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OCTOBER 1989 • £1.25

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See Pages 9 and 61

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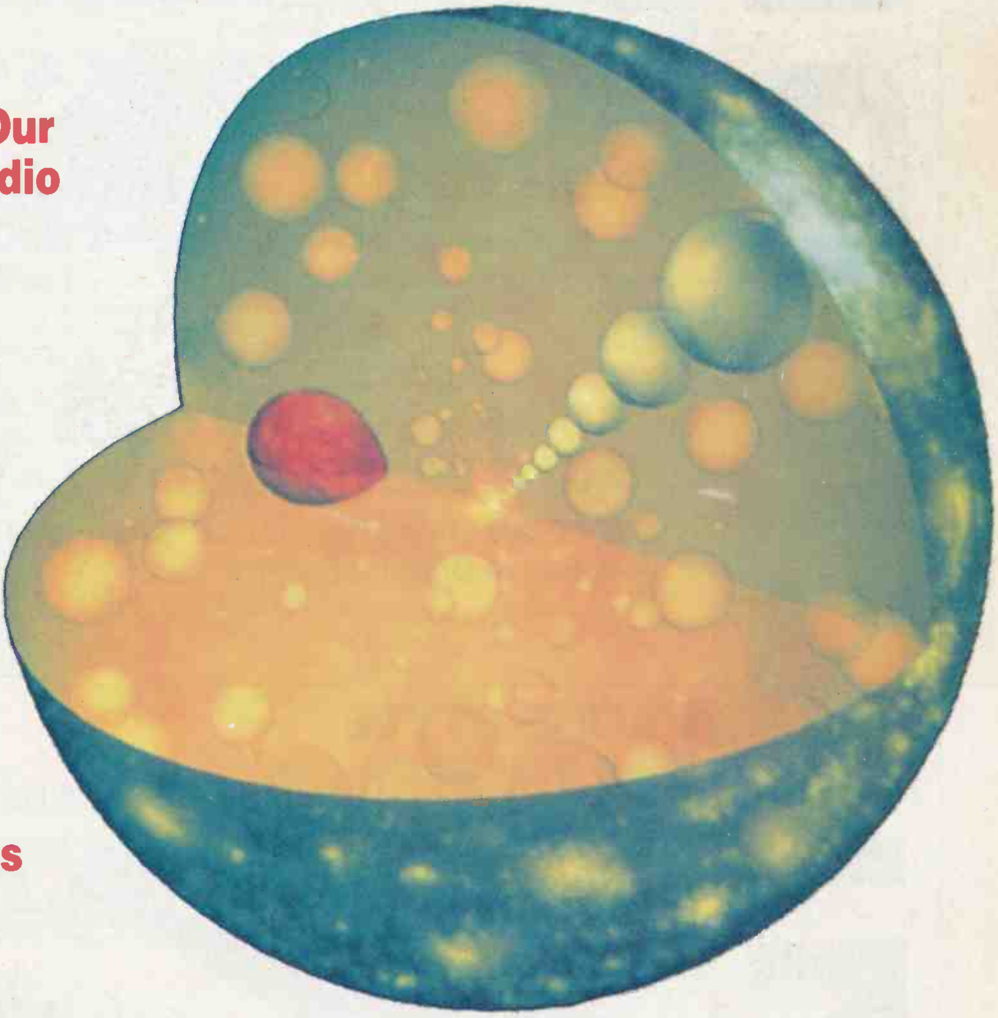

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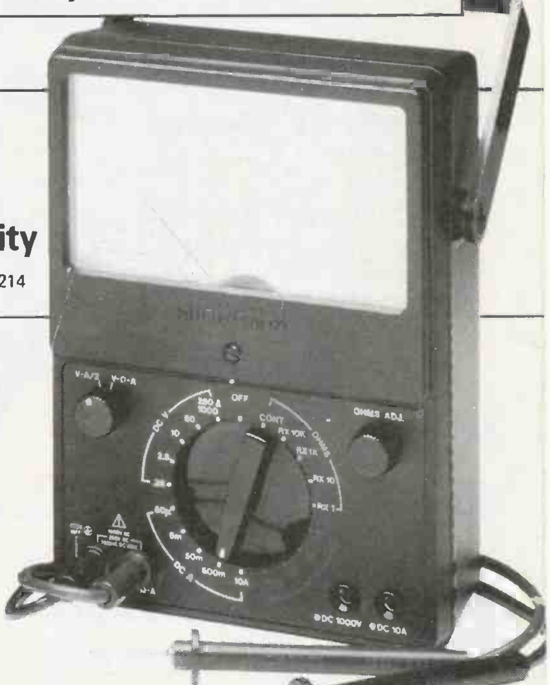

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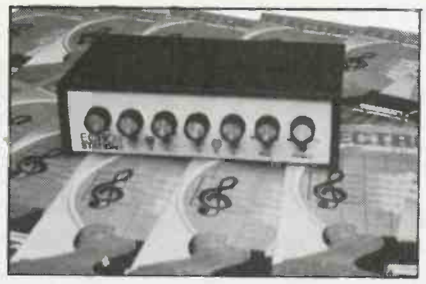

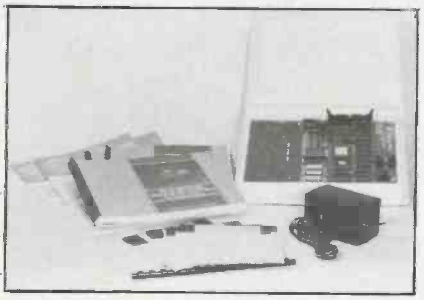

NEXT MONTH

25 YEARS OF PE!

Yes, next month PE celebrates it's Silver Anniversary! We've an extra-special bumper issue for you
- SEE PAGES 9 AND 61

★ OUR NOVEMBER 1989 ISSUE IS FAR TOO GOOD TO MISS!

★ ON SALE FROM FRIDAY OCTOBER 6TH

★ YOU CAN'T BEAT OUR VALUE

★ OR OUR CELEBRATORY OFFERINGS!

PRACTICAL ELECTRONICS

VOL 25 NO 10 OCTOBER 1989

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REGULAR FEATURES

PRODUCT FEATURES

PE TAKES TECHNO-ANNIVERSARIES FURTHER - BE PART OF THEM!

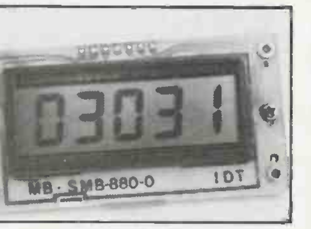
MULTI-GOOD PRINTOUT

We've had news of a new hand held digital multimeter, the Hioki 3234, which measures ac and dc voltage, current and resistance, and can produce a permanent copy of the results from an integral printer. With a large clear 31/2 digit lcd with a 3199 count, it also has a 6 digit clock which enables the start time, date and measured interval to be added to the printout. This new unit can be used as a dedicated recording printer for other measurements such as temperature, rotational speed and power, and in fact with any analogue output measuring instrument.

Fully autoranging, the 3234 measures dc voltage to 500V in five ranges with a basic accuracy of 0.35%. AC voltage is to 500V in four ranges, resistance to 30M ohms in six ranges with a 300 ohm full scale range. Low power ohms are to 30M ohms in five ranges, whilst ac and dc current are to 300mA. Powered by rechargeable batteries, this useful multimeter is supplied with an adaptor which can be used as an ac power supply or as a battery charger.

Thermal serial dot printing is employed at a speed of 1.2 seconds/line on recording paper 38mm wide and 3 metres long, giving some 750 lines of print. Print rates can be automatically set at 10 and 30 secs, 1, 3, 5, 10, 30 and 60 mins. The 3234, which weighs just 400 gms, is supplied ready for use with test leads, alligator clips, spare fuse, one roll of recording paper, instructions and an ac adaptor. Useful optional accessories include a protective carrying case and recording paper in five roll packs.

For further information, contact: Universal Instrument Services Ltd, Unit 62, GEC Site, Cambridge Road, Whetstone, Leicester LE8 3LH. Tel: 0533 750123.



COUNT ON MAPLIN

The all new electronic counter module from Maplin features a five digit, large format lcd display and an exceptionally low price. The module counts up to 99,999 from switch or relay at up to five counts per second. The display increases by one every time a positive-going edge is applied to pin 3.

The system features an anti-bounce circuit and reset input. Also available is a tone output which can drive a directly connected piezo sounder which bleeps on every count and on reset. Square wave outputs at 512Hz and 32768Hz are also provided.

Spec: Working voltage: 1.5Vdc
Current: 2µA standby (8µA average when counting)
Count range: 00000 to 99999 (resets to 00000 after count 99999)
Max input frequency: 7Hz
Input voltage range: 1Vto 1.5V
Min duration pulse: 100µs
Overall size: 68 x 35 x 24mm

The Maplin counter module type FS13P cost only £6.95, plus vat and is available by direct mail or from the Maplin nation-wide chain of shops.

For further information, please contact: Doug Simmons, Maplin Electronics, PO Box 3, Rayleigh, Essex SS6 8LR. Tel: 0702 554161.

CATALOGUE DATABASE

Continuing our browse through advertisers' literature

Cooke International describe themselves as the original source for all types of **test and measurement equipment and laboratory instruments**. Their loose-leaf brochure shows a good variety of such equipment from a range of well known manufacturers. Most of the equipment is either surplus stock or secondhand, though some new items are also mentioned. In particular, they have introduced a range of **new oscilloscopes** from Topward. **Cooke International Services,** Unit 4, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex, PO22 0EB. Tel : 0243 545111.

A somewhat specialised guide has been sent by **Lambda Photometrics**. **Its** part one of a guide to **piezo positioning technology**, and it describes itself as a user's handbook with basic principles, examples and products. If piezo products and designs are your fields, you should find **much valuable information** in this 66 page guide. **Lambda Photometrics Ltd,** Lambda House, Batford Mill, Harpenden, Herts, AL5 5BZ. Tel : 05827 64334.

It's good to see **Magenta's** catalogue again. Supplying **electronics for education, robotics, music, computing and fun** is Magenta's role in life, according to the caption on the cat cover. Magenta offer a **good variety of components and equipment.** The section on **robotics is of special interest** to those looking for mechanical bits and pieces for robot construction. **Magenta Electronics Ltd,** 135 Hunter Street, Burton on Trent, Staffs, DE14 2ST. Tel : 0283 65435.

Another company with a large catalogue is **Marco Trading**. In over 200 pages they describe **thousands of products** from right across the range of **what any constructor may be looking for.** Aerials head the list, and video equipment ends it, and in between are components and equipment as varied as diodes, grills, keyswitches, microphones, oscilloscopes, panel meters, resistors, telephones, and watch batteries. Marco also have a **variety of special offers and valuable discounts.** They also offer a full video and audio service/repair facility at competitive prices. Ah! there's a another good point as well - they say that many items in the catalogue are **made in the UK**. It's good to know where the The Flag is flying! **Marco Trading,** Head Office, The Maltings, High Street, Wem, Shrewsbury, SY4 5EN. Tel : 0939 32763. (Ask for details of their other shops as well.)

YEDA PRIZE PRAISE

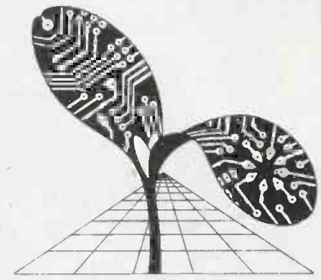
Her Royal Highness The Duchess of York, presented the 1989 Young Electronic Designer Awards at the Queen Elizabeth II Conference Centre on 29 June and showed a keen interest in contestants' projects which varied from a doorbell for the deaf to a motor vehicle computer system and from a stringless musical instrument for handicapped people to a device for measuring the distance travelled by a horse in walk or trot.

There were 22 young designers in the final representing 14 different educational institutions across the country. Their ages ranged from 13 to 23.

First prize in the Senior category of this year's awards went to Cheltenham College Roger Lucas, aged 18, who designed an electronic pill reminder for patients on complicated courses of treatment. He wins sponsorship of £900 a year from Texas Instruments Ltd, while he is at university, a reserved place in the company's graduate intake during his graduation year, a guaranteed vacation job with TI this summer and £450 cash.

Addressing the finalists after the awards presentation, the Duchess spoke of her pleasure at seeing the concern of young people for helping the physically handicapped and aged reflected in so many of the entrants' projects.

For further information, contact: The YEDA Trust, 24 London Road, Horsham, West Sussex RH12 1AY. Tel: 0403 211048.



SMART SCOPE

Now available from the IR group, both for ex-stock sales and on IR's wide range of rental or leasing options, is the Philips PM3070 Smart Series oscilloscope.

The PM3070 is a 100MHz delayed timebase instrument featuring fully automatic cursor-controlled measurement facilities and an illuminated liquid-crystal-display to give instant readout of status and settings.

A 16KV cathode-ray tube

provides optimum brightness and trace quality, while an 'auto-set' intelligent beam-finding facility automatically selects the channel, amplitude, timebase and triggering for the error-free display of any input signal.

Amplitude or timing measurements may be made automatically on any channel, and timing measurements can be made between channels. Relative amplitude measurements can be made from any reference, and the instrument maintains full calibration for accurate overshoot and modulation depth measurements.

Other facilities include cursor timing measurements on delayed sweep, and a 'zoom' function which automatically sets up delayed sweep parameters using the cursors to isolate signal detail.

For further information, contact: IR Group, Dorcan House, Meadfield Road, Langley, Slough, SL3 8AL. Tel: 0753 44878.

NEWS

MAPLIN SELF-SERVICE

Doug Simmons, of Maplin tells me that their latest store, at 146/148 Burnt Oak Broadway, Edgware in North London, is very much up and running. He says the spacious, fully self-service store is creating an impressive landmark in the area. It is also creating sales results with trading at the end of the first week, well above expectations. Unusually for London the new store boasts excellent parking facilities. Buses, London underground and motorways are also in close proximity.

Opening the store, Patrick Horton, marketing director of the Middlesex Polytechnic, welcomed the new local arrival. It was, he said, an exciting time for Maplin.

In reply, Maplin's joint managing director, Roger Allen, pointed out that this was their ninth store – a far cry from the days when the mail order operations were run from his bedroom. *(Your Editor recalls that this was probably in about 1972. Is that right, Roger?)*

Maplin Electronics stores are already located in: Birmingham; Bristol; Leeds; London – Burnt Oak and Hammersmith; Manchester; Nottingham; Southampton and Southend on Sea. With further stores planned, Reading, Brighton and Newcastle are next in line, Doug comments that the Maplin logo and service looks like becoming a familiar high street fixture.

I'm pleased to hear it, Doug. Good luck!

For further information, contact: Lawrence Saunders, Manager, Maplin Burnt Oak Broadway Store. Tel: 01-951 0969.

EVENTS DIARY

If you are organising any event to do with electronics, big or small, drop us a line – we shall be glad to include it here.

Please note: Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Sep. 4-6. Eurobus 89 – UK Conference. Novotel Hotel, London. 01-940 4625.

Sep. 12-14. Optical Systems. Ramada Inn, London.

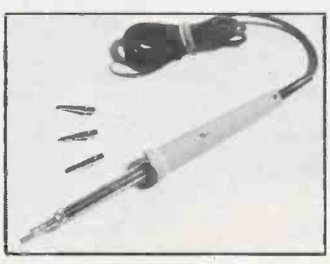
Sep. 12-15. EPOS 89. The World's largest exhibition of retail information systems. Alexandra Palace, London. RMDP. 0273 722687.

Sep. 26-28. British Laboratory Week 89. Incorporating Computer Aided Sciences. Olympia, London.

Oct. 16-20. Systems, Computers and Communications. 11th International Trade Fair and Congress. Munich Trade Fair Centre. 01-948 5166.

Oct. 24-26. Sensors and Systems – International Transducer Exhibition and Conference. Wembley Conference Centre. 0822 614671.

Nov. 7-11. Productronica. 8th International Trade Fair for Electronics Production. Munich Trade Fair Centre. 01-948 5166.



NEW BRASS IRONS

We know that a lot of PE readers are also interested in model making. Over the past few years, there has been phenomenal growth in the popularity of etched brass kits among model railway enthusiasts. Brass, however, can create problems when solder joints require the use of a miniature precision iron – simply because brass acts as a highly efficient heat sink and thus counteracts the heating efficiency of the iron.

This problem has now been solved by Greenwood Electronics with the introduction of its Oryx TC82-100 iron. Although extremely compact, the 240 volt unit features a remarkable output of up to 100 watts.

To allow for use in different applications, the tip temperature can be preset to any point between 260°C and 420°C via a simple manual adjustment. The value is indicated on a dial and close control of temperature is maintained throughout soldering operations.

The iron has a 12mm diam, 110mm long shaft and the complete unit is just 240mm long with a weight of only 190gms. It is supplied with a burn-proof lead and an iron-plated, screwdriver-shaped, 7mm wide long-life tip. Other available tips employ the same profile and include 4.8mm wide and miniature 3.2mm types.

The TC81-100 retails at £31.63, including vat, and spare tips cost £1.67.

For further details, contact: Alan Cooke-Sanderson, Greenwood Electronics, Portman Road, Reading, Berks RG3 1NE. Tel: 0734 595843.

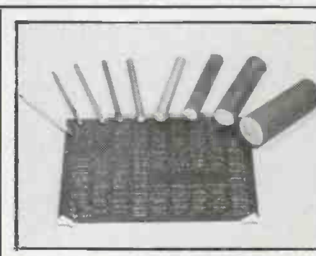
GREEN GROW BATTERIES OH!

Although several battery manufacturers have developed mercury-free zinc chloride batteries, few have addressed the far more critical alkaline types where mercury waste is over 105 tonnes (1988 – Western Europe) – compared to 3 tonnes for zinc carbon/chloride.

Alkaline batteries account for almost 50% of the UK primary battery market which is estimated at £260 million and Ralston Energy Systems has developed the first ultra-low mercury content alkaline battery.

The battery contains less than 0.02% of mercury – meeting EEC requirements for 1992 – and, in addition offers a staggering 50% increase in performance in certain high-drain applications. Mercury-free UCAR zinc chloride cells are also available.

For further details, Contact: Howard Batley, STC Electronic Services, Edinburgh Way, Harlow, Essex CM20 2DF. Tel: 0279 626777.



STICK AND BRUSH-UP

Series 4 have introduced a new range of low cost cleaning brushes for electronics use.

The cleaning brushes are high density glass fibre abrasive sticks for many cleaning applications, including pcbs, electrical contacts, commutators moulds, rust removal and print/marking removal.

They are available in stick form, which can be cut back to expose the bristles. The more bristle exposed, the less abrasive. A 2mm clutch pencil and 4mm propelling pencil with fibre inserts are also available for micro work.

Contact: Series 4 Limited, PO Box 112, Southampton, Hants SO9 7NN. Tel: 0703 474581.

ANSWERING BACK ON DAT

We have given much publicity to the technical and ethical problems relating to digital audio tape (dat). The ethical considerations have hitherto been expressed largely by those with an opposing outlook. It is thus with interest that we have now heard from the Home Taping Rights Campaign (HTRC).

The campaign says that it has responded with caution to reports of an agreement between the international recording and electronic industries concerning dat recorders.

Marianne Yarwood, HTRC Coordinator said "If this agreement means that the benefits of digital recording technology are now to be made widely available to consumers, it is to be welcomed.

"The agreement would appear to provide consumers with the ability to take first generation digital copies of pre-recorded music and two generations if an analogue source is used. This acceptance of the right to home tape is most encouraging."

Whilst the recognition of the basic interests of consumers expressed in the agreement is welcome, the HTRC, whose supporting organisations include groups representing consumers, teachers, students, manufacturers and blind people, will be looking for independent confirmation that the new system does not create the artificial degradation of quality which has been shown by devices proposed in the past.

"We will be seeking to ensure that the new dat format will meet the requirements of all our supporters and particularly of regular tape users such as teachers and blind people. Whilst we welcome any discussions between the recording and electronic industries which lead to greater public access to new recording technology, HTRC would reject totally any outcome which led to the imposition of levies either on equipment or on tapes," said Miss Yarwood.

HTRC has long opposed levies as an unacceptable, unjustified and unworkable interference in consumers rights to tape at home. The principle of levies was overwhelmingly rejected by the British Parliament only last year.

The HTRC was formed in 1986 by organisations seeking to defend home taping and to oppose any attempt to penalise it. The Campaign is supported by the following UK member organisations: Consumers' Association, Consumers in the European Community Group, National Consumer Council, National Union of Students, National Union of Teachers, Recording Equipment Group, Royal National Institute for the Blind, Tape Manufacturers Group.

For further information, please contact: Marianne Yarwood, Home Taping Rights Campaign Office, Number One, Dean's Yard, Westminster, London SW1P 3NR. Tel: 01-799 9811.

CHIP COUNT

This month's highlight choice are two high precision chopper-stabilised opamps from Texas Instruments.

TLC2652 AND TLC2654

The TLC2652/A and TLC2654/A are high precision chopper-stabilised opamps designed using Texas Instruments' Advanced LinCMOS process. Chopper stabilised techniques enable extremely high dc precision by continually sampling the input signals and nulling any offsets. Because the sampling is continuous, offset errors due to variations in temperature, time, common-mode voltage and power supplies are practically removed.

The TLC2652/A is optimised for low input offset voltage. The maximum Vio is only 1 microvolt and the offset drift due to time and temperature is guaranteed at 0.03 microvolts per degree Celcius and 0.02 microvolts per month.

Chopper stabilised opamps are used predominantly in applications needing high dc precision, but many applications also require good ac performance. Although suitable for the majority of applications, some critical designs may see problems due to intermodulation of the chopping and input signals. These effects are normally reduced by on-chip circuitry, but precise applications needing a wide bandwidth will not be able to use standard chopper opamps. The actual usable bandwidth is limited to half the chopping frequency. Until now, design constraints have resulted in a trade-off between input offset voltage and chopping frequency - the latter normally being limited to a few hundred Hertz (450Hz for the TLC2652). By using patented design techniques, Texas Instruments have developed the TLC2654/A to remove these problems. These devices use a chopping frequency of 10kHz but still have a maximum Vio as low as 10 microvolts. The usable bandwidth of nearly 5kHz now makes applications in the audio range possible.

A further benefit of chopper opamps is an ultra low 1/f noise. Because the input is continually sampled, offset errors due to the noise voltage can also be reduced and the noise voltage at frequencies from dc to greater than 10Hz is almost constant. The higher chopping frequency of the TLC2654 and TLC2654/A has also meant that the noise voltage is even further reduced, significantly improving this device, say Texas Instruments, over similar parts on the market.

The TLC2652 and TLC2654 have a common mode input range which includes ground, enabling the devices to be used with both single and dual supplies. The TLC2652 can operate with supplies down to ±1.9V.

Applications requiring the high dc precision offered by these devices may include thermocouples, strain guages and other transducer amplifiers.

For more information on the TLC2652 and TLC2654 contact **Texas Instruments Ltd**, Manton Lane, Bedford, MK41 7PA. Tel : 0234 223000.

STAR COUNTING

Alpha Electronics have available the first of a series of frequency counters from Gold Star. Model FC 7011 is a state of the art 8-digit single channel counter which measures directly from 1Hz to 100MHz. Small, compact and lightweight, this first unit comes with a choice of reference oscillators and case material.

An 8-digit led display is enhanced by switchable manual or automatic ranging and the ability to hold indefinitely the last measured value. direct measurements form 1Hz to 100MHz have resolutions of 0.1, 1.0, 10 and 100 seconds and a basic input sensitivity of 10 millivolts. Model 7011 has an input impedance greater than 1M ohm that can accept up to 150V rms.

