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**CIRCLE 95 FOR FURTHER DETAILS**
Satellite tv company aims for 25% share

Satellite Technology Systems are set to capture 25% of the UK market for satellite tv and data reception equipment. The company, formed in 1983 and who made their first sale a year ago, hope to sell at least 1,500 systems by the end of the year. They estimate the UK market size this year to be 8,000 units, give or take 2,000, with a value of £9 million and expect that to double in 1987.

Speaking at the company’s recent product launch, m.d. Roger Ashby expected STS turnover would be £1 million within a year, rising to £10 million after five years. At this sort of level prices could be expected to fall to £600 for a domestic equipment set-up.

The STS 300 ‘entry level’ domestic system costs around £1000 and comprises a 1.2m dish (for SE England) with 42dB gain, down-converter with a noise figure of typically 1.9 to 2.3dB (2.5dB max) and 50dB gain, and a receiver with 40 preset channel positions, subcarrier tuning from 5 to 8MHz, remote polarization control, and both v.h.f. and baseband video outputs.

“Our domestic product offers very high quality reception” says technical director Mike Stone, “far better than anything else at a comparable price.”

The ‘600 series’ for commercial and educational use has a larger dish diameter and a different receiver, operating with voltage synthesized tuning in 20MHz steps and wide/narrow bandwidth selection. For hotel and club installations receivers would be individually tuned to permit simultaneous reception, and could feed up to 600 tv sets.

The company disclosed that the Television South plc had acquired a 47% shareholding in STS with an investment of £440,000.

Radio waves that don’t radiate: a new resource?

Research being conducted at Bradford University could lead to a hitherto unused part of the radio spectrum being opened up for public use. The idea is to exploit wavelengths in 4.5-5.5m region (about 55-85 GHz) which normally suffer strong atmospheric absorption by molecular oxygen. At 60GHz, signals suffer an additional propagation loss factor of 20 for each kilometre traversed.

Professor Peter Watson and Dr Andrew Richardson plan to exploit this limited range in such a way that the same frequency can be re-used more or less ad infinitum for short range wideband links. Such links, for local area networks, ENG applications, etc. would for all practical purposes be non-interfering, analogous perhaps with a number of human conversations going on simultaneously in the same room.

Watson believes that these properties make 60GHz uniquely suitable for an entirely new form of regulation based on land ownership. As with a garden hosepipe, it would be possible to spray one’s own property, taking only slight care to avoid it going over the fence.

Their work is directed toward eliminating the bulky precision components at present in use. Gunn oscillators and antennas fabricated with microstrip technology are just two examples of the approach currently being explored.
Who needs it?

In a recent speech to RETRA, the chief executive of Grundig International, Wolfgang Barth, addressed the problem of technological overkill in consumer products.

He pointed out that the effect of rapidly changing technology "has often been to build new technology into products simply in order to convince the customer that they should buy something new. The real needs of the customer appear to take second place".

Going on to discuss market research into customers' requirements, Mr Barth claimed that "marketers cannot create human want. They can only succeed with products which satisfy a current human need". He sought to argue that "people are not only important... they make rational choices".

While agreeing wholeheartedly with the first remark, one must point out that the enormous success of the policy to which Mr Barth is opposed means that the second remark cannot always be true.

Conspiracies all over the developed world must surely bulge with unregarded calculators and home computers, produced as a result of market creation: no human need for them was expressed before the advertising started. It became possible to make them small and cheap, so the customer was made to feel under-privileged unless he bought them.

Mr Barth comments that one now needs the skills of an airline pilot to operate the controls of a hi-fi unit. There are buttons to press, dials and leds to take note of, switches and knobs to adjust - and all this to play a tape or disc. The kind of equipment which offers all this gadgetry enjoys a head start on the dealer's shelf, the no-nonsense variety being too devoid of Jones' impressing light-flashing to appeal to any but the person who just wants to hear music. How many purchasers of 'midis' systems, all of which appear to possess rudimentary graphic equalizers, have the use of a sound level meter and noise source with which to test them up?

There is a large section of the consumer market which relies for its very existence on persuading customers that they need a slightly reduced version of the Houston mission control centre to perform the simplest of operations, a large proportion of the front panel probably never being used, or used in ignorance.

Mr Barth's heart is clearly in the right place, but his remark that people "can only be persuaded to buy what they actually need" must, in the light of experience, be suspect.

Radar to watch raindrops

There are two respects in which the standard weather radar sets are not very good establishing the severity of a storm and deciding whether it's rain, hail, snow or whatever. The reason is that echoes on conventional radars look much the same whatever the nature of the precipitation.

Since 1982, Professor Peter Watson of Bradford University has been collaborating with the Rutherford Appleton laboratory to develop the use of switched polarization radar to overcome this difficulty. The importance of polarization in the context of meteorology is that horizontally and vertically polarized waves are reflected to differing extents by different forms of precipitation. Snowflakes, because they tumble in random fashion, reflect horizontal and vertical waves more or less equally. The same, though, is not true of rain.

Contrary to popular belief, a raindrop in flight is not pear-drop shaped; it's more like an oblate spheroid, flattened above and below. What's more, the ratio of the vertical to horizontal axis varies in a known way with the size of the drop. Because of its consistent symmetry, a raindrop of whatever size will therefore reflect horizontal and vertically polarized waves to differing extents.

Professor Watson has quantified all these effects using a switched polarization radar developed a number of years ago at the Rutherford Appleton Laboratory. This radar was originally designed to research the effects of rain on satellite transmissions. Watson has now been able to use it to assess its value in terms of terrestrial weather forecasting. So confident is he of the value of switched polarization radar that he believes it will measure accurately the amount of precipitation falling on the ground anywhere within the radar's range.
New law proposed for ideas

The whole patent and copyright regulations are to be overhauled according to plans published in a government White Paper 'Intellectual Property and Innovation'. Its main proposals are to:
- introduce a new unregistered design right which will cover protection of original designs which are not artistic works, such as spare parts.
- make patent litigation easier.
- introduce a 10% levy on blank audio tapes. The levy will entitle users to make private copies of broadcasts or pre-recorded material but not to copy programs. There will be confirmation that computer programs are protected by copyright. Private recording of TV programs will also be made legal.
- permit educational recording of radio and TV programs and to reduce copyright obstacles on photocopying for education.
- include transmissions from satellites. The statutory recording licence is to be abolished. Anyone wishing to record a perfomance of a work will have to negotiate individually with the owner of the copyright, and the Performing Right Tribunal will be extended to cover all copyrights.
- The tape levy has aroused much heated discussion on both sides, and there are likely to be some lively debates when the proposals are introduced as a Bill.

Mobile batteries

An unusual contribution to the MRA annual conference, reported on page 15 of this issue, gave some idea of developments in novel forms of battery for mobile radio use. One of the most promising is the nickel-cobalt rechargeable cell, a modification of the familiar nickel-cadmium cell. It provides twice the power density and gives a virtually identical cell voltage, yet costs only 30% more in raw materials. Prof. Tseung has solved certain unspecified technical problems in fabricating the cell and believes that all it needs now is financial commitment from a manufacturer.

The size and weight of batteries have already become limiting factors in miniaturising portable radio equipment. And indeed the battery industry has a long way to go before it can equal the 10MW power transfer rate that motorists enjoy at petrol stations. However, Prof. Tseung (City University) has narrowed the gap by investigating two other chemistries for high-power portable applications. One is the zinc-air battery, which offers an energy density of 150Wh/kg. This uses atmospheric oxygen as a depolarizer. In the conventional zinc-air button cells used for electronic watches, access to air is restricted to prevent drying and carbonation of the potassium hydroxide electrolyte; and this in turn limits the current output. However, the zinc-air battery might be radically redesigned for radiotelephone use to provide extra air holes which could be opened up to supply heavy currents under transmit conditions.

Another type, the aluminium-air cell, doubles the energy density yet again to ten times that of the conventional NiCd cell. The City University has solved problems of sludge formation and hydrogen evolution and suggests the battery may be an attractive proposition for high-power portable units.

Research initiatives

Collaboration between companies at the pre-competitive stage is to be encouraged by National Electronics Research Initiative, sponsored by the DTI. Two such initiatives has been announced by Geoffrey Pattie, the minister for information technology: pattern recognition and silicon microsystems.

Pattern recognition is part of a machine intelligence programme and consists of two parts; one for image-understanding systems and the other on self-learning machines and speech recognition. The overall objective of the scheme is to cover high-level inference, integrated pattern processing machines, automatic machine learning from training examples, and the implementation of all this in v.l.s.i. circuits.

Silicon microsystems is a method of interconnecting integrated circuits on a silicon motherboard. Chip manufacturing technology will be provided to meet fine lines for connection and allow a greater density of mounted i.c.s. The programme will cover thermal, electrical, mechanical and optical properties. Design methodologies, attachment and sealing methods and the effectiveness of the techniques.

There are a number of companies participating in the two initiatives which will both be based at the NSRE, Malvern.

Crystals for up to 75MHz fundamental

Crystals oscillating at up to 75MHz in fundamental mode and third-overtone crystals up to 200MHz can be produced "on a commercial scale" according to manufacturer STC. Devices for up to 60MHz are already available.

Current wet-etch techniques have only been able to produce quartz crystals thin enough to operate at up to about 25MHz in fundamental mode. Trying to produce crystals for operating at higher frequencies results in very low yields; the lapping processing starts to break the edges of the quartz blank.

By selectively etching quartz blanks in buffered hydrofluoric acid, say STC, it is possible to produce dish-shaped crystals with an extremely thin middle disc -- 26μm -- and a more substantial outer rim.

Is your data base illegal?

Now that the Data Protection Act has become law, there are still only a third or a quarter of the estimated 300,000 data users who have registered, according to the National Computing Centre. While many of the large users left it to the last minute, many more may have received erroneous advice that they are exempt and do not need to register.

"More worrying than the failure of so many organisations to register" says Tony Elbra, author of the NCC's Data Protection Training Package, "is the probability that they have also neglected the other requirements of the legislation. These include the obligation to take security measures to protect personal data; to grant access to the records by the subjects of the data; to keep data accurate and up-to-date and to avoid unauthorized disclosure or loss of personal data. This can only be met where all staff have a good understanding of the legislation and their responsibility under it."
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CIRCLE 48 FOR FURTHER DETAILS

ELECTRONICS & WIRELESS WORLD JUNE 1985
MANAGING ELECTRONICS

As Japan gradually overtakes the USA in the mass production of integrated circuits and is far ahead of both the USA and Europe in the adoption of surface-mounted-device technology, and with the possibility that the manufacture of Sinclair home-computers will, under Amstrad aegis, move from the UK to the Far East, there continues to be speculation on the decline of British electronics manufacture. Poor management, poor reliability, lack of marketing skills, lack of imagination and business acumen, misguided interventions by Government and civil servants or the politicians they attempt to advise...all are being mooted as prime causes of the decline.

It has always seemed to me that at least some of our troubles stem from the precipitate withdrawal of major British firms from "consumer electronics" 20-30 years ago, mainly because of profit margins seemed more assured in defence and professional electronics as a result of the calamitous "stop-go" policy on consumer credit by successive British governments. The sudden surges of demand whenever credit restrictions were relaxed gave a heady production boost when "disposals" suddenly dried up again reduced the industry to a game of chance and left the door open for the Japanese to come in, in a big way, during the colour-tv boom of the 1970s.

American industry has not been without its problems. Dr Ralph Evans, the editor of IEEE Transactions on Reliability, has attacked traditional "western movies" thinking about good guys versus bad guys. "If a bad situation is identified, any change will be (considered) a change for the better, and the sooner the better...the difficulties it engenders are directly proportional to the amount of ignorance about the situation...business schools taught for many years that a manager did not need to know much, if anything, about a company's products and processes, that management techniques were independent of these irrelevant things." On the contrary, Dr Evans stresses "managers have to know enough about the processes and products for which they are responsible to be able to answer the four quality questions: (1) What can go wrong? (2) How and when we know it did go wrong? (3) What can we do if it does go wrong? (4) How can we prevent it going wrong (or mitigate its effects)? If managers come up short of any of the answers, then they must allocate resources to find the answers.

Many of the processes for which managers are responsible are people processes rather than machine processes, but these processes do depend on the product (including services) being offered by the company. You can't control it if you don't understand it.

A report in Nature claims that the disaster to the Challenger space shuttle was in part due to the failure of bad news about the risk of rocket failure to travel upwards to the people responsible for deciding how quickly to push ahead with the programme...the familiar phenomenon that the bearers of bad news usually win less than meagre credit."

TRANSMITTING LOOPS

For many years it was usually considered that an electrically small resonant-loop antenna, although effective as a directional receiving system, had far too low a radiation efficiency to be a serious contender as a transmitting system. This was because, as for all electrically small elements, radiation resistance can be extremely low. With a conventional wire loop, most of the energy fed to the system is dissipated by the r.f. impedance to the loop. In the mid-1960s, however, the US Army Limited War Laboratory, faced with the problems of mobile and transportable radio communication in the jungles of south-east Asia, developed an octagonal loop having 5 ft sides, capacitively matched to 50 ohm coaxial cable and mounted on a short pole for use between 2 to 5 MHz. This was claimed as being capable of "usually doing as good a job as a full-length dipole 40 feet above the ground". The loop, being tunable to the operating frequency, did not, unlike a vertical whip antenna, depend on an efficient earth system or ground plane.

The ability to achieve an efficiency approaching that of a dipole depended on using a matching unit with high-value capacitors rather than lossy (ohmic) inductors and the use of large surface copper tubing of at least 1.5 in diameter, having extremely low r.f. resistance at these frequencies.

Subsequently a number of radio amateurs showed that reasonable results could be achieved using the outer sheath of good-quality 0.5 in coaxial cable, although commercial units offered for such applications as unobtrusive diplomatic radio communications (an h.f. loop antenna could - and possibly still can - be glimpsed just above the roof parapet of the US Embassy in Grosvenor Square, London) tended to use 4 or even 6 in diameter tubing. Flat roof installations usually have also a heavy copper ground plane. They form weighty but compact and unobtrusive installations.

An alternative form of "miniloop" patented by J.H. Dunlay ("Wide-range tunable transmitting antenna", US Patent 4.433.336, June 28, 1971) comprises an electrically small, capacitively tuned loop inductively excited by an even smaller inner loop. This miniloop technique has been used in various forms. At the IERE's "Radio Receivers and Associated Systems" conference at Leeds, July 1981 (incidentally, another conference in this series is being held at the University of North Wales, Bangor, July 1-4, 1986), a Swedish engineer Sven Ramstron described a three-turn, silver-plated tuned transmitting and receiving square loop (each side 500 mm) inductively coupled to a single-turn loop, which in turn was fed through a broadband balun transformer from 50 ohm coaxial cable; this had originally been tested on the 3.5, 7 and 14 MHz amateur bands, but had been developed as a compact 1.9 to 16 MHz antenna for professional or defence communications. Among the features claimed for the Swedish design were small size, integrated tuning unit, no requirement for a ground plane, omnidirectional radiation in azimuth and elevation (two 30dB nulls in near field), no sliding contacts, harmonic reduction due to high Q, etc.

A recent note by Donald E. Burch of Ocean Surface Research (IEEE Trans. AP-34, January 1986) discusses the operation and equivalent circuit of the basic miniloop antenna, verifying the advantage that the input resistance to the inner loop can be large (50 to 200 ohms) and broadband, although the input (radiation) resistance of the outer loop when fed alone is generally only a fraction of an ohm. This makes it much easier to feed a miniloop than a conventional loop design, permitting a reasonably good match over nearly a decade of bandwidth, provided that the outer loop is tuned to the desired operating frequency and is electrically small at the upper end of the band. He shows however that the miniloop technique may be unacceptable in some radar applications, because its high-Q tends to stretch and delay the pulses by many times their width.

CORDLESS PHONES

Few subscribers appear to be aware that both ends of telephone conversations made over "cordless telephones" can be received over distances of at least some hundreds of metres and, with the higher-power "illegal" models, over some miles.

While the legal cordless phones are confined to specific channels between 1.6 and 1.8 MHz (base to handset) there are still many higher-power "illegals" around 1.55 MHz (within a shared amateur band) some of which appear to be usable with low-cost, mobile-radio communication systems by small firms.

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dealers still selling "cordless" units not complying with the frequencies and power limits specified by the Radio Regulatory Department that they could lay themselves open to a six months prison sentence and a £5000 fine. However, the DTI have still not formally issued an order under the Telecommunications Act that would make it illegal to sell, advertise or rent out such equipment.

Meanwhile cordless 'phones, both legal and Illegal, are reportedly causing local harmonic interference in the 3.5 MHz shared-amateur band and fundamental interference at considerable distances to amateurs using frequencies around 1.9 MHz. The cordless 'phones use narrow-band frequency modulation and produce wide signals, both during dialling and during conversations. While it has always been illegal under the Wireless Telegraphy Acts to listen deliberately to these conversations, it would be an interfering test case under the new Interception Communications Act 1985 if a case were brought as the result of a complaint by someone using an illegal cordless telephone. But then it would appear that very few users of these devices realise how far their private conversations can be heard by anyone with a suitable communications receiver! The "base" transmitter normally radiates both sides of the conversation. It is thus possible, I am told, "accidentally" to listen to some very private conversations.

Meanwhile British Telecom are developing units operating at around 900 MHz with digital modulation techniques in the belief that by the year 2000 something like 10 per cent of all British telephones could be of the "cordless" variety.

INTERCEPTION

From April 10, it became a criminal offence, under the "Interception of Communication Act 1985", for any unauthorised person intentionally to intercept "a communication by post or by means of a public telecommunication system". This Act Covers

COMMUNICATIONS COMMENTARY

transmissions by "wireless telegraphy" although an exception is made where such communications are intercepted, with the authority of the Secretary of State, "for purposes connected with the issue of licences under the Wireless Telegraphy Act 1949 or the prevention or detection of interference with wireless telegraphy." On conviction under indictment, an offender can be sent to prison for up to two years and/or fined.

While the primary purpose of the Act is to provide safeguards against unauthorised telephone tapping and similar activities by private investigations and also by the police, the secret services and the customs (organizations that can be authorized to intercept communications), there are implications affecting anyone who tunes his radio receiver to other than broadcast or amateur radio transmissions. The Act covers not only telephones but telex and electronic data transmission, although it does not apply to the planting of radio or tape-recorder or tracking "bags", (these may come under the less savage Wireless Telegraphy Acts) nor, it would appear, to the release by British Telecom of information collected by the machines that can list incoming and outgoing dialled numbers.

Amateur Radio

Although the number of stations equipped for amateur television transmission on the 10 GHz microwave band is believed to be increasing, very little has been published on the results so far achieved. An appeal for more information appears in the current issue of CQ-TV, the journal of the British Amateur Television Club. An amateur transmitting on the 3.8 GHz into Mow Cop began operation in the Stoke-on-Trent area early this year accepting frequency-modulated vision signals on 1249 MHz and retransmitting them on 1318.5 MHz. It was "officially" noticed on April 9. Initially with an output power of only 200mW it has been received in the Birmingham area. A number of amateurs have successfully build 11 GHz systems capable of receiving the low-power distribution satellites carrying the cable TV programmes. Stuart Jones, GW3XY, for example, has drawn attention to availability of the Mitsubishi FO-UP-11K oscillator/mixer module, with a stabilized dielectric resonator oscillator developed initially for radar and retailing for less than £30. It would also appear possible to adapt this unit for the 10 GHz amateur band for either speech or television communication. The Swiss national society USKA is opposed to the use of the limited 70 cm amateur band for television transmissions, but there are still more than 20 amateur TV stations using the band compared to only one in 1255 MHz. Swiss amateurs have adopted the small-deviation f.m. vision transmission system originally proposed by the French amateur F3JXY.

