguson 3845, which is the type used by most of the present Scientific Computer group, and give guidance for modifying other models. Make sure that the monitor is on an isolated supply, i.e. that there is no electrical connection between the mains and internal signal circuits, or use an external isolation transformer. The Ferguson set has a double-wound mains transformer — as do many portable tvs nowadays — but check to make sure if you use a set other than the 3845. Apart from the risk to yourself if you use a live-chassis set, you stand a good chance of permanently reprocessing large amounts of expensive circuitry should something untoward occur.

From the circuits in the tv set, Fig.2, find where the sync. signal is separated from the video, the polarity of the sync. signal, the cathode and grid pins of the c.r.t. socket, which of the two is driven with video, and the potential on the other. In the case of the 3845 these points are the end of R72, nearest the back of the set, negative sync., pins two and one respectively, the cathode and zero volts. Modifications required are to break the sync. signal path within the set, in this case by unsoldering and lifting away the end of R72, and remaking the path with one half of a two pole change-over switch, the other input of which is a combination of the two sync. signals. The other half of the switch is used to connect a decoupling capacitor to the cathode and grid pins of the CRT socket.

SC84

Processor
4/6MHz Z80 processor. Maximum 64K-byte ram. 59K-byte ram available using SciDOS.

Display
Up to 32 lines of 96 characters full programmable. Scrolling window determined by software. Graphics mode 0 gives 192 by 96 pixels, mode 1 gives 192 by 192 resolution. Characters and graphics may be displayed simultaneously.

Input/output
Up to four single or double-sided 8, 5.25, 3.5 or 8in disc drives may be used, either single or double density.

RS232 serial i/o data rates range from 1 to 38400baud with separate transmit/receive clocks. Synchronous serial i/o format is 5 to 8-bit auto-search and sync. or asynchronous 5 to 8-bit with 1,15 or 2 stop bits. RTS and CTR signals control serial data flow. Eight-bit parallel data input is buffered by schmitt i.c.s. Eight-bit parallel output drives five t.l.l. loads. The mos i/o lines operate event counters, pulse timers and 250 interrupts. Four mos timer lines are available for timing and sound generation.

A set of three Eurocard-format plated-through-hole boards for SC84 is available from Combe Martin Electronics, King Street, Combe Martin, Devon EX4 0AD. Price is £39 for the set including v.a.t. and inland or overseas postage. John Hodson — secretary of the Scientific Computer User Group — is organizing the SC84 user group. For further information, send an s.a.e. to him at 12 Broughton Road, Basford, Newcastle-under-Lyme (new address). A listing of SC84's machine-code operating system — MCOS — can be obtained by sending an s.a.e. to Electronics and Wireless World, Room L303, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.
Keyboard and parallel i/o interfacing

Keyboard requirement is for a source of seven-bit ascii code with a positive-going level strobe, i.e. one which stays high as long as a particular key is pressed (circuit shown last month). As ascii is a seven-bit code, the eighth input bit is not wasted but used as a flag that the RS232C port is to echo v.d.u. program output when using MCOS. Not all keyboards have an auto-repeat function so it is provided on the board; an interrupt pulse is sent to the STI at the start of the strobe pulse and after a pause of approximately 0.5s further pulses occur at approximately 20Hz. Overall speed of the repeat system may be adjusted by changing the 1μF capacitor value, the 0.5s hold-off only may be adjusted by altering the 390kΩ resistor and the repeat frequency by altering the 1kΩ resistor. In all cases, reducing the value increases the speed of operation. The i.c. used for keyboard repeat, IC209, also supplies the 2.4576MHz signal for bit rate generation. I recommend that you avoid a National Semiconductor part for this i.c., CD4093BE (RCA) or MC14093BCP (Motorola) being suitable.

These are addresses of the two consecutive locations in memory at which the interrupt controller will expect to find the starting address of the service routine for that particular interrupt.

<table>
<thead>
<tr>
<th>Address</th>
<th>Service routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0FF0</td>
<td>I/O line 0 (keyboard interrupt)</td>
</tr>
<tr>
<td>0FF2</td>
<td>I/O line 1</td>
</tr>
<tr>
<td>0FF4</td>
<td>I/O line 2</td>
</tr>
<tr>
<td>0FF6</td>
<td>I/O line 3 (pulse width/event B)</td>
</tr>
<tr>
<td>0FF8</td>
<td>Timer D</td>
</tr>
<tr>
<td>0FFA</td>
<td>Timer C</td>
</tr>
<tr>
<td>0FFC</td>
<td>I/O line 4 (pulse width/event A)</td>
</tr>
<tr>
<td>0FFE</td>
<td>I/O line 5</td>
</tr>
<tr>
<td>0FF10</td>
<td>Timer B</td>
</tr>
<tr>
<td>0FF12</td>
<td>Transmit error</td>
</tr>
<tr>
<td>0FF14</td>
<td>Transmit buffer empty</td>
</tr>
<tr>
<td>0FF16</td>
<td>Receive error</td>
</tr>
<tr>
<td>0FF18</td>
<td>Receive buffer full</td>
</tr>
<tr>
<td>0FF1A</td>
<td>TO A</td>
</tr>
<tr>
<td>0FF1C</td>
<td>I/O line 6 (disc controller INTRO)</td>
</tr>
<tr>
<td>0FF1E</td>
<td>I/O line 7 (disc controller DRQ)</td>
</tr>
</tbody>
</table>

Table 1. Nominal allocations of Z80 I/O ports.

<table>
<thead>
<tr>
<th>Port address (hex.)</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0E0-3</td>
<td>Keyboard input and control port output</td>
</tr>
<tr>
<td>0E4-7</td>
<td>General purpose parallel I/O</td>
</tr>
<tr>
<td>0E8</td>
<td>Disc controller command and status port</td>
</tr>
<tr>
<td>0E9</td>
<td>Disc controller track register</td>
</tr>
<tr>
<td>0EA</td>
<td>Disc controller sector register</td>
</tr>
<tr>
<td>0EB</td>
<td>Disc controller data register</td>
</tr>
<tr>
<td>0EC-F</td>
<td>Not used</td>
</tr>
<tr>
<td>0F0</td>
<td>STI indirect register</td>
</tr>
<tr>
<td>0F1</td>
<td>Parallel I/O port</td>
</tr>
<tr>
<td>0F2</td>
<td>STI interrupt pending register B</td>
</tr>
<tr>
<td>0F3</td>
<td>STI interrupt pending register A</td>
</tr>
<tr>
<td>0F4</td>
<td>STI interrupt service register B</td>
</tr>
<tr>
<td>0F5</td>
<td>STI interrupt service register A</td>
</tr>
<tr>
<td>0F6</td>
<td>STI interrupt mask register B</td>
</tr>
<tr>
<td>0F7</td>
<td>STI interrupt mask register A</td>
</tr>
<tr>
<td>0F8</td>
<td>STI timer A and B control register</td>
</tr>
<tr>
<td>0FA</td>
<td>STI timer B data register</td>
</tr>
<tr>
<td>0FB</td>
<td>STI timer A data register</td>
</tr>
<tr>
<td>0FC</td>
<td>STI service control register</td>
</tr>
<tr>
<td>0FD</td>
<td>STI receiver status register</td>
</tr>
<tr>
<td>0FE</td>
<td>STI transmit status register</td>
</tr>
<tr>
<td>0FF</td>
<td>STI user data register</td>
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<td>000</td>
<td>STI sync. character register</td>
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<td>001</td>
<td>STI timer D data register</td>
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<tr>
<td>002</td>
<td>STI timer C data register</td>
</tr>
<tr>
<td>003</td>
<td>STI active edge register</td>
</tr>
<tr>
<td>004</td>
<td>STI interrupt enable register B</td>
</tr>
<tr>
<td>005</td>
<td>STI interrupt enable register A</td>
</tr>
<tr>
<td>006</td>
<td>STI data direction register</td>
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<tr>
<td>007</td>
<td>STI timers C and D control register</td>
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</tbody>
</table>

A switch-regulated power supply and further constructor's notes are subjects of a future article.
Continued from page 62

the p.s.d. the output voltage changes to drive the v.c.o. to the new frequency.

Operation of the phase-locked loop is exactly analogous to a servo-loop; it has a natural frequency, damping factor and a bandwidth with a second order, low-pass filter characteristic. Effectively what the p.l.l. does is to recover, from the frequency of the input signals, the original changes to the v.c.o. in the modulator. As the v.c.o. of the p.l.l. is identical to that of the 566, it is not surprising that the changes in voltage levels at the output of pin 7 are similar to those applied to the input of the v.c.o. of Fig.6. The voltage change applied to the output drive of the modulator was 430V (13.32-12.9); the voltage output from the 566 (pin 7) is thus of the same order.

The maximum operating voltage of the 566 i.c. is 30 volts. It cannot therefore operate from the +15 volt supply rails and was consequently chosen to operate from the +15 volt supply rail and ground. (+15 volt supply rails were chosen because of the large voltage drive required by the triangle-to-sine wave converter of Fig.6; it will not operate satisfactorily from +12 volt supplies.)

The two inputs of the 566 i.c. pins 2&3, require an identical d.c. bias that is slightly less than the half-supply voltage. The potential divider consisting of the 4.7kΩ resistor and 3.3kΩ resistors (configured in series with a 5kΩ variable) and the capacitor on pin 9. The values chosen are the same as those for the v.c.o. of Fig.6, except that the resistor is made adjustable. For a ±10% frequency deviation, the amplitude of the audio input signal can vary from 10mV to 1V r.m.s., and still maintain good tracking of the input frequency. The volume setting of the record/playback electronics on playback of the recorded signal is thus non-critical and a mid-way setting of 100mV r.m.s. ideal.

The expected direct voltage variation on the output of pin 7 for an input signal with frequency deviation of ±10% is, as mentioned earlier, about 430mV. This can be adjusted to +215mV about the reference voltage level on pin 6 by adjusting the value of the 5kΩ variable resistor. This is most easily achieved by connecting the output of the modulator to the input of the v.c.o. and applying logic low and high levels to the modulator input.

The output from the demodulator, pin 7, which is applied (internally) to the input of the v.c.o. needs to be filtered for the p.l.l. to operate satisfactorily. This is achieved in this circuit by the 27nF capacitor connected between pin 7 and the +15V supply rail. For the chosen v.c.o. operating frequency of 10kHz and a rate of 2400 baud this value has been found to be satisfactory. It is also satisfactory for lower rates, but possibly not for a higher rate of 4800 baud. (Unfortunately I have not been able to try this out.)

To provide a t.t.l. and RS232 type output level, the output from the demodulator, on pin 7, needs to be amplified. This is achieved using an op-amp as a comparator and the output from pin 6 as the reference level. The output from pin 7 is further filtered by the simple two-stage ladder filter composed of 5.6kΩ resistors and 4.7nF capacitors. The band-edge of the ladder filter is chosen to be approximately half way between the maximum keying rate (2400 baud or 1200Hz) and twice the input frequency (about 20kHz).