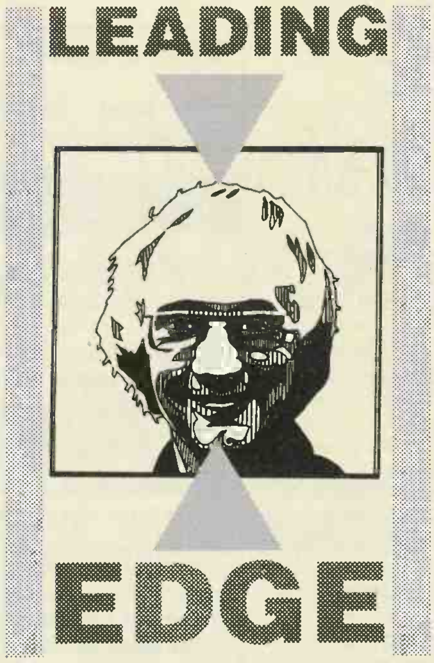
FC 7011 has a 10MHz crystal reference oscillator with better than 5 ppm stability and an ageing rate of less than 5ppm/year. Models 7012 and 7013 are both fitted with temperature compensated crystal oscillators with better than 1 ppm temperature stability and ageing rate per year.

For further information contact: Alpha Electronics Ltd, Unit 5, Linstock Trading Estate, Wigan Road, Atherton, manchester M29 0QA. Tel: 0942 873434.

POINTS ARISING

Boating Revolution (July 89).

The VHF radio telephone photo on page 53 was wrongly attributed to Seafarer. It should, of course, have been quoted as a Navico product. Navico point out that they are the only company designing and manufacturing marine VHF transceivers in the UK. They may be contacted at Star Lane, Margate, Kent, CT9 4NP.



DIGITAL STEREO TV

BY BARRY FOX
Winner of the
UK Technology Press Award

The change over to digital stereo tv sound is leaving many mute with exasperation over yet another case of double standards.

By the time you read this, ITV and Channel 4 should be officially broadcasting stereo sound with television, in the London and Yorkshire areas.

Unofficially, the BBC has been broadcasting in London for several years, and ITV and Channel 4 have been using the same system in London and Yorkshire for many months. But when ITV and Channel 4 start a regular service (it was scheduled for September) it will be a milestone.

The system used is Nicam 728 - and it will be the first everyday, scheduled use of digital sound for terrestial entertainment broadcasting direct into the home, anywhere in the world.

To re-cap briefly, Japan has for several years been using a multiplex broadcast stereo system, similar to the system used for vhf radio. The US adopted a similar system, but with dbx noise reduction on the stereo sub-carrier. West Germany uses two seperate fm sound carriers - each like the single one used for mono. All are all-analogue.

The Nicam stereo signal is in digital code and it rides on an extra carrier above the ordinary and fm analogue mono sound carriers.

The 728 refers to the total number of digital bits per second that are transmitted, 728 kilobits. Each channel is sampled at 32 kHz, giving an audio bandwidth of 15 kHz. Each sample is then coded into 14 bit words and these compressed into 10 bit words. The sound quality is not as good as cd, but only acute ears will hear the difference.

Conventional mono fm sound is still transmitted on the standard sound carrier at 6MHz above the picture. The digital code is carried at 6.552 MHz.

The two Nicam sound channels are completely seperate, both from each other and from the mono analogue sound. This means that two or even three quite different language soundtracks can be broadcast at the same time, to give listeners a multilingual choice. The digital signal is so robust, that clear stereo is heard even when the pictures have been spoiled by noise and interference.

The BBC started giving demonstrations of the system in 1984. A technical speification was agreed with IBA and in September 1986 the Department of Trade and Industry gave Nicam its formal blessing of Nicam as a broadcast standard for the UK.

Led to believe that the BBC would start broadcasting a regular Nicam service in Spring 1988, Toshiba, Texas Instruments and Mullard/Philips all developed Nicam chips. Just as JVC started selling a Nicam vcr, in October 1987, Michael Checkland, the new Director General of the BBC, unveiled his cost-cutting strategy for the 1990s. Nicam was shelved.

Test transmissions have continued from Crystal Palace but the BBC will not start a service until the 1990s. By then ITV and Channel 4 will be serving at least three quarters of the population.

All the major electronics companies now sell Nicam tv sets and vcrs. The IBA, ITV and Channel 4 have spent the last nine months learning how to use Nicam, and making some very public mistakes.

The root problem is how Nicam receivers respond to tv programmes which have different soundtracks on the fm mono and Nicam stereo carriers. If the receiver is normal in automatic mode, it wil latch onto the Nicam stereo signal, in preference to the fm mono signal. For normal programming, the two soundtracks will be the same. But to test seperation, engineers like to transmit tones or silence or music from cd or dat cassettes on the Nicam carrier, with normal programme sound transmitted only on the fm mono carrier. So viewers with Nicam receivers in auto mode end up hearing the wrong soundtrack.

There have been a lot of puzzled people in London and Yorkshire recently, wondering why their lovely new stereo tv sets and vcrs are picking up sound that has nothing to do with the pictures - or sometimes just silence.

The official IBA line is that all will be resolved when regular transmissions begin because the fm mono and Nicam soundtracks will always be the same, even if the Nicam track is simply a digital mono version of the fm mono track.

But this begs the question of how the IBA will cope with bilingual broadcasts, with multi language soundtracks, eg for a dubbed film.

London had a foretaste of the muddles that lie ahead in mid July. Withhout any announcement, Thames TV broadcast "The Marriage of Figaro" in Nicam stereo, over two nights (July 10/11).

Afterwards Thames engineers left their audio feeds patched to transmit silence on the Nicam track. This meant that anyone with a Nicam receiver set in auto mode got no sound for the following programme ("I Spy"). Then at the beginning of "Sportsworld Extra" they got a test tone.

I talked with the IBA the next day who said they would talk to Thames, who said it was all down to "finger trouble". Fair enough. Mistakes happen. But then, believe it or not, Thames made exactly the same mistake that night, when transmitting the second half of "Figaro". After the programme, a feature film ("Behind the Mask") went out with the Nicam feed line left connected to Thames' video tape recorder suite. Over the air listeners heard the telltale sound of tape rewinding at high speed. I tried telephoning Thames and asked to speak to the duty officer to warn what was going on. The duty officer had gone home at midnight and no-one would put me through to vtr.

"Our duty officers always go home at midnight", said Thames later. Yes, even when the station stays on air all night and even when the company is making history with its first major Nicam transmissions. During London Weekend's Gala Night, soon after, the programme was in stereo but the adverts had no sound.

There is even a muddle over the encoders being used to route digital sound signals round the country between transmitters.

The BBC and Channel 4 already distribute the mono sound for their tv programmes round the country, between transmitters, as digital code slotted into the gaps created in the video waveform by the picture synchronisation pulses. The system is called sound-in-sync sis. To squeeze stereo into the syncs, the gaps are slightly widened and four-level, instead of two-level, digital coding used.

ITV has been using BT analogue landlines with a bandwidth of only 8-10kHz, not sis.

Both the BBC and the IBA, are now busily converting whole networks to stereo SIS overnight. ITV listeners, regardless of whether they are receiving Nicam stereo, should hear a big difference as they are cut free from the noisy low pass landlines. PE

PRACTICAL ELECTRONICS

CONSUMER SCORING

What an exhilarating atmosphere there is around the office! The anniversary's nearly here - *The* anniversary, the Silvered 25th one! Twenty five years old, that's how old PE will be on Friday 6th of October 1989. What a birthday to celebrate! And so we shall ...

To join in with the festivities, we have some notable guests for the November issue, and there are an extra sixteen pages as well!

One of the special features is an interview with Sir Clive Sinclair. He shares his views on technology past and present, and on his own involvement with it. In a recent poll among a number of PE readers, Sir Clive was overwhelmingly voted as the personality to whom a PE award should be made for outstanding contributions to technology over the last 25 years. More on that in moment!

Veteran readers, you'll be delighted to know that Fred Bennett, PE's founding editor, will be telling his reminiscences of how PE started. They make fascinating reading. Did you know it took over two years to plan PE? You'll be interested in the photos of Fred as well, one fresh from the camera, and the other found in the archives!

Those who were reading PE before 1986 will remember PE's second editor, Mike Kenward. Even before he took over from Fred, he'd been with PE for many years. He's a tale or two tell about how he came to be involved. We've found an archive picture of him too!

We've some mini-memoirs from Richard Barron as well. He assisted Mike during IPC days at Poole and then edited PE during 1986 after it was bought by Angelo.

As a reader since Issue Number One, I'll be taking a nostalgic trip back in time. Paging through over 300 issues, I found it fascinating to relive some of the past. How things have moved on! Then, changing hats from reader to Editor, I'll lead you on from Richard's time to how PE looks at the world now.

Other regular columnists too will have their personal views of technology included. Tom Ivall assesses the significance of some major happenings over the last 25 years. A look at what the next 25 years may have in store is taken by Barry Fox. From across the pond, Wayne Green inimitably regards State-side technology with hindsight, and crystal gazes to the future.

There's an amazing story, too, from another of our contributors, Tony Smith, about a reader who runs a multi-million pound business started because of a PE project!

Nor should you miss the fabulous competition with all its valuable prizes!

As a separate celebration, we're holding a real live party at the Kew Bridge Steam Museum, on the evening of 27th September. We'd like some of you to join us! The first five readers who *write in* (please don't phone) by Tuesday September 5th telling us you'd like to come will receive a pair of invitations. Sorry, we can't offer transport or overnight accommodation. The lucky pairs will be present when Sir Clive receives his award, and have the opportunity to mingle with PE personalities and advertisers, plus our colleagues from the publishing world.

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Cover Illustration
A representation of the V1500 Cygni Binary System immediately after outburst. By courtesy of University of Arizona.

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TELESCOPE CONTROL INTERFACE

BY DAVID CLARKE

Control and data signals move in and out of the RS232 port with this versatile parallel serial interface.

Although the photometer referred to within this article may be too expensive for the electronically minded amateur astronomer, the computer control circuit described can be put to many other uses, both for astronomy and for other applications.

Astronomers piece together the mysteries of the Universe from simple measurements. In most cases, these involve monitoring the position, the brightness and the spectrum of the various celestial objects over the whole range of the electromagnetic spectrum, from γ-rays, through X-rays, the ultraviolet, the optical (visual), the infrared to the radio region.

Ground-based optical observations are very rarely made by eye. A plethora of detectors is now employed at the focus of the telescope, the devices providing an objective approach to the measurements. Permanent records are also produced for accumulation in data banks. Most detectors employ the photoelectric effect in some form whereby the starlight is converted into electrical signals which are then measured. A regular stellar photometer is likely to use a photomultiplier as the detector. Rather than measuring the current flow that each star engenders, the light is so feeble that the electrons liberated by the energy of the incoming photons can be counted as they are released by the detector's sensitive surface. Thus the brightnesses of the stars and their variations are monitored by counting the arrival of individual photons!

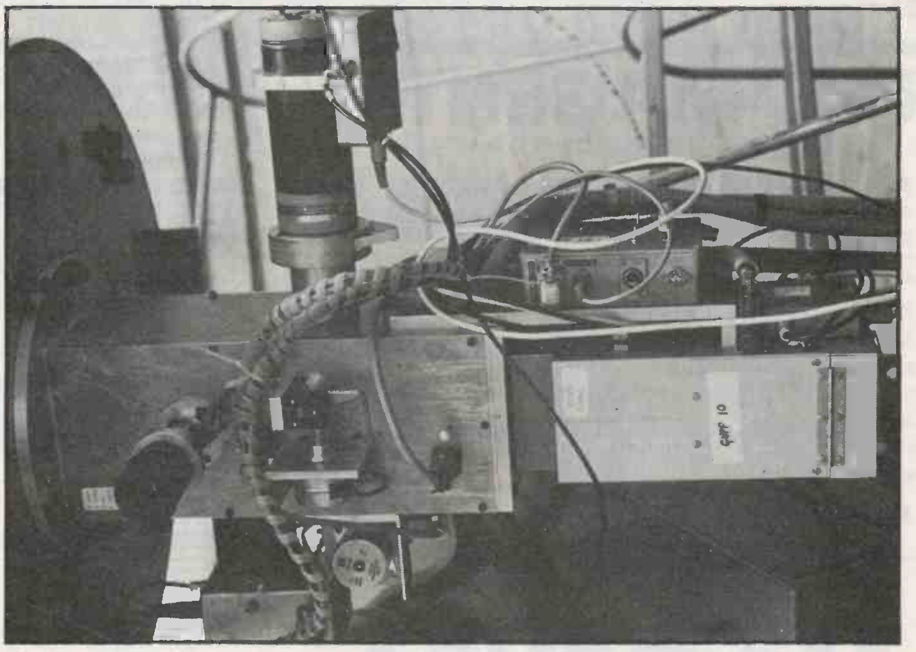


Photo 1. A photometer box attached to the base-plate of a telescope. An eyepiece allows the selected star for measurement to be checked visually. The starlight is split into two beams which are measured by photomultipliers, one housed in a cooling box. Two stepper motors are used to control the colour passband of the light that is being measured. The inside of the box is temperature stabilised to ± 0.1°C.

Accumulated photon counts recorded over set integration times correspond directly to digitised stellar brightness values, their form ideally suited for direct processing by computer.

A standard photometer also allows the colours of stars to be measured by recording the brightnesses as "seen" through optical filters. The observational routine requires the filters to be set in the light beam in turn, an operation easily undertaken by stepper motors.

At many larger observatories the control of all the instrumentation, from the dome opening and rotation, telescope pointing and tracking, the control of the analysing equipment attached to the telescope down to the logging of the photon counts is now invariably under direct computer control. Software packages are available to run all the various observational routines. It is also common practice to incorporate some level of real time analysis whereby the raw data in the form of direct photon counts are presented immediately to the operator. The observer rarely ever sees stars through the telescope; the night time vigil is spent before a keyboard and a visual display unit.

Many of the smaller microcomputers that are on the market are limited in the form of input/output ports they support. This immediately poses problems for communicating with the outside world, either in controlling peripheral machinery or taking in data from external sensing devices.

While undertaking the design of a stellar photometer for attachment to a telescope it was decided to explore an interface for use with micros with a serial output port. The developed system operates in both directions with the computer providing the control of the telescope equipment and the intaking of data, using quiet time between the various operations to perform calculations and to display real time results. Any computer with a standard RS232C interface can be used with the fabricated circuit.

The original requirements for the astronomical photometer were that it should be able to control external counters used to record the photon counts generated by a photomultiplier detector when the telescope is directed to a star. As it turns out, accumulated photon counts recorded over set integration times correspond directly to stellar brightness values, the digitised nature of the measurements being ideally suited for direct processing by computer. Also, the interface should be able to move optical devices (eg, colour filters) in the light beam prior to its detection.

Thus the interface had to be capable of opening the counters to accept photon pulses, closing them when the integration time had elapsed, latching the counts in temporary stores so that the stellar measurement could still procede during the data transfer to the computer, clearing the photon counters, advancing the position of stepper motors, etc. Even if the micro-

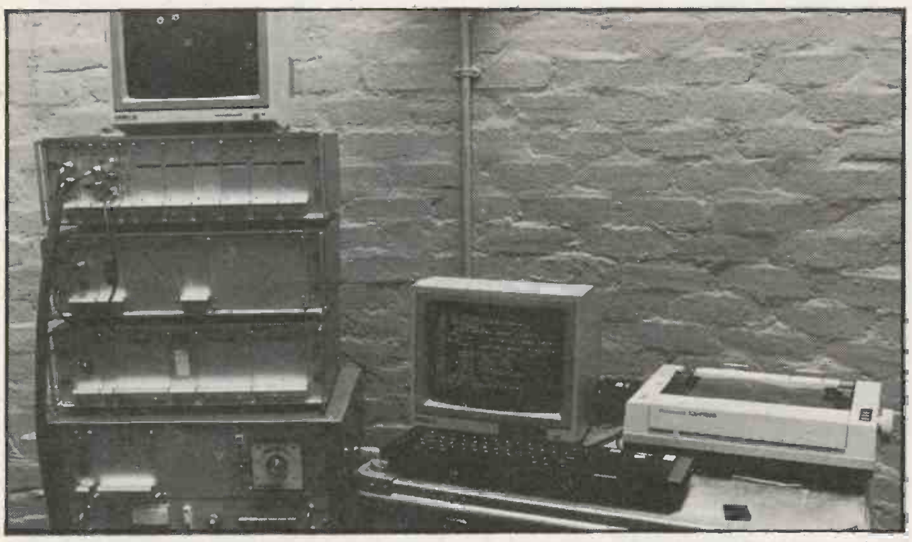


Photo 2. An array of electronic equipment allows the brightnesses of stars to be measured with an accuracy of ± 0.1%. The QL microcomputer is used to control the photometer and record the data. In order, the vertical rack comprises
(i) a monitor for displaying the starfield as seen by a tv camera attached to a tracking telescope
(ii) the designed interface system for the QL to control the photon counters (6) and stepper motors attached to the photometer box
(iii) power supplies to support the electronics
(v) a system for temperature stabilisation of the photometer box
(vi) high voltage supplies and cooler control for the photo-multiplier detectors.

computer provides a parallel port, the number of lines available would be insufficient to control all the desired operations.

In this article an interface system is described that works with a serial port, using single character messages sent by the computer. In essence it is a simple serial to parallel converter. Its operation is centred on a standard uart (universal asynchronous receive and transmit – 6402) chip. Although the original application was specific to the support of a photometer, the concept of the interface is completely general and it can be adapted to a wide variety of purposes. Experience with the system has revealed several important design problems. These are high-lighted in the various sections below with working solutions.

BASIC SYSTEM

The interface allows communication to be performed using Basic language with simple programs that can be readily written for the particular electronic control that is desired. In the design described here, 18 communication lines are set up, although this number could be increased to 255 with higher levels of sophistication in the logic circuitry. Some of these lines are used to control the operations of the observations. Others are used to manipulate a data address bus whereby a photon counter is chosen for interrogation and a particular digit is despatched from the counter to the computer. In the stellar photometer that has been made, six photon counters may be operated simultaneously each able to record to 9999999 with a leading eighth digit permanently set to identify the counter. Although the circuit design could immediately be extended to support 16 counters each with 16 digits, this level of data logging is beyond the usual requirements.

The system does not pretend to be the most elegant in terms of concept and deployment of the more modern, powerful chips but its construction is readily understood and it has proved to be most reliable in the field having been transported many times in the back of a car. Except for one chip, a simple power supply of five volts is required, most of the circuitry comprising ttl devices. The chip for receiving data from the outside machine requires a supply with ±15 volts but in cases for which only direct control is required, without the computer reading in the data, this latter chip may be excluded.

The interface has been designed to operate with any standard serial port but in the experiments described here, a Sinclair QL microcomputer has been used. Examples of the programs are written for that machine; simple modifications may be required for the programs to be run on other computers.

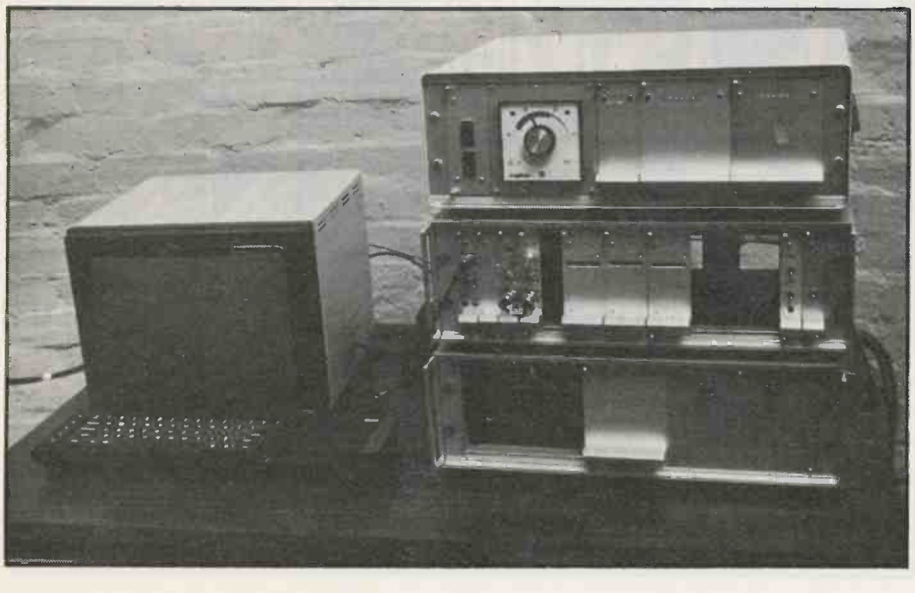
UART SUPPORT

The uart is a device that accepts characters in serial form on a line and converts them to a parallel format. It is also able to accept characters in parallel form and transmit them as a serial signal.

Several options and facilities of the uart need to be considered for the design of the interface. Switches may be fitted to pins 36, 37 and 38 so that these inputs can be connected as high (H) or low (L) according to the configuration of the character format of the computer (ie 5, 6, 7 or 8 bit characters; 1 or 2 stop bits). These could be hard wired for use with a given chosen computer. To keep things as simple as possible, many of the functions available from the uart may be ignored. The states of the 40 pins of the chip for use with the QL are readily assessed from the layout Fig. 1. Modifications might be incorporated in the wiring of the uart according the degree of sophistication required, eg whether checks on overflow or parity might be useful.

In order to operate the uart, the chip needs some simple support circuitry. In the first place it requires a frequency reference so that the characters can be received/accepted at the right speed. The

Photo 3. The QL system for solar experiments, the middle box holding the interface board, three photon counters and circuitry for controlling stepper motors.



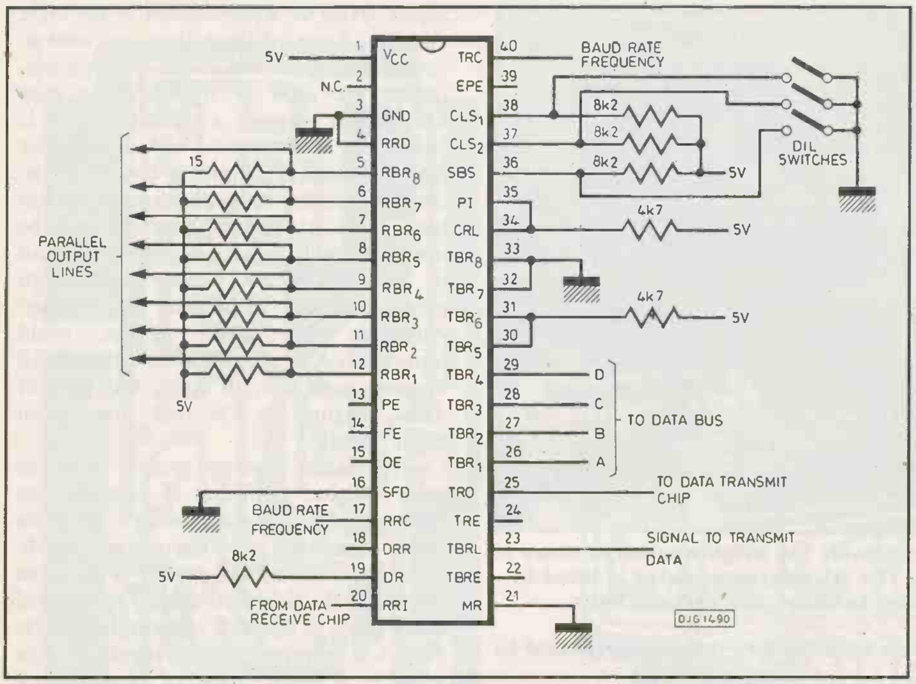
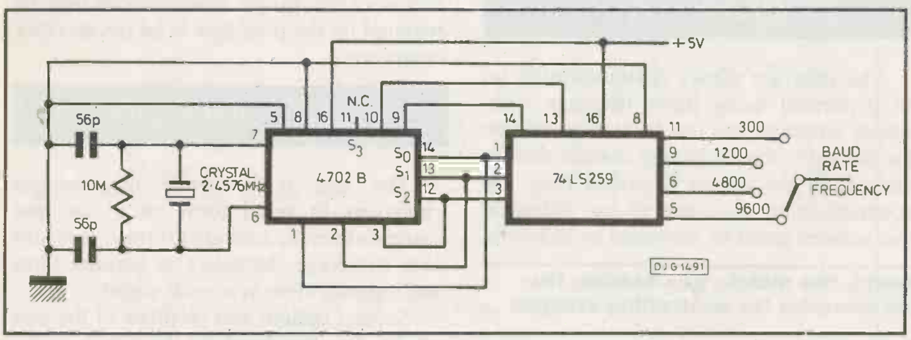


Fig. 1 The 6402 UART is shown with the basic connections wired to transmit numerical data and receive characters transmitted by the microcomputer serial port. The baud rate frequency (see Fig. 2) is connected to pins 17 and 40. Receive characters and data for transmission from the requisite chips (see Fig. 3) enter and leave at pins 20 and 23 respectively. The 8 parallel outputs each require pull-up resistors (15K); they are also connected to the decoding chips as shown in Fig. 5. All pins depicted with short legs need not be connected.