RIS POLICY UPSETS AMATEURS

Important changes in the policy of the Radio Investigation Service with the DTI now tending to put the onus on the radio amateur to clear up any cases of television or radio interference in this locality, whether caused by spurious signals or (far more likely) by lack of immunity of the domestic receiver or lack of an effective receiving aerial, have followed the Parliamentary reply by Mr. John Butcher, Secretary of State at the DTI (reported in the May C.C.). Since the end of January, according to the RSGB, several licensed amateurs have received "form" letters advising them of complaints of local interference, suggesting remedies but ending with the warning: "Let me know within the next month if you have resolved the problem... to your neighbour's satisfaction. If this is not the case, the RIS will visit you to inspect your station and determine what action should be taken. In certain circumstances the Department may need to consider varying your licence." The complainant receives a copy of this letter which cannot fail to convey the impression that the fault is primarily that of the local transmitter and that it is the responsibility of the amateur to overcome the problem, a reversal of the accepted procedure over many years. The RSGB, have told the DTI that these new guidelines are "hopelessly out of touch with reality". It is also opposed to the new DTI policy of adopting the CENELEC standard for receiver immunity, rather than BS905 as announced last year. The European standard requires that a set should not show noticeable interference only up to an out-of-band field strength of about 1.5 V/m. A local transmitter of even low power can produce higher field strengths that this in its immediate locality. While interference to a set complying with the CENELEC standard could probably be cured in many cases by the fitting of a simple filter it is not unknown for viewers to refuse that this be done even when the local amateur offers to pay the cost.

IN BRIEF

An enlarged new fifth edition of RTTY- The Easy Way is published by British Amateur Radio Teleprinter Group (Peter Adams, GB6LB, 464 Whippendell Road, Watford, Herts WD1 1PT.

A 144 MHz beacon transmitter on Iceland (TF6VHF on 144.930 MHz) is now operational.

The refusal of the DTI to permit Class B licensee to operate on the new 50 MHz has proved extremely unpopular among those affected. It was apparently the "primary user", the Ministry of Defence, that objected. Under the International Radio Regulations a morse test is mandatory in respect of licence above 1.8 MHz although a few countries including Spain, France and the UK have made some exceptions to this ruling. In the UK some handicapped or disabled applicants have been exempted on a case-by-case basis from the Morse Test although this never appears to have been announced officially.
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Mobile radio on the move

April's annual conference of the Mobile Radio Users' Association in Oxford was the first major meeting since the government announced plans for the new Band III networks.

The new allocations herald mobile radio's last but certainly not the foreseeable future. Band III, according to the agenda and two of the new licences on the list of speakers, was being discussed at the conference. In particular, the degree of congestion in London. Solutions had to be found.

The plans were outlined by the Department of Trade's Radio Regulatory Division. In the opening session, Tony Nieduzynski explained that RRD was looking for more a flexible approach to developing radio equipment.

In particular, the concern over the shortage of mobile radio channels and the high price of the first channel. The RRD was unable to provide enough radio equipment to meet the demand. The department planned to make its laboratory facilities at Kenley commercially available.

A further result of the new spirit of cooperation between the DTI and the industry was to be the setting up of a civil land mobile radio committee under the chairmanship of Mike Cooil of the DTI, with a membership drawn widely from the industry and users.

Spectrum pricing

Mr Nieduzynski announced that RRD was about to begin its first spectrum review (following a recommendation of a report). The bands under scrutiny were those between 470MHz and 2.4GHz, and the department would seek to establish how fully they were used, what future requirements there might be for services in them, and what scope there might be for reprogramming frequencies more effectively. Details of a parallel review covering the defence bands would be announced by the government shortly.

A feasibility study of spectrum pricing was also under way. "But the object is not to help RRD raise more licence money", said Mr Nieduzynski. "RRD is not a revenue-raising body." The aim was efficiency in allocating spectrum, but the government would ensure full consultation and debate before any radical changes were made. RRD recognized the concern over the shortage of mobile radio channels and the high price of the first channel. The doors of Waterloo Bridge House were open to anyone with ideas and proposals, he said; but added that they might not necessarily get their first choice of frequency. Another new possibility was that of the telepoint, which would enable owners of cordless telephones to make calls through a network of public base stations.

Training for p.m.r.

One of the first steps towards self-regulation by the industry was a dealer accreditation scheme sponsored by the MRUA, and to this Mr Nieduzynski gave a warm welcome. The scheme, in which the DTI would participate, was described in detail by Gerald David of Aerial Facilities Ltd, project leader for the MRUA.

A parallel scheme for employment training in land mobile radio was presented by Colin Smith of PMR Ltd and the MRUA. At present, he said, there was a lamentable shortage of well-qualified technicians for installing and servicing p.m.r. equipment. And he told some horror stories: "I ask applicants how do you accurately measure the frequency of a v.h.f. transmitter. And the usual reply is an oscilloscope. If he says a frequency counter, the applicant is usually an amateur radio enthusiast.

Mr Smith had met degree students who were sound on microprocessors, but who imagined they could measure the impedance of an aerial with an Avo meter. Academic courses had for a long time been biased away from analogue techniques and the balance towards radio communications had yet to recover. The MRUA was therefore negotiating with the Association of Marine Electronics and Radio Colleges to set up, with the DTI's support, two courses leading to a nationally recognized qualification.

Band III

GEC Communications is one of the dozen winners in the race for Band III licences, and plans for its national network were described by technical director Peter Delow.

The system would be founded on common base stations which shared automatically a pool of frequency pairs among many users - a trunked system. Mobiles would be able to contact one another throughout the area covered by the network. The new feature added by GEC was the large-scale networking of base stations, which would be linked by a digital voice and data switching network. Mobiles would communicate with the network by digital signalling on control channels or, when a call was in progress, through 1200bit/s data bursts.

The MRUA aims to represent all users of mobile radio, including cellular radio. For details, contact the association at 42/45 New Broad Street, London EC2M 1QY, tel. 01-62810980.
GEC hopes to begin a service in the second half of 1987. Facilities offered will include conventional mobile radio features including dispatcher-type operation and selective or fleet calls, plus some new ones such as interconnection with p.a.xs and the ability to dial out on the public telephone network. Also available will be data services, including access to public networks, store-and-forward messaging handling and vehicle tracking.

The system will conform with the MPT7520 draft standard, which sets out a unified air interface for Band III trunked systems. This common signalising specification that should benefit users by bringing down the cost of equipment and could indeed form the basis of an international standard.

Asked whether GEC's 100-channel allocation would be sufficient, Mr Delow replied that it was not clear just what sort of service 100 channels would give. The company had applied for many more.

Speaking for the National Radiophone Company (another of the new licensees), Robert Condon reviewed, with a mass of statistics, the growth of mobile communications during the past few decades and examined the commercial opportunities the new frequency assignments would bring.

Mr Condon estimated a demand by 1992 of some 200 000 subscribers, of whom about a quarter would be accommodated on regional networks. The true requirement for national coverage was quite small and most subscribers would be satisfied with interzonal coverage.

National Radiophone had been offered a licence to run regional services in London, Birmingham and Manchester-Merseyside, with a capacity of about 2500 subscribers each, and, in conjunction with Tactico, in Glasgow, Edinburgh and Aberdeen, for a further 7500. The company planned to launch these services simultaneously in the first quarter of next year.

Live demonstrations for interested parties would begin in September.

To obtain the necessary coverage, multi-site 20-channel trunked systems would be needed. In London, five sites would be required. No handover between base stations was envisaged since calls would normally be short and mobiles unlikely to travel out of range during conversation. As they passed from one service area to another, mobiles would lose the first site's control channel and would be reregistered on the new site as they picked it up.

Coming soon...

The new licensees will occupy only a fraction of the former television band and space remains available for further developments. Robin Daniel of British Telecom looked at future needs for mobile communication, and foresaw a very large potential demand which could be satisfied only if we could find more efficient ways of using the spectrum. For example, there

Mobile Radio at CeBIT

Nigel Cawthorne reports on Germany’s new cellular car telephone network: C Netz

This year for the first time the Hanover Industrial Fair was split into two events: CeBIT (Centre for Office, Information and Communications Technology), held in Hanover on 12-19 March, and the traditional Hanover Industrial Fair which ran a month later in April.

Nearly a quarter-million visitors attended the first stand-alone CeBIT. Two of the 11 halls were devoted to telecommunications and related topics such as satellite communication and broadband networks. Mobile communications included pagers, cordless telephones and car telephones.

Following the recent trial launch of Germany's new C-450 cellular car telephone network, there was considerable interest at the show in this new mobile service.

German C-450 cellular

Germany's Siemens-designed C-450 cellular network opened on a trial basis in September 1985. The official full opening of the network was planned for May 1986. During the six-month test period, users are not being charged any monthly subscription by the Bundespost. The monthly charge of DM120 will only be applied once the system is fully operational.

Two reasons were being offered at CeBIT for the partial opening. Firstly the Bundespost said they did not want to charge customers the monthly subscription until full national coverage could be provided. A second reason is that the

C-450 Summary data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear speech, frequency range</td>
<td>300 to 3400Hz</td>
</tr>
<tr>
<td>Scrambled speech method</td>
<td>Band Inversion</td>
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<tr>
<td>Data rate</td>
<td>48kbps/sec</td>
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<tr>
<td>Number of mcs</td>
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<td>Number of speech channels per MSC</td>
<td>max 1,500</td>
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<tr>
<td>Number of radio zones per MSC</td>
<td>max 150</td>
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<tr>
<td>Size of radio zone (cell)</td>
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<tr>
<td>Frequency ranges</td>
<td>461.300 to 465.740 MHz</td>
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<tr>
<td>Transmit/receive separation</td>
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<tr>
<td>Channel spacing starting from fictitious channel 0 (455.74/465.74)</td>
<td>20kHz</td>
</tr>
<tr>
<td>Electrically switchable steps</td>
<td>10 or 12.5kHz</td>
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<tr>
<td>Number of radio channel pairs</td>
<td>max 222</td>
</tr>
<tr>
<td>Modulation method</td>
<td>phase modulation (14F3)</td>
</tr>
<tr>
<td>Frequency deviation</td>
<td>max +/- 4kHz</td>
</tr>
<tr>
<td>Output power*</td>
<td>base-station 25W</td>
</tr>
</tbody>
</table>

*both power levels can be reduced in steps on instruction over the channel by a maximum of 35dB.

The Post had issued, up until early April, 11 type-approval numbers for C-450 car telephones. (Although there were 11 type-approved sets, there are only four manufacturers - AEG, Philips, Siemens, Storno). The other equipment are branded versions of the same products. There were no Japanese C-450 mobile car telephones at CeBIT, although Japanese suppliers are expected to make an early entry into Germany's new cellular market.

List prices quoted for a German vehicle-mounted cellular car telephone were around DM11,000 (£3190). Installation was quoted as DM300-500 (£97-145). Storno was quoting a list on-the-road price of DM11,500 (£3355). At this level, a German cellular car telephone is more expensive than corresponding equipment on other European networks.

System design

The present C-450 network is designed to handle 300,000 mobile subscribers when it reaches full capacity. It is also capable of being expanded to 400,000 subscribers.

The Bundespost plans to install a total of eight mobile switching centres (Mscs) that can handle up to 150 radio zones (cells). The radio zones in the coverage area of one switching centre form a radio traffic area. In the fully developed network, a radio traffic area is connected via a mobile centre to each of the eight regional exchanges of the direct-
was a mass market for messaging systems among such groups as baby-sitting circles and parents collecting children from school, if only the cost could be brought low enough.

The issues to be resolved might not be purely technical ones. For example, a typical p.m.r. contact lasted about 20 seconds whereas a telephone call averaged three minutes. Was it the character of the medium that led to the difference, or the type of business transacted?

**Happenings at RRD**

The pace of change in mobile radio depends very much on the radio regulatory division of the DTI, a body which, since its emergence from the old GPO engineering

dolling public telephone system. They are interconnected to both telephone and data lines, the last mentioned used for nation-wide automatic location of the mobile subscribers.

There are 222 radio channel pairs with a channel spacing of 20kHz available for radio network operation in the upper and lower band of the 450MHz range. Transmit and receive frequencies have a duplex spacing of 10MHz. Channel spacing is switchable in both 10kHz and 12.5kHz steps. This permits intermediate channels to be created which provides both for the best usage of the frequency spectrum and for frequency coordination with neighbouring countries.

Each base station is assigned a check-in file and each MSC is assigned a home data file and a visitor’s data file. The active file acquires all switched-on mobile subscribers located within the radio zone (cell) and reports these to the centre. If a mobile subscriber is located in his home MSC area, an active entry is made in the MSC’s home file. However, if the mobile subscriber belongs to another MSC, an active entry is stored in the visitors’ data file. At the same time, the visitors’ data file determines the mobile subscriber’s home MSC, from his number, and initiates an entry in the home data file of the mobile subscriber. In doing this, the host MSC reports the location of the mobile.

There is once only set up charge of DM100 (£29). The DFM's monthly subscription charge is DM120 (£35). Call charges are based on a DMO.25 unit. At full rate this is for eight seconds, and at cheap rate this is for 20 seconds (corresponding to 50p/ min and 20p/min respectively.

Predictions at CEFT for the likely number of subscribers on Germany's new cellular car telephone network by the year end varied between 10,000 and 15,000.

international policy, computer services and mobile licensing. And it was the head of this last, Mike Coolican, who spoke next.

The average time taken to process a mobile licence was now about 14 weeks, said Coolican, though not all of that could be blamed on his staff. P.m.r. firms tended to put their applications off in batches, which led to delays for early comers. However, forms often arrived with basic information missing, licence fees often not paid and had to be sent back. RRD aimed to be as liberalised and flexible as it could. "But the more liberal you get", he said, "the more important the remaining rules become." And he mentioned that RRD was increasing its efforts to enforce licence conditions. One of the commonest irregularities concerned transmitting sites not at the position specified in the licence.

Coolican ended by warning that mobile licence fees could be expected to rise soon. Even though charges had not kept pace with inflation, users would undoubtedly dislike the latest increases. But they had better not protest, he added, to laughter: all letters of complaint and question asked in the House ended up on his desk and distracted him from the important business of issuing further licences.

Asked about RRD’s treatment of licence transgressors, Mr Coolican said that some had been prosecuted. But a licence could be cancelled only if the person was unable to hold it under the Wireless Telegraphy acts. He could not revoke a licence just because the holder had been caught doing what he described as "naughty things!". Livelihoods might depend on it.

**Cellular**

Two British cellular networks have now been in operation for more than a year, and their representatives brought the latest news from them. Each is getting between two and three thousand new registrations per month, of these about half are in the London area, where steps are already being taken to combat congestion. The biggest problem, said Mike Finches of Racal Vodafone, was in commissioning new cell sites: it could take as long as 15 months to obtain the necessary clearance.

An interesting presentation on data communications over cellular radio came from Dr Bev Ewen-Smith of Spectronics Microsystems. Data communications scored over speech in many ways: for example, typical calls were much shorter and so spectral efficiency was high. If vehicles had a printer or other storage device on board, a driver on the move could receive instructions hands-free, which was safer than asking him to take notes on his knee. And privacy would be greater: there would be little risk of eavesdroppers overhearing a service engineer being told where to find the keys of unnumbered locks.

By giving vehicles direct access to the company’s computer, jobs could be allocated more efficiently, fleets could be better managed — and, with information in the hands of the delivery men, invoices could be generated more quickly.

Error correction was essential in data communication by radio, and Dr Ewen-Smith outlined the protocols used in his company’s radio modems. With binary data, even under conditions of total corruption, half of the bits would still arrive correctly, so the problem of recovery was not as severe as it seemed at first sight. His Sesquiplex system, a combination of automatic retransmission and forward error correction, operated at a raw data rate of 2400bit/s, giving a through rate for the user of 1200bit/s.

**Radio in the channel tunnel**

Dr David Martin of Martin, David and Partners presented a paper on leaky feeder and radio communications in tunnels, a subject he dealt with in these pages a few years ago. But he ended with some interesting speculation about communications in the channel tunnel now being planned.

During the construction phase, standard mining practice — high-band v.h.f. — would be appropriate. But when the tunnel was ready for service, problems would arise. Railway operators in Belgium, France and Britain, all use u.h.f. for communication with trains and would want to do so in the Channel tunnel too. The public would expect national and local radio broadcasting from both Britain and France, plus the public radiophone services. Railway emergency services would need their v.h.f. repeater systems.

Dr Martin said that there was no experience of equipping a tunnel of this length (50km) and that severe intermodulation problems would have to be tackled. It was possible that six leaky feeders would be needed in each direction, with separate ones for the service tunnel.

Cellular radio posed special difficulties, since the cars would be shielded by a railway wall, the answer might be to carry signals through the tunnel at v.h.f. and to transpose them on board each shuttle train to a 900MHz leaky feeder running within the train itself.

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Low-cost low-pass filter design

Tom Scharf describes circuit realisations that offer optimum trade-off between hardware simplicity and design complexity.

In common with many engineers and hobbyists, I would rather design a filter quickly by referring to a table of normalized values than by plodding through complex textbook derivations and calculations. The main aim of this article is to present such a table and the necessary minimal knowledge required to use it.

Possibly the most economical solution to active low-pass filter design is to use Sallen and Key and Goff* circuits with unity-gain buffers. The benefits of using this approach are two-fold:

* The sensitivity to circuit values is low i.e. settling for the nearest preferred values will not degrade the filter response as much as with other realisations.

* The minimum number of passive components is used. This is helpful when trying to produce a good filter layout around a quad op-amp. The equal-resistor realisation was chosen as this makes it easy to alter the filter cut-off frequency by using ganged pots, switched resistor chains, or by swapping standard resistor packs without affecting the response of the filter.

The general two-pole Sallen and Key filter, shown in Fig. 1(a), has the transfer function of equation 1 (see Appendix), and setting the gain G to 1, Fig. 1(b), and normalizing the resistors to 1 simplifies it to

\[ T(s) = \frac{1}{s^2 + \frac{2s}{C_1 C_2} + \frac{1}{C_1 C_2}} \]

Adding another RC network to the Sallen and Key circuit Fig. 1(b) turns it into a three-pole Goff filter, Fig. 2, whose transfer function is more complicated, equation 2, but on normalizing resistance to unity this simplifies to equation 3 (Appendix).

Choice of filter response

The ideal ‘brick wall’ filter with no phase delay, or transient distortion does not exist. In general, filter design is a trade-off between conflicting parameters: the sharper the cut-off the worse the transient and phase responses become.

The formulae given below are easily solved using a good scientific calculator.

Chebyshev filter. In designing an anti-aliasing filter the passband might be required to be as large as possible consistent with high attenuation in the stop-band. If transient response and phase distortion are of a secondary importance, a Chebyshev filter would be used (Fig. 3). The amplitude response of the Chebyshev I-p filter is characterized by ripples in the passband caused by the cascading of high-Q second-order stages having different cut-off frequencies (plus first-order network for odd-order filters, Fig. 4). For a given order of Chebyshev filter, the larger the ripples the steeper the cut-off slope becomes. The transient response also becomes more oscillatory as the ripple depth increases.