The input capacitor connected between pins 7 & 8 acts in the same way as that between pins 6 & 5 of the 566 i.c.: i.e. to improve high-frequency stability. Similarly, the input capacitor across the inputs of the op-amp comparator does the same thing. The input resistor connected from the inverting input of the op-amp to the -15 volt rail ensures that a logic high level is output from the op-amp when no audio signal is present on the input to the demodulator. Two outputs are provided from the op-amp, one at the t.t.l. levels suitable for sourcing directly to t.t.l. i.c. inputs, and one at an RS232 type level.

I must confess, at this point, that although I have shown the modulator and demodulator circuits of Fig.6 and 8 with RS232 type inputs and outputs, I have not tried them out on my own computer, preferring to use t.t.l. levels. It is my understanding that RS232 type inputs and outputs normally invert the t.t.l. logic levels. In so far as I have shown the RS232 type inputs and outputs being used, this should not matter since, if the modulator is connected to the demodulator then a high input on the modulator will produce a high output from the demodulator. However, in the absence of an audio signal input to the demodulator the t.t.l. output should be high. If the RS232-type connection is used on the output of the demodulator, this will also be high.

A subsequent RS232 input on the micro-computer may invert this to a logic low on its t.t.l-type output. To invert this logic, the 1MΩ resistor connected between the negative input of the op-amp comparator and the -15 volt supply rail should be connected to the +15 volt supply rail instead. A final article will describe the up/down tape counter and record/playback electronics.

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A neat modern design is carried through the S Range of meters and instruments from Philip Harris. They are designed with particular attention to reliability, ease of servicing and user safety and feature ease of storage and are clearly marked for identification. The range includes a dual-trace oscilloscope adaptor, various power supply and amplifiers, meters for joules, conductivity, pH, counters, timers and an electrical safety tester. Philip Harris Ltd, Pty, Lynne Lane, Shenstone, Staffs WS14 0EE. WW270

A CNC lathe which can be controlled from a BBC micro is produced by Colne Robotics and described in a leaflet. Included is the basic software which provides a comprehensive range of control codes to program and retain complex cutting sequences. Safety measures are provided by hardware safety cut-out switches and from within the software. Colne Robotics Co. Ltd, Beaufort Road, off Richmond Road, Twickenham, Middlesex, TW1 2PQ, WW271

A range of small p.c.b.s, each with a circuit of a circuit can be linked together to make up more complex circuits. This is the Alpha breadboard/ from Unilab. It is designed to be a 'low-cost, radical approach to the effective teaching and learning of basic electronics, initially for the 13+ age range'. There is also a range for more advanced work. Details supplied in a leaflet from Unilab, Clarendon Road, Blackburn, Lancs BB1 9TA. WW272

The functions of many different instruments are combined into one unit in the Griffin programmable scientific instrument, or GPI5. Starting from a single or dual input multimeter it may be converted into a variety of other instruments by the addition of plug-in modules and overlays to show the functions of the touch-sensitive membrane keyboard. Among the modules are a pH meter, measurements of pressure, magnetic flux, timing and counting, and many more. The meter can also be interfaced with a computer as part of a data acquisition system. Full details in a brochure from Griffin & George, 285 Ealing Road, Wembley, Middlesex HA0 1HQ. WW273

A number of programs for biological experiments are included in Micros in the Lab. Designed for use with the ZX Spectrum computer, full software and hardware details are given in this duplicated booklet. The centre that publishes it can also supply a number of components to ILEA schools. ILEA South London Science Centre, Wilson Road, London SE5 8PD. Telephone: 01-701 2224

ILEA publish two magazines for school micro-users—Computers in Primary Schools newsletter for primary schools and Educational Computing for secondary schools. Both come from the inner London Educational Computer Centre, John Ruskin Street, London SE5 6PQ, WW275

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Two-metre transceivers

A survey of amateur radio equipment for the popular 144-146MHz band

For most newly-licensed radio amateurs, the two-metre band is a natural starting point. It is the lowest band available to those without proficiency in morse code. It is also the most popular: there are no worries about finding other stations to talk to.

Most equipment now in use on 2m is factory-built, almost invariably in the Far East; and a wide choice is available with prices starting at a little over £100. But it is still possible for the constructor to get on the air with a home-built rig at a cost of perhaps a few tens of pounds.

The average newcomer's choice is likely to be a narrow-band f.m. set, for use mainly in the channelized region above 145MHz. This type of rig closely resembles the sort of c.b. set from which many new licensees have recently graduated: the controls are few and simple, and operation involves little more than pushing the button and talking.

For this reason, experienced operators often prefer single-sideband operation, where the technical demands are greater and the rewards higher. With weak signals, s.s.b. has a considerable advantage over f.m. and is essential for serious long-distance working.

Nevertheless, many old hands do use f.m. A chat on two metres, possibly through the local repeater, can be a pleasant enough way of whiling away the traffic jams on the way to work.

A type of set which has grown rapidly in popularity in recent times is the hand-held portable transceiver. Small enough to fit into the pocket, it can be taken anywhere; and for those with something grander at home, it makes a convenient second rig. The latest models offer performance figures and features scarcely inferior to those of larger units. Most hand-holds offer f.m. only, though there is at present one s.s.b. model.

The third main transceiver type is the basestation. This is typically quite a large and complex unit, normally mains-powered but often with a d.c. supply option for use with a car battery. Most ready-built basestation units are multi-mode sets, providing all three of the common amateur radio transmission modes: narrow-band f.m., s.s.b. and (for morse code) c.w. Amplitude modulation is more or less dead on v.h.f., despite one or two attempts to revive it: the few stations still using a.m. are equipped mostly with second-hand commercial radiotelephones.

The multi-mode set also makes a useful building block for forays into the higher bands by providing a stable frequency source for multiplying up through devices such as varactor triplers.

Technical features

Commercial amateur radio equipment has changed considerably during the last few years. Perhaps the most conspicuous development, in v.h.f. transceivers at least, is that digital frequency synthesizers have almost entirely displaced switched crystal oscillators and free-running variable frequency oscillators.

True continuous tuning has become virtually a thing of the past in 2m equipment. Most sets tune in steps governed in the first instance by the frequency of the synthesizer's v.c.o. With f.m. equipment for the European market, the step size is often 12.5 or 25kHz. This gives easy tuning of the numbered f.m. channels on 2m, which are spaced 25kHz apart. So an f.m.-only set which scans in smaller steps may be awkward to handle when rapid retuning is called for. However, in many synthesized sets the channel spacing can be programmed by the user.

On s.s.b., tuning steps as small as 100Hz are the norm. But s.s.b. sets also have a clarifier or receiver incremental tuning control (r.i.t.), which allows the receive frequency to be offset slightly from the transmit frequency: this is to help resolve off-channel transmissions. On the more expensive multi-mode sets there may also be a control to pull the transmitter frequency slightly, for satellite working. With this, the operator can compensate for Doppler shift as the spacecraft approaches and recedes.

In some of the cheapest sets, the hand-held portables, frequency selection is by means of a bank of thumbwheel switches. This method works well enough if the switches are reliable, though some users may prefer to pay a bit more to have a digital display giving positive indication of the tuned frequency. Many recent portables have a low-power liquid crystal display, with a calculator-
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<td>Modular kit system</td>
<td>Synthesized version, £100; many add-ons</td>
</tr>
<tr>
<td>Belcom LS-20XE</td>
<td>hand</td>
<td>1-5W</td>
<td>5MHz</td>
<td>thumb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Headset, NiCd cells, charger</td>
<td>-</td>
</tr>
<tr>
<td>FDK Palcomm II</td>
<td>hand</td>
<td>3.5W</td>
<td>5MHz</td>
<td>thumb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Throat mc, headset, speaker-mic</td>
<td>Choice of chargers</td>
</tr>
<tr>
<td>Standard C110</td>
<td>hand</td>
<td>2.5/0.15S</td>
<td>5MHz</td>
<td>thumb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Headset for VOX operation; bigger NiCd pack</td>
<td>-</td>
</tr>
<tr>
<td>Yaesu FT203R</td>
<td>hand</td>
<td>2.5W</td>
<td>5/10kHz</td>
<td>thumb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Brush 20mA on standby; optional NiCd pack</td>
<td>-</td>
</tr>
<tr>
<td>Icom IC-2E</td>
<td>hand</td>
<td>1.5/0.15S</td>
<td>5MHz</td>
<td>thumb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>20mA</td>
<td>-</td>
<td>-</td>
<td>Interchangeable NiCd packs in three sizes</td>
<td>-</td>
</tr>
<tr>
<td>Yaesu FT206B</td>
<td>hand</td>
<td>2.5-3W</td>
<td>5/6kHz</td>
<td>key Pad</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>20mA standby current; chargers, car adapter, power amplifier</td>
<td>-</td>
</tr>
<tr>
<td>NDI HC-1400</td>
<td>mobi</td>
<td>25W</td>
<td>5</td>
<td>d</td>
<td>3</td>
<td>led</td>
<td>ac</td>
<td>-</td>
<td>0-250V,12DB</td>
<td>12</td>
<td>16-18V</td>
<td>8000mAh</td>
<td>8-10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Standard CB900</td>
<td>mobi</td>
<td>10W</td>
<td>5/25kHz</td>
<td>d,v,d</td>
<td>5</td>
<td>led</td>
<td>bar</td>
<td>0-150V,12DB</td>
<td>12</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Belcom LS-202E</td>
<td>hand</td>
<td>2.5-5S</td>
<td>5MHz</td>
<td>thumb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Icom IC-02E</td>
<td>hand</td>
<td>30-5W</td>
<td>12-525k</td>
<td>thumb</td>
<td>10</td>
<td>a</td>
<td>led</td>
<td>0-252V,12DB</td>
<td>10-5W</td>
<td>12,0-420mA</td>
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<td>-</td>
<td>-</td>
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<tr>
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<td>mobi</td>
<td>25W</td>
<td>5/12.5k</td>
<td>d,v,d</td>
<td>11</td>
<td>a</td>
<td>led</td>
<td>0-24V,12DB</td>
<td>10-12V</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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<td>FDK Multi-725X</td>
<td>mobi</td>
<td>25W</td>
<td>5/12.5k</td>
<td>d,v,d</td>
<td>-</td>
<td>b</td>
<td>flour</td>
<td>0-480V,12DB</td>
<td>10-12V</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Triyo TR-2500</td>
<td>mobi</td>
<td>25W</td>
<td>5/12.5k</td>
<td>d,v,d</td>
<td>-</td>
<td>b</td>
<td>flour</td>
<td>0-480V,12DB</td>
<td>10-12V</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Standard CSBE</td>
<td>mobi</td>
<td>45W</td>
<td>5/15.5k</td>
<td>d</td>
<td>5</td>
<td>a</td>
<td>led</td>
<td>0-252V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Yaesu FT230R</td>
<td>mobi</td>
<td>25W</td>
<td>5/10kHz</td>
<td>d,v,d</td>
<td>10</td>
<td>b</td>
<td>led</td>
<td>0-250V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Yaesu FT290R</td>
<td>mobi</td>
<td>25W</td>
<td>5/10kHz</td>
<td>d,v,d</td>
<td>10</td>
<td>b</td>
<td>led</td>
<td>0-250V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Triyo TM201A</td>
<td>mobi</td>
<td>25W</td>
<td>5/10kHz</td>
<td>d,v,d</td>
<td>5</td>
<td>a</td>
<td>led</td>
<td>0-250V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Icom IC-27E</td>
<td>mobi</td>
<td>25W</td>
<td>12-525k</td>
<td>d,v,d</td>
<td>9</td>
<td>a</td>
<td>led</td>
<td>0-490V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Triyo TR-7930</td>
<td>mobi</td>
<td>25W</td>
<td>5/10kHz</td>
<td>d,v,d</td>
<td>21</td>
<td>b</td>
<td>flour</td>
<td>0-480V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Icom IC-25H</td>
<td>mobi</td>
<td>45W</td>
<td>5/15.5k</td>
<td>d</td>
<td>5</td>
<td>a</td>
<td>led</td>
<td>0-24V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Standard CB900E</td>
<td>mobi</td>
<td>35W</td>
<td>5/10kHz</td>
<td>d</td>
<td>10</td>
<td>b</td>
<td>led</td>
<td>0-19,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Yaesu FT4B0E</td>
<td>mobi</td>
<td>15W</td>
<td>11kHz</td>
<td>d</td>
<td>4</td>
<td>b</td>
<td>flour</td>
<td>0-350V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Triyo TR-9130</td>
<td>mobi</td>
<td>45W</td>
<td>5/12.5k</td>
<td>d,v,d</td>
<td>6</td>
<td>b</td>
<td>led</td>
<td>0-250V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>Triyo TW-4000A</td>
<td>mobi</td>
<td>25W</td>
<td>5/25kHz</td>
<td>d,v,d</td>
<td>10</td>
<td>b</td>
<td>led</td>
<td>0-19,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Icom IC-290D</td>
<td>mobi</td>
<td>25W</td>
<td>1/5kHz</td>
<td>d</td>
<td>5</td>
<td>b</td>
<td>led</td>
<td>0-60V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Icom IC-271E</td>
<td>mobi</td>
<td>25W</td>
<td>1/5kHz</td>
<td>d,v,d</td>
<td>32</td>
<td>b</td>
<td>flour</td>
<td>0-350V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Yaesu FT726R</td>
<td>mobi</td>
<td>10W</td>
<td>200kHz</td>
<td>d,v,d</td>
<td>11</td>
<td>b</td>
<td>flour</td>
<td>0-250V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Icom IC-271E</td>
<td>mobi</td>
<td>10W</td>
<td>1/5kHz</td>
<td>d,v,d</td>
<td>32</td>
<td>b</td>
<td>flour</td>
<td>0-250V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Triyo TS-780</td>
<td>mobi</td>
<td>30W</td>
<td>5/12.5k</td>
<td>d</td>
<td>10</td>
<td>b</td>
<td>led</td>
<td>0-24V,12DB</td>
<td>12,0-420mA</td>
<td>12,0-420mA</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
style keypad for rapid frequency selection. The display may incorporate extra features such as a bar-graph meter to indicate transmitted power and received signal strength. In mains-powered sets, or mobile equipment designed to run from a car battery, a fluorescent display is sometimes fitted: this may give better readability under unfavourable lighting conditions.