Fig. 2 The switchable baud rate frequency circuit provides the selection of the commonly used rates of 300, 1200, 4800 or 9600. For a given fixed rate, the S0, S1, and S3 inputs can be preset (H or L according to the code for the required baud rate) and the addressable latch dispensed with.



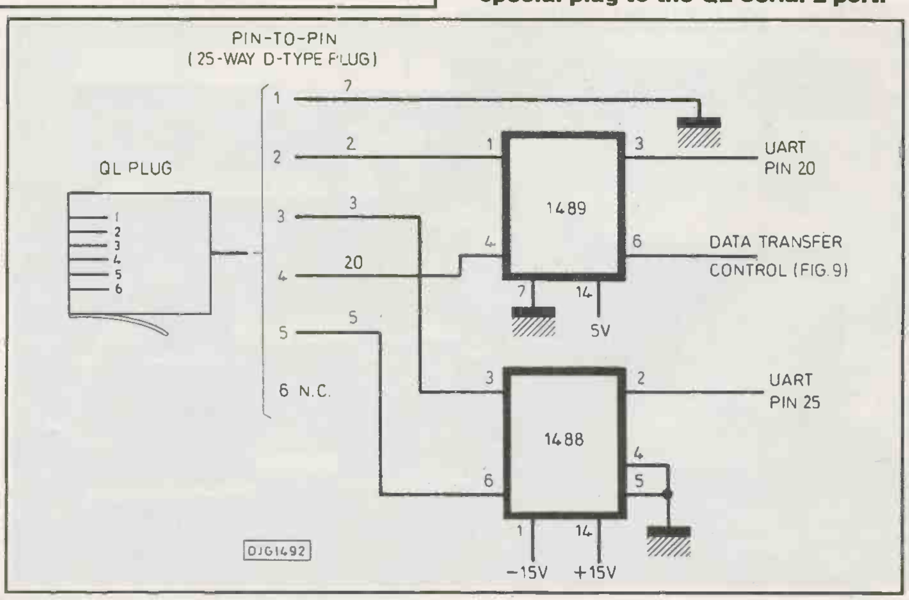
speed, or baud rate, has to match that of the computer. Secondly the received and despatched characters require special chips that allow their signals to be transmitted along reasonable lengths of cable and at the right time, eg, the computer must be ready to receive a character when the uart despatches it.

Fig. 2 displays the basic frequency generating circuit. In the configuration shown, baud rates of 300, 1200, 2400 and 9600 have been made available, but other rates are possible using the same chips with different wiring configurations. If a regular and fixed baud rate is to be used, the circuit may be simplified and streamlined. The chosen frequency is applied to both the receive and transmit sections of the uart (pins 17 and 40). By default, the QL's serial ports operate at 9600 baud but they can be programmed to other values including those above. Normally, for the photometer, the highest value of 9600 is used.

Various levels of sophistication may be needed to run the receive and driver chips depending on the kind of control envisaged or on the nature of the computer serial port. In addition to the Transmit (Tx), Receive (Rx) and ground lines from the port, the operation of the handshake lines may need to be considered. These are the Data Terminal Ready (DTR) and Clear To Send (CTS) signals. All the communications lines need either receive or driver chips to handle them. In Fig. 3 the necessary chips are depicted as 1489 (receiver) for the lines carrying signals generated by the computer and as 1488 (driver) for the lines with signal from the outside circuitry to the computer. (There are some modern chips that incorporate both receive and driver parts in a single unit.) The connections are shown in relation to the Serial Port 2 of the QL and its output via a conventional 25-way D-type connector. Before any character can be sent from the computer to the uart, the computer must "know" that the outside instrumentation is ready to receive it. In the designed system, this has been permanently set in a state of readiness by grounding the inputs on one of the drivers (pins 4 and 5) and connecting its output to the DTR of the computer. Depending on the degree of control required, this handshake line might be operated by logic circuitry rather than having it permanently set. A second circuit in the driver chip is used to transmit data characters to the computer but the description of this procedure will be given later.

The receiver chip has been wired to accept the characters from the computer and to transfer them to the uart. Also the CTS line from the computer is received on this same chip and the signal is used in timing the instruction to the uart to transmit characters from its buffer. The circuitry for this will also be described later under the section "Transmissions Control".

Fig. 3 Connections for the receive (1489) and transmit (1488) chips via the 25-way D-type connector and the special plug to the QL Serial 2 port.



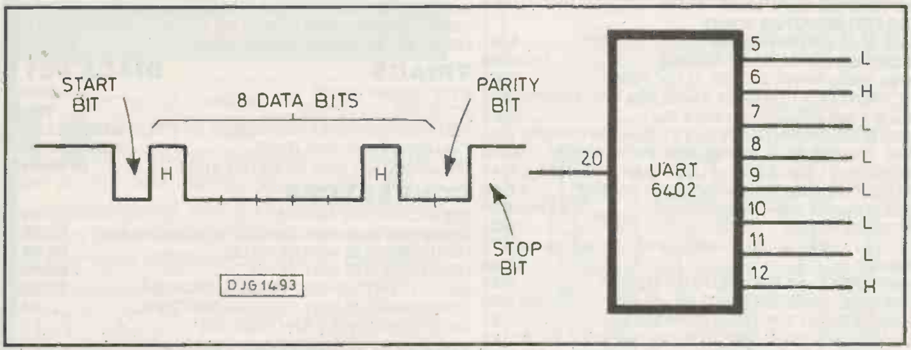


Fig. 4 Following the start bit, the transmission comprises 8 data bits which may be high or low. For the character "A", the first and seventh bits are high and this pattern emerges at the parallel outputs of the UART. The parity bit (ninth) is ignored in this design.

THE UART DECODED

When a character is transmitted on a serial line, it is coded by using a train of bits, usually seven or eight. Each bit may be in a high (H) or low (L) state; the character is recognised by its unique bit pattern. For example, using an eight bit code (as for the QL), the character "A" would be represented by

L	H	L	L	L	L	L	H
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

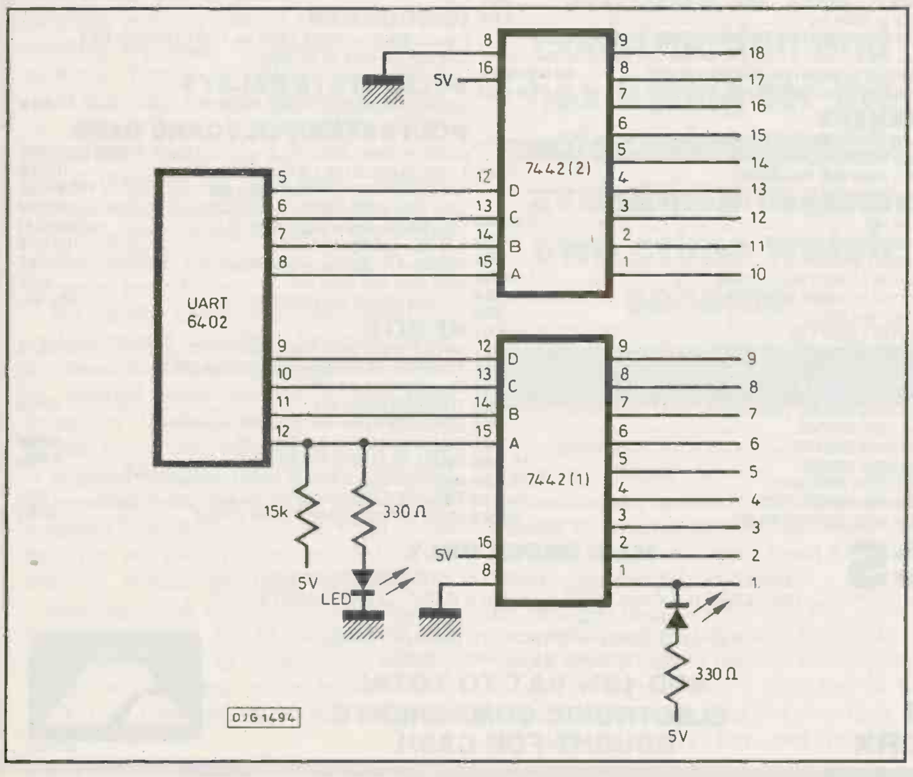
with the right had bit being transmitted and read first. Each code is equivalent to a binary number and by examining the states of the columns, as depicted above, it can be seen that "A" is equivalent to the binary representation of 1 + 64 or 65. Thus "A" may be sent out to the serial port of the micro either by transmitting it as "A" or as CHR$(65).

When the uart is being used to receive characters from the serial output of a micro, the string of bits is converted to a parallel form with the state of the bits (H or L) being displayed from the eight output buffers. A schematic for this, related again to the character "A" is displayed in Fig. 4. The transmission of each of the characters represented by the binary values of 0 to 255 allows all possible bit combinations to be produced at the output lines of the uart.

In the arrangement of the designed interface, not all of the full character set is utilised. The eight bits have been organised so that the first four act as binary coded decimal (BCD) lines which are decoded to decimal by a 7442 chip. Similarly, the last four bits are also used as BCD and then decoded. The diagram of the circuit with all the support chips is shown in Fig. 5. It will be seen that characters 0 to 9 sent from the micro operate the nine lines of 7442(1), while characters 0, 16, 32, 48, 64, 80, 96, 112, 128, 144 operate the 9 lines of 7442(2) labelled 10 to 18. The appropriate decoded line goes low according to the character that is received from the computer.

It may also be noted that the only characters to be transmitted to the computer are numerical data corresponding to the numbers 0 to 9, ie CHR$(48) to CHR$(57). As a consequence the higher binary bits of the input buffers may be permanently fixed with pins 33 and 32 set low and pins 31 and 30 both set high. The remaining four lower order buffers are connected to the data address bus and, according to their states, CHR$(48) to CHR$(63) may be transmitted.

Fig. 5 The 8 outputs from the UART are decoded as two groups by BCD to decimal chips (7442) to provide 18 switchable lines. Although available, output zero from these decoders has not been used. Each output from the UART requires a pull-up resistor and may have an led state indicator. Similar leds may be attached to the 18 decoded lines. For simplicity, these components are shown only on one of the UART outputs and one of the decoded lines.



CHARACTER RECEPTION

With the circuit completed as far as is shown in Fig. 5, it is possible to receive characters from the serial port of the micro and check that they are interpreted correctly. The eight output lines are shown with leds connected to them allowing their state to be displayed, but this arrangement is optional. Similar status leds may also be connected to the 18 decoded lines. The program below allows each binary output of the uart to be checked and also the operation of the 18 decoded lines.

```
100 REMark ** Program 1 **
110 REMark ** Exercise for Interface **
120 REMark ** Set Serial 2 Port **
130 BAUD 9600
140 OPEN #5, ser 2
150 REMark ** Check on Binary Count
160 FOR n= 1 TO 255
170 PRINT #5, CHR$(n) : PAUSE 20
180 END FOR n
190 REMark ** Check on Decoded Lines
200 FOR n= 1 TO 9
210 PRINT #5, CHR$(n) : PAUSE 20
220 END FOR n
230 FOR n=16 TO 144 STEP 16
240 PRINT #5, CHR$(n) : PAUSE 20
250 END FOR n
```

It will be noted that on receiving a preferred character the appropriate decoded output will go low. On receipt of a second but different character that same output will go high and the new appropriate line will go low. The second character may be zero, putting all the outputs at high. By dividing the outputs into two groups of four, it will also be appreciated that it is possible to control two lines simultaneously on receipt of a single character. For example, the transmission of CHR$(65) will activate both decoded lines 1 and 10.

TO BE CONTINUED NEXT MONTH

Dr. David Clarke is a lecturer at the Department of Physics and Astronomy of Glasgow University

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ELECTRONIC SNAPSHOTS

BY BARRY FOX
Winner of the UK Technology Award

The pic-a-disk carousel is spinning, and it looks likely to throw up a winner – for the Japanese in the end.

In Japan, there has for many years been no firm dividing line between different areas of consumer electronics. Electronic shops are multi-storey department stores, which stock a bewildering range of audio, video, tv and photographic equipment, domestic lighting, budget audio, rice cookers, air conditioners, refrigerators and so on.

Now these shops have another range of products on display – electronic still picture cameras, which capture images on magnetic disk instead of film.

It is too early to say yet whether the technology will become a strong market force. So far sales seem to have been slow. This is partly because the price of electronic snapshot cameras is still high compared to snapshot film cameras. The Japanese electronic companies are now likely to try and solve this problem by reducing the price of basic models to make electronic technology more competitive with film. There will also be completely new, second generation models which use solid state memory instead of magnetic disks, and thus need no moving parts.

The other, and perhaps more significant, problem faced by the makers of electronic still cameras is that the captured images are intended to be displayed on a tv screen – whereas most people like to carry paper prints in their pocket or wallet. With this in mind much of the research into the new medium is now – paradoxically – aimed at producing low cost, high quality hard copy prints of selected electronic images.

HOME VIDEO

Over the last five years video has killed film as a home movie medium. Anyone who wants to take moving pictures of their holiday, or baby on the lawn, now uses a combined video camera and recorder, or camcorder, no larger than an 8mm cine camera. It records colour tv pictures with synchronised sound. Although many camcorders cost £1000 or more, most movie makers feel the initial outlay is worthwhile. An hour's worth of tape costs what movie film costs for a minute. It needs no processing and is re-usable. Only the most dedicated buffs now use cine film. Cameras and film are increasingly hard to buy.

A similar switch to electronic still picture imaging will change the balance of commercial power in favour of companies, notably Fuji of Japan, which have equal expertise in electronics and photography. This could spell trouble for Kodak, which for many years has been the world leader in wet photography and so far announced no intention to commercialise electronic imaging for the domestic market. Although Kodak has dabbled in home video, the company has so far simply bought in ready-made product from the Far East. The lead which Japan is now building in low cost electronic imaging technology may well prove too strong for Kodak to contest.

Some advantages of electronic still imaging are obvious. Like video movies, the medium is re-usable and needs no processing. Less obviously, the electronic image can be sent down a telephone line, like electronic mail.

US companies, Polaroid and 3M, have already announced their intention to capitalise on long experience in film photography to provide the public with a cheap way of transferring video images to paper.

MAVICA

Sony was the first company to demonstrate the point and shoot magnetic still picture photography. In August 1981 Sony unveiled Mavica. It looked like a conventional 35mm single lens reflex camera, but recorded 50 colour still pictures on a small magnetic disk spinning inside the camera body. Although the disk resembles a computer floppy, of the type routinely used for storing digital data, an electronic still camera records an analogue tv waveform not a stream of digital pulses.

Once Sony had shown Mavica, most of the other major electronics companies in Japan developed their own systems. In February 1983 twenty electronics, camera and magnetic tape manufacturers formed a committee to promote worldwide standardisation of a magnetic disk format. By May 1984 there were 32 companies participating, and the first standard was set. They agreed on a disk, coated with metal powder, 47mm in diameter, and enclosed in a rigid plastic case which measures 60 x 54 x 3.6mm and weighs around eight grammes. The disk case has a dust protection shutter and safety catch to prevent inadvertent double recording or erasure. The image disk closely resembles the micro floppy disk now used by many personal computers. This is not surprising, because the micro floppy was developed by Sony as spin-off from the company's work on magnetic still picture photography.

HIGH BAND STANDARDS

Two years later, in April 1986, the disk family had grown to 42 companies, and they agreed on a standard for recording short snatches of digitally coded sound as well as analogue visual data. Sony and Canon used disc cameras to cover the 1984 Los Angeles Olympic Games but the system was still judged too expensive for domestic use, and picture quality inadequate for professionals. So in July 1988 the 42 participating companies agreed a second "high band" standard. This gives higher quality images by recording the video signal at higher frequencies.

The cameras now on sale in Japan have a solid state image sensor, usually 1.7cm across, made up from a mosaic of around half a million individual image elements, each capable of resolving a separate picture point or "pixel". The chip sensitivity to light is equivalent to domestic film rated at 200 or 400 ASA/ISO, but additional amplification circuits can raise chip sensitivity to 1600 ASA/ISO.

The chip puts out three video signals, one representing black and white detail, and two containing colour difference information. The three signals are separately recorded onto the disk as an fm signal. When mixed together again on replay, the three signals give detail and red, green and blue colour information.

The disk rotates at 3600 rpm, which is 60rps to conform with the 60 pictures per second tv system used in the US and Japan. For European tv, where 50 pictures a second are displayed, the disk speed will be reduced to 3000rpm.

FIELD AND FRAME

The magnetic disk recording standard gives users the choice between "field" and "frame" recording. All television pictures are made up from horizontal scanning lines; 525 lines in Japan and the US and 625 lines in Europe. A television set does not display all these lines on screen at the same time. Instead it displays a half scan of even lines, then a half scan of odd lines, then a half scan of even lines and so on. On screen the half scans interlace so rapidly that the human eye never realises that only half the lines are being displayed at any one time.

When a magnetic disk camera is set to record fields, it registers only half scans. These are then displayed on a tv screen twice over, to create the illusion of interlace, albeit with only half the vertical resolution.

When the camera is set to record full frames, it captures full interlaced pictures, which give better resolution on screen. The penalty is that there is only room on the disk for 25 full frame pictures, whereas there is room for 50 half frame or field recordings.

SONY MAG-CAM

Sony's magnetic disk camera, now on sale in Japan, looks like a film disc camera. It has a fixed focus lens and the iris diaphragm and shutter speed set themselves automatically to suit the room lighting conditions. When there is not enough light, the camera automatically use flash. Because there is no film to move, the disk can record up to nine pictures per second, for instance to analyse a golf swing. Fuji, Canon and Konica all offer similar toys.

Although the feature is not yet implemented on the first generation cameras now on sale, each video picture track can be accompanied by a recording of 5, 10 or 20 seconds of digital sound, depending on the required quality. The camera also registers the image and track number, the date and time of shooting, and technical data, such as the exposure time and aperture.

In frame recording mode a magnetic disk camera has a horizontal resolution of around 400 lines, which means that it can resolve 400 separate vertical lines, like vertical posts, without merging one into the other. In practice, domestic disk cameras will resolve less lines, usually around 300, because their image sensors are not good enough to match disk potential. This is still better than most domestic video recorders, but nowhere near the resolution of still picture film.

COMPARISONS

Video-versus-film comparisons are dangerous. There is no agreed method for equating video resolution with the picture information captured on film. The film image is analogue with random distribution of the silver crystals. Even though the first still picture cameras record an analogue fm signal, the image sensor samples like a digital coder and the scanning line structure of the tv picture samples the displayed image.

Both Kodak and Polaroid work to the same guideline; one frame of 35mm colour slide film records around 100 million individual bits of picture information, with clusters of six bits registering each picture point or pixel. By this reckoning, and one byte of digital code needed for each pixel of an electronic image, one frame of film is equivalent to well over 10 megabytes of computer storage; which in turn is equivalent to 10 or more computer floppy disks storing 10 million text characters. 3M puts film image quality even higher, at around 20 megabytes per frame. A Polaroid print resolves around 10 million pixels.

By comparison even the highest quality tv pictures in commercial use, the European 625-line PAL and SECAM formats, compose the image from a maximum of 0.7 million discrete picture points or pixels. Fuji is selling a camera with an 800,000 pixel image sensor, giving horizontal resolution of 500 lines. Kodak claims to have made a 1.4 million pixel sensor.

Even so the resolution gap between electronics and film is still very wide. Kodak puts it at a factor of at least fifteen for conventional colour film.

Also the contrast ratio of film, that is to say the brightness ratio between the lightest and darkest subjects recorded, is around 500:1. This is far in excess of any tv system which would usually have a ratio as low as 50:1.

MATCHING STABILITY

In a real world situation, however, snapshot photographers are content with prints of appalling quality and tv viewers sit happily and watch maladjusted sets.

The one issue on which everyone agrees, is that the public will want the option of paper prints from electronic recordings. The potential market is vast. Kodak estimates that 39 billion colour photos are printed every year; one picture every seven weeks for every person on the planet. Japanese "photo-maniacs" shoot 500 pictures in a weekend.

In Japan Fuji has for several years sold a hybrid electronic/film system, called Fujix. The photographer takes still snapshots with an ordinary camera and sends the colour film off to the lab for processing in the usual way. The lab develops the film and transfers the images onto magnetic disk.

The photographer can then display the pictures through a tv set, using a budget disk player, and ask for conventional prints of the best shots from the original film. The disk thus becomes a cheap pre-print preview tool.

Fuji has not yet marketed the system outside Japan. Says Managing Director Shozo Takekoshi: "You need the cooperation of the photo finishers and laboratories. That is possible in Japan where we are number one, but in Europe and the West Kodak has control".

Fuji admits that the Fujix pre-print preview system has not sold as well in Japan as expected.

"But the situation will change," says Takekoshi. "Previously people expected the high quality images you can only get from silver halide still photographs. But now perceptions are changing. Young people have grown up with video and tv and their standards are lower. They don't compare with silver halide quality any more."

3M disagrees. "People don't relate tv quality to hard copy quality," says Douglas Dybvig, who heads 3M's research labs at Harlow. "As people see better prints, they expect better prints."

3M RESEARCH

3M still smarts from the mistake of saying "no" to Chester Carlson and his xerography invention, the first technology to bridge the gap between electronic and paper imaging. 3M also regrets the decision to stop making audio tape, when Japanese competitors cut prices. Since then 3M has invested heavily in the development of Scotch brand video tape and has for five years been brand leader in the UK. 3M has also invested heavily in conventional film technology, since buying Italian photographic company Ferrania in 1964.

"We do not see anything coming close to photographic cameras and colour films within the next five to seven years," says Dybvig. "But we are working hard to make it happen."

POLAROID

The traditional method of transferring a video image to film without loss of quality is to display the picture on a high resolution tv screen, photograph it with a conventional 35mm camera and process the film in conventional fashion. This is slow and messy, and any mistakes do not show until after processing.

It is quicker and easier to photograph the displayed image with a Polaroid instant picture camera.