For a Chebyshev filter of order n, the attenuation in dB may be found at any frequency \( \omega \) using the formulae:

\[ a = 10 \log (1 + \epsilon^2 C_p (\frac{\omega}{\omega_0})^n) \]

\[ \epsilon = \sqrt{10^{a/10} - 1} \]

where \( \omega_0 \) is ripple amplitude in dB and \( C_p (\omega/\omega_0) = \frac{\cos(n \cos^{-1}(1/\epsilon))}{1 - \omega^2/\omega_0^2} \) for \( 0 < \epsilon < 1 \)

\[ = \frac{\cos^n(n \cos^{-1}(1/\epsilon))}{1 - \omega^2/\omega_0^2} \] for \( 1 < \omega_0 \)

where \( \omega_0 \) is at the end of the ripple band.

Fig. 2. Coupled to Sallen and Key this Goff filter using unity gain buffer allows the economical design of odd-order filters.
Butterworth filter. For audio applications where transient response is as important as amplitude response, the Butterworth filter is generally chosen. The amplitude response is maximally flat (Fig.5) before rolling off into the stop band. For a given order of filter, the Butterworth cut-off slope is not as steep as the Chebychev slopes.

For a Butterworth filter of order $n$, the attenuation may be found at any frequency $\omega$ using the formula

$$\alpha = 10 \log \left( 1 + \frac{\omega^2}{\omega_0^2} \right) \text{dB}$$

where $\omega_0$ is the $-3\text{dB}$ frequency.

Bessel filter. One of the first to study this type of filter was W.E. Thomson of the Post Office Research Station and is therefore also known as the Bessel-Thomson filter. It is generally used to delay signals by a known amount and is the lumped circuit equivalent of the known-length transmission line. The phase shift through the filter changes linearly with frequency over a range of frequencies which increases with the order of the filter. Over this range of frequencies, each signal component is delayed by the same known time (Fig.6).

Since the amplitude response of the Bessel filter is not maximally flat and because higher, more attenuated, frequency components experience less delay, a step input to the filter produces a smeared 's' shaped output signal—Fig.7.

The characteristics of the above filter types are summarized in Fig.8. Also worthy of mention are the Inverse Chebychev and Cauer low pass filter responses shown in Figs. 9&10, realised by means of low-pass notch circuits and therefore beyond the scope of this article.

**Design your own filter**

In the Table, it is assumed that even-order filters are made up from cascaded Sallen and Key filters, and that odd-order filters are made up of one Geffe stage followed by the requisite number of Sallen and Key stages, Figs. 11 & 12. For certain orders of filter, $n = 6, 8, 9$, an even more efficient realisation can be obtained by the use of

**Fig.3.** To achieve a specified attenuation at beginning of the stop band in this anti-aliasing filter a shallower cut-off slope results in the cut-off frequency being lowered to compensate.

**Fig.4.** How the fifth-order Chebyshev amplitude response is made up from the individual stage responses.

**Fig.5.** Fourth-order Butterworth filter has a Maximally flat amplitude response.

**Fig.6.** Time delay versus angular frequency for several orders $n$ of Bessel filter shows that as $n$ increases, the frequency range over which the delay is maximally flat and constant increases.

**Fig.7.** Notice the complete absence of overshoot in passing a step through a Bessel filter. As order of the filter increases, output signal becomes a squarer, more accurate copy of input step.

**Fig.8.** Comparison of amplitude, phase, delay, and rectangular pulse responses show progression from docile Bessel filter to high-Q Chebyshev.
### Table 1: Normalized low pass filter values

<table>
<thead>
<tr>
<th>Order</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>3dB Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.4424</td>
<td>0.7071</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.3993</td>
<td>0.7045</td>
<td></td>
<td>2</td>
<td>1.9708</td>
<td>2.375</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.4072</td>
<td>0.7094</td>
<td>1.255</td>
<td>2.178</td>
<td>3.135</td>
<td>3.708</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1.4172</td>
<td>0.7020</td>
<td>1.257</td>
<td>1.228</td>
<td>3.058</td>
<td>3.688</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1.4272</td>
<td>0.7030</td>
<td>2.005</td>
<td>1.180</td>
<td>3.010</td>
<td>3.580</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1.4372</td>
<td>0.7039</td>
<td>2.003</td>
<td>1.056</td>
<td>3.006</td>
<td>3.570</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1.4472</td>
<td>0.7048</td>
<td>2.003</td>
<td>0.854</td>
<td>3.003</td>
<td>3.560</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 9.** For a given order, the Inverse Chebyshev response produces a flatter passband response than the Butterworth and quicker transition to the stopband than the Chebyshev.

**Fig. 10.** Cauer filter, with Chebyshev ripple in both passband and stopband, has an even faster transition to stopband.

**Fig. 11.** Sallen and Key stages are cascaded together to produce an even-order multipole filter. All resistors are normalized to unity.

**Fig. 12.** Geffe stage is followed by Sallen and Key stages to produce an odd-order multipole filter. All resistors are normalized to unity.

**Fig. 13.** At last! A real filter designed using the Table. Other values of R may yield more convenient values of C0 – C2.

of cascaded Geffe filters (plus Sallen and Key if necessary).

A nine-pole filter would then require three op-amps instead of four. The component values can be derived from the Table using the preceding formulae.

For the three classes of normalized filter parameters tabulated, the normalized frequency ω0 = 1 has a different meaning. In the case of the Butterworth filter, it marks the -3dB point. In the case of the Chebyshev filter, it marks the end of the ripple band i.e. the point at which the attenuation becomes greater than the ripple attenuation for the last time. For the Bessel filter, ω0 is the inverse of the delay time through the filter. The Bessel filter parameters are, in effect, normalized for a delay of one second. For the last two cases, therefore, the normalized -3dB bandwidths are also tabulated.

The order and type of filter response are required to select the right line of normalized values. ω0 (ω = 2πf) is also required. Select a suitable value of R (for instance, 10kΩ).

The real value of C, R, is found from:

\[
f_d = \frac{C}{\omega_0 R} \quad 2\pi f_d
\]

This calculation may be tried with alternative values of R to find capacitor values closest to the preferred values.

**Example**

A third-order Chebyshev filter with 0.1dB ripple and f₀ = 4kHz is required. A 15kΩ standard resistor pack will be assumed for the resistances.

The required line of normalized data is:

<table>
<thead>
<tr>
<th>Order</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.1416</td>
<td>4.7924</td>
<td>0.0699</td>
</tr>
</tbody>
</table>

The real value of C0 =

\[
C_0 = \frac{2\pi \times 10^6 \times 15 \times 10^3}{3.487 \text{ nF}}
\]

Likewise, the real values of C1 and C2 are 12.71mF and 257mF respectively. The -3dB bandwidth of this filter, shown in Fig. 13, is 5.55kHz. To design a Bessel filter for a given delay D, use the relationship D = 1/ω₀ i.e. a delay of 100μs corresponds to ω₀ = 1000 rad/s.

### Appendix

**Equation 1:**

\[
G = \frac{B/C}{1 + \frac{1}{R/C} + \frac{1}{R/C}}
\]

**Equation 2:**

\[
G = \frac{R/C}{1 + \frac{1}{R/C} + \frac{1}{R/C}}
\]

**Equation 3:**

\[
G = \frac{1}{R/C}
\]
Faster Fourier transforms

The Fourier transform is established as a major analysis tool in many branches of science and engineering. Here is a machine language implementation of the FFT algorithm evaluating a sequence of 128 sampled data points with 32-bit accuracy in about one second.

The fast Fourier transform algorithm provides rapid computation of the frequency spectrum of a sampled time-related waveform. The classical solution for a waveform using equation 1

\[ X(f) = \int x(t) \exp(-j2\pi ft) \, dt \]

may be time consuming and, being analytic, it is not amenable to machine computation. An approximation to it is obtained by sampling the waveform at a sufficient number of points, see Fig. 1. Fourier analysis using equation 1 for a sample sequence yields the general expression given by equation 2, known as the discrete Fourier transform or DFT

\[ X(k) = \sum_{n=0}^{N-1} x(n) \exp(-j2\pi nk/N) \]

The waveform should be sampled and the amplitude at each sample point (from k=0 to k=N-1 where N is the total number of samples) be placed in the array x(k). Applying equation 2, the Fourier coefficients of each frequency component are left in array X(k) for values of m=0 to m=N-1. For N samples in the time domain representation of a waveform, there are N corresponding frequency components in the frequency domain representation. An approximation to the original is reconstructed by summing the frequency harmonics. By analysing the DFT equation, as in the theoretical discussion on the next page, the fast Fourier transform or FFT is produced. The analysis, however, is not a prerequisite to being able to use the FFT effectively.

**Basic concepts: sampling**

Before discussing the use of the FFT, an appreciation of sampling concepts is desirable. The waveform to be transformed into the frequency domain has first to be acquired and then sampled, and the interval over which this takes place defines a ‘window’. This window contains a sequence of events which are assumed to be periodic, as illustrated by Fig. 2; an integral number of cycles of the periodic waveform must be sampled in the window. If this condition is not met, discontinuities will be assumed to exist by the FFT algorithm at the ends of the window, as shown in Fig. 3. The transform will faithfully produce the frequency spectrum of the window contents, but this will not represent the original waveform function.

Since the implementation of the algorithm demands that the number of samples in the window is always constant, the sampling period can be increased to reduce resolution or reduced to increase resolution of the waveform. Minimum sampling period is equal to the period of the waveform. Maximum sampling interval is subjected to the constraints of the sampling theorem, which states that a waveform be sampled at least twice in each cycle Nyquist frequency. If this is overlooked, aliasing will occur, which arises due to time domain resolution deteriorating to such an extent as to make its frequency domain representation meaningless. Figure 4 illustrates this effect.

If n cycles of period T of the waveform to be transformed are contained within the window, the period of the window is equal to nT and the separation in time between samples is

\[ \Delta t = nT/N \]

where N here equals 128. If

Incorrect sampling period containing a non-integer number cycles produces effect shown, Fig. 3.

Aliasing effect caused by insufficient sampling, Fig. 4.

by Weysel Omer

Weysel Omer is completing an honours B.Sc course for which this article represents the first part of a final year projects, and hopes to continue with work in applied signal processing after graduation. He enlisted for the Brighton course after obtaining a TEC diploma from Carahalton FE college. He enjoys cross-country running as well as electronics as a hobby.

Graeme Awcock is supervisor for this project and lectures at Brighton Polytechnic whilst reading part-time for a doctorate on computer vision in low-cost robotic systems. Previously he worked as design engineer at Computing Devices, where he went after graduating with a first from the Polytechnic.
this sampled window is treated as the 'time spectrum' (Fig. 5) then the corresponding, frequency spectrum relates to the parameters \( n, T \) and \( N \) in the way shown by Fig. 6. The bandwidth of the result depends on the sampling interval and each spectral line is separated by \( 1/T \); these relationships are referred to as 'normalized'.

**Implementation**

The operations required to evaluate the DFT depicted in the signal flow graph of Fig. 7 are included in Listings 1 to 4. Listing 1 is the source code for the main FFT algorithm of 128 sample points represented by block 3. Referring to figure 7 the index \( k \), identifying the elements of \( x(k) \), is required to be bit-reversed. Two bit-reversal routines are included in this implementation, provided for processing digital data (included within the main FFT listing) and for analogue data which is produced by the source code of listing 2. These appear jointly in block 2. This process is either carried out at run-time, or as this version using a data table (produced by routine \texttt{brvsl}, prior to run-time) containing the bit-reversed values of \( k \) over the range \( k=0 \) to \( k=N-1 \). For the eight-point transform of fig. c three (\log_{2}8) stages of computation are required. In this particular case, seven (\log_{2}128) stages of computation are carried out, but rather than calculating the combining coefficients \( \left( W_N^k \right) \) during program execution, they are also calculated prior to run-time (by routine \texttt{sgen}) and referenced during execution at the various stages. In fact, much can be said for the use of data tables as they provide a significant speed advantage over run-time computation methods; their drawback is the memory required to hold the data table which may prove restrictive for large values of \( N \).

The listings should be typed in and saved separately using the appropriate names of the routines for each of the files 'listings' 1 to 4: \texttt{fftmain}, \texttt{univers}, \texttt{sgen}, and \texttt{brvsl}. Once saved, the FFT routine is formed by executing

**CHAIN "FFTMAIN".**

An object file is created named 'FFT' which should subsequently load as

"LOAD "FFT".

The memory map formed is shown in Fig. 8. Implementation is in 2's complement fixed-point integer format using 32-bit data elements stored in the BBC-Micro integer arrangement with the least significant byte first: the routine therefore requires that input data be in this format. The range of input values represented as integers should be in the range of \( \pm16384 \) to ensure that overflows do not occur during execution; i.e. if sampled data varies between \(+1\) and \(-1\) then multiplication by a suitable constant will ensure that the number input is an integer. The choice of constant should allow for representation of a sufficient number of decimal places without danger of causing an overflow, which in the example cited above would be 16384. This would give a resolution of four decimal places (16 bicipal places, where the "bicipal place" is the binary

**Development of the FFT from the DFT**

The discrete Fourier transform is

\[
X(m) = \sum_{k=0}^{N-1} x(k) \cdot \exp(-j2\pi mk/N) \quad m=0,1,2,...,N-1
\]

For each value of \( m \), \( N \) complex multiplications and \( N \) complex additions are required to solve \( X(m) \). The complete solution of \( N \) values therefore necessitates \( N^2 \) complex multiplications and \( N^2 \) complex additions.

Altering notation so that

\[
W = \exp(-j2\pi/N),
\]

the DFT becomes

\[
X(m) = \sum_{k=0}^{N-1} x(k) \cdot W^{mk} \quad m=0,1,2,...,N-1
\]

from which

\[
W^k = \exp(-j2\pi k/N).
\]

This equation represents a phasor having unit magnitude and a phase angle given by \( \alpha = -2\pi k/N \). For \( N = 8 \), the solutions are plotted on the Argand diagram:

\[
\begin{align*}
W^0 &= 1 \\
W^1 &= \exp(-j2\pi/8) \\
W^2 &= \exp(-j4\pi/8) \\
W^3 &= \exp(-j6\pi/8) \\
W^4 &= \exp(-j8\pi/8) \\
W^5 &= \exp(-j10\pi/8) \\
W^6 &= \exp(-j12\pi/8) \\
W^7 &= \exp(-j14\pi/8)
\end{align*}
\]

From this representation,

\[
W_N^m = \exp(-j2\pi k/N)
\]

which implies that multiplications are repeated thus reducing the efficiency of the algorithm. By dividing the time sequence into odd and even sample sequences, this computational redundancy can be reduced

\[
even x(k)x_N(k) = x(2k) \\
odd x(k)x_2(k) = x(2k + 1)
\]

and the DFT can be re-written as:

\[
X(m) = \sum_{k=0}^{N/2-1} x(2k)W^{mk} + \sum_{k=0}^{N/2-1} x(2k+1)W^{(m+1)k}
\]

Because

\[
W^{2N} = \exp(2\pi i/N) = \exp(2\pi i/N/2) = W^{N/2}
\]

the DFT expression becomes

\[
X(m) = \sum_{k=0}^{N/2-1} x(2k)W^{mk} + \sum_{k=0}^{N/2-1} x_2(k)W^{2mk}
\]

in which \( X_1(m) \) is the \( 2 \)-point DFT of \( x_1(k) \) and \( X_2(m) \) is the \( 2 \)-point DFT of \( x_2(k) \). Therefore

\[
X(m) = X_1(m) + W_N X_2(m)
\]

Thus the \( N \)-point sequence can be decomposed into two \( 2 \)-point sequences, and after evaluation recombined by using equation (ii). The \( X(m) \) sequence is defined for \( 0 \leq m < N - 1 \) and the sequences \( X_1(m) \) and \( X_2(m) \) are defined by \( 0 \leq m < \frac{N}{2} - 1 \). A rule governing the use of equation (ii) is established for \( m \geq N/2 \):

\[
X(m) = X_1(m) + W_N X_2(m)
\]

From this representation,

\[
W_N^m = \exp(-j2\pi k/N)
\]

which implies that multiplications are repeated thus reducing the efficiency of the algorithm. By dividing the time sequence into odd and even sample sequences, this computational redundancy can be reduced

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\[
X(m) = X_1(m) + W_N X_2(m)
\]

(iii)

Rabiner and Gold describe an eight-point DFT in the signal flow graph shown next:
Fig. 7. Abbreviated flow diagram shows stages in evaluation of the discrete Fourier transform.

Fig. 8. Memory map of the FFT routine.

The even and odd values of \( n \) are shuffled to obtain \( x_{2m} \) and \( x_{2m+1} \) which after transformation give \( X_{2m} \) and \( X_{2m+1} \). The two \( 2 \)-point DFTs can be broken down into four \( 2 \)-point DFTs

\[
x_{2m} = (x_{2m} + x_{2m+1}) / 2
\]

\[
x_{2m+1} = (x_{2m} - x_{2m+1}) / 2
\]

Equation (i) allows \( X_{1m} \) to be written

\[
X_{1m} = (A) + W_{2m}B
\]

where \( A \) is the \( 2 \)-point DFT for even elements of \( x_{2m} \) and \( B \) is the \( 2 \)-point DFT for odd elements. Similarly for \( x_{2m+1} \), even and odd elements are identified as \( C(m) \) and \( D(m) \).

The signal flow graph below shows how the two four-point DFTs above can be broken down into four two-point DFTs.

For an N-point DFT, where \( N \) is a power of 2, the DFT can be broken down until two-point DFTs remain. The results of the four DFTs are combined using the principle of equation (i). The number of combining stages is equal to \( \log_2 N \) with \( 2 \) multiplications in each of these stages; the number of multiplications required in the complete evaluation is therefore \( N \log_2 N \). As the majority of processing time is taken up in multiplications, the relative efficiency of the DFT and FFT can be established by comparing the number of multiplications required in the evaluation of each; i.e.,

\[
Q = N^2 \log_2 N - 2N \log_2 2 \approx 36 \text{ for } N = 128
\]

For moderate values of \( N \), the saving of time is appreciable.

The combining nodes represent equation (iii) rewritten as follows:

\[
X = A + W_{2m}B
\]

\[
Y = A - W_{2m}B
\]

\( W_{2m}B \) is computed for each node and saved to obtain \( X \) and \( Y \). Results \( X \) and \( Y \) can be stored back into the locations previously occupied by \( A \) and \( B \). This type of arrangement is termed "in-place computation."

The arrangement of data elements, \( x(k) \), had to be shuffled to obtain the even and odd sequences for the two \( 2 \)-point DFTs. The value of indices for \( k \) have to be converted from the natural order from 0 to \( N-1 \) to a shuffled order. By representations the natural order index in its binary form and bit-reversing this value, the required shuffled order index is obtained. Consider the case where \( N = 4 \):

<table>
<thead>
<tr>
<th>Index (natural order)</th>
<th>Binary</th>
<th>Bit reversed binary</th>
<th>Index (shuffled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>00</td>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>01</td>
<td>10</td>
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<td>10</td>
<td>01</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>11</td>
<td>3</td>
</tr>
</tbody>
</table>

The computed values will be in natural order when processed after the final combining in the algorithm.

appear that assuming a real signal renders consideration of \( x(k) \) as a complex quantity meaningless, however, it is to be recalled that Fourier transformation produces a complex result and therefore, in the consideration of inverse transforms, a complex buffer is required.