### The transmitter

The maximum power level permitted to British amateurs on the 2m band (other than those with special dispensation from the licensing authority) is a carrier power supplied to the aerial of 26dBW, or in the s.s.b. mode a peak envelope power (p.e.p.) of 26dBW. These figures correspond to 100W and 400W respectively.

The power output of the average 2m mobile f.m. transceiver is in the region of 10W. Since this type of set is probably the most common, there is little point choosing something more powerful unless the performance of its receiver is better than average. There is no virtue in being able to shout at other stations if their replies are going to be lost in noise.

With portable and hand-held transceivers, transmit power is usually restricted to a watt or two for reasons of battery life; but often the power can be switched to a still lower level for contacts under good signal conditions, with dramatic reduction in battery drain. Under typical conditions, with one-minute transmission periods alternating with three minutes of listening, the life expectancy of a battery pack is likely to be in the region of two and a half hours.

The current drain in the standby condition is a detail worth seeking out on the manufacturer's data sheet. Some of the early portables had led displays which were so heavy on current that they had to be blanked for much of the time. But if the user anticipates long periods of intensive operation, it is worth looking for a model with a quick-change battery pack so that a spare can be slipped in when the output starts to droop. With certain sets, the manufacturers offer a choice of battery packs in different sizes, some of them having a higher-than-usual nominal voltage to give increased transmit power.

### The receiver

Receivers too have their share of design improvements. Ceramic filters offer excellent filtering at low cost, and new low-noise r.f. devices are bringing enhanced performance in the front-end. Beginning to make an appearance in commercial two-metre equipment is the gallium arsenide fet. But it is worth bearing in mind that fashionable components do not automatically make a set better.

Receiver sensitivity usually features prominently in radio manufacturers' promotional material, though the figures quoted are not always expressed in the same units and it can be difficult to raw meaningful comparisons. However, the 'goodness' of a receiver is affected by many other factors, including resistance to overloading, response to out-of-band signals and the quality of the filters. The sensitivity figures should not therefore be taken on their own as an index of the receiver's overall merit.

As it is with cars, so with transceivers: even the cheapest will get you from A to B if the road is open. So what are the advantages of buying one of the more expensive models? With radios, even the costliest cannot offer extra speed. But it can provide a range of features designed to make a session at the microwave more interesting and less tiring.

Among these are extra memories for storing commonly used frequencies; additional scanning modes; accessories such as a voice synthesizer to supplement the front panel display; plug-in radio-frequency modules for other bands; an interface unit enabling the transceiver to be controlled automatically by the user's computer; and of course more transmitter power and a better receiver.

### Notes on the table

**Price:** the distributor's UK price, including v.a.t.

**Style:** entry indicates whether the set is intended for portable, mobile or base-station use. However, for many mobile units it is possible to buy desk-top consoles with mains power units; and for some portables, car fixing kits are available.

- 'n' indicates narrow-band (f.m.); 's' indicates s.s.b.; 'c' indicates c.w.
- **Other bands:** this survey includes one or two dual-band models. For certain other sets, r.f. modules giving coverage of additional bands are available as an accessory.

**Tx power:** the transmitter power quoted by the manufacturer, normally for the f.m. mode. Two figures separated by an oblique stroke indicate high and low power settings. The separator '>' indicates that the power is continuously variable between the limits shown.

**Sensitivity:** 's' denotes frequency-synthesiser tuning, 'x' denotes a crystal oscillator providing only those channels for which suitable crystals have been fitted.

**F.m. step:** the normal minimum tuning step in n.b.f.m. use. Some multi-mode sets are capable of much smaller steps even on f.m. In many cases, the size of the step is programmable: for example, 12.5 and 25kHz can be selected instead of 5 and 10kHz if the user wishes.

**Tuning method:** 'd' indicates a conventional knob or dial, 'thumbw' indicates thumbwheel switches and 'u-d' indicates up-down buttons.

**Memories:** most present-day sets permit storage and instant selection of a number of the user's favourite frequencies. Certain models also have one or more variable-frequency oscillators which can be used as additional memories.

**Scan modes:** some sets allow scanning of frequencies stored in memory ('m'), others provide scanning of the entire band ('b') or programmable sectors of it.

**S-meter:** most sets include a received signal-strength meter of some sort. Often this doubles as a power level indicator. The entry 'bar' indicates a bar-graph indicator as distinct from a moving-coil meter, 'mc'.

**Receiver sensitivity:** the figure shown is, where possible, for the f.m. mode.

**Power needs:** some hand-held sets tolerate a wide range of supply voltages, while mobile sets work best on the 13.8v provided by a reasonably healthy car battery. Figures for current indicate the consumption on standby and while transmitting on high power. Battery, mA-hour: storage capacity of the standard battery. Most portable sets are supplied with nickel-cadmium rechargeable batteries. Batteries of other sizes may be available as an accessory. Many sets, portable and otherwise, have a smaller battery (not indicated here) for memory retention.

---

**Amateur Electronics UK**
504-516 Alum Rock Road
Birmingham 8
Tel: 021-327-1497/6313

**Yaesu**

**Arrow Electronics Ltd**
5 The Street
Hatfield Peverel
Essex
Tel: 0245-381626

**NDi**

**Lee Electronics Ltd**
400 Edgeware Road
London W2
Tel: 01-723-5521

**Standard**

**Lowé Electronics Ltd**
Chesterfield Road
Matlock, Derbyshire DE4 5LE
Tel: 0629-2817/2430/4057

**Trio, Belcom**

**Microwave Modules Ltd**
Brookfield Drive
Aintree, Liverpool L9 7AN
Tel: 051-523-4011

**Numerous preamplifiers, power amplifiers, converters and transverters**

**Modular Electronics Ltd**
95 High Street
Selsey, Chichester, Sussex
Tel: 0243-602916

**Preamplifiers, linear amplifiers and r.f. components**

**Mutek Ltd**
Bradworthy
Holsworthy
Devon EX22 7TU
Tel: 0409-24-543

**Preamplifiers etc.**

**Thanet Electronics Ltd**
143 Reculver Road
Birling, Herne Bay
Kent CT6 6PD
Tel: 02273-63859/63850

**Icom**

**South Midlands Communications**
Rumbridge Street
Totton, Southampton SO4 4DP
Tel: 0703-867333

**Yaesu, KDK**

**Waters and Stanton Electronics**
18-20 Main Road
Hockley, Essex
Tel: 0702-206835/204965

**FDK, Trio**

**Wood and Douglas Ltd**
Unit 15, Youngs Industrial Estate
Aldermaston, Reading RG7 4PQ
Tel: 0736-5324

**2m transceiver modules.**

**WPO Communications**
20 Farnham Avenue
Hassocks
West Sussex, BN6 8NS

**Transceiver kits**
PREFERRED VALUES

It is not unusual for the engineer to be condemned for incompetence when his strictly practical camel fails to look like the mathematician's image of an elegant but non-existent breed of horse. Preferred values are selected not by rigid arithmetic, but as the result of some very clear and simple thinking about tolerances and their application to the real world. Since the 20% range has produced the most glaring 'anomaly', let us use it as our example.

To produce a series of figures such that any value will fall into the tolerance band of one of them, they must be related so that the top end of the lower band coincides with the lower end of the higher one. In our case this is to say that 120% of the lower should be 80% of the higher, so they should stand in the ratio of 1 : 1.5. In practice the 'Two-digit' rule will prevent this from always being met, and rounding of a calculated value will be required. This must always be in the sense to close the gap between the two values, since the other way will produce a 'hole' into which components could fall and so be lost. This consideration also leads to the conclusion that when rounding has taken place, the next value must be based on that rounded value and not the calculated one. This destroys once and for all any elegant arithmetic relation. Lastly, in order to keep the total number of values down as far as possible, it is sensible to select the 10% values from those already existing in the 5% range (if possible) and the 20% from the 10%.

We can now see where this reasoning gets us. Starting initially from the lowest value:

<table>
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<tr>
<th>previous values</th>
<th>selected value</th>
<th>selected value</th>
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<tbody>
<tr>
<td>1.5</td>
<td>1.5</td>
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<tr>
<td>2.25</td>
<td>2.25</td>
<td>2.2</td>
</tr>
<tr>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>4.75</td>
<td>4.75</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Now the problem. On this basis the next value should be 7.0 (although it could be less) and the next is over 10 by quite a bit. Let us therefore consider what happens if we calculate back from

10. We will now have a value 6.7 (although it could be more). So there are four possible values available all of which would meet the 'no holes' criterion. 6.8 is the only one to appear in the 5% range, or in the 10% range for that matter.