Edwin Land invented instant picture photography, soon after the war, to keep his young daughter happy. "Why?" she asked her father on holiday "do I have to wait a week before I see the photographs you are taking?" Back at his laboratory in Cambridge, Massachussets, Land immediately began work on film which would develop itself. His seminal invention was the concept of a lead pod full of chemical developer, and packed with the photographic film. Easily broken, by squeezing through a pair of rollers, the lead pod gives each exposed photograph a fresh supply of chemicals so active and unstable that they could not possibly be stored in bulk and dispensed shot by shot.

The first instant picture cameras went on sale in America in November 1948. The disadvantage of the system was that the two halves of the film, negative and positive, had to be peeled apart after a minute or so development time. In 1972 Land introduced the SX-70 system, which no longer required that two layers be peeled apart after development. Since then Polaroid has changed the chemistry many times, speeding development to a few seconds, but the principle remains the same.

RESOLUTION

Polaroid has shown how easy it is to build a "black box" which takes a video input and outputs a Polaroid print. The box contains a Polaroid camera permanently focussed on a tv screen. To improve resolution the image is exposed in three stages one for red picture content, one for blue and one for green. This takes longer. Polaroid photography is more expensive than conventional photography, and especially for large prints, more expensive.

As a first step into electronic imaging, Polaroid is working with British company Hadland Photonics, of Bovingdon, on a high resolution system which records still images onto Super VHS video tape. The picture is captured with a 600,000 pixel image sensor, and broken down into 26 horizontal strips. Each strip is then recorded on tape as if it were a full picture. To reconstitute the picture, the tape is replayed and the 26 partial pictures blended together into a single high definition image. This way one two-hour video tape can store up to 14,000 high resolution still picture images.

JETS AND THERMALS

The Japanese electronics firms are all using either ink jet or dye thermal transfer printers to produce hard copy images. Both were developed for the computer industry.

An ink jet printer paints a colour image on paper by the digital control of different ink sprays. The system is slow, and neither resolution nor colour rendition can match film.

In a thermal dye transfer printer, a dot matrix printing head heats a sandwich of plain and coloured dye papers, so that the dye sublimates from one sheet to the other to create a colour image. Calibration of the head elements is vital, as the print must be made by repeating the sublimation process three times, with cyan, magenta and yellow sheets, and ideally with a fourth transfer using a black dye sheet to sharpen resolution. The technique is slow and colour rendition poor.

DRY CHEMISTRY

3M's ace is the new technology of dry silver halide chemistry. This grew out of an office copy system, called Thermofax, which 3M developed to rival the xerographic paper copy system which the Xerox Corporation bought from Chester Carlson after 3M turned the idea down.

"Twenty-five years ago we tried to make the material sensitive to light instead of heat," says David Morgan, technical director of 3M's photo colour systems laboratory in the US. "Making it light sensitive took us a week. We have spent the last twenty-five years perfecting a product which copies in colour."

A sheet of paper (or transparent film) is coated with an emulsion which contains a small quantity of light sensitive silver halide and a much larger quantity of a non-light sensitive organic silver compound, such as silver behenate. There are three separate layers, individually sensitive to red, green and blue light.

When the emulsion is exposed to light, the light sensitive silver halide registers a latent image. To develop this image, the paper is heated to 135°C, for six seconds. This triggers a chemical reaction which releases silver from the reservoir of non-light sensitive chemicals to produce cyan, magenta and yellow dye images.

MATCHING STABILITY

Although many thousands of dyes obligingly behave in this way, only a few colours match and balance to give a natural colour image. 3M has now found a cyan dye, which almost exactly matches the dyes used by Kodak in conventional colour print paper. Magenta dyes proved more difficult, and yellow the most difficult of all. The first dry halide papers are now available. They give a colour image which is slightly blemished by a yellow green tinge to areas which should be pure white, but 3M is confident it can match Kodak's colours.

The emulsion is ten times less sensitive than conventional emulsions, but this is of no consequence because the image is formed by exposing the emulsion to an electronic image either by freezing the image on a tv screen, or by scanning the paper surface with a light beam which is modulated by the video signal.

The main snag is that the image is not stable over a long period of time, because some chemicals remain active in the finished print. So 3M has now developed a second generation technology, which superficially resembles the early Polaroid system.

The print paper is made from two layers, one a slightly porous plastics material. After heat development, any remaining active chemicals migrate into the plastics. This is then stripped off and thrown away to leave a stable colour image.

Simplified printers should eventually sell for a few hundred pounds, with the paper costing around £1 for a 20cms x 25cms sheet. Photographic shops and processing laboratories, which currently spend around £40,000 on a "minilab" for automated film processing could offer customers an additional service for transferring video images onto paper.

"For a hundred years people tried to make light sensitive silver halide work dry, and failed," says Morgan. "We started with dry silver material and tried to make it light sensitive."

LASER WRITING

In the much longer term, 3M hopes to adapt a technology currently used to write video images direct onto conventional photographic emulsion, using laser diodes. A rotating mirror scans the emulsion with three infra red laser beams, each of slightly different wavelength (789 nanometres, 830nm and 890nm). The photographic emulsion contains three separate layers, each capable of producing a yellow, magenta or cyan dye in response to illumination at one of the three infra red frequencies.

To create a colour image, the video signal is converted into digital code, and the red, green and blue content separated. The red content is then used to control the intensity of one laser beam, the blue content controls the second laser, and the green content the third. In this way the three laser beams produce a full colour image, even though they themselves are all in the infra-red range and bear no visible relationship to the colours.

3M's next step is to modify the dry silver halide paper, so that its three dye layers respond to infra-red laser light, instead of visible red, green and blue.

Polaroid is working on parallel lines and developing a printer, which will use laser diodes to expose instant picture film.

KODAK'S OUTLOOK

Kodak's position remains a mystery. Although it sells professional electronic disk recorders, and a dye printer made by Hitachi, the company has never announced any intention to commercialise a domestic electronic camera. Instead, in February 1982 Kodak launched a film camera system which uses a disc of film instead of the normal roll.

Each disc has 15 exposure frames, approximately 8 x 10mm in size. Because the frame area is so small, picture quality is poor when an attempt is made to make an enlarged print.

Patents on the system show that it was originally designed for use with a video reader so that colour positive pictures from a series of discs can be displayed on a tv set. But this option was never offered.

Film disc cameras initially sold fairly well because six years ago 35mm cameras were still bulky and awkward to use. Now there are light and cheap 35mm cameras which are fully automatic. Budget 110 cameras are even cheaper and easier to use. Film disc picture quality never fulfilled early promises, manufacturers have stopped making disc cameras and the fixed batteries in many of the units sold are now worn out. Some retailers no longer bother to stock disc film.

Kodak points to the fact that most of the snapshot cameras used in the US today cost less than $150, whereas there is no sign of an electronic camera and playback system selling for less than $450.

On the face of things Kodak can afford to be confident. In the US, photographers took 13 billion pictures last year, most on the Kodacolour films and papers Kodak has been selling since 1942. But there is a fine line between confidence and complacency.

FUJI DIGITISED

Even before the first magnetic disk cameras had gone on sale, they had been made potentially obsolete by a new technology developed by Fuji.

The new Fuji system is much lighter and smaller, because it uses computer memory chips instead of a motor and disk drive. Also, instead of recording the video signal as an fm analogue waveform, the new Fuji camera converts the signal into digital code and stores it in a 16 megabit random access memory card.

One card can store five full tv picture "frames" or ten "fields", each made up from half the normal number of tv scanning lines.

Fuji developed the memory card with Toshiba, as spin-off from the company's work for Robert Maxwell on a solid state sound recording system for language tuition. Fuji says it is now working on data compression technology, which will allow a single card to store up to forty full frame images.

Because the camera contains no mechanical drive it weighs only 0.5Kg. And because the stored signal is digital it can be fed to a personal computer for image processing, or sent down a telephone line like an electronic mail signal.

ELECTRONIC IMPACT

Wilbur Prezzano, General Manager of Photographic Products at Eastman Kodak in the US, is still sceptical about the immediate impact of electronic imaging.

The company has in the past made the valid point that if electronic imaging had been invented first, and someone now discovered the remarkable ability of silver salts to record optical images, it would be heralded as a dramatic breakthrough.

Prezzano cites the mistake made by book publishers, who thought they could sell copies on microfilm. The idea flopped because people want to see books on their shelves and touch the paper pages.

"Paper is one of the most perfect devices ever invented," says Prezzano. "Silver halide has a long and healthy life ahead of it. And so does electronic imaging. By the year 2000, both systems will co-exist."

But the year 2000 is still over a decade away and it took the Japanese electronics industry less than that to create and dominate a home video industry in which Kodak's only role now is to sell tape made by Far Eastern competitors, TDK of Japan and Goldstar of Korea. PE

THAT'S STILL LIFE

So, photo technology zooms ever onwards. However, your Editor has a digital pre-tech light meter from his childhood days that may deserve museum status, but which still works. It's a rectangular tube containing a numbered translucent grey-scale; you point the tube at the subject and note which one of the five numbers you can just see through. The number represents the light value factor from which exposure settings are then calculated using a rotary disc on top of the tube. It served me well enough until my one-shilling a week pocket money had been saved up to buy a selenium cell meter. And that digitally inspired interest eventually took me into professional film making for fifteen years. What is hi-tech one day, may become lo-tech the next, but the crucial test for any tech is: does it do the job that's needed?

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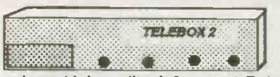

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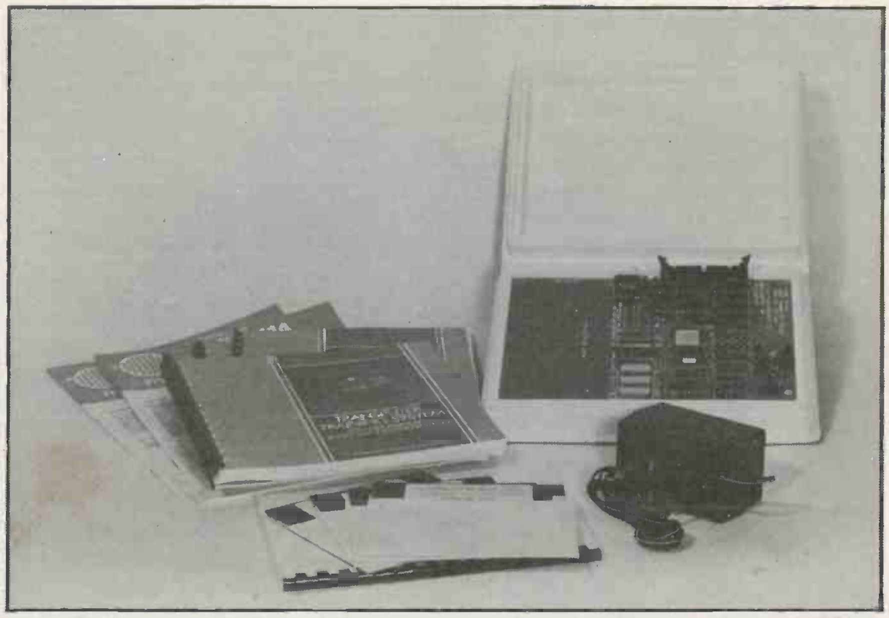
It would be difficult to take an interest in the world of computing for any length of time without stumbling across a few references to transputers. On the other hand, relatively few people have any more experience of them than reading articles on the subject. Although transputers have, as yet, failed to gain widespread acceptance and use, they are becoming more common. They are certainly available in a number of commercial products such as add-on processor boards and intelligent graphics displays for the IBM PCs and compatibles. For someone wishing to master transputer technology, gaining the all-important hands-on experience at programming and interfacing to these devices is by no means easy. It is made somewhat easier by the introduction of a transputer training system by Flight Electronics, and it is this interesting system that forms the basis of this review.

This is not the place to go into great detail about transputers, which is the purpose of the Flight Electronics transputer training system, and its several hundred pages of documentation.



The Flight Electronics training system is based on the Inmos IMS-T414 transputer. The system consists of no less than five manuals plus manufacturer's data sheets and IMS C012 link adaptor.

TRANSPUTER TRAINER REVIEW

BY ROBERT PENFOLD

A solid investment in the future with Flight Electronics and their Inmos transputer training system.

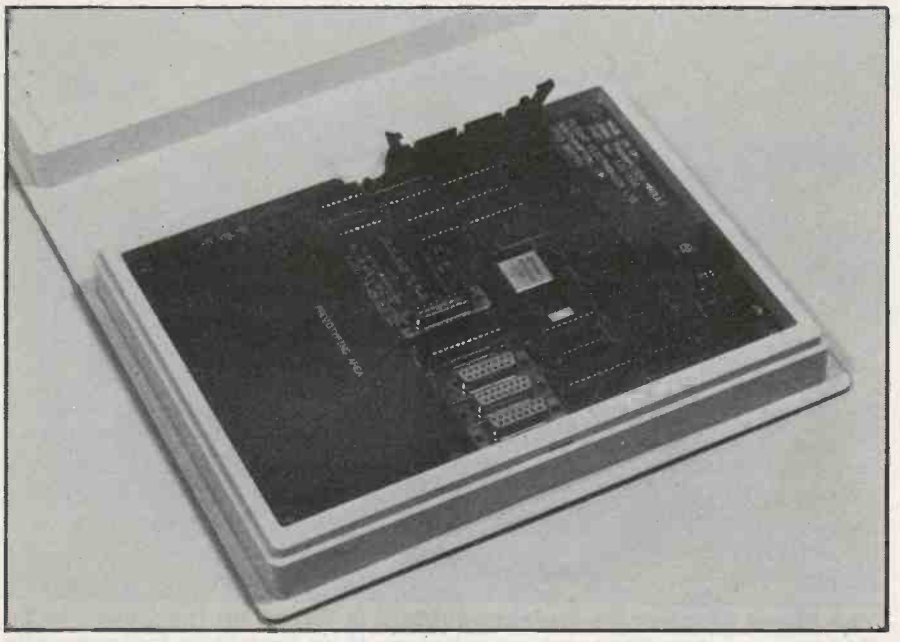
THE SYSTEM

For the uninitiated it should perhaps be explained that a transputer is a powerful processor which utilizes risc (reduced instruction set computer) technology. This is a processor which, as its name implies, has a limited (but well chosen) set of instructions. The reduced instruction set enables the architecture to be streamlined so that few clock cycles are required per instruction. In fact most risc processors operate largely on the basis of one or two clock cycles per instruction. Even though it may sometimes be necessary to use a few instructions where an ordinary microprocessor would require only one or two, this approach permits faster processing to be achieved. Bear in mind that some microprocessors take over twenty clock cycles to perform many of their instructions. The yardstick by which processors are normally judged these days is their mips rating. MIPS stands for "million instructions per second", which is self explanatory. A single IMS T414 transputer provides 10 mips' performance, which is very impressive. For comparison purposes, the highly rated Acorn Archimedes computers are based on a risc chip which provides approximately 4 mips operation, and this is several times faster than something like an 8MHz 68000 processor. RISC processors are normally of the 32 bit variety, which also aids high performance in many applications.

Perhaps the transputer's main claim to fame is that it is possible to use several of them in a network to perform parallel processing. In other words, tasks are split up into several jobs which are undertaken simultaneously by several transputers, each job being tackled by its own device. With several processors working on a task simultaneously it can obviously be completed several times quicker than by using a single device. With half a dozen transputers you could obtain 60 mips operation. This is largely irrelevant in the current context, since the Flight Electronics training system is based on a single Inmos IMS-T414 transputer. However, it is possible to use up to thirteen of these transputer boards together to act as a network.

The training system consists of no less than five manuals plus the manufacturer's data sheets for the IMS T414 transputer and IMS C012 link adaptor. The latter is responsible for the link to the host computer, plus any linking to other transputer boards. None of the ring-bound manuals are particularly long, and they seem to have been produced on something less than the ultimate dtp system, but all the documentation you should need is there. The four main manuals are a general user guide, a hardware installation guide and manual, an introduction to the Occam programming language, and the main user manual. The fifth manual is Inmos' Occam manual. The hardware manual includes circuit diagrams for the main and interface boards, together with brief circuit descriptions. The large number of manuals and data sheets can be a bit confusing at first, and there is a certain amount of overlap in their coverage. The inclusion of the data sheets is a nice touch – often training systems make numerous references to data sheets which you have to obtain by your own means, if you can.

The hardware consists of the transputer board, a power supply, and an interface card. This training system is not a stand-alone unit, and it must be used in conjunction with an IBM PC or compatible. As yet, no other computers can act as the host for the system. The host



Thirteen of these transputer boards may be linked to act as a network.

computer does not need to be anything too exotic, and the system worked fine with both an Amstrad PC1512 (upgraded to 640K ram) and a 12MHz AT clone. Some PCs are unsuitable though, since at least 640K of ram is needed, together with 1M of disk space. A twin 360K machine is therefore unsuitable, and a computer fitted with a hard disk is clearly an asset. The interface card is a standard half length type which can be fitted without difficulty. It refused to work at first, but we had omitted to configure its jumper terminals correctly. Connection from the interface card to the transputer board is via the 15 way D lead supplied. Although the system includes a small mains power supply unit, in most cases power can be drawn from the host computer, and the power supply will be unnecessary. Last but by no means least, there are four 5.25 inch (40 track DS/DD format) disks which contain the software including the Occam compiler.

THE OCCAM LANGUAGE

Occam is the language of the transputer. It is specially designed to allow programs to be configured to run on more than one transputer at a time, in true parallel processing. However, Occam programs can also be run on a single transputer, by a system of time slicing.

The language supplied with the TTS is Occam 1. This is a fairly limited language, and in terms of high level/low level it is somewhat lower than, for example, C. It has only integer arithmetic, and there are no in-built facilities for reading a string from the keyboard or writing one to the screen, for instance, only for character-by-character reads by means of channels. However, 'library' routines to perform these functions are included in the supplied software.

Channels are important in Occam. As well as being used for communication with the outside world, channels are also used for communication between transputers in a network. When only a single transputer is being used, these channels are logical channels within the language, but when a network of transputers is available, these same channels can be configured (explicitly by the programmer) to become physical channels between the components. Thus it is that only a single transputer is necessary on the TDS board to allow parallel programming to be explored.

THE EDITOR/COMPILER

It is not surprising that an unusual language like Occam needs a fairly unusual editor. It is described as a 'folding' editor. The explanation of this name is that, when a suitable section of code has been written, it can be referred to in future by name, and hidden from view, like folding up a piece of paper. The contents of a fold are similar to the procedures, modules and subroutines of other languages. In part, this folding is necessary because of the way Occam is written. The indenting used in some other languages to indicate program structure is compulsory in Occam, as it is used by the compiler. As you go deeper into the program, you can tend to get rather a long way from the left margin. Within a fold, you start afresh flushed left, making the screen display much more readable. One problem, however, is that it is very difficult to get a coherent printed listing from the editor.

The editor is not friendliest or most helpful of programs. For example, it displays a message to press 'Enter Fold' to continue, referring to one of the function keys, whereas a message to 'Press F7 to Enter Fold' would be clearer and also save having to reach for the manual and look up the keyboard chart. On the plus side, the program is undoubtedly robust. Unlike other languages which have separate editor and compiler programs, in the TDS the two are integrated. Facilities are also provided to download the code to the transputer board and execute it.

Compiling includes syntax and error checking, and, probably as a result of this, compiling is not a fast process. However, providing the code within a fold meets certain rules, it can be separately compiled (and is then termed a 'separately compiled fold'). The advantage of this is that recompiling of this section is not necessary if the program is modified, which saves some time.

The transputer board does not have to be connected to the host computer for either editing or compiling, so where there are several students, it is not necessary to have one of these, or an interface board, for each student. It is necessary to have the boards to actually download and run the programs, of course. Unfortunately, the ability to run the programs under DOS on the host computer is no longer implemented.

SOFTWARE

The software included is supplied in MS-DOS backup format, and has to be installed on the hard disk (or high capacity floppy disk) using the RESTORE command. As this could give problems with differing versions of DOS, the system files are included on the master disk, and provided you boot up from this, file transference should present no problems. As well as the editor, compiler and utilities, all the example programs from the manuals are provided on the disks. The bias of the examples is towards real-time and control applications, rather than data processing, but all aspects of the language are covered.

There is also an on-line tutorial which takes you through all the stops of writing, compiling, downloading and running a simple program. However, as (nearly) always with such tutorials, having been led through by the hand, and told at each step exactly what keys to press, I found myself at the end wondering if I had in fact actually learned anything. The problem with such tutorials is that you tend to proceed through them, idly pressing keys and wondering how the test match is progressing. When you are left to do something yourself (in this case completing a line within a fold) you find yourself foundering because you have not been paying attention. I am just not convinced that this is a valid teaching method. This is only a small criticism of the Transputer Training System, of course, as it is only a small part of what is supplied. All in all, there is everything here that is necessary for a thorough grounding in programming the Transputer. It is just up to the student to pay attention!

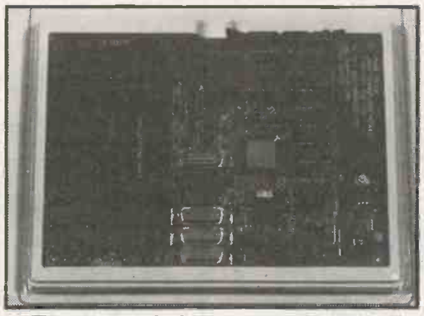
THE HARDWARE

It has to be stressed that this is primarily a training system, and it is not designed to turn the PC into a lightning fast computer capable of running transputer applications software. It is very much in the same vein as the training systems for processors such as the 6800 and 68000 which have been available for many years. Like many of these systems, it has some development potential, but it is primarily aimed at teaching you about the processor. Traffic light simulation rather than flight simulation is the type of thing you are likely to produce on a system of this type.

The processor board is a double-sided type of good quality, and contains about a dozen ttl logic chips, the transputer, a couple of support chips, and 256K of 41464 dram chips (organised as 32 bits by 64K of course). All the chips are fitted in sockets. There are fourteen leds on the board, five of which give status information, and eight of which are memory mapped and driven via latches. These eight leds provide a means of trying out simple control programs, and make an interesting alternative to obtaining output via the screen of the host computer. The board has a 15 way D plug which takes the lead from the interface card in the host computer, and there are three 15 way D sockets which can be coupled to further transputer boards. The nine sockets on these additional boards can be connected to further transputer boards, permitting up to thirteen boards to be networked. As we had only a single board available for review purposes, we were unable to try out any multi-board systems. The interface sockets on the boards carry an interface which is essentially the same as that on the interface card – a high speed synchronous serial type.

There is a decent size "PROTOTYPING AREA" on the board which can be used to wire-wrap your own hardware. A 40 way IDC plug provides 8 bit input and output ports which permit communications with your prototype circuits. There is no general expansion bus incidentally, and these ports would appear to be the only method of interfacing to your own hardware. Controlling a few leds is fine initially, but in order to really do some worthwhile experiments with the system, and to really learn about transputers, I think that you would soon need to make use of the ports and some simple add-on circuits.

Someone who already has some programming and electronics skills should soon be able to get to grips with transputers with the aid of this training system.



Further information on the transputer training system can be obtained from:
Flight Electronics Ltd., Ascupart Street, Southampton, SO1 1LU. Tel: 0703 227721

CONCLUSIONS

This system certainly ranks as one of the more interesting things I have reviewed over the years. It is reasonably straightforward to get everything up and running, there is plenty of documentation of adequate quality, and given a moderate amount of effort it enables you to learn a fair bit about transputers. It is not aimed at complete beginners to electronics and computing, which is sensible, as transputers are probably not a good starting point. Someone who already has some programming and electronics skills should soon be able to get to grips with transputers with the aid of this training system.