The BBC operator \( ! \) provides a useful means of defining a number consisting of four bytes. The elements of the array, \( x(k) \) are stored in this form for values of \( k \) from 0 to 127(N-1), which therefore require 128 4-byte elements in the case of real signals.

A program to initialize a pulse waveform in the input buffer may be written as follows:

\[
10 \text{ FOR } I = 2200 \text{ TO } 22FF \text{ STEP } 4 \text{ OF } 256 \text{ NEXTI}
\]

\[
40 \text{ FOR } I = 2200 \text{ TO } 22FF \text{ STEP } 512 \text{ OF } 0 \text{ 60 NEXTI}
\]

This corresponds to a pulse of amplitude 256 with a period equal to the length of the sampling window. The frequency spectrum of this pulse may be generated by adding a line which calls the FFT routine.

After execution of this line, the time domain data has been Fourier transformed leaving the results in the locations \&2C00 through to \&3000 corresponding to the array \( x(m) \). Again, the buffer is divided into two parts representing the real and imaginary parts of the into two parts representing the real and imaginary parts.

locations \&2C00 to \&2CFF

\[
x_{2m} \text{ } 2m \text{ THz}
\]

locations \&2D00 to \&2EFF

\[
x_{2m+1} \text{ } 2m+1 \text{ THz}
\]

where \( N = 128 \). This ordering is for the real part, and the imaginary part is similarly arranged, thus:

locations \&2E00 to \&2EFF

\[
x_{2m} \text{ } 2m \text{ THz}
\]

locations \&2F00 to \&2EFF

\[
x_{2m+1} \text{ } 2m+1 \text{ THz}
\]

These results are obtained in rectangular form, but it is possible to present them in polar form.

To be continued.
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</tr>
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<td>4126 256x4 8x2</td>
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<td>116 2x8</td>
<td>27C56 8x8</td>
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<tr>
<td>664 4x8</td>
<td>27C64 8x8</td>
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</tbody>
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**CIRCLE 88 FOR FURTHER DETAILS**

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**CIRCLE 41 FOR FURTHER DETAILS**
ELECTRONICS & WIRELESS WORLD JUNE 1986
**SEMICONDUCTORS**

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**INTEGRATED CIRCUITS**

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TELEPHONE RECORDING

I am interested to see that my circuit idea (November 1985, p.75) for automatic telephone recording on cassette has stimulated Mr O.F. Carter to a response (EWW March 1986, p.63) but I regret he is mistaken in some of his technical points.

Isolation of the recorder, the circuit and the telephone line from the mains (indeed, the recorder is mains and not battery powered) is provided by the mains transformer of the recorder, by the contacts of the solenoid switch which are isolated from the rest of the circuit, and by the audio transformer. A further improvement in isolation could be made by including a miniaturised 100pF blocking capacitor in the connection between the B line and the audio transformer. The value of these capacitors could be reduced well below 100pF at some prejudice to lower audio frequencies, and the voltage rating of the capacitors should exceed 240V a.c. It would be useless to connect the circuit to the telephone lines via a 600 ohm isolating transformer of 1:1 ratio (or any other transformer), as this would prevent the circuit from sensing the d.c. voltage levels on the telephone lines. Naturally, I would agree with a fuse in the mains supply to the recorder.

The risk of some voltage to ringing voltage has been greatly exaggerated, and is no worse than with any other telephone apparatus. The step-down audio transformer makes the telephone connection safe from shock. No harm has been done to the recorder input by telephone ringing, partly because of the blocking effect of the 100pF capacitor at the low frequency (25Hz) involved, and partly because of the step-down transformer. A suitable diode clamping circuit could be added in series with the input transformer primary or secondary, if desired.

Recording level may be adjusted (as originally suggested) by an attenuator between the transformer and the recorder input, but it may be sufficient to rely on the automatic recording level system commonly provided in recorders, as this can make adjustments for both remote and local speech levels.

Lastly, due to its high impedance, this circuit will not short out or in any way affect normal telephone use.

It may be mentioned that compatible automatic telephone recording circuits are now on retail sale from telephone shops and the Tandy chain of stores, although I have no details of the circuit designs involved.

H. T. Wyne
Glasgow

EARTHING

With reference to the longstanding debates as to the best methods for earthing, may I add further information.

The necessity for providing a non-corrosive earth-conductor only applies when there is a d.c. component in the earth-current, or when the a.c. component is of a low frequency.

Otherwise, the earth-plate may be connected with any suitable substance to prevent corrosion, or else merely left plain (providing its adequate thickness prevents total disintegration). This latter case still allows for capacitive coupling to earth; but of course a plate is now better than a rod.

Alternatively again, a metal cylinder could supplant the plate so that the coupling is that of a cylindrical capacitor.

The only drawback to this scheme (which is also a limitation in the normal case, is that the immediate earth surface must be wet.

R. N. Barr
Bournemouth
Dorset

COMPUTER TESTING

G.B. Williams' article "Simple test equipment for microcomputers" in your April, 1986 issue was of considerable interest and was studied carefully for comparison with the method adopted here in d.i.y. computer manufacture for applications equally intensive. These Z80A computers are built around a 10k-to-earth framework from each address/data pin, reduced to 1k for certain higher address members. For simple programs in eeprom which begin with an Exchange Block Transfer to ram, the initial working of the unit can easily be checked by resetting the Z80A, switching to ram, and examining the data lines at various d.c. addresses from a multiway switch, using a display system. With a suitably constructed program, inputs and their consequences can all be recorded in ram as they occur, so that by switching to ram at any point the complete "state of the art" at that point can be ascertained. One example of the memory map for such a system is for the Z80A to work the eeprom at addresses from 0000 to OFFF, and to engage the ram when A12 is high, i.e. at addresses 1000 to 1FFF. After reset, a double-pole switching putting 10k between CK and earth, and 0 and earth of the ram permits data stored on the latter to be displayed, whilst eeprom is disabled by the high on no job led.

The only additional apparatus required for test, apart from a voltmeter, is a display & address-setting unit * with leads for connections to the 10k address/data framework, most simply by a few minute's work with a soldering iron (earthed to the earth of the equipment, and with the power supply switched off. This method avoids the 74374 octal D-type flops of William's data-bus analyser, and also the 74688 hit comparators, which can be expensive for humber workers of the d.i.y. engineering type.

*available from me at this address.

G. F. Lewin
Samtronix
29 Llanvair Drive
South Ascot
Berks

STEREO HISS

It is interesting to compare Mr Price's concern with compatibility with existing equipment (EWW March 1986, p.36) with the BBC's previous performance in respect of their programme labelling system, currently being used experimentally, and due to come into service in the Autumn of next year, according to the Financial Times (25 March, 1986, p.9).

This system gives rise to objectional background noise in certain older receivers such as my own, and I wrote to you about it in 1986, as the BBC had been attributing it to continental interference (my letter and Dr Leggate's reply WW October 1980, p.49).

While I did get a personal reply from Dr Leggate at that time along the lines of his letter to you, I have had no constructive suggestions so far as to how to eliminate the noise, and I now usually have to listen in mono.

R. Camp
Brentwood
Essex

'EINTELLLIGENT' MACHINES

I have just read Tom Ival's interesting article "Human responses to 'intelligent' machines" in your March issue. His argument that human factors engineers, people, or many of them, have been largely ignoring AI, while the AI people have been so excited with what they are doing that they for the most part have not taken human factors or psychology seriously and the more powerful and subtle the computing capability, the subtler and more difficult the clash and possible damage.

Your contributor's thoughts seem to have been running almost parallel to mine about the Turing test. In a letter to the Applied Artificial Intelligence Reporter I have argued that the test is simply invalid, precisely because it was framed in a way that took no account of human factors psychology. However, I have found that AI people do not react sympathetically to an argument that in effect removes a pet theory that intelligence can be isolated from the rest of the human mind. Rather, they ignore it (with the obvious exception of the editor of the Applied Artificial Intelligence Reporter); which is a pity, for the lure of the Turing test is, I judge, likely to divert AI efforts directed at real machine intelligence away from the most useful directions. Another way to put it, perhaps, is that a machine process that can be expressed in mechanical logic may be vastly useful and powerful but should not be considered as intelligent in any way that can be directly compared with human intelligence (for example, a machine that could type better than I can). On the other hand, any process subtle and complex enough to be comparable in 'intelligence' to a human mind had better be given a background of knowledge and 'experience' similar to that of a human, if we are to recognize it and that will be a major problem all on its own.

Roderick Rees
Kirkland Washington USA.
LIGHT, DISTANCE, TIME AND RELATIVITY

It seems to me that Alex Jones (April) is limiting his thinking to light being a solid particle rather than a packet of energy shunted linearly by successive I.s.m. such a packet is just as much as the limiting sub mass which eventually delivers it, and it is the packet which we call a photon. If his “particle” is small enough it appears possible that it could be hammered successively by the same I.s.m. at the frequency of radiation.

On the other hand, if the particle is large enough to be entered by the I.s.m., then the spin energy of the latter would wind it up and so increase its relativistic mass by accelerating it gravitationally, and that in the opposite direction to the hammering if both effects came from the same massive source.

I suggest that Mr Jones is only totally correct about c.m. Doppler and the propagative effect of the radiation if the spin energy of the I.s.m. which carry it be zero, something which is of very low probability and certainly a degree of freedom which must not be denied.

Nor am I happy about the time dilation quoted by Alan Watson (also April) as being unequivocally shown: movement can be considered to be throughput of energy and it only distance per unit time in terms of classical mechanics. Certainly I accept the apparent of time dilation, but it could equally well be an accelerating effect due to a gravitational gradient of spinning I.s.m.s.

As to Prof. Archibald Medes standing on his hairless head down under, the specialist sciences differentiate by probing linearly (and thus radially) into little bits of totality (can we apply a specific date in April?) and we have to integrate their findings in order to discover the nature which is within us: self-analysis is limited to and by our own experience. Mathematics is an extra, and devoid of causality as every nonsensorial should have learned by now.

Therefore, if we are to tidy up the matter, we must first accept that energy has two degrees of freedom whence the picture seems to become clear: time is the constant “rate” by which we judge changes in energetic behaviour and measure the life of mass between its creation and its catastrophe, but because energy is only deduced to exist it appears that time dilates: this seems to me to be the working basis for Relativity.

James A. MacHarg
Wooster
Northumberland

I have now had the chance to study in more detail the very important paper that I mentioned in a footnote in my recent letter (February, p.42). The author, Prof. Michael Sachs, quotes only extracts from Einstein’s own published writings. These conform to his impression from personal discussion that Einstein had changed his mind: he no longer believed that the mathematical space-time transformation of relativity implied physical consequences such as length contraction, time dilation, and the asymmetric ageing of the Twins Paradox.

G. Burniston Brown
Padstow
Cornwall

TRANSISTOR FULL-WAVE RECTIFIER CIRCUITS

Mr Lewis (E&WW, March 1986, pp.22-24) rightly draws attention to the value of using transistors with op-amps to perform full-wave rectification or, to give the operation its less specific description, absolute value generation.

The circuit shown in Fig. 1 is Mr Lewis’s final circuit, while the circuit shown in Fig. 2 is a related circuit developed by the authors several years ago and described in detail elsewhere ("Versatile precision full-wave rectifier", R.W.J. Barker and B.L. Hart, Electronics Letters 13, No. 5, March 1977, pp. 143-144). We would like to comment on the relative performance of the two arrangements.

In the circuit of Fig. 1, the output waveform is quite different for both I+ and I- and it is critically dependent on the matching of resistors Rm and Rf. It is true that one of these may be made variable for ‘trimming’ purposes. However, this does mean the complication of a setting-up procedure. Furthermore, the trimming will be dependent on the source resistance at A.

In the case of the circuit of Fig. 2, no resistor matching is required, because only a single resistor is used. Thus, waveform symmetry is ensured without the requirement of a setting-up procedure. As the input impedance seen at point A is very high, the circuit operation is virtually independent of the source resistance at A. In addition, different values of R can be switched in to give a programmable transconductance, if required.

Finally, it should be noted that both arrangements can provide for differential input operation. Thus, if a second input is applied in both circuits at point B, the output current is a function of the absolute value of the difference between the signals. We have used this property to remove unwanted mains interference in the rectification of a low-level signal.

R. W. J. Barker
B.L. Hart
Trent Polytechnic
Nottingham

CLASS B OUTPUT

I thank Mr Wrigley for his interesting comments (May, p.22). Yes, my circuit does seem superficially similar to the design published by Mr P. Lambrecht in Hi-Fi News in October 1971. But there are major differences.

My purpose was to design an amplifier that did not require (at least) a bias adjustment and at the same time to avoid low-level non-linearities. This was not a design feature of the ‘Edwin’ amplifier although it had a fixed bias.

My design uses fairly high-power transistors in the driver stage at the highest practical current. The Edwin amplifier uses standard driver transistors at a current not that much greater than a typical Class B amplifier.

My design requires the driver transistor to be mounted on the same heat sink as the output devices. This not only dissipates the heat, but also reduces temperature-generated distortion. T.g.d. is the distortion that occurs when a transistor junction heats and cools rapidly due to fast changing variations in current X voltage. It can be reduced by heat sink, which can dissipate the heat quickly, and by better temperature tracking between devices which are closely related in the circuit.

I found Mr Wrigley’s comments on the sound quality of his amplifier very revealing. I do not think the Edwin output stage would sound better than a typical Class AB stage with other stages being equal, but in a couple of ways that design was far ahead of its time. One very advanced feature, possibly not realised at the time, is the lack of electrolytic capacitors. The other is the use of a dual matched input differential (CA 3046) which permits close temperature tracking between Tr1 and Tr2. I wonder how much this improves the sound.

I am grateful to Mr Wrigley for his comments on the sound of his amplifier. If he would like to improve the sound quality of his
amplifier, I would like to recommend that he replaces his driver transistors with BD139
d110, replaces his dual diode with a
transistor BD139 and two
resistors and mounts all three
extra transistors on the same heat
sink as the output devices. I am
willing to bet that he will notice
and be very pleased with the
difference.
Graham Salt
Borrowash
Derby

'PRECISION'
PREAMPLIFIER

Mr Self has also asked a few
details in his letter published in
EWW, February 1986.

In the real world, music signals
differ from sine waves in that they
are predominantly composed of
tones and harmonics. In the
domain, this may be expressed as a
continuously varying
asymmetry. The nett effect is a
variable de-coupling due to
its unipolar-union liaison
with electronic capacitors. Rock music's
asymmetry in particular does
naughty things to speaker cones when
driven by bridged power
amplifiers. For example, in the US
I witnessed a DL12X 12in drive unit
which had been offset 90°/200°/30°
from its neutral axis, the
result of an OTT Funk bass line.

In Mr Self's version of John
Curt's venerable capacitance
error analyser, his square-wave
test pulse is clearly symmetrical,
and lacks the variable c-
component. Ergo the error
component can only be raised in a
pudding fashion at high voltages,
whereas Mr Self's version has
exposed the phenomenon of the sort
that have no relevance to properly
designed audio...

If Mr Self repeats his tests using an
asymmetric waveform i.e.
where the area-under-the-curve of the +
and - components sum to a figure of zero,
he'll discover that even 160 volt non-polarized
electronics get mighty upset with just +0.5V
of asymmetric excitation.

I don't know when Mr Self
perused his letter, but in calling
for probe doubler biasing I
gave no indication that rigorous
-Statistics, measurements, rational
explanations,etc. he submitted to
mention work of this nature by
Martin Colloms' and John
Atkinson's. More to the point, if Mr
Self would cast open the window in
to his tower and volunteer to test
some of his un-doubled statistical
and practical skills to the work
being done on capacitors at present
in the UK, then we'd sooner
have some results in the scientific
format.

Let's tackle the topic of gold
plating. I do agree with Mr Self,
gold-plating isn't the sole way to
attain a good contact. Nevertheless, he has missed Mr
Armstrong's point. There's a
clearcut correlation of
reliability and perceived sound
quality, one is an extrapolation of the other. If a sound-system
component is unreliable, the music
we would like to get across
will disappear after a while, and
the perceived sound quality
then falls to nil. Now tying in
with David White's masterpiece of
some FX, gold-plated contacts
may sound better because their
confidence level for working
99.9% of the best is high, at say
999% in contrast with tin-lead-
nickel, where the confidence gets
tricked by a smart oxide film. Ask
Dr Marlowe.

References
1. Martin Colloms: "A passive role?"
Hi-Fi News & Record Review, October
1985.
2. "A capa's for change", HFN RR,
December 1985.
3. John Atkinson, "Listening & hearing"
Reports on public double-biased
-capacitor tests, HFN RR, January
1986.
4. Rouch, Dr. Anond J. "POWERFET
block uses advanced capacitor
technology to defeat asymetrical
output in powered monitor wedges."
Monitor System Technology UK DBT
5. Ben Duncan
Tattershall
Lincoln

DTMF - WHY NOT JAM TODAY?

With the rapid introduction of
electronic telephone exchanges I
have wondered for some time why
the DTMF system is not used.
I believe it's because of the
publicity and emphasis on the
'hi-tech' appeal of today's telephone
system, so a quick search against
the introduction of DTMF-Dual Tone
Multi-Frequency dialing. It is easily
located in Kingspon-Upon-Thames,
where all three exchanges have the
dual tone and are of the TXF-4
Type. Following my phone calls
to different departments in BT it
was confirmed by engineers at the
exchange that they would all
accept DTMF dialling on any lines
that were so programmed at the
exchange. They would only be
programmed to accept both DTMF
and loop disconnect. However,
the sales department gave the
go-ahead. The engineers were
very reluctant to admit that this
was so, and even more reluctant
to confess that it would be done at
charge. They were adamant that
there was no benefit, that it would
be no faster, and that BT policy
was that no DTMF phones would
be installed until the whole
country is System X in the late
1980s.

With vast numbers of
telephones now being bought

86000 board
Several important improvements have now
been made in this project. The original software
release was documented fully in our January and
February issues but in
version 2.0 many useful
commands and facilities
have been added and some
problems have been
eliminated. The additions
include a disassembler, a
useful single-stepping
facility, printer controls
and up for four user-defined
commands.

Both serial ports now
permit hardware
deshielding, enabling port
7 to be used for a printer.
Default baud rates for the
twoports can be set
independently. The monitor
now supports the
alternative 68010 virtual
memory processor.

The assembler too has
undergone improvement, it
now gives descriptive error
messages and allows
comments to be entered.
Components for the
860000 board, including
a double-sided p.c.b., are
available from Magenta
Electronics, 136 High
Street, Burton-on-Trent,
Staffordshire.

Literature received
A whole library of data books
came to us from Samsung. Full
data is given of logic families
and line i.e. Mos products
include watch and clock circuits
as well as microcomputers. The
company manufactures
discrete transistors and n-c-mos
memory i.e. Samsung UK
Ltd, Victoria House, Southampton
Row, London WC1. EWW 250 on
the reply card.

Included in Harwin 67-page
connector catalogue are plugs
and sockets for data transmission,
modems and connectors for
mother daughter boards, p.c.b. and
i.c. sockets and a variety of hardware.
Harwin Engineers S.A.
Fitzherbert Road, Farlington,
Portsmouth, Hants PO1 3BF. EWW
251 on the reply card.

Mos memory designers guide
comes from Hitachi. It is intended
to acquaint electronic designers
with memory devices and gives
examples and advice on their use.
Hitachi Electronic Components (UK) Ltd,
221 Station Road, Harrow,
Middlesex HA1 2XL. EWW 252 on
the reply card.