Mr Scott tells my namesake that he will find the 'same standard of arithmetic' in all three ranges. Precisely so. However we have one more obstacle to overcome. Calculate the 5% range and you will get two values (1.4 and 1.7) which do not appear in the standard, transgressing the 'no holes' rule. With them in there was a great deal of overlap, while without them the holes are only very small. The need to keep the number of values to the minimum was presumably judged to be the over-riding factor.

Even if the poor beast does have bad breath, it is still not a bad camel in a hard world!

Alan Watson
Pollense
Mallorca

GPIB COMBINER COMMENTS

I refer to the article in the April 1984 issue of Wireless World by D.J. Greaves., the 'GPIB combiner'.

Mr Greaves' design, though ingenious, is a complex hardware solution to a problem imposed by his choice of GPIB controller. The particular machine he employs (the CBM Pet) does not implement the full GPIB standard and lacks the ability to pass control. The concept of the design is based on a fallacy brought about by the author's reliance on a particular manufacturer's interpretation the function of a GPIB controller. Mr Greaves states 'The main disadvantage of the [GPIB] bus is that only one controller may be connected to the string of peripherals at one time.' That statement is incorrect.

The IEEE-488 Standard specifically allows for multiple bus controllers. A GPIB controller which implements the full IEEE-488 standard includes the capability to pass control to another controller connected to the same bus. Most GPIB controllers commercially available include this capability, typically as a high-level language statement. Also, several commercial l.s.i. devices are available which implement this GPIB feature. As recently as February 1984 your magazine described an interface module available for the BBC microcomputer using an l.s.i. device which includes bus control transfer.

More than one controller may have access to peripherals on a single GPIB through the existing standard using software. It is not necessary to spend time designing a hardware multiplexer for GPIB controllers. The user who finds that he needs to attach several controllers to his bus will find a nearer and quicker solution by selecting his bus controllers with this capability built-in.

There are several well known international manufacturers of GPIB instrumentation, and several less-well-known national ones, who can supply GPIB controllers with pass-control as a standard feature.

J. Summers
Application Manager
Fairchild Camera and Instrument (UK) Ltd.

IS LIGHT VELOCITY A CONSTANT?

The questions about relativity theory will not go away, Michael M. Albahari ("Is light velocity a constant?" February letters) is mistaken if he considers that the issue could be resolved by accurate measurement of time and distance; the real conflict is between incompatible philosophical hypotheses.

The complex of notions embodied into the Special Theory of Relativity (and from which the General Theory was developed by processes of logic) is based on two propositions selected from several alternatives:

1. All inertial frames of reference are equivalent in their physical characteristics.
2. Light travels in any fixed direction with the same velocity everywhere.

The unambiguous interpretation of (2) because velocity exists between two physical entities and is not something that resides independently within frames of reference.

Implicit in the theory as developed from (1) and (2) are two generally unstated propositions:

1. Electromagnet radiations impinge upon the surfaces of all materials conglomerates, from unoccupied space with the same velocity c.
2. Unoccupied space has no characteristic which regulates the propagation of radiations crossing it, except to guide it in a straight path.

To render (3) and (4) some appearance of plausibility, Einstein made the suggestion that "The relations between co-ordinates of two systems in uniform motion relative to each other cannot be indetical with those of Newtonian physics in which simultaneity is absolute."

The problem of interpretation of this assertion in terms of experience is the real stumbling-block for relativity theory; the late Professor Herbert Dingle strongly suggested that no meaningful interpretation is possible. Some further propositions which readers may like to contemplate are:

5. A unique universal medium (or aether) propagates radiations at the velocity c.
6. Material conglomerates moving through the aether (of which the L. Fitz-Gerald effects as consequences of (2), the former effect being considered as 'apparent' and the latter as real, which was a blatant inconsistency.

The development of the General Theory requires the Lorentz-Fitz-Gerald contraction time-dilation effects as consequences of (2), the former effect being considered as 'apparent' and the latter as real, which was a blatant inconsistency.

In his 1905 paper Einstein recognised the Lorentz-Fitz-Gerald contraction time-dilation effects as consequences of (2), the former effect being considered as 'apparent' and the latter as real, which was a blatant inconsistency.

The development of the General Theory requires the Lorentz-Fitz-Gerald effects to be physical; it is not generally stated that this in turn produces difficulties with the dynamics-energy possessed by rotating entities, and the
XY PLOTTER

I am prompted to write to you because of the very interesting XY plotter by P.N.C. Hill. I am retired now, from running a plastics injection factory, but have long been keen on electronics, photography, and astronomy.

For a number of years, I have been experimenting with a method of printing colour photographs direct on to paper by scanning in the facsimile process. This started with EF50s and multiplexer cards and progressed to transistors and has involved many different models using ballpens and also carbon paper for the image. I even tried a mixture of metal indicators soaked into paper with glycerine and electrodes of copper, nickel and molybdenum to mark the paper. So far, the carbon paper has seemed the best to manage with limited funds to spend on research.

In the course of these experiments I have used various steppers including the Cio-Syn motors from Stewart. Not being good enough with logic circuits I have had to use simple chips like the 4017BE which give a decade count from simple pulsing and can be made to count fewer steps for the line style in my sketch. A useful chip is the SAA1027 which will drive a Slo-Syn motor and reverse in an easy manner, but my circuits have been mainly for unidirectional running.

I think by the way that Mr Hill is wrong to state the rotor is not a permanent magnet. You can feel the holding force if you turn this by finger and thumb and generate about 50 volts or so in one winding by running it as a dynamo. Also, I have some motors from the States, including a Rapid Syn with four coils which has a magnetic hold so strong that it is hard to turn by hand. This performs very well as it has 12 volt coils and better torque than the Slo Syn.

Despite this one seeming error, the article is most interesting as I have made up a plotter in the past, using ordinary motors and a potentiometer to balance circuit to do transistor curve tracing. It was not very good and needed to be refined so it was scrapped.

Your write-up leaves out some important details for me since it would be nice to make up a stepper plotter controlled by Basic and digital-to-analogue output from the computer with a potentiometer to compare positions.

The ball bearing idea is a good one and simple. I have used a system of crossed ball races with silver steel rods and this has proved quite good. See sketch.

A further article dealing in much more detail, with the electronics of the plotter would be welcome to me and I suspect many others.

A.J. Quinton
Thorpe Bay
Essex.

TECHNOCRATIC BONDAGE?

Your April leading article put the blame for restrictive aspects of our society on "technocrats". But government ministers rely on the advice from their ministers, i.e. from civil servants, and it has long been notorious that few graduates in science subjects make their way to the higher ranks of the civil service. (I guess that in addition to the fact that few of those who apply are

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accepted, it is probable that few apply. So far from our troubles being due to 'technocrats', many are due to the fact that few of those in a position to influence policy have what might be called an 'engineering' outlook, a knowledge of scientific fact and method plus some appreciation of the human side of 'management'.

On the narrow issue of GCHQ I can only say that those who go to work in such an establishment should be forewarned of the burden which 'security' will place on them. From the little which I have seen from the outside, I would regard this burden of knowing things which must on no account be disclosed as the most serious factor associated with such work.

D. A. Bell
North Humberside

RELATIVITY

Much discussion concerning the Special Theory of Relativity has appeared of late both in your letter columns and in other publications, even to the extremes of scrapping the theory altogether and returning to the day of classical mechanics and the aether. On the other hand, some have raised more fruitful suggestions concerning the physical basis of the relativistic (or \( e = m \)) Doppler shift.

Surely at this stage in the career of that theory it should be evident that the theory suffers from a number of definite shortcomings: (a) it is physically incomplete, i.e., certain questions of physics are still left open by the theory itself; and (b) as basically a correction factor to classical electrodynamics it suffers from an instrumentalist interpretation that prevents those fruitful physical questions from being asked, i.e., the theory concerns rigid rods and clocks, but does not directly have a microbasis.

Assuming that there is some validity in these observations on the theory the following questions seem to be quite open.

What is the physical basis for the constancy of light's velocity if there is relative motion between source and observer, especially since the classical physics requires that velocity to vary?

What is the physical basis for clocks (or any natural process) running slower than in the inertial system of which it is a part in relative motion? How is the special theory related physically to quantum mechanics? Does the paradox of the twins that age at different rates depend more on relative acceleration than on relative velocity? Is the special theory valid for systems in instantaneous velocity rather than constant relative velocity?

Einstein's early success (1911) in deriving the red shift formula for a gravitational field could only be explained by assuming he used relative instantaneous velocity. Finally, does the wavelength change under conditions of relative motion between a light source and observer while the velocity of the light is constant? The constancy of wave length (and associated wave number) is an unwarranted carryover from classical physics, and even Einstein himself showed his conservative nature is making this latter assumption.

G. Blondeau,
CANMET, Dept of Energy,
Mines & Resources,
Ottawa, Ont.,
CANADA

I am beginning to get the hang of much that you have recently printed; in spite of the titles, it has had nothing to do with relativity!

Science comprises a considerable body of facts and theories which support one another and which are widely considered to be true. This body can grow in two different ways. We may wake up to new implications of what is already accepted — 'new', that is, in the sense that no one had got round to digging them out before — or we may add new facts which fit in to the old body and so consolidate it. That is, we may build on the old structure.

But we can also work on the foundations. Some of the theories in science are fundamental, which means that their truth cannot be inferred from other accepted facts or theories— their sole purpose is to provide explanations of other theories and facts. Science likes a fundamental theory if it is felt on balance inexplicable things outweigh the unsatisfactory aspects of introducing a many inexplicable idea, and provided that it does not lead to inferences which conflict with observations. In other words a fundamental theory has to be useful (it must survive Occam's razor) and it must be refutable by established facts.

Now the special and general theories of relativity, wave mechanics, gauge theories and so on are all fundamental in this sense. All that their advocates claim for them is that if you assume them to be true, you can explain a wider range of facts than you can if you assume them to be false. It is not a valid objection to a fundamental theory to say that it embraces a concept which clashes with your old preconceived ideas, or that it cannot be derived from something else.

Science has always had trouble getting people to modify their tenaciously held ideas: the sun revolves around the earth, action at a distance is conceptually impossible, and so on. Even today people get stuck with wrong ideas through failing to look at all the evidence; a clockmaker would say that the great property of a pendulum is that its period is constant but a church bellringer would say that the one thing which makes change ringing possible is the fact that a small change in the amplitude makes a big difference to the period!

J. G. D. Pratt
West Horsley
Leatherhead
Surrey

You do your journal no service by continuing to publish these embarrassing articles by Dr Murray. It is true that there are serious imperfections in both Relativity and Quantum Mechanics and if Dr Murray confined himself to explaining them to your readers one could not object, even if one had doubts whether he was the man best qualified to do so. But it is really too much when, although apparently not able to offer any constructive comment himself, he jeers at those men who have, over the years, painstakingly put these theories together. Newton is supposed to have said that he saw so far because he stood on the shoulders of giants. No such humility from Dr Murray who can apparently see nothing from an even better vantage point.