The only serious drawback is the price of around the thousand pounds mark. The system does not seem to provide you with very much for this sort of outlay, but you need to bear in mind that transputers are relatively expensive at present. Anything that gives hands-on experience with transputers is likely to be pretty expensive for the foreseeable future. Also, training systems and development systems do not sell in the same sort of numbers as home and business microcomputers. This inevitably makes them less good value for money. I have no doubt that most PE readers could have great fun using this system, but at this price I do not know how many will have the funds to buy one.

While the high price takes the system beyond the reach of all but the richest of electronics hobbyists, it will no doubt still appeal to companies and educational establishments. The system is unusable without an IBM PC or compatible, but presumably most companies and educational establishments will have a suitable computer available. As a transputer training system this Flight Electronics system succeeds quite well, and is certainly worthy of recommendation to organisations that can justify this sort of monetary outlay. PE

MAKING ELECTRONICS C.A.D. AFFORDABLE

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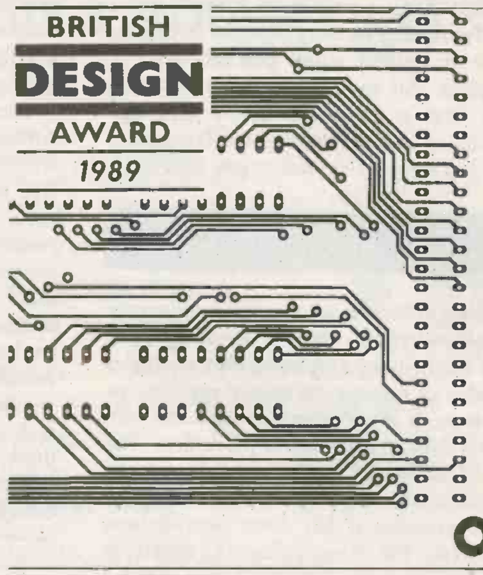

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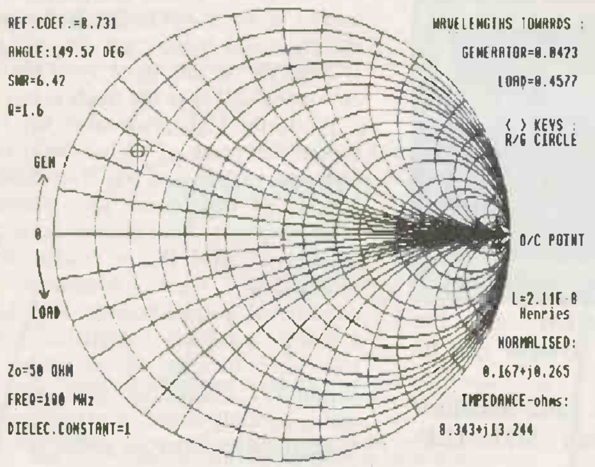

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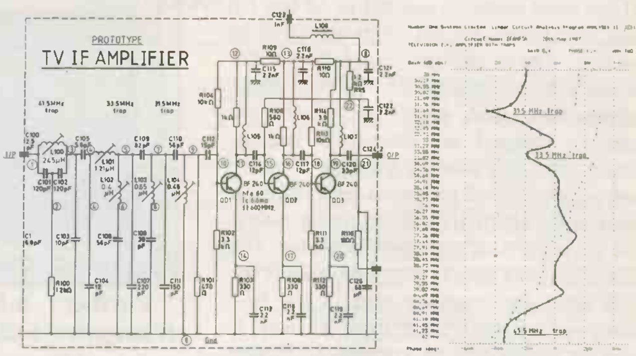

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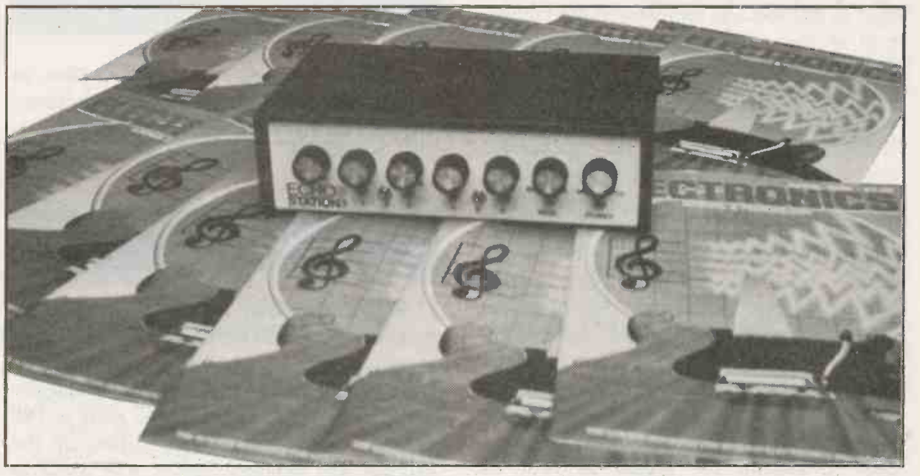
MONO-STEREO ECHO STATION

BY JOHN BECKER

By popular request, here's a new multi-function echo unit using Panasonic delay chips.



The lament has been loud and clear : "Why, dear Editor, why did Mullard/Philips kick the bucket brigade delay line chips TDA1022 and TDA1097 from their repertoire? Can't you produce an echo-delay unit that uses alternative chips?"

Even before my Editorial comment in PE August 88 bemoaning the loss of these delay chips, readers were asking why they had become scarce and what could replace them. My reply was to the effect that more than one manufacturer had deleted bbd chips from the production lines, but at least Panasonic had retained their series of MN3004, MN3008 and MN3011. Since my reply, the cries for PE's help have fairly reverberated my ear drums. So, by popular request, herewith a new echo unit!

REPEATING OPTIONS

Being a great believer in giving value for money, I've made you an offer you'll find hard to refuse. The design to be described here is far more than just an echo unit. With a bit of judicious sleight of hand I've added a few more lines and symbols to the circuit diagram so that the unit can produce nearly the full range of echo-related effects possible with delay chips. More than that, it can be used for both mono and stereo input signals.

The line up of controlled options consists of echo, reverberation, double tracking, phasing, flanging, chorus, vibrato and a delayed signal independent from the original signal. I'm additionally (is there no end to my good-heartedness?) offering you a choice of which delay chip you can use, depending on the status of your cash-flow criteria.

CHIP CHOICE

The choice of delay chips open to you is either the MN3004 or the MN3011. The former offers 512 internal delay stages in a single block, whereas the latter has 3328 stages split into six combinatory blocks. Not unexpectedly, the MN3011 is the more expensive. But I reckon you'll find it hard to resist the enticement of the extra stages. Even if you do resist, though, you'll undoubtedly find a lot of satisfaction from using the shorter delay chip. I'll tell you about the actual echo and reverb times later.

For those of you who missed my Echo-Reverb and Chorus units of PE Aug 84 and Jan 85, as well as Robert Penfold's discussion in his Signal Processing article of July 87, (and who haven't been eavesdropping elsewhere!) here's a quick mini tutorial on bbd principles and the delayed nature of life with the bucket brigade. Those who've graduated through previous lectures can fast-wind down to "DELAY CIRCUITS".

SHIFTING BUCKETS

You've probably heard of shift registers. These are normally associated with digital electronics and consist of a number of electronic switches coupled in series and connected to a clocking oscillator. At each clock pulse each switch becomes set to the same on or off state as the one before it, except for the first switch which takes on the logic state of the input line. The output is taken from the final switch. If the shift register has 16 switches, then it takes sixteen clock pulses to pass a single input bit to the output. The longer the series of switches, or the slower the clocking rate, so the delay between input and output becomes greater.

A bucket brigade device works in a somewhat similar fashion to the shift register, except that it is not clean-cut high and low logic levels that are clocked through, but discrete voltage levels. The logic switches are replaced by capacitors, and at each clock pulse each capacitor takes on the charge level of an adjacent capacitor. The name 'bucket brigade' has been coined for such devices since the principle is supposedly analogous to the pre-tech fire-fighting method in which buckets of water were passed along a chain of people, from the pond to the pyrotechnics! Personally, I don't think it's a totally representative analogy - with bbd devices the charge on each capacitor is effectively tipped into the following capacitor. Bucket-brigade firemen don't normally go tipping their buckets of water into each other's buckets! However, the term is now part of the language, so I'll have to live with it ...

In reality, with a bbd, capacitor A does not transfer its contents to capacitor B while B is still transferring to C. To continue the analogy, you can't add your bucket of water to the next man's until he has passed on his, or at any rate, not without loss of load! Instead, a buffer bucket/capacitor is used but, contrary to what you might expect after the previous statement, the buffer starts off full.

Imagine five buckets, 1, 2, 3, 4, 5. Buckets 1, 3 and 5 are partially empty, 2 and 4 are full. On the first clock pulse 2 fills 1, 4 fills 3. The charge remaining in 2 is equal to the charge originally in 1, and similarly with 4 and 3. On the second pulse, 3 fills 2, and 5 fills 4. On the next pulse, the cycle starts over again. Although the buckets are emptying from right to left (5 through to 1), the residual charge quantity is moving from left to right (1 to 5).

For this operation, two antiphase clock signals are needed, one controlling odd numbered capacitors, the other controlling even numbered capacitors.

The original charge was sampled at the input to the bbd and represented the voltage level of the audio signal at that moment. The next sample will also represent the audio signal level at the next moment, and will quite likely be a different level. Consequently, the chain of successive sample levels will move along through the bbd to its output, at which point the overall waveform will be equivalent to the original sampled waveform, albeit delayed by the number and rate of the clock pulses required to pass it through. Although the basic wave shape will be the same, there will be a minor, but significant, change since the shape is made up of a series of discrete steps, corresponding to the sample points. These must be smoothed out by a filter to restore the signal as near as possible to its original shape.

Having delayed the output signal with regard to the original, we can do a variety of things with it, such as use it on its own, feed it back to the start of the delay loop, or mix it with the original. We can also constantly vary the delay time by modulating the clocking rate. Depending on which combination of options we choose, so we can produce a range of different effects. Let's examine the major ones.

STRAIGHT DELAY

One useful function for simply delaying a signal is that the technique can be used to help eliminate feedback howl between a microphone and loudspeaker. If the delay is of such a length that there is a phase difference between the original signal and that arriving back at the mic from the speaker, the returning signal will not reinforce the original, successively increasing its amplitude until feedback saturation is reached. The best delay to shift the phase will vary with the acoustics of the room and the distance between the speaker and the mic, and should be found by trial and error.

DOUBLE TRACKING

This makes one sound become two. You simply mix the delayed signal with the original, and listen to the combined output. The delay time required is usually quite a short one, and the levels of the two signals should be roughly equal.

REVERBERATION

For reverb the delayed signal is fed back into the delay chain, but at a level slightly lower than that which comes from the delay output. Too much feedback level will cause the system to go into perpetual howl. The art is to allow the signal to decay slightly each time round the delay loop. It is usual, though not vital, to mix the reverb signal with the original at the final output and listen to the composite. Short delay times are best for reverb.

ECHO

This is produced in the same fashion as reverb, except that much longer delay times are used so that even short individual words can be heard repeating at diminishing levels.

PHASING

Due to the delay time, the phase of the delayed signal will normally be shifted with regard to the original. The amount of phase shift will depend on the signal frequency and the length of delay. If the shift is 180 degrees, mixing equal quantities of the original and delayed signals will result in mutual cancellation. If the shift is 360 degrees, adding equal quantities of each will double the amplitude. If we constantly vary the delay period, the phase shift for a particular frequency will likewise vary in response. The combined signal amplitude will thus similarly vary in amplitude. With signals consisting of multiple frequencies, as with music for example, each frequency will be subjected to a different phase shift. Consequently, different regions of the signal will be given varying amounts of cancellation or enhancement, producing the phasing effect with which we have become familiar. The best effects are produced with signals that have a harsher quality to them; those that are close to sinusoidal in shape will not produce such dramatic effects.

(The most pronounced phasing effects are often produced by also introducing variable filtering characteristics, though this technique is not offered here. See my *Filter-Shift Phaser* of PE Oct 84 if you're interested in the technique.)

To repeatedly vary the delay time, and thus the phase shift, a low frequency oscillator is used to vary the rate of the master clocking oscillator. The modulation rate is usually set for a period of several seconds.

FLANGING

Flanging is produced in the same way as that used for phasing, except that we also feed back some of the signal through the delay line. In other words, we add reverb to it. For the most interesting sounds, the reverb feedback is set just below the level at which howl occurs. As with phasing, the modulation rate should be very slow.

CHORUS

This is another variation on the phasing technique, but for this the modulation rate is much faster, usually at about 6Hz, though faster rates can be used. With this modulation rate, the effect sounds as though the voice or instrument quantity has been multiplied many times over. It's an ideal technique to use for making a small group of instruments sound like an orchestra! It's necessary to mix the modulated signal with the original.

VIBRATO

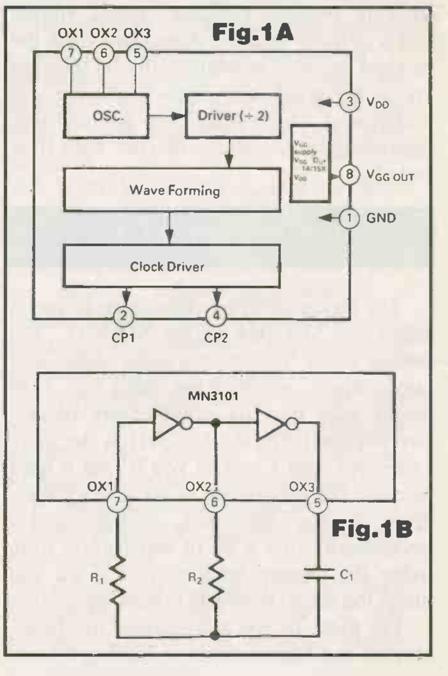
For this effect, the delayed signal is used on its own without being mixed with the original. The delay rate is modulated at about 6Hz. The constant speeding up and slowing down of the signal as it passes through the delay line results in an apparent shift of the signal frequency. The modulation depth is usually set so that the frequency shift is about one third of a tone for the middle octave. Since each note will be subjected to an apparently slightly different frequency shift, the result is less precise than would be produced by a professional musician on a manually tuned instrument.

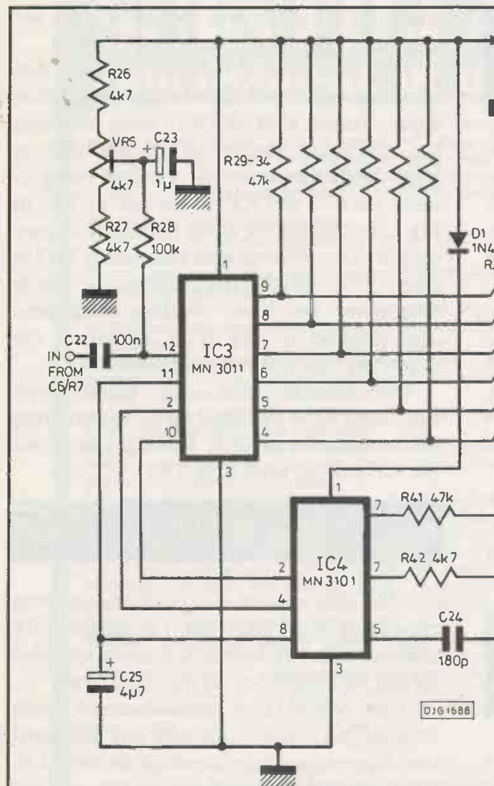
DELAY CIRCUITS

On previous delay-type circuits I have used a variety of analogue and digital techniques for producing the clocking oscillator. This time, though, I am making use of Panasonic's MN3101 purpose-designed delay line clock chip, the pin-outs and block functions for which are shown in Fig.1.

As you will see in Fig.1b, the frequency generator is based on the conventional twin-inverting gate technique. C1 is the frequency range controlling capacitor, and R2 sets the particular frequency within that range. By varying the value of R2, so we can vary the clock rate. We could replace R2 by a potentiometer to provide panel control of the delay rate, or we can substitute a field effect transistor and control the resistive drop across it by means

Fig.1. MN3101 block functions and internal oscillator circuit.





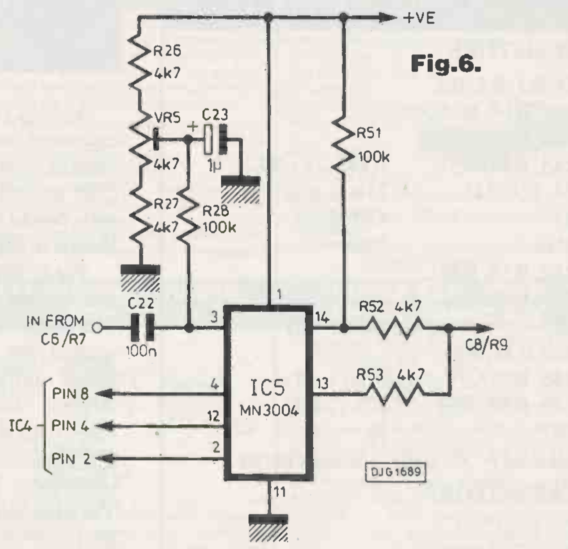


Fig.2. Clock generator and MN3011 delay chip circuit.
Fig.6. Alternative delay circuit using MN3004.

of the bias applied to its gate. In Fig 2, the MN3101 clock chip is represented by IC4, and you will see that I am using the fet technique, TR2, to control the clock rate. More on that in a moment.

Pins 2 and 4 of IC4 are the antiphase clock outputs which are fed to the delay line chip itself, IC3. It doesn't matter which clock line goes to which clock input.

With the now-obsolete TDA1022 and TDA1097 devices, a series of resistors were used to set the required tail bias. The bias for the MN3011 chip, though, is supplied directly by IC4, from its pin 8.

MULTIPLE DELAY CHIP

Audio signals are brought into IC3 at pin 12 via C22. A second bias level is required at this point, and requires adjustment to minimise waveform distortion. Several ways for doing this are possible and I've chosen the one I've normally used with the TDA delay lines. This comprises the circuit around VR5, adjustment of the pot presetting the bias voltage.

The pin-outs and internal block diagram for the MN3011 are shown in Figs.3 and 4. Each of the six delay outputs require a pull-up resistor, represented in Fig.2 as R29 to R34. They are then taken via R35-R40 and S2-S7 to a mixer/filter stage that will be described later. The switches can be used in any order or combination. You can thus individually select a chosen output delay, or combine several output delays together. The latter option allows not only for normal double-tracking, as referred to above, but multiple-tracking of up to seven differently delayed tracks. This has further significant implications to the types of sound produced with all other main effects options of reverb, flanging, chorus, and so on.

The chip typically introduces no insertion loss of signal amplitude, though individual samples could show a change of around ±4dB.

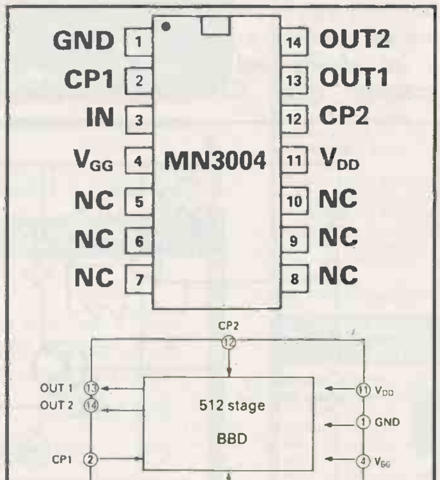


Fig.5. Pinouts and block diagram for MN3004.

Fig.3. Pinouts for MN3011.
Fig.4. Internal block diagram for MN3011.

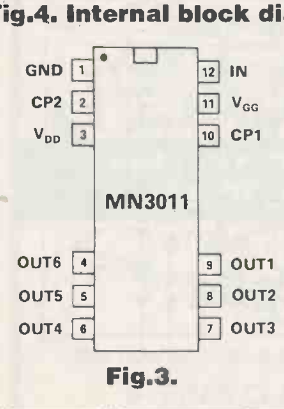
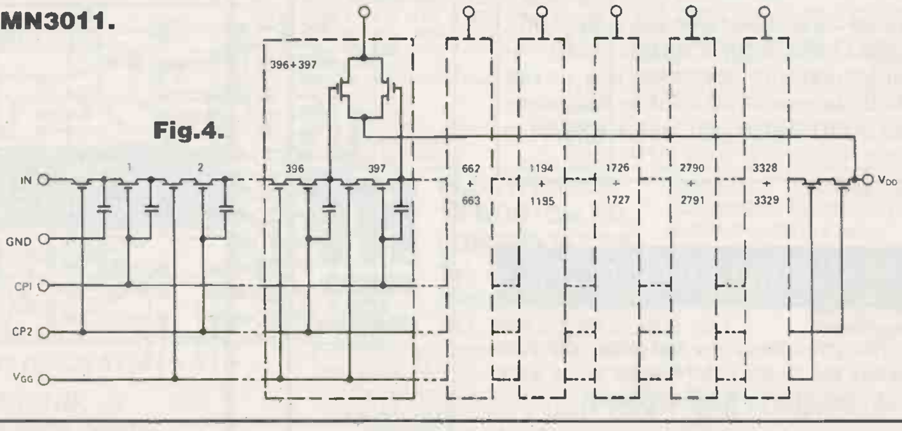


Fig.3.



COMPONENTS

RESISTORS

R1-R3, R5, R6, R11, R14, R16-R25, R28, R35-R40, R43, R44, R51	100k (27 off)
R4, R9, R15	75k (3 off)
R7	470 ohms
R10	200k
R12, R13, R26, R27, R42, R52, R53	4k7 (7 off)
R29-R34, R41, R46, R48	47k (9 off)
R45, R49, R50	10k (2 off)
R47	1k

All 0.25W 5% carbon film or better.

CAPACITORS

C1, C2, C5, C6, C10, C17, C20, C22, C26, C30	100n polyester (10 off)
C3, C9, C12, C24	180p polystyrene (4 off)
C4	330p polystyrene
C7, C8	1n polystyrene (2 off)
C11, C21, C31	22µ 16V elect (3 off)
C13-C16, C18, C19, C23	1µ 16V elect (7 off)
C25, C27	4µ 7 16V elect (2 off)
C28, C29	470µ 25V elect (2 off)

POTENTIOMETERS

VR1, VR6	1M lin mono rotary (2 off)
VR2	25k lin mono rotary
VR3, VR4, VR8	100k log mono rotary (3 off)
VR5	5k skeleton preset
VR7	100k skeleton preset
VR9	10k log mono rotary
VR10	10k skeleton preset

SEMICONDUCTORS

D1	1N4148
TR1	BC549
TR2	2N3819
IC1	LM324
IC2, IC6	741
IC3	MN3011 (see text)
IC4	MN3101
IC5	MN3004 (see text)

SWITCHES

S1-S8	min spdt toggle (8 off)

MISCELLANEOUS

Printed circuit board pair, pcb clips (8 off), knobs (7 off), 8-pin ic sockets (5 off), 14-pin ic sockets (2 off), stereo jack sockets (2 off), box size 9 x 5 x 2.5 inches, rubber feet (4 off), battery clip, wire and solder to suit.

ACKNOWLEDGEMENT

The pin connection and block diagram circuits for all three MN series ships were kindly supplied by RS Components.