Lambda have completely revised
their power supply catalogue
which includes switch-mode
linear, regulated supplies,
d.c.d.c. converters and many other
products to do with protecting and
filtering supplies. Lambda
Electronics, Abbey Barn Road,
High Wycombe, Bucks HP11 1RW.
EWW 253 on the reply card.

Items from completecomputer
in semiconductors
are detailed by
Midwich and detailed in their
catalogue, which also
has
descriptions of disc drives,
network components and many
peripherals.

Midwich Co. Ltd, Gilney Road,
Diss, Norfolk.
IP22 3EU. EWW 254 on the reply card.

Linear and data conversion
products are listed in a product
selection guide. The PML products
include i.e., precision op-amps, d
- to-a converters, analog
switches, multiplexers etc.
Available from RR Electronics
Ltd, St Martins Way, Cambridge
Road, Bedford MK42 0LF. EWW
256 on the reply card.

Data acquisition and control
interfaces are available as plug-in
boards for IBM-PC XT AT
computers or compatible clones
and for the Apple PC computer.
They are made in USA by
Metabyte and detailed in a
catalogue available from Keighley
Instrumentation, 143-145
Reading, Berks RG20 2NL. EWW
257 on the reply card.
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<th>25.99</th>
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<td>2114 200ns Low Power</td>
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<td>2716 450ns 5 volt</td>
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CIRCLE 81 FOR FURTHER DETAILS

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By J. H. Owens

Improving 4000 series oscillators

Enhanced cmos oscillator circuitry has application in tv, data processing and facsimile transmission, as well as keying

This describes some newly developed circuit refinements for use with the 4000 series cmos integrated circuits, specifically the CD4001 and CD4013 types. Like most discoveries, the ones described resulted from the pursuit of redesigning a piece of equipment in the interest of superiory, simplicity and savings. The end-result, if the design work is successful, is the creation of circuits which find uses beyond, and some-thing unrelated to, the project that originally stimulated the engineering effort.

In this case, the target was what is known as a 'fully automatic keyer', used to key radio transmitters on and off in relatively short or long intervals, on dots and dashes, which can be decoded into intelligence by machines or by persons trained in the art. Similar coded bursts of electrical energy are to be found in many fields, such as television, data processing and facsimile transmission.

Typical keying machines, used in the communications field, comprise four functions, a keyable squarewave generator, a flip-flop divider, a mixer-inverter, and an output driver used to key the radio transmitter. Theoretically, these functions could be obtained from two gates, one flip-flop divider, one mixer-inverter, and one discrete transistor as the output stage. But practically, keying instruments in use now contain a separate clock and inverter for the generator, two or more flip-flop dividers, two or more mixer/inverters, and two output drivers, with occasionally an electromechanical relay. These differences between the theoretical and practical suggest an opportunity for many improvements.

Every project has a starting point, as well as a finishing point. This one started with the circuit shown in Fig.7 on page 732 in the RCA SSD-250C Data-Book, which is reproduced here in bold lines in Fig.1. The operation of this circuit is well known, so it will not be further described here, except as inference to its limitations and deficiencies. For example, if a negative (low) gating pulse is applied, as by closing and releasing the switch SW1, a corresponding high pulse will appear at T2, together with a low pulse at 4; then both terminals will return to their quiescent state positions instantly when the switch is opened. The insertion of a resistor, R1, between 1 and 4, will make the pulses self-latching and self-completing. Self-latching means that, for example, the switch contact reaches zero resistance, or has a chance to bounce, the 'lo' pulse at 4 will drive 1 to its lo state. Self-completing means that the lo pulse at 4, through R1, will hold in its lo state until R and C have gone through their discharge-recharge action

Another imperfection of the SSD-250C circuit is that the first pulse (dot) will be longer than the ensuing dots in a string. This is caused by the fact that C is charged to the full Vcc voltage while in the quiescent condition; so when 4 goes lo, it will drive the RC junction that same amount more negative than Vcc before 3 brings it back and up to the 5 and 6 transfer voltage. After the first pulse is completed, the average RC junction voltage reestablishes at a higher than ground voltage, therefore less time is now required for each of the discharge-recharge cycles, so the succeeding dots are uniform in their time-cycle, and faster than the first one.

Insertion of diode D1 into the circuit as shown in Fig.1 clamps the first pulse at the RC junction near Vcc level, and so makes the first dot almost exactly the same length as the succeeding dots. A very slight improvement can be made by substituting a zener diode for the simple diode, one which has a zener voltage approximately equal to the 5-and-6 transfer voltage. However, this very slight improvement is realized only if the Vcc-to-Vcc voltage is constant, a condition that is not compatible with this design which has to operate
over a battery voltage range of 2-to-1.

In some instances there would be a desire to make the dots slightly lighter or heavier than the normal 50% duty factor. Such correction can be made by adding $R_2$ to the circuit. Connecting $R_2$ to $V_{dd}$ will make the dots heavier... to $V_{cc}$ lighter. In this circuit, there is already a d.c. path from the RC junction to $V_{cc}$, so the dots will be on the light side. For this reason, $R_2$ will probably be connected to $V_{cc}$.

The Fig.1 circuit becomes a semi-automatic keyer by the addition of $R_3$, $R_{pa}$, $D_1$, and $SW_{a}$ which in combination comprise an override facility for making manual dashes. If the value of $R_3$, is selected for a 50% duty-factor, $R_2$ can be adjusted so that the elapsed time between dots and dashes and dots will be exactly the same as the time between dots. Suggested relations are as follows: $R_3$ will equal $R_1$; $R_{pa}$ will be half of $R_1$; $R_2$ will be twice $R_1$, and $R_2$ will be three-quarters of $R_1$.

A semi-automatic keyer has little interest in today's world, but the override facility does perform a special aid to those operators who use manual 'Morse' keys. If $SW_{a}$ is closed and released quickly, the circuit will make one self-latching self-completing dot, just like $SW_{b}$... but if held closed, it will make a dash with the same qualities as the dot. The advantages over the unprocessed key are uniform dot weight, uniform spacing between dots and dashes and dots, and freedom from keying transients.

Deviating from the design-objective use of the circuit, consider its possible use in a tv continued on page 58

Automatic electronic keyer

You're gonna like this one! It has all the features of the expensive ones except memory. It uses just two cheap chips and one output transistor. The key-up current is only a few microamperes, so no on-off switch is needed. Even used every day, the current drain of a couple hundred microamps, with satisfactory operation down to 5V, the 9-volt radio battery can be expected to last its shelf-life.

Performance features
- Self-latching and self-completing dots and dashes,
- 50% duty-cycle for dots, and 75% duty cycle for dashes, with provision for increasing or decreasing weights,
- instant starting with the first dot being no longer than succeeding dots,
- uniform automatic spacing between dots and dashes and dots,
- good immunity to strong r.f. fields from high s.w.r.s on transmission lines,
- freedom from key clicks and bounce transients,
- capability of keying both negative-grid-block and positive-cathode keyed transmitters, and
- continuous hold-down for transmitters tune-up.

After assembly, measure the terminal voltage of your 9-volt battery. Then connect the voltmeter from any $V_{cc}$ point to either one of the i.c. terminal 14 points, and snap in the battery. The voltmeter should read about 4 volts less than its terminal voltage... this reading will be called 'hi' in the following test procedures. If a reading is near zero, it will be
cates that the 4013 is making one dash for every two dots, i.e. dividing by two. Going back to the 4001, terminal 10 will be hi in the key-up condition, but when dots are made, it will drop to the half-way point and quiver... when dashes are made, it will drop to 1/4 hi and rock back-and-forth.

For the final test, connect the keyer to the transmitter and turn on the a.c. power. If the transmitter 'keys on', simply reverse the position of $SW_{a}$. Operating the paddle will now make the transmitter make dots and dashes. To check the duty-factor, connect your voltmeter to the $TR_1$ collector, and read the transmitter keying voltage. Now close the dot paddle and note that the meter drops to half the unkeyed voltage, and quivers. If it is not exactly perfect, you can use $R$ to adjust.

This circuit mounts on ready-made p.c. board, details from the editorial office. Please send s.a.e. and mark your envelope 'keyer'.

ELECTRONICS & WIRELESS WORLD JUNE 1986

35
Digital altimeter

An updated liquid crystal display and much improved temperature compensation for the May 1985 electronic altimeter

This improved design uses the same type of cheap, automotive pressure transducer and chopper stabilized operational amplifier as the original. The digital model incorporates both first and second-order temperature compensation enabling a readout stability of ±10ft over a 30°C temperature change (equivalent to climbing through 15,000ft in normal conditions). The sealing accuracy is better than one per cent at 20,000ft equivalent pressure. The 3½ digit meter module provides a resolution of 10ft maximum altitude reading is 19,990ft.

The original also incorporated a vario, a differentiator circuit fed directly from the meter drive. This added considerably to the instrument’s bulk and current consumption, and reduced the full scale deflection to 3000ft. This has been thrown out. The display is still with its 10ft reading intervals clocks up or down with relatively small rates of climb or sink, largely obviating the need for a separate vario circuit.

Operating principle

Heart of the instrument is an MPX100 pressure transducer manufactured by Motorola. This comprises a thin silicon disc etched on its reverse side to form a hollow cavity when mounted onto the device header. This space under the chip is in a state of high vacuum. Integrated silicon resistors on the chip topside — silicon strain gauges — register flexing of the dice through applied air pressure. The Wheatstone bridge arrangement of these gauges provides a differential output from the transducer, typically around 2.5mV/lb in² change in applied pressure. This works out at about 1.2mV/1000ft at the lower altitude levels. A low drift differential d.c. amplifier — stability co-efficient about 0.1pV/°C — raises this to 12mV/1000ft at the d.v.m. input.

The chopper stabilized opamp, IC1, in the circuit diagram Fig.1, actually produces around 60mV/1000ft at its output subsequently attenuated down to 1mV/lb by network R12, R13 for the d.v.m. This is to allow for a healthy vario drive signal, obtained by differentiating IC1 output.

Temperature compensation

The silicon resistors used in the pressure transducer exhibit large positive temperature coefficients. In the intended application, automotive fuel injection systems, a couple of percentage points over a 50°C temperature range is neither here nor there. The transducer includes a basic compensation mechanism without which the temperature coefficient would be even greater.

The MPX100 and other transducers like it have two distinct problems associated with altimeter use. The internal bridge is balanced during manufacture at the zero pressure end of the scale. This means that normal air pressure causes a standing voltage of some 40mV across the bridge connection in the circuit shown here. This imbalance is subject to variation with temperature, a first-order correction.

Secondly, a substantial change of altitude also causes a substantial change of temperature; the standard environ-
mental lapse rate is 1.98°C/1000 ft. The internal transducer compensation network requires external series resistance, \( R_2 \), to make it work. Since the entire bridge resistance changes with temperature, the differential output for a given pressure change also changes with temperature. This requires a second-order correction.

The common-mode voltage at the transducer outputs varies positively with temperature. By unbalancing the differential amplifier — making \( R_6 \) at the non-inverting terminal slightly lower in value than \( R_7 \) which is connected to the inverting terminal — the reduced common-mode rejection works against the temperature coefficient of the standing voltage on the transducer.

Second-order scaling errors are simply rectified by using the total voltage developed across the top and bottom of the bridge as the reference voltage for the d.v.m. The internal bandgap reference in the module is left out of circuit. More volts across the bridge means more volts for a given pressure change. Since indicated voltage on the d.v.m. is inversely proportional to reference voltage, the correction is absolute.

Only one more correction remains. Reverse c.m.r. provides near perfect compensation for the transducer but resistor \( R_6 \) through which the offset current flows also has a temperature coefficient. This is taken care of by resistor \( R_3 \) and silicon diode chain \( D_3 \) to \( D_4 \). The value for this chain was found empirically and depends on the resistor type used for \( R_6 \). Uncorrected, a metal oxide component contributed about a 200 pA reading error over a 30°C temperature change.

As a general point the circuitry associated with the transducer requires use of a temperature-stable supply. Over the life of the battery, the regulator circuitry comprising current source, Zener \( D_1 \), and series-pass transistors offers far better stability than the standard three-terminal regulator.

**Practical considerations**

The prototype, built on Vero-board, occupies a black ABS box measuring 3¼ by 2½ by 1½in. It uses a DP3200 module available from Lascar Electronics Ltd, of Module House, Whiteparish, Salisbury. SP5 2SH. Resistors should be of high-stability, metal oxide construction.

The design requires good quality trimmers for the variable resistors; I suggest either cermet or, if size is no object, multturn types. A 240 degree moulded-track component for "calibrate", together with a pointer knob enables a barometric subscale to be calibrated and marked on the instrument. Alternatively, a further d.v.m. display measuring the voltage between the slider and a static resistor chain could provide direct l.c.d.

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**Fig. 2. An extra d.v.m. module to read barometric pressure setting may be added with this additional circuitry.**

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**Connections to the DP3200 module**

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Low-noise v.h.f. pre-amplifier

This circuit, designed for Amsat-UK as a 145MHz pre-amp for Oscar-10 working, is very tolerant of modification.

The design requirements for this pre-amplifier were a gain of 15dB or more, a noise figure below 1dB and a simple and reliable construction technique capable of withstanding the weather. I also planned to keep the cost of components below $10.

There is a wide variety of seemingly suitable r.f. transistors, at a wide range of prices. My first choice was the NE4137, which offers a gain of 20dB at 900MHz and a noise figure of 1.5dB. Many 'black box' manufacturers use this device at 432MHz. But its price ($1.50) seemed rather high and it was not very tolerant of mishandling or of high r.f. levels as I found to my cost. Since the prototype was to be used in conjunction with a 40W transmitter, some elaborate coaxial relays would have been needed to protect it.

After further research I came upon the BF981 dual-gate mosfet, which gives around 18dB gain and 0.7dB noise at 200MHz, all for a price of only 85p. To my delight I found the circuit simple, effective and also very tolerant of modifications.

In addition, the device seemed more durable. I have been using this pre-amp in a sealed die-cast box at the masthead for a year with no measurable deterioration in its performance.

Construction

The preamplifier is built on a double-sided copper-clad board. To provide a ground-plane the component side is left unetched. All leads through the board to earth should be soldered both top and bottom, others should have the drilled hole chamfered to avoid shorting.

Coils are of 22swg wire wound on a 6mm diameter former: 1 has six turns, tapped one turn from the cold end; 12 has six turns and 13 three turns.

The last piece to be soldered in should be the BF981. Its leads should be as short as possible.

For best results you should install the unit at the masthead to overcome losses in the downlead. It is small enough, however, to fit inside most 2m transceivers.

Typical noise-figure quoted by the BF981's manufacturer is 0.7dB at 200MHz. The 8V regulator reduces gain to 15dB but helps maintain stability.

A ready-made p.c.b. for this design is available by post at £2 plus postage from Amsat-UK, 94 Herongate Road, London E12 5EQ. Amsat is a non-profit-making body: please enclose a stamped self-addressed envelope or an international reply coupon with any enquiry.
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The new face of 50 Mhz scope technology
Relativity simplified

Whilst aiming to demystify relativity, Prof. Butterfield suggests a basis for explaining many phenomena concerning light and matter

This simple and unusual approach requires barely A-levels in mathematics. Starting from the premise that energy has mass, it rederives Einstein’s results for clocks and measuring rods in practical life without making any assumptions about light; it explains the existence of light and the various forms of action at a distance via an 'impact theory'. This approach leads to the concept of a 'spatially distributed single event' which provides a realistic basis for a theory of matter akin to quantum mechanics.

The early Theory of Relativity has changed remarkably little since its early presentation by Einstein. The theory is widely thought difficult to swallow since the basic assumption that the speed of light v is the same irrespective of relative motion of the source and the observer, goes against common sense: "You cannot add to a velocity and get back the original velocity". The fact that the famous law of addition of velocities that is derived from Einstein’s Theory, namely

$$w = \frac{u + v}{1 + \frac{uv}{c^2}}$$  \hspace{1cm} (1)

reduces to the usual w = u + v when u and v are small and yields w = c when u = c for any v, is regarded simply as demonstrating that the algebra is consistent but not as answering the problem.

Basic kinematics – mass and energy

We can take the mystery out of relativity if we start again with traditional Newtonian concepts plus a law stating that 'energy has inertial mass'. This is a much more reasonable proposition to accept than the usual one about the absolute nature of the speed of light. We argue that if something increases its energy by virtue of motion, heat content etc., its mass will also increase and it will require a greater force to accelerate it. The idea of conservation of energy and mass is satisfied if the increase of mass is directly proportional to added energy, that is

$$\text{mass} \propto \text{energy}$$

On the basis that nature is essentially simple we use this very simple relationship.

Suppose we take any object, for example a brick, of mass m, place it at rest on a long smooth straight table and apply a constant force F to accelerate it along the table. When the brick has moved a distance x the force will have done work Fx on it equal to the increase in kinetic energy. This increase of energy Fx appears as an increase in mass AF; the brick gets more massive and its acceleration reduces. According to Newton, force is rate of change of momentum, so

Consider now the two laboratories l1 and l2 moving with relative velocity V and both observing the same brick under prolonged acceleration. Even if the accelerating force is different according to l1 and l2, we conclude that both will observe the brick to approach the same asymptotic speed c = 1/V. Hence we have the situation that c plus v gives c. Notice that the concept of light has not yet been introduced, nor the principle of relativity, except as it is embodied in Newtonian mechanics.

Light and the ‘impact theory’

The previous section explained that the clock is accelerated relative to t1, it is observed to go more slowly according to equation 6. Ultimately on approaching the velocity c its mass would become infinite and it would cease to go round. As seen by t2, any two events (x1, t1)/(x2, t2) on the path of the moving clock at the origin of t2 are such that

$$x_1 = x_2 - c(t_1 - t_2)$$

But as seen by t2

$$x_1 = x_2 = 0 \text{ and } t_1 - t_2 = 0$$

Both events are at its origin. Hence in the limit according to t2, spatial separation is zero and time separation zero: they are the same event!

A photon of light is considered to be a particle of zero rest mass moving at speed c, hence the two points on its track corresponding to its creation and absorption are the same event as observed by the photon. Consider for example the photon created as an electron in a lamp filament is allowed. It is seen at a photocell by knocking out another electron. According to our analysis the emission and absorption of the photon are the same event. The energy exchange can therefore be regarded as a ‘Direct impact’ between the photon and the electron at the sensor. The whole history of the photon is one event!

Simultaneity and measuring rods

It is essential to understand that the length of any object must be defined in terms of simultaneous measurements at the ends. It is therefore necessary to be clear what is meant by simultaneity or synchronizing clocks. This is another area of misunderstanding in writings on relativity.

The experimenter in t1 synchronizes identical clocks at A and B by sending a pulse of light from A to B and reflecting it back to A. Then half time between start and finish at A is attributed to the reading of the clock at B when the reflection took place. In this way any number of stationary clocks can be synchronized in the system fully consistently.

The experimenter in t2 moving at speed v relative to t1, would go through similar procedures for clocks fixed in the frame. While the experimenter sends a signal forward from C to D which is reflected back to C in t2, the position of C in t2 moves. Hence according to t1, the length of the first leg from C to D is greater than the return distance from reflection at D back to C. Since (as we have established) the speed of light is constant in t1, t2 registers the reflection at D after half time. Measuring the length CD, t2 will see it to be shorter than t2 since t2 registers the simultaneous position of D with half time somewhat earlier than t2. This for shortening corresponds to the Fitzgerald contraction (ref.2) which was subsequently explained by relativity theory and this analysis also shows the length ratio to be $(1 - \frac{v^2}{c^2})^{1/2}$.