The community of theoretical scientists — Dr Murray's despised establishment — is well aware of the imperfections of fundamental theory but is far from complacent about them. On the contrary it continues to devise procedures for obviating them while at the same time looking for more fundamental changes which would remove them altogether. A consensus is beginning now to emerge on what the basis of a new theory might be. As usual in these matters the roots of the new theory go back a long way — originally to Hamilton's quaternions but more significantly to the work of Eli Cartan at the beginning of the century. Cartan showed that a geometrical space could be described not only by vectors and tensors but also by more elemental entities variously called half-vectors or spinors. These entities were first used in physics by Pauli and slightly later by Dirac who in 1930 constructed a relativistically covariant wave equation in which electron spin is inherent. What is now becoming apparent is that the spinor formulation may also be required to remove the difficulties of macro-theory.

Dr Murray may denounce these developments as even more counter to common sense than Minkowsky space but then common sense has never been of much help in theoretical physics. The rub of the matter is however easily explained to any reasonably competent mathematician. Spinors are a sort of complex number, distinguished from ordinary complex numbers by the fact that their law of multiplication is not in general commutative; i.e., \( A \times B \) is not necessarily equal to \( B \times A \). In a group of spinors there is usually a sub-group whose multiplication law is commutative and whose properties palesly reflect those of the full group; in the present case this sub-group is the complex numbers. What physics in general has been doing up to now is to use complex numbers when they should have been using the full group. Thus they have been in much the same situation as electrical engineers trying to make do with real numbers, knowing nothing about complex ones.

If a new theory along these lines is ever formulated and accepted it will be because it works better than the one it replaces.
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**BASES ETC.**

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**ZENER DIODES**

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ELECTRONICS & WIRELESS WORLD JULY 1984

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NEW PRODUCTS

Communications 84, Birmingham

Business communications seemed to be the central theme of the exhibition held at the NEC in Birmingham. The integration of communications services usually thought of as separate entities was emphasized by several exhibitors — the office computer terminal can also be a telex and teletex terminal and an autodial telephone as well as offering local computing, word processing, calendar and diary, calculator and directory. One such device launched by STC Telecommunications was Executel, a multipurpose work

station with optional extension for a secretary which offered most of the same facilities and a built-in intercom.

If you believe that electronics is communications, then the exhibition has something to offer to anyone interested in electronics. This is certainly confirmed by the variety of the products on show: anything from a complete satellite receiver station to a single transistor and almost anything that can be thought of that includes the prefixes tele or trans.

from fumes or acid spillage. Under normal operating conditions there is no loss of water and so it is possible to dispense with normal vents though there is a small safety vent in case of accidental over-changing. The Powersafe range includes 2V cells of 48 and 110Ah capacities and a 6V block of 80Ah. Another range, Powerstore, is available in 12 different sizes with capacities ranging from 3 to 240Ah, in 2, 4, 6 and 12V configurations. Chloride Power Storage, PO Box 5, Clifton Junction, Swinton, Manchester M27 2LR.

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A number of hand-held terminals may also be used as support devices for communications equipment. Such devices made by G. R. Electronics have been used to test p.a.b.xs, multiplexers and other processor-based systems for commissioning and installation of such systems in the field. The 14B, for example has a 14-digit display, 92-character memory and RS232 and/or 20mA loop interfaces as standard. Options include a rechargeable battery pack making it completely independent of outside power sources, and RS422/432 interface for longer-cable signals. Larger memories and more facilities are offered by the 42B and 42C terminals which have 40-character displays, battery operation with memory protection, signalling up to 9600 baud and from 8K to 64K of ram. Different protocols are optional and the units can store diagnostic routines for on-site testing and capture data for later analysis. The company also offers an acoustic coupler and a data recorder to complete a battery-operated system for the collection and transmission of data. G. R. Electronics Ltd, Fairoak House, Church Road, Newport, Gwent NPT 7EJ. EWW 215

FIBRE-OPTIC MODEM

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A fibre splicing technique has been incorporated into the system and this is claimed to take one third of the time needed normally to make splices and yet offers a high-fidelity connection into each modem. The modems are priced at £250 each and saving is claimed from the use of single strand fibres, lower in cost than the equivalent twin strand or screened twisted pair cables normally used. Easdata Ltd, 7 Charlton Rise, Welwyn, Herts AL6 9RP. EWW 217

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Electronics & Wireless World July 1984
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AWARD-WINNING TAPE STREAMER

Using standard 0.5in computer tape the 9800 tape streamer from Thorn EMI Datatech may be used as archival back-up for hard disc data and for transferring data from minicomputers to mainframe computers. The 9800, while taking a standard reel of tape is amazingly small and the combination of electronic, mechanical, and software design, combined with its ergonomic and aesthetic appeal has won for it a Design Council award.

The combination of hard disc and tape has become established in main frame computer usage for some time. With many peripherals and minicomputers however there has been a lot of reliance on floppy or hard discs and a system failure can lead to the loss of valuable data. The use of a back-up or archival tape can overcome the vulnerability of such a system. Datatech recognised a need for a high-speed, high-capacity desk-top tape store which was comparatively low in cost, hence the development of the 9800. Compatible with any computer system, the machine can automatically lace the tape through the tape path and onto the take-up hub. The tape cannot be put in the wrong way round, the machine will refuse to accept it and signal an error. Internally, all circuits are on plug-in cards and there are self-diagnostic testing routines built in for fault findings. As a trump card Thorn EMI Datatech is hasty to point out that the system is compatible with the IBM PC and expect to find a large market for the device amongst micro users. Thorn EMI Datatech Ltd, The Mill, Wockey Hole, Wels, Somerset BA5 1BB. EWW 210

ADAPTIVE H.F. RADIO

A radio system which improves frequency management for communication networks that have several transceivers is announced by Racal Messenger. The VRM4550FS combines a frequency-scanning receiver with a selective call transmitter. It monitors up to ten pre-selected frequency channels, locks automatically onto a received signal and decides if it is the station being addressed before warning the operator of an incoming message. This facility enables the optimum receiver frequency to be selected, from the ten pre-programmed channels, by the transmitter station, taking into account the existing h.f. propagation conditions.

Sets of the transceivers can have a different selection of channel frequencies so that networks can interface or overlap while being secure from each other. With a transmitting power of 100 or 120W the synthesized frequency transceivers operate between 1.6 and 30MHz. A small display indicates the selected channel while an audible tone and a flashing light warn the operator of an incoming call. Racal Messenger Ltd, 5 Bennett Road, Reading. Berks RG13 1LJ. EWW 211

DATA MULTIPLEXER

The Polynet local-area network from Logica has been enhanced by the introduction of a highly flexible multiplexer, Polylene, to interface computers with the network. The device may be used with any computer or peripheral device with an RS232 port to give it access to the network which may also be used with high-speed computer-to-computer traffic. Polylene may be used to connect normally incompatible networked or stand-alone devices. In addition the multiplexer may be used to interface a terminal with external services, such as electronic mail, which may be available to the host computer. Each multiplexer can support up to eight asynchronous channels which operate full duplex and support communications over the network for six signal lines. Control of the network can be undertaken by a Terminal Manager software package. The Polynet/Polyline combination can be used to provide high-speed links between a number of otherwise incompatible mini and microcomputers from different manufacturers. Logica VTS Ltd, 84 Newman Street, London W1A 4SE. EWW 213

VOICE-OPERATED SWITCH

A microphone/switch combination that allows hand-free operation of a transceiver has many uses. The Sonic Tornado voice-operated switch is such a device and uses a inertial throat microphone or noise cancelling microphone. The unit can be used with ear-hanger headphones, or be fitted into breathing masks and helmets. Field trials have established that the sets will respond in 8ms when used by fremen with breathing apparatus, or in fully enclosed anti-radiation or laboratory suits. It has also been tested successfully by RAF search and rescue helicopter crews and by free-fall parachutists. Sonic Helmets Ltd, Communications Centre, 202 Bradford Road, Castle Bromwich, Birmingham B36 9AA. EWW 214

ELECTRONICS & WIRELESS WORLD JULY 1984
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ELECTRONICS & WIRELESS WORLD JULY 1984
PCB TOOLS

Repair and reworking of printed circuit boards is claimed to be simple and economical with miniature power tools from Foredom. Based on a motor unit and a flexible shaft drive the tools can be used to clean, alter and modify boards with a variety of attachments including buffs, brushes, sanding discs, abrasive wheels, ball cutters, burrs, drills and saws. Power is supplied by a 0.1hp electric motor through the flexible shaft at speeds from zero to 14 krev/min. Speed may be varied by a foot control. Hirsh Jacobson Merchandising Co. Ltd, 91 Marylebone High Street, London W1. EWW 219

PROM REMOVER

New from Sweden are these i.c. removers which can pull a rom from its socket without damage to the p.c.b. or to the circuit. For once the model numbers seem to make some sense; 2428 is for 24 and 28-pin devices while 3640 is for 36 and 40 pins. Called Prom-out they are available from Welwyn Tool Co. Ltd, 4 Black Fan Road, Welwyn Garden City, Herts AL7 1EH. EWW 220

REEL TAPE RECORDERS

Analogue sound tape recorders designed for audio and video production work have been manufactured by Tascam. The 40 series comprises three different machines; the 42 with two tracks for stereo and 7.5 or 15in/s tape speed; the 44 with four tracks and the same two speeds, and the 48 with eight tracks on 0.5in tape and a single speed of 15in/s. The machines can all use the SMPTE time code, which may be locked on to time code synchronizers, and search and cue facilities are available using the real-time counters. The machines use ceramic capstans to improve performance and minimize wear. Three heads are used and flux levels of 250nWb/m or 320 may be accommodated. NAB or IEC/DIN equalization may be used. The tape transport is heavy-duty, servo controlled with claimed low wow and flutter figures. Optional plug-ins provide synchronization with automated broadcast equipment or remote transport control. Each machine has both XLR (balanced 600Ω connections with a recording-level headroom of +28dBm) and phono (unbalanced 10kΩ) connections. Internal switching enables a +8dBm operating level.