SINGLE DELAY BLOCK CHIP

Should you feel that you don't want the enhanced versatility of having six delay outputs, you can use the MN3004 delay line chip instead of the MN3011. The pin-outs and block diagram for the MN3004 are shown in Fig.5.

Fig.6 shows the circuit implementation, and is very similar to that used with IC3. The clock signals, tail bias and signal input section are identical to those for IC3. A minor difference is that IC5 has two outputs. These are summed at R52 and R53, with a pull-up bias provided by R51. The combined output is taken to the same subsequent filtering stage as used for IC3. The chip introduces an amplitude change in the range of ±4dB, typically about 1.5dB.

MODULATION CIRCUIT

Modulation and delay range bias are controlled by the circuit in Fig.7. There's less to this circuit than meets the eye!

IC6 is configured as a squarewave oscillator with its rate set by VR6. We don't use the squarewave, though, instead we are a bit sneaky and use the waveform generated across C27. This is roughly triangular in shape and so can be used for smoothly varying the main clock rate.

The waveform is buffered by TR1, and taken via VR7 and C28 to the modulation depth control VR8. VR7 is there to preset the maximum output swing available at VR8. With S8 closed the varying swing is taken via C29 and R50 to the gate of TR2 in Fig.2, so causing the clock frequency to vary up and down. The dc bias controlling TR2 is taken from VR9, the setting of which determines the basic clocking frequency. The purpose of VR10 is to preset the minimum bias that can be applied to TR2.

For normal echo and reverb type functions, S8 is switched open, so removing the modulation control, leaving you to set the static delay time with VR9.

DELAY PCB

The delay board has positions for both choices of delay chip, but it is intended for use with *either* IC3 *or* IC5. It is not intended for use with them both at the same time.

The MN3011 is manufactured with unusual pin connections and you will need two 6-pin ic sockets in which to mount it. Alternatively, use two 8-pin sockets and cut off the extra legs. PE

Next month we conclude with the interface circuit and setting up.

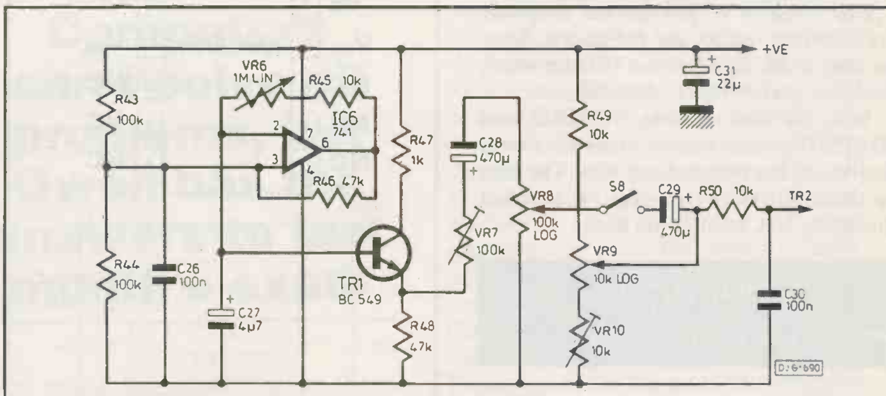
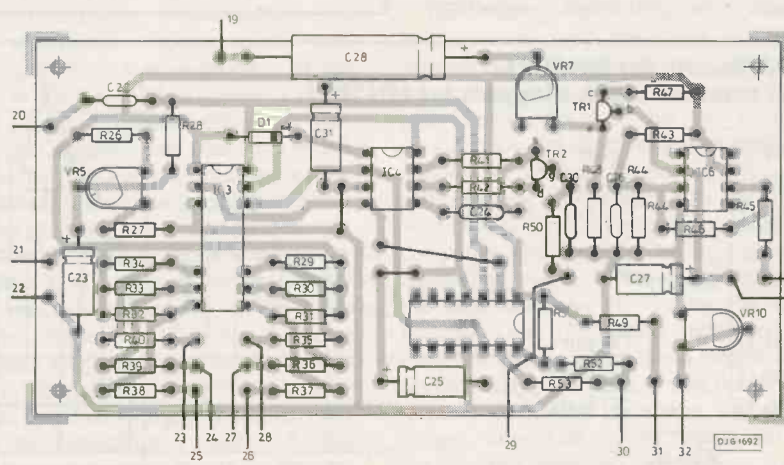


Fig.7. (Above) Modulation circuit.
Fig.8. (Below) PCB layout for delay and modulation circuits.



BECAUSE I LIKE IT

Dear Ed,

I have been an avid reader of PE for as long as I can remember. I still recall sitting in bed one night, with an early edition of PE (was it Dec 68?) and learning all the circuit symbols (as they were then!). Over the years I have seen other magazines come and go, each purporting to supply electronic enthusiasts with what they need to know about electronics, but I have avidly stuck with PE - *because I like it!*

I used to subscribe to Practical Wireless, because it was a general electronics magazine, but when it specialised in amateur radio I found it did not give me what I was seeking. This was a pity as I have some early "Camm's Comics" in my collection, older than I am!

Originally I used to take PE, PW, PT (later Television) and EE (when it first came out), mostly for the constructional articles. As my tastes developed, and I learned more about electronics (at school, and later at Polytechnic) I culled this down to PE and PW, buying mostly for the adverts! Unfortunately the days of Doram and Home Radio are long passed, and "The Smiths" seem to have left Edgware Road, along with a few other suppliers. Consequently fewer firms are advertising components, and most bits are now only obtainable via catalogues (possibly because people are trying to reduce their advertising costs). Fortunately PE has expanded the General Interest articles, so although I really only buy PE for the adverts, I also find it a very good read, and often find that I have much to learn from the constructional projects.

I fully applaud your Easi-build series and look forward to many articles in the series. It will be interesting to see how this series develops, and to what cost ceiling it extends.

As praise is no useful criticism I would just like to say, in closing, that the only part of your magazine that I would slightly criticise is the "clever" play on words accompanying the article titles (and I bet it takes you ages to think them up!).

Please rest assured that I for one will continue to subscribe to PE, especially as it seems to be evolving just as my tastes are!

John Rendall BSc (Hons)
Wyken, Coventry.

If you have any comments, criticisms or suggestions, write and let us know. We are interested in what you think and say.

One of the interesting facts to come from our recent survey is just how many people have been long term devotees of PE. Many of these will remember with affection the reference to "Camm's Comics" - a reference to Frederick (?) Camm who, I believe, started the ball rolling by introducing wireless-orientated magazines for home constructors. (Some day I must track down the full story behind the reference.) His initiative resulted in the eventual arrival of PE, EE, PW and PT, all of which at one time were sister magazines, though we each go our independent ways now.

Yes, over the years many once-familiar trading names have gone. Some because people simply retired, others because they found the recent recession too destructive, and some because their interests have taken them into different fields. But a lot of new names have come onto the scene and a very healthy marketplace exists with an excellent selection of good suppliers around. It will pay any reader to spend a few stamps and obtain catalogues from our advertisers and so have an enormous variety of components and other products readily accessible. The stack of catalogues I have from our advertisers measures about two feet high - too much to fit into PE each month!

Many readers are pleased with our introduction of the Easi-build project series. In designing them I shall continue to have regard for their simplicity, low cost, and ready availability of components.

In claiming responsibility for the frequent word plays, I must also honour my assistant editor, Helen, whose sense of word and phrase relationships is equally prolific to my own! Electronics is a serious subject, but it doesn't mean that we have to be totally serious in everything. Playing around with a few puns and conundrums is just another way to keep investigative minds alert to different ways of looking at things. ***Ed***

ENCRYPTION SOFTWARE

Dear Sir,

I have read with interest the article in PE July 89 entitled *Encryption* and found it highly interesting, and a good introduction to the subject.

Having been involved with cryptology for some years, I thought you and the author of the article may be interested in a collection of encryption programs that I have developed for use with the IBM PC.

The programs are grouped together under the name 'Iris' and provide access to some sophisticated cryptographic techniques. I have released this software into 'Shareware' recently, and feel that your readers may be interested in using such software.

Iris is available from the leading Shareware suppliers, such as the Public Domain Software Library (PDSL), and directly from myself.

If any of your readers would like to obtain the latest copy, then they can write to me enclosing £5.00 plus £1.00 p&p, at Digital Crypto, PO Box 1, Penarth, South Glamorgan, CF6 2WB.

Peter S. Moreton, Penarth.

Many thanks for the offer, and for the disk you sent me. Fascinating!

Ed

ENCRYPTION HARDWARE

Dear Ed,

The *Encryption* articles in PE July and August greatly interested me. I was additionally intrigued by the illustrative cover of the July issue.

You showed an artist's impression of four related circular objects. Obviously they were all representing aspects of cryptology. The one at the top appears to be a silicon disc comprising many chips, and must represent the solid state microprocessing aspect of cryptology. The next disc is then a reel of computer tape, as used for a similar purpose. Thirdly, the disc with pointers, is the Wheatstone encryption disc as mentioned in the text on page 21. But, try as I might I cannot decide what the bottom disc shows, though it's obviously some ancient coded disc of some sort. Please enlighten me!

Jim Stevens, Salisbury, Wilts.

Quite right on the first three. The last one is the famous Phaestos Disc.

Phaestos is the site of an ancient Minoan palace in south central Crete dating back to around 1900 BC and excavated at the turn of this century. The Minoans, you may recall are particularly remembered for their labyrinths, their worship of bulls, and for the myth of the Minotaur, a creature half bull and half man.

The best known finds from the excavation are a superb series of Kamares ware vases, and for the intriguing Phaestos Disc. This is a unique clay disc of about six inches in diameter with stamped inscriptions in a spiral on each face. Although scholars believe the symbols hint at Anatolian origin, no one has yet succeeded in deciphering them.

When thinking up the illustration for the July cover, I was firstly tempted to use the Rosetta stone image, since this enabled archeologists to start deciphering Ancient Egyptian hieroglyphics. The Phaestos disc, though, seemed more appropriate since it is circular, in keeping with the other images, and because it remains an encryption mystery - despite all our modern computerised ciphering and deciphering techniques.

Your mystery is solved, but not that of the Phaestos disc. Perhaps it's just a route map to the centre of a labyrinth, or simply means "Beware the Bull"!

Ed

Originally, the general title to this series of simple projects was to be the *Quick-Chip Series*. The name was changed, though, to *Easi-Build* since the former title implied that each project would be designed around just a single integrated circuit. Upon consideration, I found that concept to be too limiting. Nevertheless, the philosophy behind the series is that, where possible, only one or two chips should be used. With the project I have for you this month, I stick to the original concept, and use just one ic, the LM324.

REMOTE CONTROL

The intention of this month's design is to show you one way in which simple remote control of a device can be accomplished without any interlinking wiring. In this instance we simply use sound as the linking medium, using it to activate a relay, which in turn can be used to turn another device on or off.

You only need two hands to build this handy unit that turns your voice into a third hand!

VOICE OPERATED SWITCH

BY JOHN BECKER

Such a technique has far more applications than I would care list here, or indeed than I could even possibly think of. Applications could range from vocally activating a light switch should your hands be laden with goods, to automatically switching a radio transceiver between send and receive. But I am sure that you will have your own ideas on how to use it.

CIRCUIT SECTIONS

The circuit in Fig.1 consists of five main sections, signal input gain stage, simple bandpass filter, envelope extender, delay control, and relay driver stage.

Basically, the circuit is intended for use with a cheap high-output crystal microphone. Other mics can be used so long as their signal strength is sufficient to trigger the envelope stage. However, with the amount of gain available across the two stages of IC1a and IC1b, I've had the unit working with all my mics, ranging from cheap crystal ones to expensive magnetic types, and at a distance of several feet.

GAIN AND FILTERING

IC1a is the input stage at which you can control the gain from a panel mounted pot, VR1. With VR1 at minimum resistance, the gain is set at about times two, increasing to around times 100 at maximum resistance. C2 is there to cut out some of the higher frequencies to give a little bit of noise immunity.

Following IC1a, a further filter restricts the signal frequencies to those normally associated with speech. The value of C5 determines the top cut, and the combination of R11, R12 and C10, restrict the lower frequency end. If the unit is to be used in a very quiet atmosphere free from low frequency noise, the latter three components may be omitted. In the middle of the bandpass range, the gain is round about 100, as set by R4 and R5.

ENVELOPE DETECTION

In the absence of an input signal, the voltage on C6 will hold the comparator IC1c in a high output state, ensuring that C7 is charged. This in turn keeps the output of comparator IC1d low, so keeping the relay driver, TR1, turned off.

When a sufficiently strong input signal starts, the positive-going output from IC1b is passed through D2, causing IC1c to change to a low output state. C6 filters out the voice frequencies, leaving the basic speech envelope, with a decay rate set by R6 and R7.

When IC1c goes low, C7 is almost instantaneously discharged via D3 and R8. The result is that IC1d changes its output state from low to high. The current now passing through R10 turns on TR1, which consequently turns on the relay coil. Within the voltage and current limitations of the relay contacts, you can switch on or off any electrically operated device.

When the input speech signal ceases, C6 will discharge, principally via R6, and when the voltage level falls below the reference level, IC1c will revert to its high output state. C7 will then charge up at a rate set by VR2. When that level passes the reference point, IC1d also reverts to its original state, TR1 is turned off, and so is the relay coil. The action of C8 gives a little bit of additional smoothing to the response time.

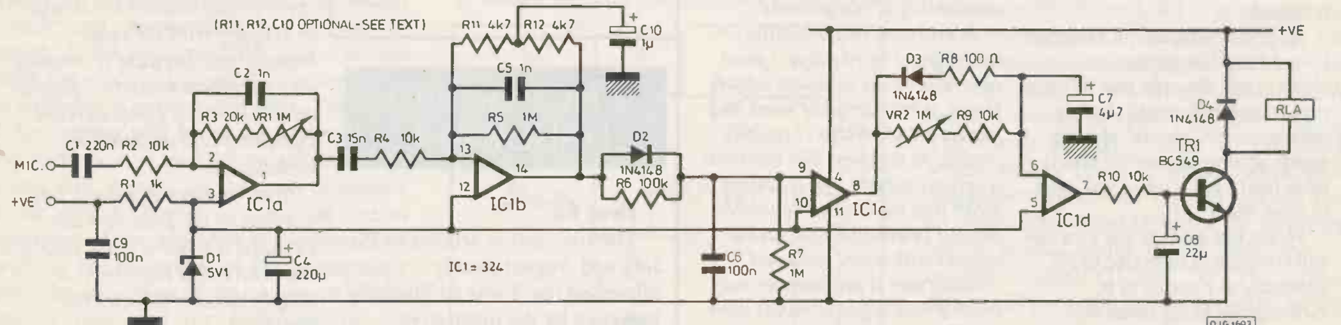


Fig.1. Circuit diagram for the voice operated switch.

REFERENCE AND TIMING

Zener diode D1 sets the reference level at about 5V. This method of setting the reference was found to be preferable to the more customary twin resistor potential divider, providing a greater degree of stability to the trigger points.

Although VR2 allows for a fairly wide range of delays to be set for the relay hold-on, you can modify this by changing the value of C7. It is most likely that you might wish to extend the hold-on time, in which case C7 may be increased, probably up to about 470µF.

DISCRETIONARY USE

You must obviously use discretion and common sense in determining where and how this unit is used. It will not, of course, on its own recognise the difference between noise and speech unless suitable precautions are taken. The unit can, as mentioned above, be operated at a distance of several feet, but in reality you should have the mic as close to you as is reasonable. This will enable the gain control to be kept down, inhibiting the detection of background noise. It is also recommended that the unit is only used in locations where the background noise is minimal.

The unit's switch-on response time is fast, typically around seven milliseconds, but for speech to trigger it this fast, it is preferable for your command word to start with a hard letter, such as D, G (as in "good"), K or T.

COMPONENTS

RESISTORS

R1	1k
R2, R4, R9, R10	10k (4 off)
R3	20k
R5, R7	1M (2 off)
R6	100k
R8	100 ohms
R11, R12	4k7 (2 off)

All 0.25W 5% carbon film

CAPACITORS

C1	220n polyester
C2, C5	1n polystyrene (2 off)
C3	15n polyester
C4	220µF 16V elect
C6, C9	100n polyester (2 off)
C7	4.7µF 16V elect
C8	22µF 16V elect
C10	1µF 16V elect

SEMICONDUCTORS

D1	5V1 zener
D2-D4	1N4148 (3 off)
TR1	BC549
IC1	LM324

POTENTIOMETERS

VR1, VR2	1M lin mono rotary

MISCELLANEOUS

14-pin dil socket, 16-pin dil socket, spst toggle switch, dpco dil relay (see text), knobs (2 off), printed circuit board, box and connecting sockets to suit.

RELAY AND CONNECTIONS

I used a double pole changeover pcb mounting dil relay on my unit, having a rating of 125Vac at 1 amp on its switch contacts. You can equally well use other types of relay mounted off-board. The relay coil should be of the 12V variety. For mains switching, the relay I used is not suitable and you must choose one capable of handling at least 250Vac across its switch contacts.

Even though cb radio is largely out of favour now, I know there are many of you who still have active rigs. This unit is ideal for automatically switching the rig to transmit when you start speaking. When you stop speaking, it will then switch back to receive after the pause set by VR2. A typical example of cb socket wiring is shown, but note that some rigs may have different connections - consult your handbook on this one.

POWER SUPPLY

The unit will run off any dc power line between about 9V and 15V. Consequently, a 9V battery is a suitable source of power, or even the 13.5Vdc supply associated with many rigs. PE

There'll be another interesting Easi-Build project for you in PE Dec 89.

Fig.2. Printed circuit board layout
Fig.3. Basic panel wiring.
Fig.4. Relay connections schematic
Fig.5. Alternative wiring for use with CBC4 type sockets.

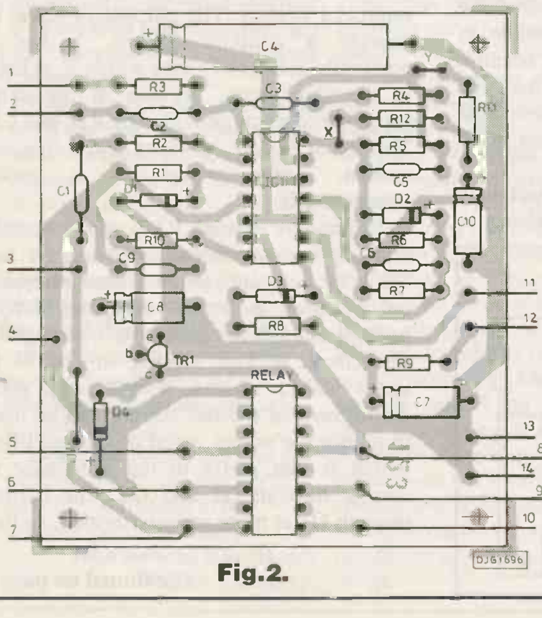


Fig.2.

Fig.3.

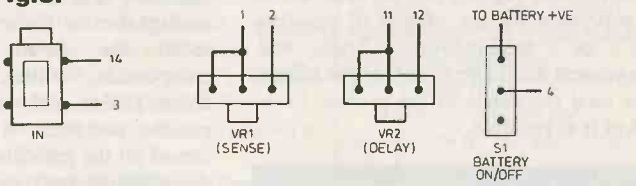


Fig.4.

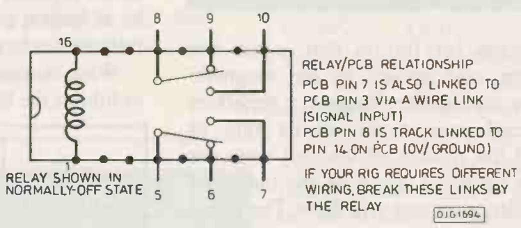
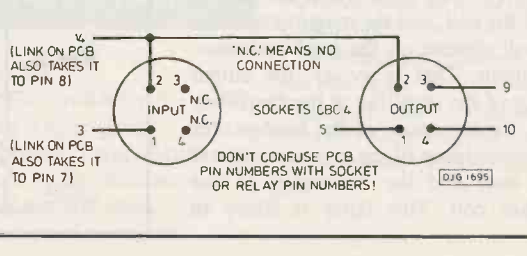


Fig.5.



This month we have an enquiry about the mosfet power amplifier featured in Part 7 (June 88) of my series on semiconductors. A reader says "I have purchased amplifier pcbs and, refering to Fig 1, would like to take the negative feedback directly from the loudspeaker terminal connected to L1. Would this work, or would it upset the stability of the circuit? I would also like to use solid state regulation before the output stage. I envisage two conventional adjustable 3-pin regulators respectively supplying Q1, Q2, and the Q3 network. What voltages are there at Q1 and Q2, and between R8 and R9?"

I will address the question of the negative feedback first. The one certain way to find out if it will work is to try it, because this will depend on the actual installation. If the feedback is taken from the end of a high resistance cable connected to a low impedance loudspeaker with a reactive crossover unit, the circuit could become unstable and the sound unpleasant. On the other hand, a short low resistance loudspeaker cable should cause few problems, though the sound could still end up worse if the crossover unit generates significant phase shift at higher frequencies. Of course, the negative end of C4 should be connected to the junction of Q5 and Q6 rather than to the feedback point.

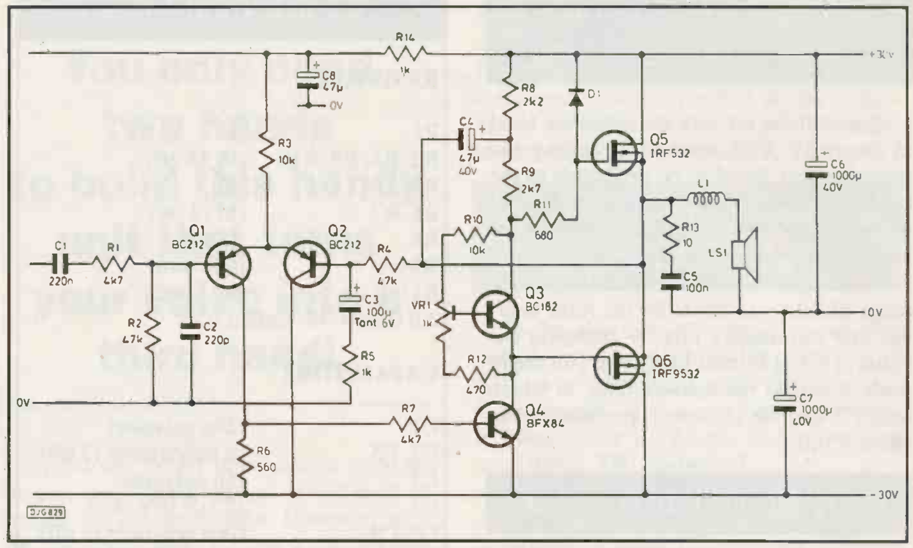


Fig.1. Circuit for a mosfet poser amplifier, as shown in Fig.65. of PE June 1988

dominate the situation in most cases, because the coil must be light and hence must use thin wire.

There is a way to do this, and it can definitely improve the sound of smaller loudspeakers, though I have not tried it on anything large. Many years ago I constructed a system with the amplifiers mounted on the loudspeaker cabinets, and with a separate amplifier for treble and

"to its own thing", and make the bass sound cleaner. Too much feedback introduced a muddy sound once again, and I concluded that a little less feedback than the perceived optimum at the time of adjustment would ensure long term good performance. This technique is not magic, and cannot compensate for limp speaker cabinets and the like, but it does produce a marked improvement.