Notice that this result is consistent with the effects of motion on clocks described earlier. Since t2 sees a measuring rod in t2 as shortened, its ends will pass a point in t1 more quickly than if the rod had its full length. Alternatively, as explained earlier for a series of events at a fixed point in t1, t2 will record a shorter time interval than t1, which is a consistent result. This foreshortening is also consistent with the direct impact experienced by a photon, since at the speed c, the photon sees everything else foreshortened to zero length.

This equation is easily solved for x as a function of time and gives position.

$$x = -m_0 \sqrt{m_0^2 + F^2 \Delta t^2}$$

and speed,

$$u = \frac{dx}{dt} \frac{Ft}{\sqrt{m_0^2 + F^2 \Delta t^2}}$$ \hspace{1cm} (3)

As clock moves faster along toggle balance wheel becomes heavier and clock ticks more slowly

by M.H. Butterfield

Michael Butterfield works on the system dynamics and control at UKAEA, Winfrith, and is a visiting professor in the School of Electrical Engineering and Applied Physics, City University, London.

ELECTRONICS & WIRELESS WORLD JUNE 1986
This result has the remarkable property that as $t$ becomes very large, the speed $v$ tends to $\sqrt{V/F_0^2 t^2 - 1/\sqrt{t}}$, but this speed is never actually reached. This limiting speed is independent of the initial mass of the brick or the force applied to it, so material of any shape can be carried beyond (or even quite up to) the speed $\sqrt{V}/\sqrt{t}$ if we call this limiting speed $c$ then $\lambda = 1/c^2$ and therefore

$$v = \frac{\text{mass}}{\text{mass}} \times c^2$$

Now since (3a) and (3b) give

$$u^2 - m_0^2 c^2 = m_0 + m_1 c^2$$

and $m = m_0 + m_1$ as in (2) we get

Einstein's formula:

$$m = m_0 \left(1 - \frac{u^2}{c^2}\right)^{-1/2}$$

This mass, $m$, is what an experimenter standing by the side of the long table would measure by displacing the brick sideways, for example.

### Time and relative motion

Suppose now the experimenter made a batch of identical clocks with balance wheels of rest mass $m_0$ and subjected one of them to the acceleration of the balance wheel of the moving clock would become more massive as the speed along the table increased and this would alter its observed timing. In practical terms we arrange for the moving clock to spark and burn a hole in the table every time the balance wheel goes through the central position. These 'events' are then timed using the stationary clocks synchronized by conventional means, for example by sending signals or projectiles back and forth.

To quantify the motion of a spring and balance wheel requires relativistic knowledge which we do not have at this stage of the argument. But we can use a simple mechanism since, by Newton's Laws of Motion, the time spacing must be consistent with a simple clock rotating about an axis parallel to its motion on a frictionless bearing. The mass and hence the moment of inertia of the clock both increase with speed according to equation 5. To maintain consistent angular momentum the rate of rotation must therefore reduce as the speed $u$ along the table increases. If the disc made a mark on the bench every time it completed a full rotation the time interval between rotations would increase as the disc moved faster along the table. Hence as seen by the experimenter

$$t = \frac{u}{\sqrt{F_0^2 t^2 - 1}} \times t$$

If the force $F$ is removed on reaching speed $u$ the subsequent motion will be uniform and the speed $u$ of the brick or clock could be computed, revised via any appropriate history.

Consider now the situation as observed by a second laboratory $t_2$ moving with constant speed $u$ relative to the first laboratory $t_1$. The disc was initially travelling backwards at speed $u$ relative to $t_2$, as seen by $t_2$ it has been brought to rest by a deceleration force giving up its translational kinetic energy and now has rest mass $m_0$. Again we can consider the rotating disc marking both observers, it completes each revolution. Initially when the disc is at rest in $t_2$, it will have short time intervals $T_2$ and $T_2/\sqrt{1-u^2/c^2}$ observed by $t_1$ and $t_2$ respectively, but when at rest in $t_2$ the situation is reversed. Hence a clock which is stationary in $t_1$ appears slow to $t_2$ and a clock fixed in $t_2$ appears slow to $t_1$. These are both two extremes of events in which there is no inconsistency as often presented to provide a reticuttio ad absurdum argument against Einstein's theory of relativity. Both observers see time being the same. It is not the case that clocks are going both faster and slower.

### Conclusions to be drawn

1. The existence of light and the absolute nature of space and time and the space and space properties of the Lorentz transformation follow directly using Newtonian mechanics from the simple proposition that energy had inertial mass.

2. Along a path covered at speed $c$ all events are the same and the two ends constitute an 'impact' in that form of reference. This provides an explanation for electromagnetic radiation and other actions at a distance at the speed of light.

3. Form of reference invariance provide a mechanism whereby every particle in the universe can interact directly with every other particle. While this may seem far-fetched we know that it occurs in universal gravitation. An explanation for gravitational attraction may lie in the fact that the further apart the interacting particles are the more energy is expected to be in transit as we view it; and if the energy of a system increases as particles are separated this shows as an attraction.

4. Since energy is conserved, this continual exchange between all particles may be the mechanism that makes universal constants universal.

5. The idea that the space-time trajectory of a photon is one event yields the concept of a 'spatially distributed single event.' It is not reasonable to consider a fundamental particle such as an electron as a point. The concept evolved here enables an interaction with another particle to occur throughout both as one event. The concept therefore promotes a theory of matter akin to quantum mechanics.

6. The concept of a spatially distributed single event rationalizes interference phenomena. It, as it seems, means that the photon goes through both parallel slits then it is not obviously a single quantum! We can follow the ideas put forward by Feynman in ref.3 and consider all the conceptually possible paths collectively as constituting one distributed event. We say that the passages through both slits in the interference experiment are parts of one event and any experiment that we perform to look at this will participate in this series of events.

7. While the 'impact theory' describes light as 'corpuscular', it also offers a possible explanation for light to have a wave nature relative to time being the same. According to quantum mechanics particles are subject to a quantization of angular momentum or spin reversal of $h/2\pi$. If we can establish that absorption of light entails spin reversal then the 'impact' or photon of light as we observe it will have angular momentum $h/2\pi$. If we attribute moment of inertia and angular velocity $= 2\pi$ to the photon then it has rotational energy of $\frac{1}{2}m_0\omega^2 = \frac{1}{2}m_0 h^2/2\pi^2 = \frac{1}{2}h\omega$.

The 'time-shorting phenomenon' and a singularity concept for the photon leave open the argument that the photon only has two degrees of freedom (rotation about and translation along its line of motion). If the total energy is equally partitioned we explain the required factor of two to deduce $E = h\omega$.

8. A different type of 'impact' or photon (for example with different or zero angular momentum) would not be absorbed by intervening matter in the same way as in point 7. This could explain the difference in character between electromagnetic radiation and gravitation which is not influenced by intervening matter.

### References


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CIRCLE 34 FOR FURTHER DETAILS

CIRCLE 50 FOR FURTHER DETAILS
by Hugh Gleaves

An introduction to 3D graphics

Software for producing wire-frame objects in perspective using the QL microcomputer

Last month's article discussed the theory of producing three-dimensional images using a microcomputer. This software is an example of how that theory is implemented in Super Basic on the QL microcomputer.

Using the program

The entire program is constructed from three major Superbasic procedures, ERASE, SETUP, and VIEW.

ERASE. Once you have loaded the program into the QL, you should enter ERASE to invoke the ERASE procedure. The procedure dimensions all arrays used to hold the 3D a.e. This effectively deletes any previous environment arrays.

SETUP. Whenever the command SETUP is entered, it invokes the SETUP procedure which examines the present 3D a.e. and makes arrangements to insert any new data in its logical place. It then presents a series of screens to the user, requesting various forms of environment data.

VIEW. This procedure is the heart of the graphics program and is responsible for drawing the perspective image on the screen and obtaining camera commands. Once you have used SETUP to define a body, you should enter VIEW. This places the camera at position x = 0, y = 0 and z = -10, while setting YAW, PITCH and ROLL, all to zero. The view from this position will then be drawn together with a table of your position.

The bottom of the screen is used to enter various camera commands for changing position and/or orientation. If you do not want to change a particular parameter then simply press enter to skip to the next.

When you have been through all six parameters, the program calculates the changed parameters and draws the new view. You can break into the program and update the 3D a.e. at any time and then reenter VIEW. You should avoid using a break while you are in SETUP though, as if SETUP is not allowed to finish its job, corruption to the 3D a.e. may occur.

Software notes

The task being performed can be performed by any microcomputer with a line drawing facility. I have endeavoured to make the software modular and structured, with each module clearly annotated.

Superbasic is an enhanced version of BBC Basic, and the two have many features in common. Procedures, i.e. subroutines, are invoked merely by the appearance of their name.

For example the identifier APPLY-YAW when encountered during execution causes a call to the yaw application procedure which on completion causes a return to the statement following APPLY-YAW. BBC Basic is similar, except that procedure names must be prefixed by 'PROC' both in their definition and invocation.

Keyword LINE is a built-in procedure that allows a line to be drawn on the screen from point \( x_1, y_1 \) to \( x_2, y_2 \) as follows:

\[
\text{LINE} \ x_1, \ y_1 \ \text{TO} \ x_2, \ y_2
\]

Here, \( x \) and \( y \) are the numeric identifiers.

Keyword AT is an improved version of \( \text{TAN} \), and the pointer or input cursor can be positioned anywhere on the screen using \( \text{AT} \) line, column. This allows full control over displaying and entering data.

In my opinion, SuperBasic facilities are far more sensible and less idiosyncratic than those of the BBC microcomputer. Drawing a line on the BBC computer involves extra parameters and codes and the SuperBasic version of the graphics software is far more readable to the novice than would be an equivalent implementation on the BBC computer.

Further reading

Real time 3D graphics for microcomputers, Marcus Newman, Byte, Sep. 1984, p521.

Computer Images, Joseph De Ken, Thames and Hudson, contains many photographs of artefacts of the art 3D graphics.

The universal encyclopedia of mathematics, Pan, contains a useful treatment of coordinate transformations.

Software in QL Basic for producing and manipulating 3D wire-frame objects.

This program, and a more advanced one including features such as colouring and hidden-face removal—subjects of Hughes's next article—can be obtained by sending £3 and a blank QL tape or £5 to Hugh Gleaveis, PO Box 594, Muswell Hill, London N10 3PF.


ELECTRONICS & WIRELESS WORLD June 1986
Using SmartWatch

How to improve your computer's timekeeping with our current special offer

Adding a real-time clock to a microcomputer system equips it for a wide variety of uses in equipment control. And with Dallas Semiconductor's SmartWatch, clock and calendar features can be added to most types of micro with little or no modification of the hardware.

As an example, we show here how to fit SmartWatch to a BBC Micro. For further information about the facilities SmartWatch offers, see page 27 of last month's issue.

The i.e. and its built-in lithium battery are mounted in a 28-pin DIP socket which also carries an 8K-byte low-power static ram. The module will fit any of the sideways ram rom expansion boards sold for the BBC machine. However, a small addition to some such boards may be needed to enable the computer to write to SmartWatch.

Details of the modification, which may be found necessary in certain other computers, are shown in Fig. 1. Its purpose is to stop the ram's output-enable line pin 22 of the 28-pin memory socket from going low during write operations a condition which with ram is illegal. The 74HCT00 may be soldered piggy-back fashion on top of some other small diode device, its unused input pins connected to 0V or 5V. Do not be tempted to substitute a 74C00 or a standard 4000 series e-ros device - these are unlikely to have sufficient drive capability.

Software

The first listing, in BBC Basic and assembler is for setting the clock. To gain access to the clock it is necessary to write an unbroken sequence of 64 initialization bits to the a0 line of its socket. The sequence is held in the program in packed form as a set of eight bytes which are rotated one at a time and written until every bit has been sent. The same procedure is then used to write eight bytes of time data to the clock, in binary-coded decimal format.

The address we have chosen for write operations is $8008. In the Asum rom format this location holds a version number which can be disturbed without ill effect.

For reading the clock the initialization sequence is followed by 64 read operations. A suitable arrangement is shown in our second program example, which produces an interrupt driven date and 24-hour time display in Mode 7.

The program makes use of the vertical sync event of the BBC Micro, a pre-packaged interrupt which occurs every 20ms at the start of each field scan. To keep the interrupt service routine as short as possible the code is split into two parts, a section which reads the clock and stores the 16-bit time data at eight locations in page zero, and a display routine which formats it and writes it direct to screen memory.

A counter (flag) is decremented every 20ms by the event handler. When it reaches zero the code branches to the read routine. On the next event, the counter reaches $1FFF and the display routine is called. This routine ends by setting the counter and so fixing the number of events which must occur before the next read operation begins. Since the sync event occurs every 20ms, a value of eight gives five read-display cycles per second.

When the computer is in a display mode other than Mode 7, flag is set to a high value which will ensure that the clock is not accessed. It is certainly possible to use SmartWatch in other screen modes, but the display routine will be slower.

The machine code fits just less than a page and a half of memory: we have put it into the upper half of the soft key buffer and the storage area for characters 221-255 (page $C$).

But by deleting those parts which form the date display lines 310-370, 390, 410, 430, 460, 1120-1390 and 1760-1950 you can reduce it to under a page, or you can remove the display routine entirely and have your program extract the data direct from page zero.

Starting SmartWatch

SmartWatch is delivered with its oscillator turned off. It can be switched on by writing to one of the device registers. Full details, including logic levels and read write timing, are given in the data sheet supplied with SmartWatch.

In this application, the reset pin is not used. The pin can be disabled by writing to one of the SmartWatch registers.
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CIRCUIT IDEAS

Charger with reverse shut-down

Simple NiCd battery chargers have no built-in reverse connection safeguards. They simply discharge the battery at the set charge rate. This circuit cuts out automatically when the battery is reverse connected.

Two diodes, $R_1$, and $T_1$, form the charger and the second transistor and $R_2$ are the protection circuit. If an NiCd battery of more than 0.6V is connected, $T_2$ switches on and the circuit works as normal.

One-chip phase detector

A phase detector can be built using one XR13600 dual transconductance op-amp.

Cut-off frequency depends on control voltage $V_c$, which can be varied over a wide range.

The phase detector consists of a multiplier and voltage controlled low-pass filter. Given two input signals of $\sin(\omega t)$ and $\sin(\omega t + \phi)$, a signal of

$$\frac{1}{2}\cos\phi - \frac{1}{2}\cos(2\omega t + \phi)$$

appears at the multiplexer output.

Having low-pass filter cut-off frequency $\omega_c$ at far less than $2\omega$ gives $\frac{1}{2}\cos\phi$ at the output, i.e. output of the low-pass filter is proportional to phase of the incoming signal.

Kamil Kraus
Rokvany
Czechoslovakia

Reverse-connected batteries or ones giving less than 0.6V cause $T_2$ to turn off and shut down the circuit. Values shown are for PP3-type batteries.
John Wyrill
Huddersfield

S100 bus interfacing

Two 8212 i/o latches are used here to transfer data between an 8255 parallel i/o device and the S100 bus.

From the S100 side, port A of the 8255 is address byte BF0, and port C is byte BF6. Buffer-full information is on data line zero.

Hakikur Rahman
Dhaka
Bangladesh
16bit Z80 direct memory access

This circuit allows 16bit direct memory access (d.m.a.) to and from 16bit I/O and Z80 memory. Memory of the Z80 is logically divided into two - a low-order bank accessed when the A7 is low and a high-order block accessed when A7 is high. In this way the c.p.u. sees a single 128Kbyte memory.

The 245 buffers and write multiplexor prevent bus conflict during normal c.p.u. operation. During refresh, Z80 address line A7 is multiplexed with Z80 line A16 to ensure a full refresh cycle.

Memory-management unit M.M.U. maps the 128Kbyte data ram and program rom into the 64Kbyte logical c.p.u. address range. Data ram is mapped as four 32Kbyte blocks in the upper half of the Z80 address range, selected by writing the block number to the m.m.u. latch.

An inverted WR signal is used by the write-multiplexor to produce an early-write cycle which allows input/output pins on the d-rams to be connected together.

During c.p.u. accesses, Z80 line A16 switches the write-enable signal between high and low-order rams. When d.m.a. access is granted this function is disabled, allowing writing to both high and low-order rams.

Connection of the d.m.a. controller to the c.p.u. control bus is as usual, IORQ, MREQ, WR, BUSSQ, BUSAK, etc., but its address bus is shifted up by one so that the d.m.a. controller A7 is the Z80 A1, etc. In this way, the controller sees only 64K of 16bit wide ram.

Direct connection is used for interfacing the low-order data bus and controller. High-order data lines connect to an 8bit three-state latch controlled by the d.m.a. controller (the high-order data latch).

During a d.m.a. operation, the controller first reads the data bus, either memory or i/o, and strobes it into an internal latch. Using a write operation, the controller switches this latched data onto the data bus (16bit) and strobes it into the memory or i/o.

Assume that BUSSQ has been asserted, bus-release granted and that BUSAK inactive. The controller starts a memory-read cycle, output of IC, goes low (VDRAM). Bistable device IC, reset is released and on the first rising edge of clock, bistable device IC, output goes low.

One T-state later, which is 250ns at 4MHz, the rising clock edge raises IC, output and strobes data into the high-order data latch.

When the controller runs an i/o-read cycle it inserts an extra T state - a wait state - which causes the cycle to start on the rising clock edge. To prevent this first edge toggling IC, TIMAR is delayed by about 40ns by three LS07 buffers.

Controller write cycles DMAWR are detected when INRQ or MREQ is low, indicating data request (IORQ) and MREQ is high. Signal DMAWR goes low, resetting IC, Output which puts high-order data from its latch onto the data bus.

At the end of the write cycle, DMAWR goes high, removing the set condition from IC. Output of IC, remains low until the rising clock edge sets it high. This ensures stable data at the rising edge of the WR signal.

Address decoding, not shown, should be straightforward; decoding Z80 A15 must be high. This is done using INRQ, I/O and OUT (I/C) instructions. The C register is loaded with the port address and the B register with 8016. On execution of these instructions, the B-register is placed on Z80 lines A7.

Internal registers of the controller appear twice since the controller address lines are shifted. Apart from this, memory i/o source/destination and length registers can be loaded normally, although as one d.m.a. word is two bytes, the length and addresses should be carefully calculated.

Using the d.m.a. controller as an interrupt could cause problems since the IN instruction cannot supply an interrupt vector or sense an RETI return-from-interrupt instruction.

To produce IN, INP, and INA, I recommend reading John Adams' first SCS84 computer article in the May 1984 issue of EWW.

W. K. Todd
Colchester
Essex
Automotive telephone recording on cassette

These improvements to Wynne’s circuit on page 75 of the November 1985 issue included indicator leds and diodes which stop tape running but allow a standby indication. The main improvement is that the unit is powered by the tape-recorder low-voltage supply.

N. Cook Abbott
Ipswich
Suffolk

Linear led voltage indicator

The range of colours produced by the three-colour led in this arrangement gives a fair indication of input-voltage level.

This version indicates from 0 to -12V as a smooth progression from off through green and yellow to red and it can easily be modified for other input ranges and polarities.

H. R. Banton
Manchester

Reliable LC oscillator

LC oscillators can be temperamental. Either they require experimentation with circuit values to make them oscillate or they are complicated.