Tascam see the use of the 40 series to be in smaller studios, video post-production, dubbing, and in training and education. In contrast they have taken the opportunity to upgrade the two series 50 machines which they claim to be in the full professional league. The 50 series now includes the —10dBV phono outputs and balanced +4dB balanced connections. The two-track 52 now has front-mounted input and output level controls with pre and post fader switching. The 50 series also offers remote control facilities for the transport and for selection of channels. All switching and preset controls are available on the front panel. Model 58 offers eight tracks on 0.5in tape. Both the 52 and 58 machines have their bias and equalization set for use with high output/low noise tapes such as Scotch 226 or Ampex 456, and may be easily adjusted to the correct parameters for such tapes. If a particular low-bias tape is to be used, a small modification is needed to adjust the preset's range. Distributor: Harman (Audio) UK Ltd, Professional Products, Mill Street, Slough. Bucks SL2 5DD. EWW 221

SERIAL COMMUNICATIONS

Much more than a dumb buffer is the serial communications card which includes an on-board M68000 processor running at 8MHz. The SCC-01 can also have up to 32Kbytes of local program stored ineprom or fusible-link prom, and 128Kbytes of dynamic ram. The unit communicates with a host processor through a VME bus by means of interrupt generation and 4Kbytes of dual port ram. There are twelve u.a.r.t.s on the card, eight of which are used for several peripherals while the other four are available for monitoring in receive-only mode. The u.a.r.t.s have programmable data rate generation and can detect breaks in a data stream. Four of the u.a.r.t.s have been designated as fast channel devices and, if selected all four can be operated in synchronization at up to 1Mbaud. Plug-in daughter boards provide conversion from t.t.l. level to RS232, RS422 or 20mA level. The double Eurocard with the system on board has been designed for use in industrial environments and can operate within a temperature range of 0 to 70°C, and a relative humidity of up to 95%. All boards undergo a 48h temperature/power cycling programme. Manufactured by Wormald Data Systems, they may be obtained from Unit-C Ltd, Dominion Way West, Broadwater, Worthing, West Sussex. EWW 222

FORTH EPROM PROGRAMMER

A single Eurocard accommodates a circuit which can be used to program, read, verify, and copy eproms. The TDS960 card is used in conjunction with the single-board TDS 900 Forth computer and the programmer software is provided on rom as well as a listing. The Forth listing enables the user to add any particular programming needs as may be required. The programmer card is the same cost as the TDS 900 Forth computer; both are £179.95. Triangle Digital Services Ltd, 100A Wood Street, London E17 3HX. EWW 223

ELECTRONICS & WIRELESS WORLD JULY 1984 85
LINSLEY-HOOD 300 SERIES AMPLIFIERS

The very latest in high quality audio amplifiers in "Wireless World" by the renowned John Linsley-Hood. This may now be taken as the standard by which others are judged. Our line-up, engineered by the designer, has massive heat sinks and power supply and includes all components needed to build. Case size is 150mm wide, 254mm deep and 145mm high. It is finished in the very latest assembly. Size 400 volt, 8W. Matching unit 1000 volt, 8W. Flexible construction with switched inputs for up to 1000 volt, 8W.

LINSLEY-HOOD 100-WATT MOSFET POWER AMPLIFIER

The unique "enhancements" built into this amplifier are worthy of the name "Wireless World" by the renowned John Linsley-Hood. The very latest in high quality audio amplifiers in "Wireless World" by the renowned John Linsley-Hood. This may now be taken as the standard by which others are judged. Our line-up, engineered by the designer, has massive heat sinks and power supply and includes all components needed to build. Case size is 150mm wide, 254mm deep and 145mm high. It is finished in the very latest assembly. Size 400 volt, 8W. Matching unit 1000 volt, 8W. Flexible construction with switched inputs for up to 1000 volt, 8W. These have been on offer at a price of £4.99, and now have VAT and postage! Circuit if required at £1.50.

STUART TAPE RECORDER CIRCUITS

Components for these circuits are available in the usual range of suppliers. Circuits are designed for the use of hobbyists and are suitable for the use of hobbyists and are suitable for the use of hobbyists.

HIGH-SPEED DIGITAL CASSETTE RECORDER

A really super facility for the computer enthusiast. These decks, made by Burroughs, require a user-friendly computer interface to record and replay data at 1000 tracks per second. The related read head uses an MRZ system with separate tracks for clock and data. Power supplies of ±10, ±3 and ±2V are required. Front panel is 130mm square and the unit is 200mm deep including rear connector. Circuit and parts are complete.-----

COMPONENTS

For ease of use, a wide variety of components are available from suppliers. For ease of use, a wide variety of components are available from suppliers.

Add 8 channels to your scope

New Thurlby OM358 multiplexer £169.95

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

Thurlby Electronics Ltd
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PE17 4BG Tel: (0480) 63570

OM358 with two BNC cables £197.80

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Do your tapes lack luster? A worn head could be the problem. Fitting one of our replacement heads can improve performance to better than new! Standard magnetisations make fitting easy and our TCI test Cassette helps you set the azimuth spot. We are the actual importers which means you get the benefit of lower prices for prime parts. Compare us with other suppliers and be sure. The following is a list of our most popular heads, all are suitable for use on Dolby machines and are pre-toted.

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CIRCLE 31 FOR FURTHER DETAILS.
Amstrad sounds off

On paper, Amstrad's CPC464 microcomputer scheduled for June introduction seems an ideal all rounder — cheap, fast, 64K ram, high-resolution graphics and with a colour or monochrome monitor included in the price. Of interest to we of technical bent there's the promise of even more, including full access to the 4MHz Z80 processor, CP/M, Basic interrupt operations, assemblers and disassemblers.

With built in cassette recorder and direct-drive green-tube monitor the basic version costs £229, and for a further £100 one can have the colour-monitor version. Monitors will not be available separately. Disc-based monochrome and colour-monitor versions will cost £429 and £529 respectively including CP/M and Logo (a US import language for educational programs). The Japanese Hitachi format (IBM data format) 3in disc drives should be available separately for around £200. There is as yet no CP/M compatible software on 3in disc.

At these prices one couldn't buy the parts and build one cheaper. Assuming no hidden snags, the only remaining question is reliability. Bill Poel, general manager of Amstrad's new software company Amsoft and co-founder of Ambit International (recently sold to Bulgin), told E&WW "Amstrad has increased reliability of its products over the years and will continue doing so. We expect a 2 or 3% return rate — the biggest problem will probably be with people who haven't read the instructions properly and those who spill tea in the cassette mechanism".

Main I.e.s used are the 6845 c.r.t. controller for 80-column text and up to 640 by 200 picture elements, an 8912 three-channel sound generator and an 8255 parallel I/O device. Screen memory is 16K. There is a Centronics parallel printer output and an expansion port but regrettably the connectors are the edge of the p.c.b. and not gold plated.

The keyboard and its separate numeric and cursor-control pad is full size and uses familiar keytops but has a membrane switch matrix underneath to keep costs down. Matsushita membrane technology is used, conductive rubber against gold-plated p.c.b. contact areas so, theoretically at least, it should last a long time.

Considering that the average consumer is now wary of microcomputer manufacturers who promote products using predictions made by design engineers, Amstrad would be risking too much to promise all this but to present only part of it, especially when one takes into account Britain's current aggressive home microcomputer market. Delays in the introduction date could be devastating. The company expects to produce 200 000 units this year and sell them mainly through Dixons, Boots, Comet and Rumbelows. Amstrad Consumer Electronics plc, Brentwood House, 169 Kings Road, Brentwood, Essex CM14 4GF.

EWW 208

COMMUNICATIONS PROCESSOR TO EASE NETWORKING

Instead of employing separate communications devices, protocol converters, data concentrators, multiplexers, cluster controllers, packet processors, or nodal processors, the Network communications system from Scicon combines all these functions into a single unit. The system can be configured to connect virtually any type of microcomputer, terminal, wordprocessor and local-area network with host computers from IBM, ICL, DEC and Burroughs. Subsequent additions of dissimilar equipment to the network can be accommodated by upgrades to the disc-held software.

Netway has multiple distributed microprocessors within its hardware structure which has been optimised for communications. It uses a dynamic multi-tasking, multi-operating system called NCOS. The central unit of the system, Netway 200 with its 800Kbyte disc drive can be configured, on-line if necessary, to support local or remote microcomputers and other devices using the protocols of the host mainframe. Netway 200's works in conjunction with Netway 100's which interface individual devices into the network, and with the Netway 150 which provides remote connection to Netway local networks. The full capacity of the system is a large multi-node network incorporating up to 254 Netway processors each having a combination of up to 32 workstations and host ports, though the system can start by serving just one or a few workstations. Scicon Ltd, 49 Berners Street, London W1P 4AQ. EWW 209
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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 4 3/4" 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 tools 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 31st July 1984.

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ANY SOUND SYNTHESIZER

Up to eighteen different sound envelopes may be stored in the synthesizer/amplifier unit from Haven Automation. These may be selected and mixed to emulate any combination of sounds 'from birdsong to double bass'. The synthesizer was originally developed to reproduce the complex sound spectra of a ship's engine room to make training exercises more realistic. The company is now exploring markets in the electronic enhancement of musical instruments, speech therapy, vehicle and aircraft simulations and the generation of sound effects.

The system fits into 19in racks and includes a sound simulator, three mixer/amplifiers and a distribution unit. Each circuit is identical to the others except that the different sounds are retained on eproms. The units interconnect and are controlled through a GPIB which is also used to control a set of filters to produce a required sound. Eighteen signals from the distribution unit are combined in the three mixer/amplifiers to give the desired mix and output level for a specific environment.

Haven Automation Ltd, Cwmru Industrial Estate, Gendros, Swansea SA5 5LQ.

EW 207

EPROM EMULATOR

For use in conjunction with their E series of editing eprom programmers, Elan have introduced the E11 eprom simulator which can speed up program and hardware development by simulating a target eprom. Programs may be run, checked and easily altered before being committed to permanency in an eprom. One E11 may be used to simulate any of the current range of 24 and 28-pin devices including 2716, 2732, 2764, 27128 and 27256. Two units in a master/slave configuration may be used to provide twin eprom simulation or 16-bit simulation. The E11 is available in two versions; one up to 16K of memory (27128), the other up to 32K (27256).

Data is entered into the main programmer which is connected to the E11, the target eprom and to the microprocessor control system. The E11 has an access time typically of 175ns. Once programmed, the system may also be used connected directly to a microprocessor unit where it will function as a pseudo-EPROM. Elan Digital Systems Ltd, 16 to 20 Kelvin Way, Crawley, West Sussex RH10 2TS.

EW 206

SATELLITE WEATHER MAPS

The use of new circuitry and a study of users' requirements has enabled Feedback to produce a weather satellite system, the WSR513, at a fraction of the cost of similar systems. The basic version will receive the APT (automatic picture transmission) signals from orbiting satellites in the 136 to 138MHz band. The addition of extra modules and a parabolic dish antenna allows reception of S-band transmission from geosynchronous satellites in the 1690 to 1697MHz band.

The basic version is supplied with a helical omnidirectional antenna which incorporates a single-stage preamplifier. This feeds a tuneable v.h.f. receiver and the a.m. subcarrier from this is output to a decoder which converts it to digital form which is entered into the internal memory and provides a synchronizing signal. The memory is continuously scanned by the raster timing generator, and images are converted back to analogue signals and displayed on the screen.

Front panel control allows the selection of resolution and format and local or satellite time for scan resolution and this can retain or remove the Doppler effect caused by satellite motion. The version to receive S-band transmissions includes a low-noise preamplifier in the dish antenna. The signal from this goes through an r.f. switch which is used to select S-band or APT transmissions. Controls include channel selection, automatic scan synchronization, semi-automatic picture acquisition and the selection of a specific part of the image for storage in the memory. Apart from its obvious uses in weather prediction, the system may be used as a teaching aid in geography and in the study of the technical and engineering aspects. Each equipment is supplied with a comprehensive installation and operation manual as well as information on satellites and the prediction of orbits. Feedback Instruments Ltd, Park Road, Crowborough, East Sussex TN6 2QR.