ASK PE

NUMBER TWO – IN WHICH ANDREW ARMSTRONG ANSWERS A QUESTION ON SPEAKER FEEDBACK

On the other hand, why do it anyway? If the resistive losses in the cable are tiny compared to the losses in the loudspeaker coil, which should be the case with a properly chosen cable, then the question arises as to whether any audible improvement is possible by altering the feedback point. All this can do, after all, is to compensate for the effects of resistive cable or terminations. The real improvement would be to cancel the effects of the total resistance in the system, or as much of it as possible.

DAMPING FACTOR

The reason for this is that, when the loudspeaker coil moves in the magnetic field of the loudspeaker magnet, it generates a back emf proportional to its rate of motion. If the motion of the coil does not match the electrical signal on the output of the amplifier, a current will flow. The effect of this current will be to try to correct the motion of the coil, and the magnitude of the current will depend on the total resistance on the circuit. That is to say, the output impedance of the amplifier at the frequency involved, the resistance of the loudspeaker cable, the resistance of the crossover unit if there is one, and the resistance of the loudspeaker coil. This latter is likely to

bass. This eliminated cable resistance and crossover resistance at a stroke. Current feedback was then taken from the bass loudspeaker as shown in Fig. 2. I do not recall the details of the stability components, but the circuit worked at up to about 150Hz without overall phase shifts causing problems. It was not possible to cancel all the resistance, of course, because the effective resistance including dynamic losses depends on frequency, and there must be at least a small positive resistance at all frequencies to avoid oscillation.

What this did do, however, was seriously to inhibit the bass loudspeaker's tendency to

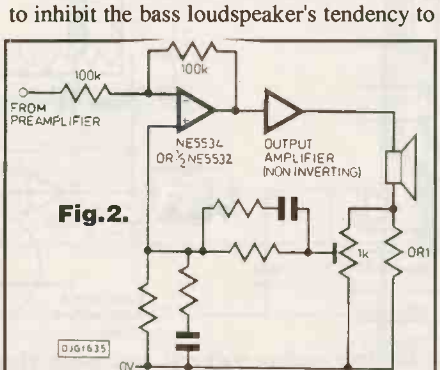


Fig.2.

REGULATION

The idea of adding voltage regulation to earlier stages is presumably to minimise the effects of voltage variations imposed on the power supply by the varying load of the output stage. Regulating the voltage as such is not the best approach, but if R3 were changed for a constant current source the performance of the long tailed pair could be improved slightly. The purpose of R3 is to provide a constant current. It has a nominally constant voltage across it, at least in the short term, because of the extra supply decoupling provided by R14 and C8. This is not perfect, however, and a constant current source would be a useful improvement.

The current through R3 is approximately 3mA, split almost equally between Q1 and Q2. If the constant current source were used on its own it would dissipate 90mW, perhaps enough to cause it to drift slightly. The circuit of Fig. 3 using an LM334 in series with a resistor, should work well. Adjustment of the tail current can be used to reduce the output offset of the amplifier, which is due partly to the imbalance in current through Q1 and Q2. The current through Q1 is more or less constant, so that

Continued on page 39

THE OTHER FACE

Just before we take a deep breath and look at the problems that computers bring, let us have an appreciative look at their benefits. The applications quoted above and other applications which we have not had space to include, may be summarised like this:

* *services* – banking, cash points, police records, medical records, medical diagnosis, intensive care units, library cataloguing, specialised databases (eg data on past legal cases for use by solicitors and barristers).

* *government* – tv licence records, DHSS records, DLV (vehicle licence) records, immigration records.

* *commerce* – point-of-sale (ie supermarket checkouts), buying from home (eg through Prestel, Telecom Gold etc), stock-keeping and re-ordering, word processing, payrolls, accounts, fax, airline reservations.

Unauthorised persons (or previous employees of the organisation) may be able to access the data, even to tamper with it. The data holder may agree to transfer the data to the computer of another organisation without the knowledge or permission of the individual.

It is to prevent abuses such as this that the Data Protection Act was brought into operation. The Data Protection Act is intended to ensure that people have access to their own personal data stored on computers by firms and individuals, and the right to complain if it is found to be incorrect. However, despite the Act, there still remains the feeling that somewhere there is someone who can obtain private and personal information (perhaps incorrect) about an individual and use that information to the individual's disadvantage. Some people feel that we are only a short step from the Big Brother type of society.

* *computer fraud* – there have been several instances of computer systems

* *information control* – control of information is a major key o power – military or commercial. The rich and already powerful nations have the computer technology to amass and analyse information on a scale never dreamed of hitherto. They can select what information is released and what is suppressed; they can distort and misrepresent the truth. This brings the danger that the poorer nations and other minorities will become even more dominated by the larger nations and the majorities. This point was discussed in some detail by Tom Ivall in PE July 1988. It is an aspect of the use of computers that is only now becoming apparent and to which we must become increasingly vigilant.

* *employment* – there must be many who have lost their jobs because a computer has taken it over. Employment opportunities in clerical work and many industrial assembly jobs have been reduced. This has caused distress and disillusion to many of those involved. But

DIGITAL ELECTRONICS

Part 12 – Conclusions

BY OWEN BISHOP

Computers can't solve all problems, but Owen has the answers to last month's exam

* *industry* – robots, computer-aided design, graphics, control of industrial processes, research and development.

* *computer assisted learning* – educational programs at school, in further education and in industrial training; flight simulators.

* *aid for the infirm and elderly* – a largely neglected field?

* *communications* – electronic mail, digital telecommunications.

* *home computers* – games, home accounts, word-processors, educational programs, communications (Prestel, Telecom Gold, bulletin boards).

* *domestic appliances* – washing machines, video recorders, watches and clocks, tv sets, teletext, Prestel terminal, video games.

* *administrative aids* – electronic diaries and 'organisers', decision-making systems.

* *aerospace* – air navigation, aeroplane control systems, satellite information processing, spacecraft navigation and control.

Most of these applications of computers can be said to be of benefit, either to the individual or to society as a whole. But there are aspects of computer use that do not necessarily bring good to all:

* *privacy is threatened* – details of an individual are held in many data banks – employers, banks, credit card companies (including department stores), DHSS, tv licences, book clubs – maybe the local tennis club. This is reasonable as long as the data is correct and remains confidential. But this is not easy to ensure.

being broken into, either with the aim of altering data or for financial gain. In many ways this is no different from ordinary robbery but, with computers, the results can be more serious. A bank robber or a person who falsifies documents may well leave clues which lead to bringing of the culprit to justice. With a databank, data can be altered or deleted without any clue being left. Computer data files don't reveal fingerprints! Moreover, alterations in data are absolute and undetectable. A bit that has been changed from a '1' to an '0' is now an '0' and no evidence remains that it has ever been a '1'. Massive stores of data invite massive catastrophe if they are corrupted. There are many ways of making stored data secure and it is obvious that, in the past, companies and individuals have been lax about providing data security. But most are becoming aware of the precautions that must be taken and the situation should improve in the future.

most surveys show that, taking society as a whole, computers have created as many jobs as they have destroyed. There is a continual reduction in many traditional occupations but increases in new occupations. The rapid expansion of the service industries made possible by computers is one of the more obvious changes in employment patterns. The real problem arises not with the changes themselves, since re-training and other measures can make the transition fairly painless, but with the speed at which the computer has brought these changes about. Government, employers and trade unions have frequently been taken by surprise. Experience of the impact of the computer is growing and one hopes that the future will be less harassing for the individual employee.

The headings above cover the main problem areas. As experience in using computers grows, ways are being found of overcoming them. In spite of this there still remains the fact that the average person does not find computers easy to understand. They are frightened by them; computers seem to be unfriendly and alien. This feeling is not necessarily restricted to computers. We remember having a bedside tea-making machine that evoked exactly the same emotions. It was just not 'user friendly' and frequently provoked a traumatic start to which could have been a beautiful day. The point is that the device – be it computer, tea-maker, or video-player – should be easy to operate and (in the case of computers) help you out when you operate it wrongly.

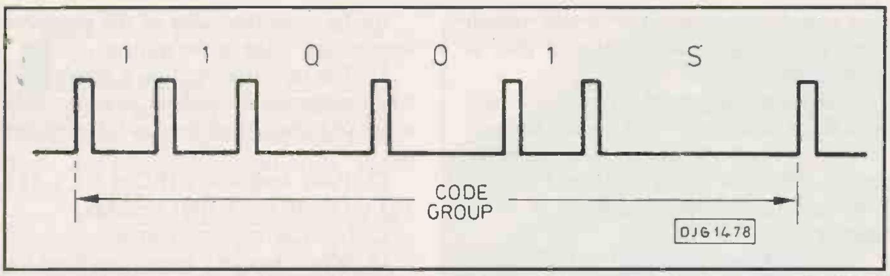


Fig.6. Pulse coded modulation. In the system above, a code group consists of six short pulses. The code transmitted depends on the intervals between the pulses. The 1, 0 and S (synchronising) pulses are in the ratio of 2:3:6.

PULSES IN CONTROL

Although the world (and this article) is becoming dominated by computers, we must not forget that digital electronics has many other applications. One of these is remote control, as in the device that is used to control the tv set or video recorder. The tv controller usually operates by transmitting an infra-red signal to the set. When you press one of the buttons on the controller, the infra-red leds at the front end of the controller flash a series of pulses towards the tv set. The controller contains a special digital ic that produces a different series of pulses according to which button is pressed. In other words, the pulses are a *code* (Fig. 6). The infra-red detector on the tv set picks up the signal, amplifies it and feeds the pulses to a decoder ic. This is another digital ic. It registers the code that has been received and as a result one or more of its outputs changes from low to high, or from high to low. This might result in changing the tv channel being viewed, altering the teletext mode, or muting the sound. The decoder ic may also have analogue outputs which produce varying output voltages. For example, as long as the associated code is being received, the output voltage increases or decreases step by step. This output could be used to control something that needs to be varied gradually, such as picture brightness or sound volume.

The possibility of interference in transmission is reduced by the logic of the decoder ic. For example, it could be annoying if a spark from the coal fire or a chance reflection of the infra-red from an object in the room caused a '0' to be substituted for a '1'. In one particular system the decoder registers two successive pulse groups and compares them. If they are both exactly alike, it accepts the command. If not, it waits until it *does* receive two consecutive groups that are identical.

The ics used for this type of control (known as *pulse code modulation*) are good examples of specialised applications of digital electronics. Internally, these ics are built up of just the same simple logical units – gates, flip-flops, counters etc – that we have already looked at in this series. Other examples of specialised digital ics include those used in telephone modems, digital measuring equipment (such as digital test-meters), clocks, watches, timers, counters, lamp flashers, stepper motor drivers, speech synthesisers, and many more.

PULSES IN CONTROL

An audio signal is normally an analogue signal. It is an analogue of sound, the variations in air pressure caused by the source of sound, and detected by a microphone. The signal usually takes the form of a varying *voltage*. To digitise the signal, it is fed to an analogue-to-digital converter (see Part 6A, PE March 1989) and the output of the converter is sampled at regular intervals. Fig. 7 shows the results of sampling, assuming an 8-bit a-to-d converter is used. Most audio digitisers would use 12 or more bits, but the principle is the same.

The audio signal is now represented as a series of 8-bit bytes which can be recorded, or maybe transmitted over a telephone line using suitable equipment. On playback, or at the receiving end of the telephone line, the digital signal is sent to a digital-to-analogue converter. The output from this converter is a varying voltage that is *approximately* like the original audio signal. If the approximation is near enough, this varying voltage can be fed to an amplifier and loudspeaker. The sound coming from the speaker is an approximation to the original sound.

Speaking of 'approximations' might give the idea that digitisation is a rough kind of process which gives poor quality reproduction. The opposite is usually the case since digital circuits are designed so that the approximation is extremely close. Even the most critical listener can not tell the difference between the original sound and the digitised sound. (*PE does not always agree with its esteemed authors! Ed*). To ensure faithful reproduction, the digitising circuit must be designed to:

* **sample frequently** – too slow a sampling rate will 'miss' rapid changes in the analogue voltage. The frequency of sampling (ie reading the output of the a-to-d converter) must be at least double the highest audio frequency that it is required to cover. For example, to cover a range up to 10kHz, the signal must be sampled at least 2000 times per second.

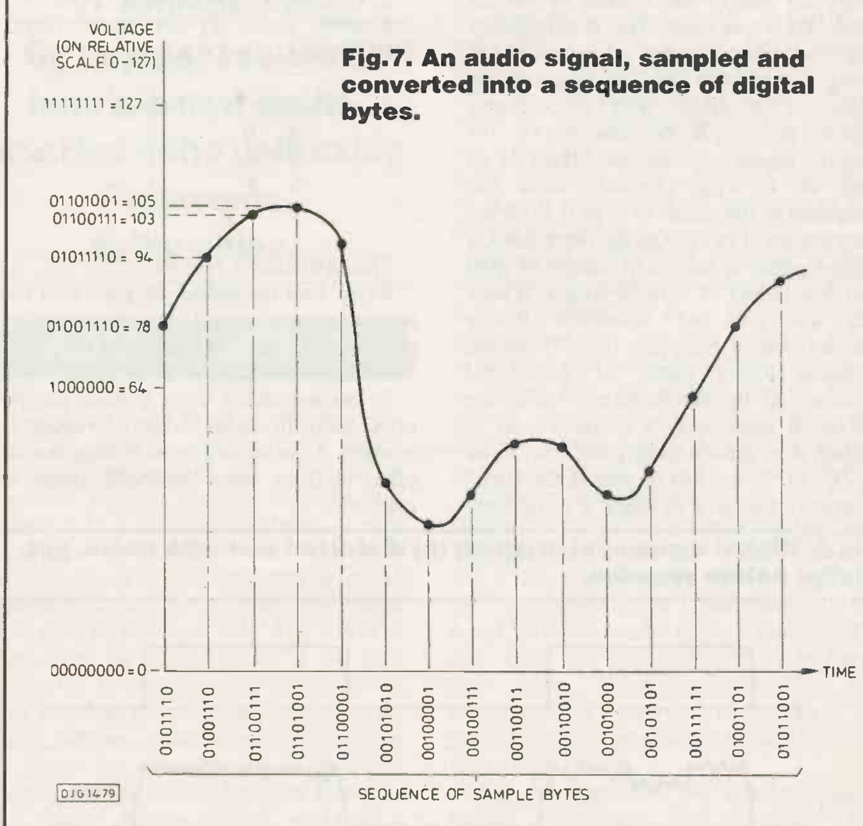


Fig.7. An audio signal, sampled and converted into a sequence of digital bytes.

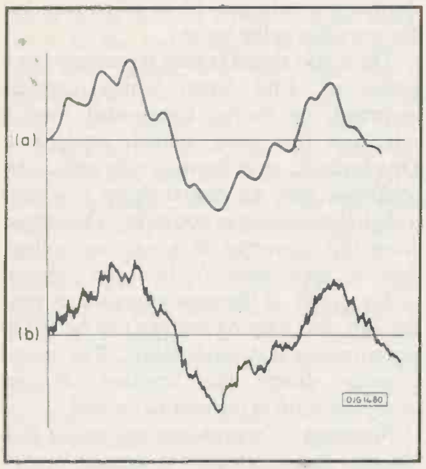


Fig.8. Audio signals (a) original; (b) distorted and noisy.

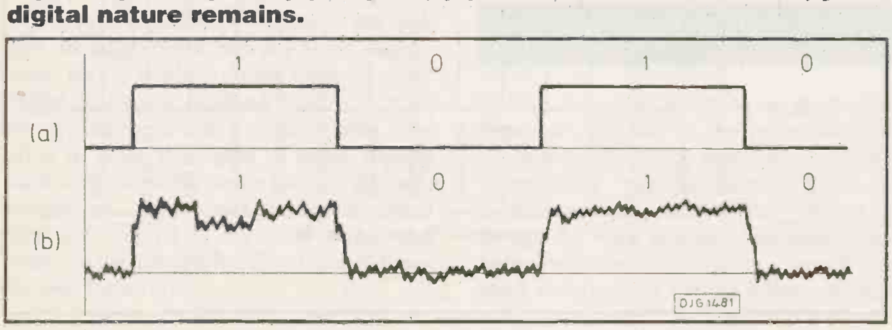
* **sample precisely** – an 8-bit a-to-d converter gives only 256 possible outputs (00000000 to 11111111), so only 256 different voltage levels can appear in the final digitised signal. In other words the 'steps' in the output signal are coarse. To make the digitised signal smoother and more like the original signal, we need finer 'steps'. A 12-bit converter gives 4096 'steps', which gives a much better approximation to the original.

Readers may be wondering why we go to the trouble of digitising an analogue signal only to convert it back to an analogue signal again. One of the reasons is to do with transmitting or recording the signal. Any electronic signal is subject to distortion and to interference of various kinds, known as noise. This is particularly important when a signal is transmitted (eg along a telephone line, or broadcast by radio) or recorded. With an analogue signal, any such degradation of the original signal is permanent. There is no way of knowing precisely what has happened to the signal so as to remove the interference (Fig. 8). On the other hand, a digital signal is known to consist of high and low pulses of definite length. It may get distorted and corrupted during transmission or recording (Fig. 9) but the essential binary nature of the signal remains. At the receiving end (or in the player) it needs only a simple circuit to restore the signal to its original crisp form. No '0's or '1's are lost or gained, the signal is *exactly* the same as when it came from the a-to-d converter. This is one reason why reproduction from a digital disc is less affected by wear.

This immunity from interference and distortion is a reason that digital audio is being increasingly used for telephony, compact disc audio and digital audio tapes. The same applies to digitisation of video signals.

Another feature of digital audio is that it lends itself to precise processing. Processing includes amplification, filtering and innumerable other 'tricks'. Amplifiers and filters may operate on the analogue signal but they may introduce distortions due to the nature of their circuits. Amplification and filtering may be achieved much more exactly by performing mathematical operations on the bytes of the digital signal. Obviously, if this has to be done in real time (eg during actual transmission) it has to be done fast. Back to computers again! (*Readers may also care to read Vivian Capel's article on cd technology in PE July-Sept 88. Ed*)

Fig.9. Digital signals (a) original; (b) distorted and with noise, yet digital nature remains.



ANSWERS TO QUESTIONS

(The questions were posed last month)

1. 100, 1111, 1101110, 11111110.
2. 2, 6, 13, 170.
3. By the value '1', or by a 'high' voltage.
4. (a) AND, (b) exclusive-OR.
5. Transistor-transistor logic- 5V dc.
6. '4000' series, 3V-18V dc; *or* 74HC, 74HCT, 74AC, 2V-6V dc.
7.

Input		Output
A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

This operation is NAND.

8. (a) Join the output of gate 1 to the unused input of gate 2. Join the output of gate 2 to the unused input of gate 1. (b) Make input B briefly low, then high.
9. An increasing input voltage has no effect until the upper threshold voltage is reached. A decreasing input voltage has no effect until the lower threshold voltage is reached.
10. Increase the value of the capacitor; increase the value of the resistor.
11. The monostable gives a single pulse when triggered; the astable gives a regular series of pulses for as long as it is switched on.
12. Pulse length = 1.1RC = 1.1 x 33 x 103 x 47 x 10-6 = 1.7061 seconds
13. Input, processing, output.
14. When the clock input rises from low to high, data present at the D input appears at the Q output. The inverse of the data appears at the Q output.
15. Binary counters, frequency dividers, storage registers, shift registers.
16. &D, &58, &F1.
17. 100, 1100, 1010110.
18. In the synchronous counter, all stages are clocked at exactly the same time; they all change state at once.
19. The fanout of a gate is the maximum number of inputs of a given logic series that can be driven by that gate.
20. Light dependent resistor. Resistance decreases. In the dark the ldr has high resistance. Potential at A is low. The transistor is off. Potential at B is high. Gate output is low. As light increases, resistance of ldr decreases and potential at A rises. Transistor is switched on. Potential at B falls to low. Gate output becomes high.
21. LDR, photodiode, phototransistor.
22. Thermistor, negative temperature coefficient (ntc).
23. Use a power transistor or a relay.
24. The output may be logic low, or logic high, or 'high impedance'. In the high impedance state the output is in effect disconnected from the circuit.
25. Short for 'parallel-in, serial-out'; describes a shift register with parallel loading and serial output.
26. 11010100; doubles the value.
27. A register records the data that was being fed to it at a given instant (eg when the clock input rises). At other times it ignores the data (its output remains unchanged). The output of a latch changes as the data changes (it is transparent) as long as the clock input is high. When the clock goes low the data present at the output is held until the clock input goes high again.
28. When WE is low, data on the bus is stored in the chip; when WE is high data stored in the chip is put on to the data bus.
29. Data can be read from both types. Data can be written into ram by a computer circuit. Data is written into rom only during manufacture of the rom, or by a special rom programming device.
30. Erasable programmable read only memory. It can be programmed electrically. Its contents are erased by exposing the chip to ultra-violet radiation.
31. The arithmetic and logical unit (alu).
32. For holding the data that is currently being worked on.
33. It has a single input, which accepts a continuously changing voltage. It has (typically) eight logical outputs. As the

input voltage changes, the binary value at the outputs changes correspondingly. In other words, it converts an analogue voltage input to the corresponding binary digital output.

34. Digital-to-analogue converter (dac).

35. Voltage-to-frequency converter, voltage-to-time converter (507C).

36. A device (usually electronic) that processes data automatically.

37. Central processing unit.

38. Data bus, address bus, control bus.

39. Op-code.

40. Load and store, increment or decrement accumulator, compare a value with the value in the accumulator, jump to another part of the program.

41. An assembler program.

42. The abbreviated instructions used in writing programs in assembler language. Anything that helps you to remember something.

43. Artificial intelligence (AI).

44. Washing machine, video recorder, dishwasher, Prestel terminal, video games machine, home computer.

45. Parallel processing.

46./47. Refer to the article.

48. 10kHz.

49. Precision is improved.

50. Reduction or elimination of distortion and interference; precision of processing the sound.

And here we end this series on digital electronics. Owen Bishop will soon be starting a new series – this time on basic electronics. Don't miss it! PE

ASK PE NO2

CONTINUED FROM PAGE 34

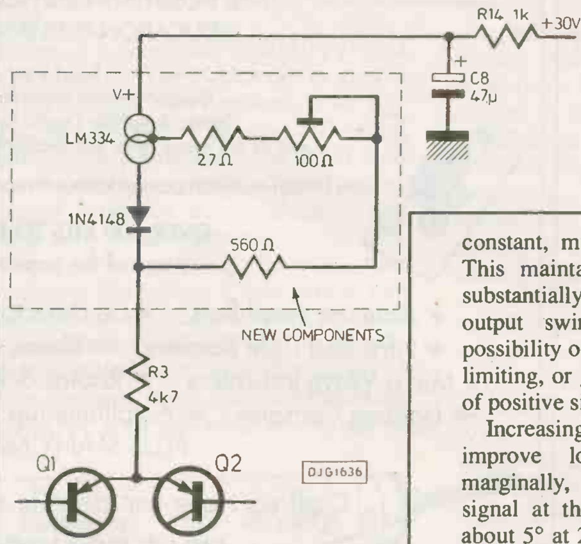


Fig.3.

variation of the tail current will vary the current in Q2 and hence vary the balance. The very best performance would come from using matched transistors and then balancing the dc level.

Voltage regulation cannot be used around R8, R9, and C4 because the voltage on the junction of R8 and R9 is designed to exceed the power supply voltage for part of the output cycle. The voltage on this point, far from being constant, must follow the output signal. This maintains the current through R9 substantially constant over the whole output swing, and thus removes the possibility of premature clipping, slew rate limiting, or gain reduction at the extremes of positive signal excursions.