This one is guaranteed to work, tunes from 2-10 MHz, is stable and has low harmonic output. It would be ideal as the v.f.o. for a transmitter or receiver.

P. Hall
London

Telephone-line microphone output

This is a very simple passive audio take-off for recording from a telephone line. It can be shunted across the line at any point and left in place if desired. Normal working of the telephone is unaffected. Ringing current and line surges are suppressed and it is unlikely that the recorder will be damaged; I use the circuit without the limiting diodes.

Good quality components are essential and the capacitors should have a 250V direct rating. A 600Ω 1:1 ratio isolating transformer can be inserted between the output of the device and recorder input if required.

D. Brooks
London

Telephone circuits

Please remember that in the UK, all equipment for connection to the public-switched network must have BABT approval. BABT does not consider circuit diagrams for approval, only complete apparatus, and the approval process is expensive and time consuming.

The approval system is intended to ensure that signals passed down the telephone line are within certain limits so that they do not cause interference on other lines, and to ensure that lethal voltages never appear on the telephone line.

British standards relating to connection of apparatus are given in the December 1985 issue, page 77.
CIRCUITMATE DM10
MINIATURE DIGITAL MULTIMETERS

Small size, great accuracy, gigantic value.

This 3½ digit multimeter has a basic DC accuracy of 0.8%, compared with 3% of full scale on most low-cost analogue instruments. For around £32.

Measuring only 4.75 x 2.75 x 0.95 in, the DM 10 is light in weight and easy to carry in a shirt pocket. It features DCV, ACV, Ohms and diode test, with fuse protection on current ranges.

For an extra £3, model DM 10B gives you a continuity bleeper, too. It's part of a great range of CIRCUITMATE low-cost test instruments from Beckman Industrial.

Please write for details.

Circuitmate by Beckman Industrial. Performance at a practical price.

Beckman Industrial
Beckman Industrial Ltd., Queensway, Glenrothes, Fife, Scotland KY7 5PU. Tel: 0592 75 3811. Telex: 72135.

CIRCLE 48 FOR FURTHER DETAILS

TRANSFORMERS EX-STOCK

Mains Isolators

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300V or 500V Test Volt. 400V 600V

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CIRCLE 49 FOR FURTHER DETAILS

ELECTRONICS & WIRELESS WORLD JUNE 1986
BBC Computers & Ecomet Referral Centre

ABC15 BBC MASTER Foundation computer 128K................. £435 (a)
ABC12 BBC MASTER Ecomet computer 128K (only AN5S)........ £348 (a)
ABC 1F 1/8th O2 Expansion Module............................. £107 (b)
ADIF Rom Cartridge .................................................. £135 (a)
ADP11 Ecomet Module.................................................. £151 (a)
ADU2 Ref. Manual Part I............................................. £149 (a)
ADU3 Ref. Manual Part II............................................ £149 (a)
ADU4 Advanced Ref. Manual..................................... £130 (a)
View 3 User Guide ..................................................... £10 (d)
RAD DOS Version 4.0.......................... £17 (c) 1700D3 UPGRADE for Model 5 (including 8K DRAM)........ £35 (d)
ROB 3.5D Processor.............. £232 (c) 1700D2 Processor............. £232 (c) 8K UPGRADE KIT FOR 8K DRAM........ £33 (d)
COMA 3RD Processor (2 Card).................. £199 (c) 6552 2nd Processor............. £169 (c)
MULTI FORM 2nd Processor.......... £130 (c) 6552 1st Processor.............. £109 (c)
TREC 886 Dual Processor ZEP 100........... £229 (a)
TDP92 Dual Processor ZEP 100........... £229 (a)
TDP90 ZEP 100 with Technicam PD90P dual drive with built in monitor stand........ £249 (a)

META-ASSEMBLER. Both an editor and Macro-Assembler. Meta can assemble most 68xx, 680x, 6804, 6805/6305, 6809, 8048, 8080/8085, 280, 180 and more. Please phone for comprehensive list. Meta-Assembler £126 (c)

We stock the full range of ACORN hardware and firmware and a very wide range of peripherals for the BBC. For detailed specifications and pricing please call for our latest list.

PRINTERS & PLOTTERS

EPSON LQ-500Q ......................................................... £195 (a) Optional Tractor Feed........................................ £29 (a)
EPSON FX 80 .......................................................... £315 (a) FX90 (16K)....................................................... £220 (a)
EPSON NLQ-500 ......................................................... £315 (a) Colour printer.................................................. £220 (a)
EPSON LQ Printer ...................................................... £210 (a) LQ1500 (120 col) 2K Buffer................................. £297 (b)
LP90 (48K)............................................................ £275 (b) 32K buffer...................................................... £295 (b)
TAS105 (48K).......................................................... £230 (b) TASC01(TS)..................................................... £187 (b)
KPII2010 (60K)....................................................... £220 (b) KPII150 (60K).................................................. £139 (b)

DAISY WHEELS

BRC100 MOTORS (4).................................................. £285 (a) JUNK6100...................................................... £289 (a)
CENTRICCOLS CLP (NON CLIP) Printer........... £169 (b) Tractor Feeder.................................................. £14 (d)
CENTRIFUGAL CLP (CLIP) Printer............... £169 (b) NOL TRACTOR Feeder................................. £28 (d)
Epson Printer (68 LQ)............................................... £325 (b) Integrex Colour Printer............................... £16 (b)
JUNK1010 Dot Matrix Printer.............................. £229 (b) JUNK510 Colour upgrade.......................... £99 (b)

PRINT ACCESSORIES

We hold a wide range of printer attachments (sheet feeders, tractor feed etc) in stock. Serial, parallel, IEEE and other interfaces also available. Ribbons available for all above printers. Pens with a variety of tips and colours also available. Please phone for details and prices. Plain Fanfold Paper with extra fine perforation (Clean Edge): 2000 sheets 9.5 x 11 £11 (b). 4000 sheets 14.5 x 11 £18.50 (b).
Labels per 1000: Single Row 3.5 x 11 £13.95 Label 18 Row 3.75 x 16 £18.50 (b)

MODEMS

MIRACLE WS 2000

The world standard BT approved modem covering all standard CCIT and BELL (outside UK only) standards up to 1200 baud. Allows communication with virtually any computer system in the world. Expandability to Auto Dial and Auto Answer with full software control enhance the considerable features already provided on the modem. Mains powered. WS 2000 E102 (b), Data Cable £78 (d).

NEW WS-3000 RANGE — the new professional series. All are intelligent and "Haved compatible, allowing simple "English" command to control its many features. All models feature Auto-Dial with 10 number memory, Auto-Answer, Speed buffering, printer port, data security option etc. All models are factory upgradable.

WS3000 V2123 (V21 & V23 + Bell £295 (a) WS3000 V22 (as above plus 1200 baud full duplex £495 (a) WS3000 V22bis (as above plus 2400 baud full duplex £550 (b) Data Cable for WS3000 £96 (b). Data Cables for other micros available

The WS3000 range all have BT approval.

GEC DATACHAT 1223: An economically priced BAS7 approved modem complying with CCITT V32 standard capable of operating at 1200/75bps and 75/1200bps and 1200/2000bps pseudo full duplex. It is line powered. It has a standard 15pin serial I/O and 2 line I/O. Can be used as an emulator, carphone interface, etc. Supplied with internal 9pin to 25pin Adaptor £295 (b).

SOFTWARE

This low cost intelligent accessory can be run on 216, 216A, 2500, 2700, and with an Option, 3500 and 3700. Displays 2k byte capacity with a standard TV and has a serial parallel input and output. Can be used as an emulator, carphone interface, etc. Supplied with internal 9pin to 25pin Adaptor £295 (b).

SPECIAL OFFER 2764-25 £200 (c) 27128-25 £250 (d) 6264 LP-15 £340 (d)

ABC ECOMET INTERFACE £278 (a) INDUSTRIAL PROGRAMMER £980 (a) EPROM 27128 £160 (a)

I.D. CONNECTORS

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CONNECTOR SYSTEMS

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ATTENTION

All prices in this double page advertisement are subject to change without notice. PERCENTAGES EXCLUDE VAT. Please add 50% if indicated as “(a).” £3.25 for £1.50 (c) £1.00 (a)
From Shure, a microphone system that mixes automatically

Presenting a remarkable breakthrough from Shure — microphones, mixer and logic technology all combined in one totally integrated system of quite astounding aural quality. Each microphone has complete independence within the system, eliminating all unwanted sounds.

AMS 24

AMS 28

AMS 26

Privacy button, free discussion or single speaking facilities — and many other important capabilities. The AMS offers a choice of four effective types of microphone for all purposes: the unimodulating Low-Profile AMS22; the AMS26 Lavator for wearing round the neck; the adaptable AMS26 Probe for table, floor stand or gooseneck mounting; and the AMS24 Condenser specially designed for the gooseneck unit.

In short, the AMS represents a major advance in sound technology. For further information or a demonstration, simply contact Shure at the address below.

AMS by

SHURE

HW International 3-5 Eden Grove London N7 8EG Tel 01-607 2717

CIRCLE 68 FOR FURTHER DETAILS

PINEAPPLE SOFTWARE

Programs for the BBC model 'B' with disc drive with FREE updating service on all software

ARE YOU GETTING THE MOST FROM YOUR DOT MATRIX PRINTER AND DISC DRIVE? DIAGRAM is a new program which really exploits the full potential of the BBC micro and will enable you to obtain printouts of a size and quality previously unobtainable from your system.

FEATURES

- Draw diagrams, schematics, plans etc. in any aspect ratio, e.g. 1.5, 1.5:1, 1:2, 1:3 etc.
- Access any part of the diagram rapidly by entering an index name, e.g. 10, 5, 2 etc. to display a specific section of the diagram, and then scroll around to any other part of the diagram using the cursor keys.
- Up to 128 items may be pre-defined for each diagram, e.g. Transistors, resistors, etc. in full mode 0 definition, up to 52 points horizontally by 24 vertically.
- Hard copy printouts in varying print sizes up to 128 x 128 points on an A4 sheet, compatible with most dot matrix printers.
- Many other features including selectable display colours, comprehensive line drawing facilities, 148 settings, etc.
- The latest version of DIAGRAM is now fully compatible with the Marcon Tracker Ball which allows "scratching" of the screen and many of the editing features to be carried out using the tracker ball.
- DIAGRAM is supplied in an attractive hard backed book with a slip case and comprehensive instruction manual.

OSCILLOSCOPES

- PRF. 1 10MK Dual Trace 20MHz 0.3mV/ Div Dyn Sweep $250
- PRF. 1 10MK Dual Trace 50MHz 0.3mV/ Div Dyn Sweep $350
- TEXT 10MK Dual Trace 90MHz 1mV/ Div Dyn Sweep $450
- TEXT 20MK Dual Trace 100MHz 1mV/ Div Dyn Sweep $550
- TEXT 30MK Dual Trace 100MHz 10mV/ Div Dyn Sweep $650
- TEXT 50MK Dual Trace 100MHz 100mV/ Div Dyn Sweep $750
- TEXT 100MK Dual Trace 100MHz 1V/ Div Dyn Sweep $850
- TEXT 200MK Dual Trace 100MHz 10V/ Div Dyn Sweep $950
- TEXT 300MK Dual Trace 100MHz 100V/ Div Dyn Sweep $1050
- TEXT 500MK Dual Trace 100MHz 1V/ Div Dyn Sweep $1150
- TEXT 1000MK Dual Trace 100MHz 10V/ Div Dyn Sweep $1250

MULTIMETERS

- PRF. 1 10MK Dual Trace 20MHz 0.3mV/ Div Dyn Sweep $250
- PRF. 1 10MK Dual Trace 50MHz 0.3mV/ Div Dyn Sweep $350
- TEXT 10MK Dual Trace 90MHz 1mV/ Div Dyn Sweep $450
- TEXT 20MK Dual Trace 100MHz 1mV/ Div Dyn Sweep $550
- TEXT 30MK Dual Trace 100MHz 10mV/ Div Dyn Sweep $650
- TEXT 50MK Dual Trace 100MHz 100mV/ Div Dyn Sweep $750
- TEXT 100MK Dual Trace 100MHz 1V/ Div Dyn Sweep $850
- TEXT 200MK Dual Trace 100MHz 10V/ Div Dyn Sweep $950
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- TEXT 500MK Dual Trace 100MHz 1V/ Div Dyn Sweep $1150
- TEXT 1000MK Dual Trace 100MHz 10V/ Div Dyn Sweep $1250

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CIRCLE 72 FOR FURTHER DETAILS
Coin recognition in vending machines

Inductive sensors and custom l.s.i. combine to reject dud coins

Social trends are making it increasingly impractical to employ people in routine point-of-sale tasks; vending machines are rapidly becoming the norm rather than the exception here. Some advances in vending machine technology have been obvious—the ability to accept a variety of coin values, give change, and even to synthesize verbal prompts—but the less obvious developments which underwrite the more extensive use of vending machines lie in the improved accuracy of coin-recognition mechanisms. It is the application of the latest l.s.i. and transducer technology which has permitted this enhanced performance.

The vending and amusement industry is constantly on the lookout for ways of combating the ingenuity of would-be fraudulent users who continue to devise new kinds of coin counterfeits, known colloquially as 'slugs'. To frustrate these efforts, more discriminating coin-recognition mechanisms became essential. Yet, with the average life of a coin stretching to ten years, sufficient tolerances to cope with the subsequent change in characteristics of valid coins must be accommodated.

Mars Electronics achieved the first reliable solution to these conflicting requirements. The design described here can accept up to six different 'valid' coins.

Inductive sensors

The combined results of three independent tests, matched against a "template" held in prom, determine whether a coin is accepted. The sensors measure the thickness, material composition and diameter using inductive principles. The location of these successive transducers is shown in Fig. 1, which also indicates the physical passage of the coin; the ceramic snubber serves to absorb excessive kinetic energy and ensure smooth passage of the coin through the mechanism. There are subsequent monitor devices (not shown) which check that the mechanism has not been tampered with. Economical use of the electrical power is achieved by implementing a standby mode, where only the first sensor and the c-mos detection circuits are active until a coin is inserted.

Each sensor is made up of one or two ferrite-core coils, which are arranged symmetrically to face the path of the coin. The inductors are components in resonant circuits; the physical size of the coils and the fundamental frequency are different for each sensor, being carefully chosen to give the optimum sensitivity for the desired characteristics being measured. As the coin passes the coils, the oscillator frequency is increased and the amplitude of the oscillation is reduced through energy absorption by the coin.

In the case of the first sensor (thickness), the fundamental frequency is 1MHz. This is sufficiently high to ensure that the electromagnetic energy does not penetrate significantly into the bulk of the coin (because of skin-effect), and the frequency shift can be almost totally ascribed to the distance of the coin surfaces from the coils (i.e. the thickness of the coin).

Further information can be gathered by this transducer. The circuit is sensitive enough to accurately read the depth of the stamping on the faces of the coin and to some extent the pattern. This information is most valuable for differentiating between coins of otherwise similar characteristics: for example, the 5p piece and the German 1DM.

In the case of the second (composition) sensor, the aim is to evaluate the conductivity of the material, so a lower fun-

Fig. 1. Physical path of the coin through mechanism, indicating the position, relative size and sequence of the three sensors.

Fig. 2 shows how the acceptance window is modified to individual machine manufacturers requirements by adjusting the acceptance rate for valid (but worn) coins and the rejection rate for counterfeit or foreign money. 5p coin is accepted 90% of the time, with a worse-case 10% acceptance of the 5 peseta coin. Broken line shows 5p coin accepted 98% of the time, with a worst-case 30% acceptance of the 5 peseta coin.
Improving 4000 series oscillators

Continued from page 35

receiver as a synchronized horizontal or vertical oscillator. Inasmuch as there is no 'long first pulse' to react against the sync pulse, it will become instant starting dependably. Then consider adding a three-five-eight crystal into the circuit to interrupt the pulse, and it becomes a combination horizontal oscillator and colour burst generator in one chip... actually in half a chip, as the other half could be the synchronized vertical oscillator. But this is outside of the scope of this article.

Fig. 2 shows an output circuit for coupling the negative-going signal on IC2 pin 4 to the base of TR1, which keys a negative-grid-block transmitter. Resistor R5 is for decoupling, capacitor C1 is for d.c. blocking, and U5 is used to turn the transmitter on continuously for 'tune-up'. Turn-on is accomplished when SW2 is reversed from the position shown. Then the negative voltage at the transmitter key jack will go through D3 to the base of TR1 and then through the base-collector diode of TR1 in forward direction to ground, thus keying the transmitter on continuously. Study of the circuit will show that in the reverse switch position, the keyer will key a positive-cathode keyed transmitter... and in that case, returning the switch back to the position shown, it will turn on the transmitter continuously. In other words, the circuit will key both negative and positive keyed transmitters.

An interesting factor, not generally known, is that the pulse at IC1 pin 3 may be too fast to trigger a flip-flop. There are several ways to overcome the problem, but the simplest and most effective one turned out to be the addition of a small capacitor between IC1 pin 3 and IC2 pin 4. It serves to slow down the transfer-time at pin 3 by some inverse feedback from pin 4. It is an important part of the circuit shown in the panel.

Figs 1 and 2 turn out to be a practical and operable keying instrument. The only other modification would be the addition of r.f. by-pass capacitors (1nF) from IC1 1 and 2 to ground and from TR1 collector to ground.

An alternative to the Fig.2 circuit would be the use of an n-p-n transistor in place of the p-n-p transistor. In that case, the input would be taken from Iq pin 3, and C1 would be eliminated. It would still key both plus and minus keyed transmitters, but the common ground would be better for cathode-keyed transmitters. In Fig.2, D3 prevents a positive cutoff charge from building up on the base of TR1. It may also increase the actual drive, but these effects may not be prominent due to the high resistance of R4 and any leakage in C1 and TR1. The Fig.3 r.f. amplifier circuit shows the effect more predictably. Notice that D3 replaces the usual base-return resistor, thus eliminating the circuit loading which would occur on both the positive and negative halves of the driving cycle. On the negative half, it puts a positive charge on C1 so that on the positive half the driving voltage is double. Transistor TR3 collector current becomes a square wave that is rich in odd harmonics. If a resistor is connected in series with D1, some negative bias will be allowed to build up, so the TR3 collector current will become a pulse wave, rich in even-order harmonics. Either way, circuit efficiency will be higher, whether it is an amplifier or frequency multiplier.

Wallchart of frequency allocations

Since the mid-1970s, when our last wallchart of frequency allocations appeared, there have been many changes in the radio spectrum. Some have been minor points of detail; others, like those that flowed from the World Administration Radio Conference in 1979, have been more far-reaching. Following the recommendations of the Merriman committee, the UK administration recently released much information not previously available about its frequency assignments. Within the civilian allocations, our chart therefore carries more detail than its predecessor. However, information about bands occupied by the government is still in short supply.

Allocations in the United Kingdom follow closely the general pattern for Region 1, which includes Europe, Africa and Soviet Asia. However, other national telecommunications administrations, the DTI enjoys the freedom to depart from the basic plan where the risk of creating undue interference between neighbouring countries is small. Some information on the chart therefore does not hold good for other European countries.

The aim of the chart is to give a picture of the uses to which the various parts of the radio spectrum are put. Detailed information has been included where space allows but much has had to be left out. Several categories of radio user have been merged in the interests of readability; for instance under the heading Aeronautical we have bracketed the aeronautical fixed, mobile and satellite services.