EW 205
DECADE OSCILLATOR

LEVELL ELECTRONICS have a range of oscillators covering frequencies from 0.02 Hz to 2 MHz. There is a FUNCTION GENERATOR that provides sine, square, triangular, pulse and ramp waveforms with high output levels over a wide range. Low distortion RC OSCILLATORS are available with analogue tuning and sine and square wave outputs. The digital tuned series are as detailed below:

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<tr>
<th>FREQUENCY</th>
<th>0.2 Hz to 1.22 MHz on four decade controls.</th>
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<tr>
<td>ACCURACY</td>
<td>±0.02 Hz below 10 Hz, ±0.3% from 10 Hz to 100 kHz, ±1% from 100 kHz to 300 kHz, ±3% above 300 kHz.</td>
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<td>SINE OUTPUT</td>
<td>5 V rms down to 30 µV with Rs = 600 Ω.</td>
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<td>DISTORTION</td>
<td>&lt;0.15% from 15 Hz to 15 kHz, &lt;0.5% at 1.5 Hz to 150 kHz.</td>
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<td>METER SCALES</td>
<td>2 Expanded voltage and 2/4 dBm.</td>
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<tr>
<td>SIZE &amp; WEIGHT</td>
<td>260 x 190 x 180 mm, 5.4 kg.</td>
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<td>TG66B Battery model</td>
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<td>TG66A Battery model</td>
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Prices exclude VAT. Free delivery in the UK. QUANTITY DISCOUNTS available. We supply many other instruments including: FUNCTION GENERATORS, COUNTERS, OSCILLOSCOPES, dB & MICROVOLT METERS.

LEVELL ELECTRONICS LTD.
Mexon Street, Barnet, Herts. EN5 5SD, England.
Telephone: 01-440 8686/449 5028.

CIRCLE 8 FOR FURTHER DETAILS.

The Archer—Single Board Computer

The ARCHER — a new Z80 based single board computer for professional applications. After a power failure, it carries on where it left off and the on board watchdog guards against software crashes.

FEATURES
* 4 MHz. Z80A
* 2 serial ports
* Counter-timer chip
* CMOS battery back-up
* Bus expansion connector
* On-board mains power supply
* 4 Parallel ports with handshaking
* 4 Bytewide memory sockets — up to 64k
* Power-fail and watchdog timer circuits
* High quality double sided plated through PCB

SDS ARCHER single board computer £150
SDS DEBUG ROM £20
SDS BASIC ROM £30
SDS ARCHER, CASED with on/off switch, mains connector, lead etc. £200

OEM and distributor discounts available

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

Tel. 02814-5067

CIRCLE 76 FOR FURTHER DETAILS.

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£7,000-£22,000

★ Where does your interest lie: Graphics; Comms; Robotics; Simulation; Image and Signal Processing; Medical; Automation; Avionics; Sonar; Acoustics; Weapons; Radar; Opto and Laser?

★ Experienced in: Microprocessor Hardware or Software; Digital and Analogue circuitry; RF and Microwave techniques?

★ There are hundreds of opportunities in: Design; Test; Sales and Service for Technicians; Engineers and Managers

★ For free professional guidance: Call 076 384 676 (till 8pm most evenings) or send your C.V. (no stamp needed) to:

ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
Freepost, Barkway, Royston, Herts SG8 8BR

MICROPROCESSORS IN SOUND RECORDING

We make a range of timing and control products in the professional audio and broadcasting field and have a vacancy for an engineer to be in charge of production and test. The successful applicant would have experience in digital and microprocessor circuits (we use 6802), formal qualifications are important but not essential, an interest in sound recording would be an advantage. A certain amount of field work would be involved, so a driving licence would be required. A small expanding company such as ours is greatly in need of a bright and intelligent person who will not only fill this post but also become involved in all parts of the company.

Salary in the range of £6,000 - £10,000.

Apply in writing to
STEPHEN BROWN APPLIED MICROSYSTEMS LIMITED.
TOWN MILL, BAGSHOT ROAD, CHOBHAM, WOKING, SURREY.

RADAR/RADIO ENGINEER

SALARY: Scale 3/4 up to £8,700 approx p.a. including shift pay and weekend allowances

HOURS: 37 hr wk. including Saturday and Sunday (no night duties)

QUALIFICATIONS: CITY AND GUILDS FULL (TT4)—TECH/ONC or equivalent. + a clean driving licence

DUTIES: Repair and maintenance of airport 10mc & 3cm ground radars. Navigational aids including ILS and Communications equipment

Applicants should have considerable experience and be capable of working without close supervision. Fault finding to component level is essential. Application forms are available from:

Airport Director, Southend Airport, Essex, SS2 6YF.
Tel. no. (0702) 40201 Complete applications to be returned by Friday 6th July 1984

BROADCASTING ENGINEER

LATIN AMERICA

To work as a technical advisor with a Latin American organisation for education by radio, with 40 affiliated radio stations in 17 countries.

The engineer will initially be based in Guayaquil, Ecuador and will later travel to radio stations in other countries. The job consists of planning and running training courses for local technicians in the maintenance of studio equipment and mainly small short and medium wave transmitters and aero.

Applicants should be familiar with the operation and repair of studio equipment and small transmitters and must be able to advise and instruct people with non-technical backgrounds in these skills. The post is initially for three years on a basic salary. Because of extensive travel it is unlikely to suit applicants with families. CIIR provides Spanish language training, pre-departure orientation (including instruction in teaching methods), insurance, air fares and various allowances.

For a job description and application form, please send a brief c. v. to CIIR Overseas Programme, 22 Coleman Fields, London N1 7AF, quoting ref. WW1.

The Catholic Institute for International Relations operates a secular overseas programme and is a member of the British Volunteer Programme.

ELECTRONICS TECHNICIAN

required for expanding South London company in the armament industry.

Applicants are expected to have the appropriate qualifications (minimum HNC) and experience of electronic engineering.

The work is interesting and varied, involving repairs, fault-finding and some research and development.

Salary scale is currently £8,400-£9,000 per annum.

Applications giving full details of age, qualifications and experience.
MEDICAL PHYSICS
TECHNICAL OFFICER

Medical Electronics
Saudi Arabia
£14,950 p.a. inc. tax free

Allied Medical Group are the British health care consultants to the prestigious 650 bed Riyadh Al-Kharj health care programme in Saudi Arabia. The two hospitals which comprise the programme are new, superbly equipped, mainly U.K. staffed and enjoy a full range of paramedical and support services. The Bio-Engineering Section of the Department of Medical Physics and Bio-Engineering — based in Riyadh — is responsible for servicing approximately 2,200 items from a wide range of bio-medical equipment.

We now need an MPTO to specialise in the maintenance of an extensive range of laboratory equipment covering clinical chemistry, haematology, microbiology and histopathology. The complexity of the equipment ranges from multi-channel analysers and centrifugal analysers to simple tissue processors and centrifuges. You will work with two other technicians repairing and scheduling maintenance of the laboratory equipment. This small group also provides a maintenance service to the Medical Physics Department’s Nuclear Medicine, Radiation Protection and Radiotherapy Sections for their nuclear counting equipment.

For this post, you will need an HNC or equivalent plus at least four years experience.

The Sterling salary quoted (based on 5.0 Saudi Riyals = £1) includes a bonus of one month’s salary for each twelve months satisfactory service, payable at the end of contract.

In addition to the tax free salary, this two year single status contract post attracts one of the best benefits packages offered in the Middle East.

For further details and an application form, please write quoting Ref: PKH/6653/WW, to: Kate Vincent, Personnel Officer, Allied Medical Group, 12/18 Grosvenor Gardens, London, SW1W 0DZ. Alternatively, call our 24 hour answering service on 01-730 5339, quoting reference number. All applications will be dealt with in the strictest confidence.

Allied Medical Group
The Best of British Health Care in the Middle East

TEST EQUIPMENT
DESIGN ENGINEERS

Rediffusion Consumer Manufacturing design and manufacture a full range of advanced specification colour television receivers and monitors.

We are looking for experienced Electronic Design Engineers to help us maintain our industry lead in sophisticated computer controlled test gear for production testing of our products. Future test equipment will be an interesting mix of digital and analogue circuitry aimed at increasing the automation of the production testing operation.

If you are able to conceive, design and implement production test equipment with minimal supervision, we’d like to hear from you.

These positions are based in our Chessington Engineering Centre but some visits to our factories in the North East and Lancashire will be required at infrequent intervals. Salaries are obviously dependent on qualifications and experience, but will reflect the importance of future test gear projects to the Company’s long term development.

Interested? ... Then write or phone:

Harry Brearley,
Rediffusion Consumer Manufacturing Ltd.,
Fullers Way South,
Chessington, Surrey, KT9 1HJ.
Telephone: 01-497-3411.

ELECTRONIC INSTRUMENT FIELD SERVICE TECHNICIANS

Sartorius Instruments is a world leader in electronic weighing in the analytical, research, quality assurance and allied industries. The product range is expanding further into industry and personnel are required to supplement our already established Field Service team. Areas with a vacancy include the South Midlands and Northern home counties plus a relief engineer prepared to travel nationwide.

Successful applicants will service and install our electronic weighing instrument systems. Primary responsibilities will be problem solving of Sartorius equipment contract maintenance and customer liaison.

Education to a suitable allied qualification ie C & G/TEC — Electronics is preferred for the relief engineer. A successful trouble shooting ability in electronics experience of balance/scale service or maintenance of fine instruments is otherwise necessary. On appointment you will spend 4 weeks training in our workshop in Belmont.

Candidates must be in possession of a current driving licence and over 23 years of age. A company car is provided.

In addition to the above vacancies trainees are required for general electronic and mechanical maintenance at our in-house service centre at Belmont — Surrey.

If you would like to apply for a position then write for an application form to the Service Co-Ordinator:
Sartorius Instruments Ltd
18 Avenue Road Belmont Surrey
Telephone No. 01-463 8829

www.americanradiohistory.com
ELECTRONICS

High of form, it is to DEGREE with Communications your salary requirements.

Engineers & Wireless World July 1984

Electronics Engineers

£9561 Communications Design in High Tech Country

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, test 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 (£5682-£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 work environment most suited to your career plans. The Recruitment Officer, HMGCC, Hanslope Park, Buckinghamshire MK19 7BH.
Senior Wireless Engineer
telemcommunications training of vital national importance

This is an opportunity to join a team which provides vocational training for technical staff in the operation and maintenance of telecommunication equipment for Police Forces and Fire Brigades in England and Wales and for the Home Defence and Prison Services.

You will identify staff training requirements, develop new training techniques, approve applications for academic training, operate to a financial budget, prepare estimates, provide statistical reports and cost data on Directorate of Telecommunications training and serve as Training Liaison Officer.

Candidates should have an appropriate degree or equivalent (including overseas) qualification in electronics or be suitably qualified senior technicians who have appropriate training and about 15 years experience in a related field of work and who have either satisfied the CEI requirements for registration as a Technician Engineer or hold an HNC/FTC in Electronics or Telecommunications. Applicants should have at least 4 years experience in the design, installation and maintenance of communication systems, preferably in the field of mobile radio and be capable of the day-to-day supervision of a small section of technical instructors and administrative staff. The post requires an officer with a good knowledge of telecommunications practice and principles, including micro-eletronics, and the capability of preparing and presenting courses which are essentially orientated towards the maintenance of telecommunication equipment coming into service because of the World Administrative Radio Conference (WARC) Frequency Conversion Programme.

Salary for this Stanmore-based post will be within the range £10,375-£12,660 (including £500 Outer London Weighting) according to qualifications and experience.

RELOCATION ASSISTANCE MAY BE AVAILABLE. For further details and an application form (to be returned by 13 July 1984) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1BJ, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Please quote ref: T/6352.

The Civil Service is an equal opportunity employer.

Home Office (2638)

Outstanding opportunities to move into Sales or Sales Management U.K. & Export

The expansion in our markets means that we urgently need to recruit the following staff for key positions in the U.K. and overseas:

- **SALES ENGINEERS**
- **TECHNICAL SUPPORT ENGINEERS**
- **AREA SALES MANAGERS**
- **REGIONAL SALES MANAGERS**

We are Racal - Dana Instruments Ltd., an international manufacturer of sophisticated electronic test and measurement instrumentation for the radio communications, ATE and microprocessor based industries.

We are looking for men or women educated to at least HNC level in electronics who have a solid basis of practical experience. Knowledge of the radio communications industry would be advantageous and for overseas sales a second language (French or Spanish) would be useful.

If you are ambitious and are seeking a new challenge these opportunities will allow you to develop your career in selling high technology products and will open up exceptional promotional paths in several different areas.

We can also offer an attractive salary package including company car for U.K.

direct sales staff, over five weeks annual leave, staff pension and free life assurance scheme plus many other benefits associated with a major employer.

If you are interested please telephone Graham Addison to find out further details on Windsor (07535) 68101. Or write giving full details of career and current salary to: Personnel Officer Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire.

Racal's people are Racal's success
As a candidate you will have a degree in electronics and experience in one or more of the following:
- Customised Chips, High Density PCB assemblies,
- CAD/CAM, Computer Based Systems using Pascal/Assembler or BITE, Proprietary Test Systems eg Gen Rad, Membrain, Marconi and Hewlett Packard.

To support the growth of the above mentioned engineering division our client also has vacancies for Engineers in less Senior positions.

These important positions present a major opportunity to the professional engineer set to establish a career in Hi-Tech Electronic and Automatic Test Equipment Design and Development. Our client provides an attractive salary package, the possibility of travel and full company benefits, including five weeks holiday and a generous relocation package to an attractive location in S. England.

To find out more and to attain an early interview please contact KEN 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.

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**PRINCIPAL DESIGN and ATE ENGINEERS**

**HIGH TECHNOLOGY / ATE EQUIPMENT**

**S. ENGLAND**

**to £16K**

This is a first class career opportunity for a person with knowledge and experience of Hi-Tech Electronic and Automatic Test Equipment Development. Your technical interest will be immediately captured by the highly advanced technology now being employed. Your challenge will be to integrate the product with the design of the ATE providing innovative solutions to both design and test methodology problems.

From original concept you will be providing an active contribution to the design and development of systems using analogue, digital signal processing, digital data, electro-optics, infra-red and millimetric circuits and systems. You will provide a consultancy service to development teams on testability. BITE and ATE applications, developing testability and methodology as applied to future and specialised microelectronic packaging.

Executive Recruitment Services

THE INTERNATIONAL SPECIALISTS IN RECRUITMENT FOR THE ELECTRONICS, COMPUTING AND DEFENCE INDUSTRIES

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Applications are invited for immediate and forthcoming bachelor status vacancies with our Company in the Sultanate of Oman. The work involves the maintenance of modern military equipment associated with the three branches of the Armed Services.

Ideally, applicants should have a thorough knowledge of techniques and have been employed for a minimum of 5 years' within the field of one or more of the following: mobile and static military radio systems, associated antennae and ancillary equipment, cryptographic and teletypewriter equipment, weapons fire control systems and navigation aids used in air traffic control.

If you feel you are suitably qualified and interested in joining our Company, please write giving a brief summary of your qualifications and experience to: The Company Personnel Manager, Airwork Limited, Bournemouth-Hurn Airport, Christchurch, Dorset BH23 6EB.
Appointments

Electronics Technician

Move up with the award winners.

Our winning of the Queen's Award for Technology 1984 is just one example of our outstanding success. The company has an enviable reputation in the marketplace and this is reflected in the calibre of staff we recruit. The Special Products Division designs and builds special purpose machines for engine and fuel system manufacturers worldwide.

An additional ELECTRONICS TECHNICIAN is now sought - someone aged 22-35 who has served a recognized apprenticeship and has an ONC/HNC, to be involved in work of an interesting and practical nature, featuring assembly, wiring and testing one off PCB's, prototype machines and test rigs, followed up by analysis and reporting of results. 2 years relevant experience is therefore essential.

The salary offered will be according to your age, experience and qualifications. If you would like the opportunity of working for an award winning company with a secure future please apply for an application form from Rod Michell, Personnel Manager, Leslie Hartridge Limited, Timwick Road, Buckingham, Bucks. MK1 8 TEF.

Tel: Buckingham (0260) 813661.

Hartridge
A Lucas Company
(2630)

Power Supply Development Engineer

Negotiable Salary
Coventry

Our sustained growth in the expanding new telecommunications technology - combining voice, data and video services, is creating some exceptional opportunities, at the Company's Headquarters in Coventry.

Applicants must have at least two years' experience in the field of Switch Mode Power Supply design or in a related field where he/she has acquired a sound understanding of closed loop control theory and/or magnetics, will be an advantage.

The successful candidate must be able to work as a member of a small team and make a real contribution to the development of high frequency power supplies to customer specifications.

We're offering excellent negotiable salary, dependent upon qualifications and experience, plus the usual big company benefits. Assistance with relocation expenses may be available where appropriate.

Interested? Then please write enclosing a brief C.V. to Joan Thorpe, Personnel Department, GEC Telecommunications Ltd, P.O. Box 53, Coventry CV3 1HJ.

GEC Telecommunications
(2627)

Product Management Engineer
Audio Mixing Consoles

Sony Broadcast Limited, one of the world leaders in the professional sound broadcast and recording industry, markets a complete range of professional audio equipment throughout Europe, the Middle East and Africa. In addition to microphones, analogue tape machines, mixing consoles and RF communication products, we are also at the forefront of digital audio technology.

An excellent opportunity has now arisen to join a team responsible for the product management of our professional audio equipment. The successful applicant will provide support on our full range of mixing consoles. There will be a combination of in-depth technical involvement with inter-departmental and customer liaison. This position will also entail some overseas travel as required.

Applicants should be educated to HNC (Electronics), or equivalent, and have several years experience in the professional audio industry. Knowledge of the operational features of mixing consoles and experience of console design would be particularly relevant.

We offer attractive salaries together with first class conditions of employment, and relocation assistance will be given where appropriate.

If interested, please contact: Mike Jones, Senior Personnel Officer, Sony Broadcast Ltd, City Wall House, Basing View, Basingstoke, Hants. RG21 2LA. Tel: (0256) 55011

Sony Broadcast Ltd.
City Wall House
Basing View, Basingstoke
Hampshire RG21 2LA
Telephone (0256) 55011
(2619)

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
ELECTRONIC SERVICE UNIT
CHIEF TECHNICAL OFFICER (COMPUTING)

Applications are invited for the above position, which becomes vacant at the beginning of 1985.

Duties include planned maintenance and repair of an extremely wide range of electronic equipment, upkeep of servicing records, advisory service to academic staff, supervision of technical staff, and training of Technical Officer trainees.

The Electronic Service Unit is housed in recently enlarged air-conditioned quarters, and has a wide range of modern equipment. Computer facilities are available.

Applicants should be qualified to Technician Engineer level and should have substantial experience of electronic workshop technique and management. Experience with microprocessor-controlled equipment and microcomputers would be an advantage.

Salary: Chief Technical Officer (Computing) K20,520 per annum (K1 - 1.81) (Level of appointment will depend upon qualifications and experience).

The initial contract period is for approximately three years. Other benefits include a gratuity of 24% taxed at 2%, appointment and repatriation fares, leave fares for the staff member and family after 18 months of service, settling-in and settling-out allowances, six weeks paid leave per year, education fares and assistance towards school fees, free housing. Salary protection plan and medical benefit schemes are available.

Detailed applications (two copies) with curriculum vitae, together with the names and addresses of three referees and indication of earliest availability to take up appointment should be received by The Registrar, Papua New Guinea University of Technology, Private Mail Bag, Lae, Papua New Guinea, on or before 30th June 1984.

Applicants resident in the United Kingdom should also send one copy to the Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF, from whom further information may be obtained.

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
ELECTRONIC SERVICE UNIT
(2618)

ELECTRONICS & WIRELESS WORLD JULY 1984

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DESIGN ENGINEERS

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THORN EMI Electronics
Defence Systems Division

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To design, develop and test high-speed analogue and digital signal processing electronic circuits for active infra-red, microwave and millimetric radar systems incorporating advanced techniques and state-of-the-art devices.

TEST EQUIPMENT DESIGN ENGINEERS
To develop specialised manual and automatic test equipment associated with active infra-red and radar systems products.

RF MICROWAVE DESIGN ENGINEERS
To design and develop millimetric components and sub-systems for miniature high performance integrated millimetre-wave transmitter/receiver systems.

Write or phone for an application form and further details to Sue Godfrey, THORN EMI Electronics Ltd, Defence Systems Division, Victoria Road, Feltham, Middlesex TW13 7DZ. Tel: 01-751 0702 or 01-899 9600, Ext. 2325. These positions are open to men and women.
Advanced telecommunications:
careers with extensive scope at Cheltenham

Join the Government Communications Headquarters, one of the world's foremost centres for R & D and production in voice/data telecommunications ranging from HF to satellite — and their security. Some of GCQH's facilities are unique and there is substantial emphasis on creative solutions for solving complex communications problems using state-of-the-art techniques including computer/microprocessor applications. Current opportunities are for:

Telecommunication Technical Officers

Two levels of entry providing two salary scales:
£6362-£8958 & £8420-£9322

Minimum qualifications are TEC/SCOTEC in Electronics/Telecommunications or a similar discipline or C & G Part II Telecommunications Technicians Certificate or Part I Plus Maths B. Telecommunication Principles B and either Radio Line Transmission B or Computers B or equivalent: ONC in Electrical, Electronics or Telecommunications Engineering or a CIE Foundation, or formal approved Service technical training. Additionally, at least four years' lower level or seven years' (higher level) appropriate experience is essential in either radio communications or radar, data, computer or similar electronic systems. At the lower entry level first line technical/supervisory control of technicians involves "hands-on" participation and may involve individual work of a highly technical nature. The higher level involves application of technical knowledge and experience to work planning including implementation of medium to large scale projects.

Radio Technicians — £5485-£7818

To provide all aspects of technical support. Promotion prospects are good and linked with active encouragement to acquire further skills and experience. Minimum qualifications are a TEC Certificate in Telecommunications or equivalent plus two or more years' practical experience.

Cheltenham, a handsome Regency town, is finely endowed with cultural, sports and other facilities which are equally available in nearby Gloucester. Close to some of Britain's most magnificent countryside, the area also offers reasonably priced housing. Relocation assistance may be available.

For further information and your application form, please telephone Cheltenham (0242) 32912/3 or write to:
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Recruitment Office, Government Communications Headquarters.
Oakley, Priors Road, Cheltenham,
Gloucestershire, GL52 5AJ.

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**DESIGN SERVICES**

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ELECTRONICS & WIRELESS WORLD JULY 1984
Appointments Vacant Advertisements appear on pages 91-103
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