'Primary' and 'permitted' services are the principal users; 'secondary' users may not cause interference with either of them, but can claim protection against interference from other secondary users assigned later.
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ELECTRONICS & WIRELESS WORLD JUNE 1986

59
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**ELECTRONICS & WIRELESS WORLD JUNE 1986**
APPLICATIONS SUMMARY

Low power f.m. transmitter system

This is one application of a chip designed for f.m. communication equipment transceivers, cordless telephones, remote control and data links.

In the circuit shown, tone oscillator and microphone output can be summed at the audio amplifier input or at the modulator input through resistors.

Motorola application note AN1102 for the MC2831A i.e. describes further applications including a single-channel cordless telephone and base set, and 10 channel versions. A brief functional description of the i.e. and wiring for tone burst or dual-tone f.s.k. are also given.

The MC2831A includes an audio amplifier with limiter, r.f. oscillator for up to 30 MHz, tone oscillator for pilot data signalling and a variable reactance frequency modulator. Designed for battery operation, the 2831 has a supply voltage monitor and runs from 3.8-V.

EW200

Application notes received

Analog Devices
AD670 8-bit ad converter applications.

Low-cost two-chips voltage-controlled amplifier and video switch.

Brooktree
Comparison of NTSC, PAL and SECAM video levels, AN3.

Digitonal-to-analogue converter definitions, AN4.

Differential gain and phase characterization of Videodac AN5.

Motorola
Interfacing the MC145418 and MC145419, AN945.
MC68HC052C4 8-bit eeprom MCU programming module, AN966.

Floppy disk drive design using FDP control processor and MC2870 read-write amplifier, ANHK04.

New mosfets revise power transistor performance specifications, ARR1468.


Rockwell
B6511Q-based terminal.

Low-power c-mos terminal design, Application Note 2185.

Apple Ile to LCE download program, Application Note 2194.

Quality of received data for signal processor-based modems, Application Note 671.

8088 microprocessor to R1212/2041 modem interface, Application Note 672.

Interfacing Rockwell signal processor-based modems to an Apple Ile computer, Application Note 673.

R9FAX modem tone detector filter tuning, Application Note 688.

R2424 and R1212 modems auto dial and tone detection, Application Note 676.

Analog Devices Ltd, Central Avenue, East Molesey, East Molesey, Surrey KT8 0SN.

Brooktree: Thame Components, Thame Park Road, Thame, Oxon OX9 3XD.

Motorola: Hawke Electronics Ltd, 45 Hanworth Road, Sunbury-on-Thames, Middx TW16 5DA.

Rockwell International Ltd, Central House, Lampton Road, Hounslow, Middx TW3 1HA.

ELECTRONICS & WIRELESS WORLD JUNE 1986
Using video d-to-a converters

In video d-to-a conversion, proper component selection, hardware and p.c.b. layout are essential for stable, low-noise operation.

Because the video converter is part analogue and part digital, the analogue output signal is subject to degradation from power-supply noise, ground loops, radiated pickup and magnetic coupling.

Brooktree application note AN1 provides guidelines to help both the design engineer and p.c.b. designer get the best from a video d-to-a converter.

EWW301

12 bit analogue i/o port

Details of an i/o port for measuring and producing analogue signals are given in Analog Devices note “12 bit Analog I/O Port Uses AD7549 and 8051 Microcomputer”.

The 7549 consists of two 12bit multiplying digital-to-analogue converters, each with its own data register. Output current settling time of each converter is 1.5µs.

Data is loaded into the 7549 from the 8051 microprocessor through a 4bit data bus in three parts. One of the two d-to-a converters is used with comparators and software successive approximation for analogue-to-digital conversion.

Software described consists of two main routines, one for each conversion direction. Output software for d-to-a conversion uses 55 program bytes to transfer the 12bit digital word from 8051 memory to the 7549 register. This routine takes about 74µs.

Execution time of the 15 byte analogue-input routine varies between 140 and 180 µs depending on the input signal value. This variation is caused by the successive approximation.

For increased bandwidth, the input buffer can be replaced by a sample-and-hold circuit to allow sampling of signals up to 2.7kHz. Details of the s/h circuit are not given in the note.

EWW302

Solid state pressure switch

Output from MPX piezoelectric pressure sensors is a millivolt-level analogue signal. By adding two op-amps and a relay, as in Motorola application note AN962, these sensors become simple and economical pressure limit switches.

Construction of the sensor is detailed in the note and there is a table of operating characteristics for comparing various sensors in the MPX range. There are devices for four pressure ranges between 0-10 and 0-200kN m⁻² (0-1.5 and 0-30lb in⁻²).

The circuit – with p.c.b. layout – is well described and the note includes suggestions improving circuit performance. Applications of the circuit include compressor motor control, liquid level control and clean-room pressure maintenance.

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CIRCLE 20 FOR FURTHER DETAILS

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CIRCLE 28 FOR FURTHER DETAILS

ELECTRONICS & WIRELESS WORLD JUNE 1986
NEW PRODUCTS

Colour palette on a chip

A resolution of 1024 by 1024 pixels and a virtually unlimited (16 million) range of colours are available through the Am8051 graphics colour palette. The device is a 200MHz d-to-a converter with look-up table Ram and video sync mixing. It has inputs for horizontal and vertical syncs and for blanking. Another input enables the overlaying of text or graphics. For high-speed applications, greater than 60MHz, the chip will accept ECL signal levels, otherwise t.t.l. levels are accepted.

Three of the devices, one each for red, green and blue would be required in a colour graphics system. In monochrome applications, the 8151 can be used as a gamma corrector or as contrast enhancer for image processing. Advanced Micro Devices (UK) Ltd, Goldsworth Road, Woking, Surrey GU21 1JT.

EWW 215 on reply card.

Logic analyser for microprocessors

New from Gould Electronics is the K 115 logic analyser which is specifically designed for use in designing, debugging and testing microprocessor application circuits. It has 32 or 64 channels at 20MHz for logic level and timing in 8, 16 and 32-bit applications and a direct link to either four or eight channels at 5ns, or 8 or 16 channels at 10ns. A major feature is the ability to switch between state and timing modes by push button, without the need to reconfigure the hardware. Gould Electronics Ltd, Instrument System, Roebuck Road, Hainault, Ilford, Essex IG6 3UE.

EWW 229 on reply card.

Frequency-counting multimeters

Built-in frequency counters have been added to two Beckman digital multimeters. DM800 (€125) has average readings for alternating current and voltage, while the DM850 (€175) offers true r.m.s. D.c. accuracy for both meters is 0.05%

The frequency counter facility allows measurement up to 200kHz and may be used, for example, on modem tone testing. There is a 'data hold' switch which retains the

Quiet fan

Suitable for use in office computers or other electronic devices, the Papst 812GL fan operates from a nominal 12V direct supply. Its noise level is claimed to be 24dBA, quieter than the background noise in a quiet office, it is fitted in a 79mm square frame with a depth of 39mm. Speed, airflow and noise can be adjusted by varying the power voltage between 8 and 16V. Available through Dialogue Distribution Ltd, Watchmoor Road, Camberley, Surrey GU15 3AQ.

EWW 218 on reply card.

Long-life slide potentiometer

A new wiper design, patented in Germany by Novotechnik, incorporates two wiper arms mounted in line with each other. Their pivot points are on opposite sides of the wiper carrier. Both units act as a single pick-up, providing an average output which lies between the values picked up by each arm. Mechanically the arms operate in opposition and cancel out errors which can be caused under extremes of acceleration and wear. The general result is more tolerance of spacing between the rack and the wiper; capability of high linear acceleration and a fourfold increase in wiper reliability. The TLH series of potentiometers are available with linearities down to 0.01% and in lengths up to two metres. The rodless design also saves on space. Available through Variohm Components, Cattle Market, Watling Street, Towcester, Northants NN9 7HN.

EWW 219 on reply card.

Compact stepper motors

High torque and performance characteristics are claimed for these compact, lightweight Vextra stepper motors. The PX series of two-phase motors have step angles of 0.9, 1.8 and 3.6°, with versions suitable for bipolar and unipolar drives. Working over a wide temperature range and with high insulation resistance, the motors are thought to be best used in computer applications such as floppy or rigid disc drives, small printers and x/y plotters. Leeway Data Products Ltd, Central Way, North Feltham Trading Estate, Feltham, Middlesex TW14 0RX.

EWW 225 on reply card.
Oscilloscopes from Hitachi

VC6020 costing £1395 is a 1000MHz dual-trace digital storage oscilloscope. It features a maximum sampling frequency of 1MHz, a vertical resolution of eight bits and a storage capacity of 1Kbyte/channel. It has a pre-triggering function. Storage modes are Normal, Hold, Single and Roll, the latter is used for monitoring at very low speeds. The instrument is provided with an output to a chart recorder and a GPIB interface to controllers or to computers for data storage. Hitachi Denshi (UK) Ltd, 13 Garrick Industrial Estate, Garrick Road, Hendon, London NW9 9AP.

EWW 223 on reply card.

Low-cost 50MHz oscilloscope

Two particular features make the Philips PM3055 different. The first is that it has a green button on the front marked ‘Auto set’. This automatically adjusts the settings on the oscilloscope to find the trace, scale the amplitude and select the correct timebase and trigger to display the incoming waveform correctly. The second new feature is the large L.C.D. panel which gives a direct readout of all the settings in use. The settings can be easily altered by the use of the rocker switches next to the L.C.D. panel and the series of push buttons to select functions such as timebase and trigger settings. It is possible to have an add-on GPIB interface. The dual trace oscilloscope has the additional ability to display the trigger waveform.

Philips have taken a leaf from the Japanese manufacturers’ book to automate the production of the PM3055. It has a one-shot moulded case and all the internal electronics are plugged in easily and quickly. This leads to easy servicing, and a quick-test program through the GPIB interface is used to diagnose any faults. It also leads to the low cost of £850 for a dual timebase unit and £890 for the single timebase. Pye Unicam Ltd, York Street, Cambridge CB1 2PX.

EWW 228 on reply card.

Surface mount resistor networks

Resistor networks in miniature packages for surface and through-hole mounting offer considerable space saving on P.C.B.s. They can be used in pull-up/pull-down applications and for 7-segment I.E.D. current limiting, d-to-a conversion ladders etc. These from CorinTech come in two configurations, as seven separate resistors or 13 resistors with a common connection. Standard values are from 10Ω to 1 MO in the E6 series, with a tolerance of 2%. Other configurations and values are available to order within four weeks. CorinTech Ltd, Ashford Mill, Station Road, Fordingham, Hants SP6 1DG.

EWW 212 on reply card.

Telecomm ICs

Several new integrated circuits aimed at the telecommunications market appear to be on the market. Philips’ products include the V22/Bell modem chip set which includes a high speed capacitor filter, a modulator, demodulator, data buffer and V22 filter for full-duplex operation up to 1200bit/s. Another chip is the V22/160 data set, a low-power PIC line driver. The bi-directional TIC repeater chipset provides data transmission at up to 3,152Mbit/s. Other telecomm ICs are an interface circuit for operation at 2 or 8Mbit/s and speaker phone chips for use in intercoms, mobile telephone, etc. Exar are also promoting their standard cell approach to application-specific analogue and digital integrated circuits and claim that their analogue ICs are designed as easily as digital circuits using a building-block approach. Available through MicroCall Ltd, Thame Park Road, Thame, Oxon OX9 3RS.

EWW 230 on reply card.

Immersible switches

A series of d.i.l. switches are available which have internal rubber sealing and can be immersed for cleaning. They do not need to be taped up and thus save much time and trouble. The A6D range comes in ‘top’ or ‘side’ actuated types and with 4, 6 and 8 ways. The switches can cope with 100mA d.c. at 50V and have a life expectancy of 5000 mechanical switchings. They also save space by being smaller than comparable d.i.l. switches.

IMO Precision Controls Ltd, 1000 North Circular Road, Stanmore Corner, London NW2 7JP.

EWW 213 on reply card.

Extruded enclosures

The traditional die-cast box may have reached the end of the line with the launch of an ingenious range of extruded aluminium boxes by Lincoln Binns Ltd. The Line-Ace system is based on three standard extrusions, the largest of which is big enough to house a disc drive or medium-sized power supply. On the outside are dovetails which interlock with those on other units in the range, or can accept fixing brackets or rubber feet. Inside, as well as the usual mounting slots for P.C.B.s, is a slide-way into which can go a clever heat-sinking bracket for power transistors up to TO-3 size. On its bracket a transistor may be soldered direct to the board. Yet the user can slide the whole assembly in and out freely without the need to dismantle anything.

The metal panels at front and back can be weatherproof with sealing gaskets. No drilling is required.

All units are obtainable black anodized or with natural finish. In one-off quantities, the natural finish version costs no more than an ordinary die-cast box of the same size. Lincoln Binns Ltd, P.O. Box 110, Haywards Heath, West Sussex RH17 5YU.

EWW 227 on reply card.

Pulsed probe

This digital pulser injects a signal into a circuit node to determine if the device at that node is working correctly. This avoids the need to isolate the device from the circuit. It can inject a 2μs single pulse, or a pulse repeated at 0.5Hz or 500Hz. It can drive a node that is not powered by the host circuit or sense the state and voltage of the node and provide the power to force the node into the opposite logic state. The instrument has a high input impedance, while output impedance is low to avoid loading the circuit under test. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4SL.

EWW 214 on reply card.
The programming language Fort is much to offer electronics engineers wishing to develop microprocessor based boards running specialized applications. Normally, assembler or machine code would be used and ROM memory. Forth can give substantial advantages over this approach, such as programming at both machine and high levels, rapid and interactive development of code, and high speed and compact programs. A cross compiler will then allow a forth application developed and debugged on a particular operating system, such as on a desktop micro, to be transferred to run on a given processor in ROM.

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CIRCLE 10 FOR FURTHER DETAILS

CIRCLE 9 FOR FURTHER DETAILS

ELECTRONICS & WIRELESS WORLD JUNE 1986
68000 second processor for BBC

A second processor for the BBC features the full 68000 16/32 bit processor. Intended for the professional and educational markets the system enables the study of 68000 software and hardware. The system monitor included on the board enables the user to load and execute programs, examine and dump the memory, alter 68000 registers, load the BBC memory to the 68000, or from the 68000 to the BBC and execute all BBC osbyte calls. It is possible to step through a program with a register dump following each step. The board has a Eurocard connector to enable expansion of the data, address and control lines. All the usual BBC peripherals: printers, disc drives, analogue i/o etc. can be driven from the 68000.

The board comes with 128K ram, assembler, monitor and BBC link in eprom, two systems discs, connecting cables and fixings, and three manuals. All for £299.
Delcom Microcomputer Systems Ltd, 46 Nasmyn Road, Glenrothes, Fife KY6 2SD.
EWW 208 on reply card.

...and a user port extender

When a user wishes to add serial printers, modems, touch screens or such special input devices as mine or tracker balls, the BBC is somewhat limited by the serial interface provision. The need to use a touch screen within an interactive video workstation led the National Physical Laboratory to develop the Soft Switch. This uses the software of the BBC's operating system to select one of eight devices which can be permanently connected to the computer through 5-pin DIN connectors on the Soft Switch. The switch itself connects to the computer through the user port. By controlling the handshake of the eight peripherals it is possible to ensure accurate data transfer in complex configurations.

The Compton Soft Switch is manufactured under licence from the NPL and marketed (£165) by Soft Option Ltd, Imperial House, Lower Teddington Road, Kingston, Surrey KT1 4EP.
EWW 209 on reply card.

Mosfet power amplifiers

Modular 60W power amplifiers can be fitted in parallel to provide outputs of 120, 180, or 240W. Powerbloc, developed by Audix, are incorporated into the Wenden range of integrated mixer and amplifiers. The mosfet modules are inherently resistant against short and open-circuit, and their modularity enables the use of multi-channel outputs within a single rack unit.

Audix managing director, John Bilet, said that they had achieved a method of providing a wide range of outputs in mixer and power amplifiers using as few building blocks as possible. Audex Ltd, Wenden, Saffron Walden, Essex CB11 4LG.
EWW 221 on reply card.

TV tuner on a chip

Push-button synthesized selection of up to 39 tv stations is provided by the SAA1293 integrated circuit from IFT. The device uses voltage synthesis rather than frequency synthesis thus reducing the number of components required and the cost. Tuning voltage is generated by a 12-bit d-to-a converter. Three outputs for uses such as volume, colour intensity and contrast control are also provided. As well as direct station selection the device offers sequential selection, automatically scanning through the stations at intervals. The control program, held in the chip's on-board ram, contains a number of alternative program paths. A companion non-volatile memory chip provides storage of station tuning and analogue settings. Simple setting of flags within the memory permits the addition of extra features, such as picture fade when changing stations. The 1293 offers a direct interface to a standard teletext chip set and is operated from 32-key pad. ITT Semiconductors, 146 Ewell Road, Surbiton, Surrey KT6 6AW.
EWW 222 on reply card.

Z80000 cpu uses 32 bits

Where high speed and/or large system tasks need to be performed, the Zilog Z8000 is ready for the job, says Hi-Tek. The chip is provided with 16 registers which can handle 8, 16 or 32-bit words. It can also use 16 or 32-bit addresses and has a 256Kbyte on-chip cache which can store the most recently used logical addresses and instructions. This is coupled with an instruction pipeline and a memory management unit. There is also a clever error-trapping mechanism. The Z80000 series uses Zilog's Z-bus and can be used with the full range of Z8000 support chips. Hi-Tek Electronics Ltd, Beadle Trading Estate, Ditton Walk, Cambridge CB5 8DQ.
EWW 210 on reply card.
Complete 8052 BASIC Controller Development System

Yes, for the remarkable price of under £1,000 we are able to provide a complete turn-key 7000 Series Development System which includes the superb full-featured Lear Siegler AMD3 terminal, card cage complete with all guides, 12 slot backplane, 7030 CPU complete with 9K static RAM, 7040 Decoder/BUSS Drive card and quad output switched-mode power supply. In addition we include serial cable and full documentation which takes the user from switch-on to through to applications programming.

The system has a number of advanced and unique features which enables many applications programmes to be written in BASIC for the first time rather than as assembler. The 7000 Series is supported by over 40 types of card including memory options DAC, ADC, various I/O, buffer conditioning and switching cards. Call for details.

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The MATRIX ROM provides a comprehensive range of commands for performing matrix operations (including inversion). One of the many commands will solve a set of linear simultaneous equations, and another deals with sets of banded symmetrical equations. In addition there are commands for deleting and redimensioning arrays (to re-use valuable memory space), for finding maximum and minimum values of any row or column, and for printing, saving, loading and printing arrays. All commands are executed in machine code much more quickly than is possible in BASIC. Many lines of code can be eliminated and much memory space can be saved.

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ELECTRONICS & WIRELESS WORLD JUNE 1986

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**LEARNING RESOURCES BRANCH**

Television & Publishing Centre
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Salary range £5222 – £9327 + £1494 London Weighting Allowance

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Further details of the post are available from the Chief Engineer's Office at the Television Centre (0222 9966).

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Application form and full job descriptions for all the above posts from Personnel Services Department, PS4/A, Room 366, The County Hall, London SE1 7PB. Please enclose S.A.E.

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Reply to Mr. Spackman on 01 837 4106

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**Inner London Education Authority**

**LEARNING RESOURCES BRANCH**

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**Television Engineer**

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