Increasing the value of C4 could improve low frequency performance marginally, but the phase shift on the signal at the junction of R8 and R9 is about 5° at 20Hz. The current variation in R9 caused by this is unlikely to affect the output signal detectably, because the effect of current variation is anyway a second order effect, which is reduced by a large factor by the action of negative feedback. We are looking here at an effect which would probably contribute under 0.1% distortion open loop, but which negative feedback divides by several hundred. Halving this contribution to the overall distortion is unlikely to matter. PE

HF RADIO

PART THREE
BY MIKE SANDERS

Piggy backing audio and radio signals helps minimise the incidence of pierced eardrums!

At the end of last month's article we looked at mixers, refering to Figs 19 and 20. These figures are shown here and illustrate the transistor versions of single-ended and balanced mixers.

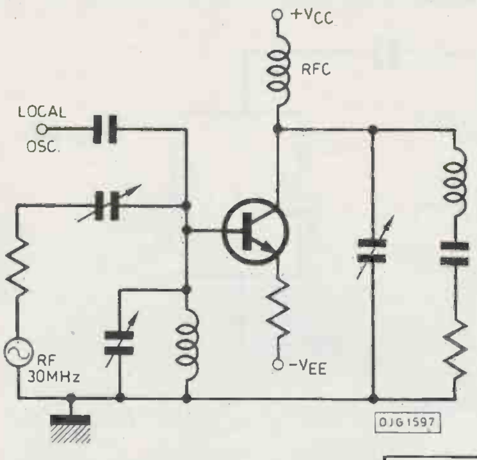


Fig.19. (above) Single ended transistor mixer

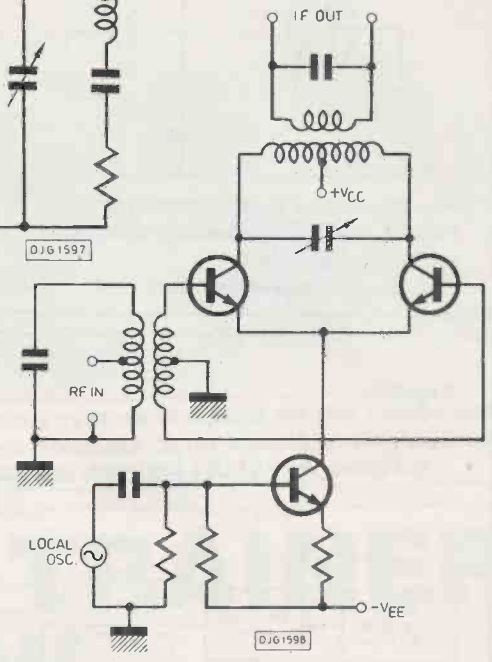


Fig.20. (right) Balanced transistor mixer

MODULATION

The basic principles will be dealt with here and the techniques special to a particular kind of modulation will be covered again under the relevant kind of receiver or transmitter. Similarly some of the foregoing sections will be expanded wherever relevant.

Many of the techniques applied to receivers are also applied to transmitters. For instance phase locked loops are relevant to both for holding the local oscillator within the required limits. Mixers are used to translate a carrier from the if to the rf range in transmitters and in the reverse direction for receivers.

Modulation is a process of piggy backing the audio signal to be transmitted, onto a radio frequency. The reverse process called demodulation is used at the receiver. Modulation is necessary because the energy of an audio wave is rapidly dissipated in the atmosphere whereas a radio wave travels much further. Apart from this the incidence of headaches and pierced eardrums would rise significantly if every transmitter sent out high energy audio waves.

There are many kinds of modulation and they will be touched on briefly. One of the oldest type is on-off keying as in telegraphy, called continuous wave (cw), Fig. 21. Although there are breaks in the transmission of rf energy as in the Morse code, the amplitude of the signal when transmitted does not change and for this reason it is called a continuous wave.

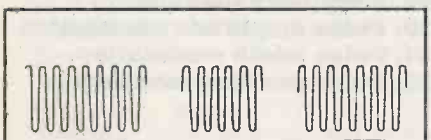


Fig.21. Continuous wave (CW)

Another type of modulation which followed Morse transmission was amplitude modulation (am), Fig. 22. The modulation index is the ratio a/b in Fig. 22 and should not exceed 1 or 100%, or distortion will be incurred.

A simple method of amplitude modulating an rf carrier is to incorporate the modulating signal in series with the collector voltage of a class C rf amplifier, Fig. 23. The opposite process, demodulation or detection, can be carried out by the simple circuit of Fig. 24. The diode merely removes the bottom part of the waveform since the audio is contained in both top and bottom half and only one half is required. The voltage V_2 contains a dc component which is blocked by the capacitor C_2 giving only the ac variations at V_3.

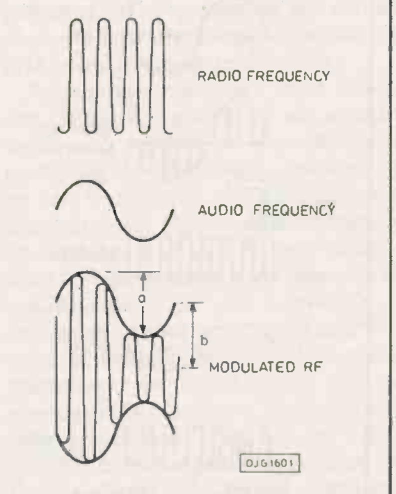


Fig.22. (right) Amplitude modulation

Amplitude modulating an rf wave with an audio wave produces sum and difference frequencies, called double sidebands (dsb) Fig. 25. The rf carrier transmits no information and if suppressed, the output is called a double sideband suppressed carrier (dsb/sc).

There is no need to transmit both sidebands since the information is duplicated and if one sideband is also suppressed the result is a single sideband suppressed carrier (ssb/sc). Therefore, a ssb/sc not only occupies half the bandwidth of a dsb/sc but requires only half the power for transmission.

A single sideband can be generated by two methods: the filter method or the phasing method. In the filter method one of the sidebands is filtered out and the rejection of the unwanted sideband must be at least 40 dB.

The filter scheme is shown in Fig. 26,

Fig.23.

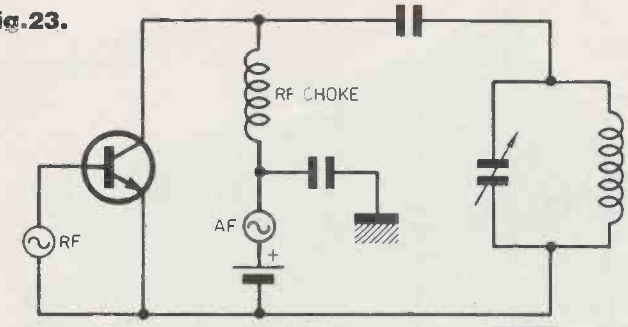
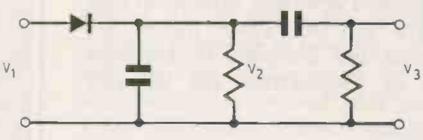


Fig.24.



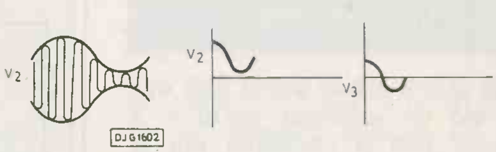


Fig.25.

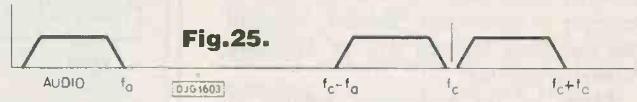


Fig.23. Class C RF amplifier
Fig.24. Simple detector circuit and waveforms
Fig.25. Double sideband

Fig.26.

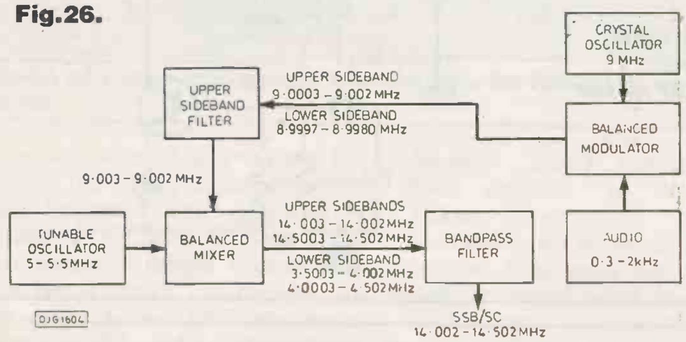


Fig.27.

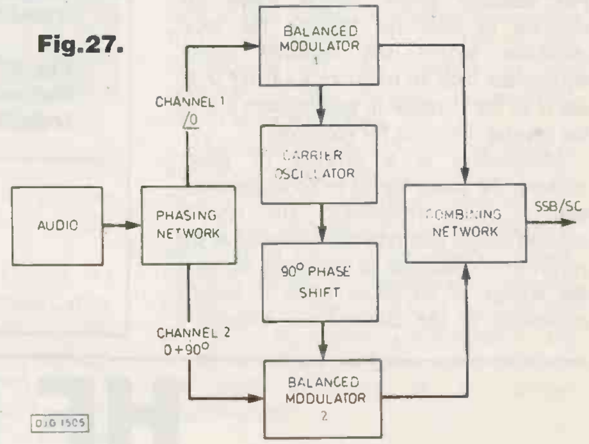


Fig.26. SSB by filter method
Fig.27. Phase method of SSB generation

where a balanced modulator and 9MHz crystal oscillator provide two sidebands. A crystal filter rejects the lower sideband and passes the upper sideband on to a balanced mixer with a 5MHz to 5.5MHz oscillator input. The upper sideband is now in the 14MHz to 14.5MHz range which is much higher than the lower sideband range of 3.5MHz to 4.5MHz. Therefore, a fixed tuned bandpass filter is sufficient to pass the upper sideband.

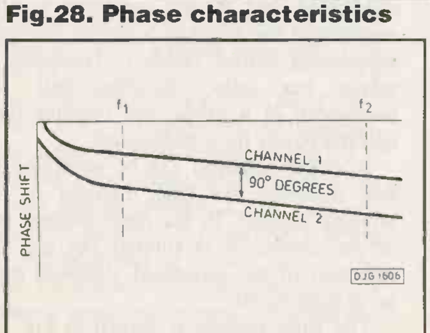
The combined output then cancels for one sideband and adds for the other if the balanced modulators are identical and the phase networks are accurate. Therefore, sharp filters are not required.

In practice a circuit cannot produce a phase shift of 90 degrees in one channel over the required frequency range. To overcome this, two all-pass networks are designed, Fig. 28, to give a phase shift of 90 degrees in the required frequency range.

Frequency modulation (fm) does not alter the amplitude of the carrier like amplitude modulation but alters the frequency of the carrier, Fig. 29. Therefore, fm is immune to amplitude induced noise, as are digitally modulated signals.

Using pulses, an audio signal can be encoded using pulse amplitude modulation (pam), pulse width modulation (pwm), pulse position modulation (ppm) or pulse

Fig.28. Phase characteristics



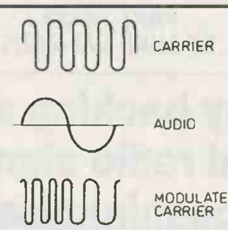


Fig.29.

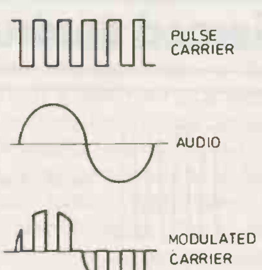


Fig.30.

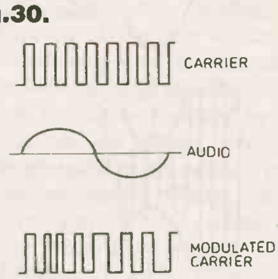
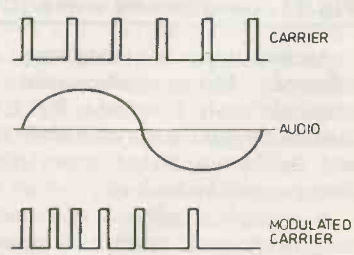
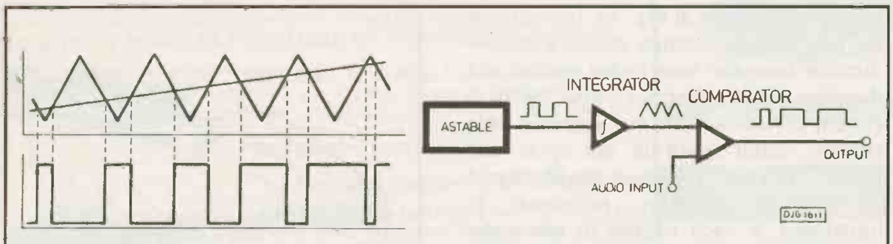


Fig.31.

Fig.29. Frequency modulation
Fig.30. Pulse amplitude modulation
Fig.31. Pulse width modulation
Fig.32. Pulse position modulation

Fig.32.





Fit.33. PWM generation

code modulation (pcm). In pulse amplitude modulation, the waveform is sampled at regular intervals and a pulse produced of a height that corresponds to the height of the waveform at that instant, Fig. 30. Although digital techniques are applied, the result remains analogue since the resultant output is continuously varying in height.

In pulse width modulation, the width of the pulse varies to encode the height of the pulse, Fig. 31, and in pulse position modulation the time window in which the pulse appears varies, Fig. 32. Each of these methods would have their own peculiar problems in the design of modulators and demodulators. Fig. 33 shows one method of generating pwm using a comparator and a sawtooth waveform.

The most popular pulse method is pulse code modulation where samples must be taken at twice the highest frequency to be transmitted. The samples are also spaced out non-linearly, Fig. 34, so that more samples are taken of lower amplitudes and

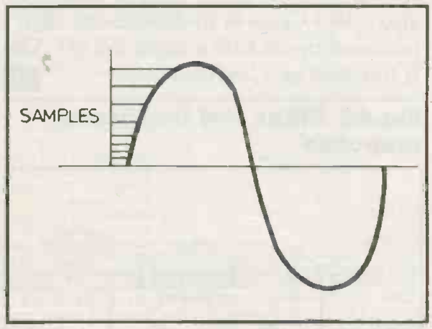


Fig.34. PCM non-linear sampling

encoding is better in the presence of noise.

For a 4kHz speech circuit the sampling rate is 8kHz and eight bits are used to encode each sample giving a transmission rate of 8 x 8 = 64Kbits. Therefore the bandwidth is much greater than for an amplitude modulated wave but the noise immunity is a distinct advantage.

A further development of pcm is delta modulation where only the change in amplitude of the previous sample is transmitted hence cutting down on the required bandwidth. Shannon's law shows the relationship between the transmission rate, bandwidth and signal to noise ratio:

$$C = B \log_2 \left(1 + \frac{V_s}{V_n}\right) \text{ bits/sec}$$

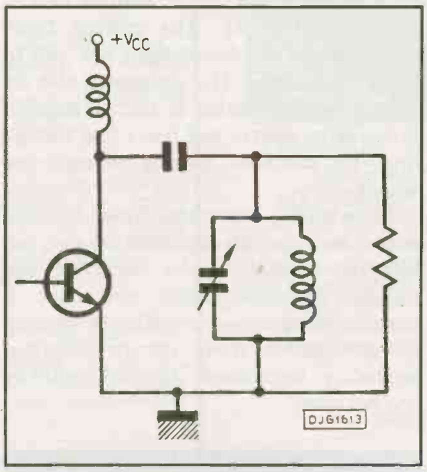


Fig.35. Class A amplifier

Where C = transmission rate in bits/sec
B = bandwidth in Hz
V_s = signal volts
V_n = noise volts

This means that if the bandwidth is increased in order to increase the transmission rate, the signal to noise ratio degrades.

AMPLIFIERS

In addition to mixers, modulators/demodulators and detectors, amplifiers play an important part in radio circuits. Transmitters require high power amplifiers operating at the carrier frequency in order to broadcast the signal. Receivers require audio amplifiers to boost the signal after it has been detected and good quality receivers even have an rf amplifier to give the weak signal a lift before it is processed. So there is a variety of amplifier design to include the combinations of low/high frequency and low/high energy.

LINEAR AMPLIFIERS

Amplifiers are designated classes A, B, C, D, E, F, G, H, S. These differ from each other by method of operation or circuit configuration. Class A amplifiers are similar to small signal amplifiers (hf amplifiers) and can be modelled by two port or linear equivalent circuits.

Class A and B linear amplifiers will be dealt with here. They have a reasonable gain and help amplify the input current or voltage. This is important in ssb operation which requires a faithful reproduction of the envelope and phase.

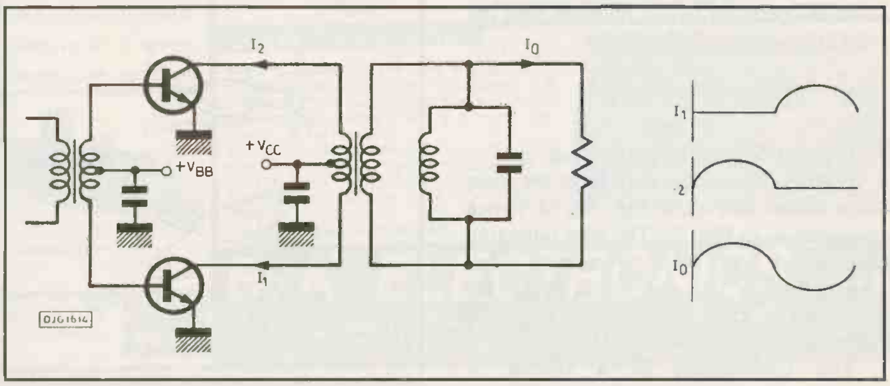
Bipolar transistors as well as vertical mosfets (vmos) are used. The latter are particularly popular because of resistance to secondary breakdown and ease of biasing. The ratings on data sheets occasionally relate to actual applications. For instance a transistor for class B rated for a 28V dc supply has a maximum rating of 56V.

Fig. 35 shows a class A amplifier and Fig. 36 a class B. The class B push-pull is the more common version although a single ended class B narrow band linear amplifier similar to class C can be used. The class B push pull is more efficient than class A for linear power amplification and therefore used for medium and high powers.

The class B application for rf is the same as for audio with two transistors driven in alternate half cycles. The higher efficiency of class B is due to zero collector current when the voltage is at its peak.

In practice, amplifiers have saturation voltages and resistance and loads are reactive instead of being purely resistive. At high frequencies, closer to the design limit of the transistor, the efficiency is reduced because the collector current is distorted by charge storage effects. These problems are insignificant at frequencies below $f_T/10$, where f_T is the cut off frequency of the transistor, and start to gain importance above $f_T/2$.

Fig.36. Class B push-pull



CROSS OVER DISTORTION

Active devices like valves and transistors do not switch sharply from active to cut off and vice versa.

Since the switching is gradual and non-linear, an offset voltage is involved, Fig. 37, and the result is called crossover distortion. This problem is more pronounced when the signal is small compared to the maximum output of the amplifier.

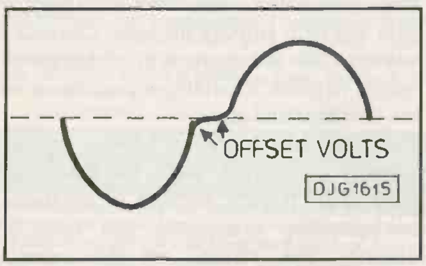


Fig.37. Crossover distortion

The effect is reduced by biasing the base or gate of the transistor so that there is a quiescent current in the collector or drain respectively. The value of the quiescent current is decided experimentally since too little bias means there is no output for signals below the bias threshold. Too much bias means that even small signals will receive excessive amplification. The minimum intermodulation distortion ratio occurs when the quiescent current is 1% to 10% of the peak collector (or drain).

The term class AB has been applied to transistors conducting over slightly more than half the rf cycle but class B is quite widely used with the understanding that it is drawing quiescent current.

HEAT SINKS

The maximum permissible junction temperature of a transistor is about 200°C and the reliability decreases so heatsinks are necessary. A heatsink for dissipating the heat is usually made of aluminium with fins to give a large surface area.

For class A operation with a resistive load the maximum power dissipation is twice the maximum output power. For class B operation with a resistive load the maximum power dissipation is:

$$\frac{2V_{cc}^2}{\pi^2 R}$$

or about 40% of the peak output.

rf power transistors may be in the form of a screw stud as in Fig. 38, or flange mounted as in Fig. 39. The stud mounting is found on old transistors and overtightening the stud could break the mounting. The flange in Fig. 39 overcomes this problem.

The construction of a bipolar rf transistor is shown in Fig. 40. Interleaving the base with the emitter means a smaller distance from the base to the emitter and therefore lower resistance. Also the base current divides evenly, but so many little emitters could result in hot spots and thermal runaway. To reduce the likelihood of thermal runaway, resistance is introduced in each emitter to cause the current to divide equally. This is called ballasting.

A power fet of vmos construction is shown in Fig. 41. The current flows vertically and the device has a low gate to drain capacitance. The advantage of a fet over a bipolar device is that it requires lower drive current and has a low storage time for electrons passing through the device.

In switching operations, vmos fets can pass current in both directions, ie, they are bilateral whereas bipolar transistors are usually unilateral. FETs also have a negative temperature co-efficient so they do not suffer from current hogging, secondary breakdown, thermal runaway and hot spots.

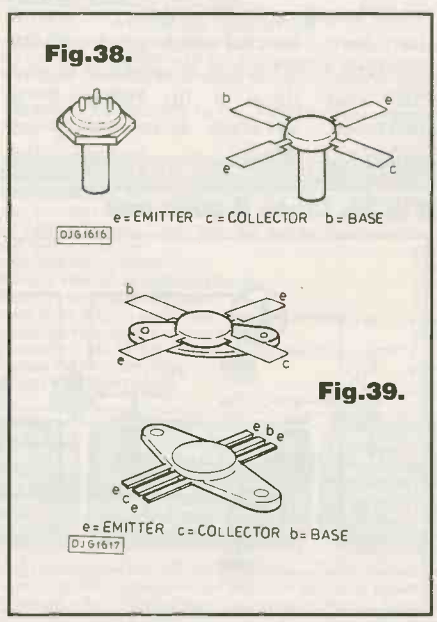
FILTERS

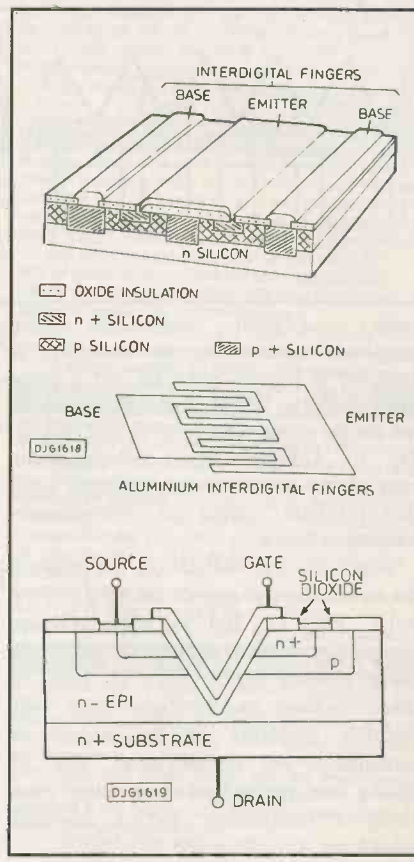
Power amplifiers produce harmonic currents and before connecting the transmitter to the aerial these harmonics must be filtered out. Odd harmonics at 15dB to 20dB below signal level are the result of current distortion, and even harmonies at 20dB to 40dB below signal level are the result of gain variation.

It is necessary to attenuate these to at least 60dB below the carrier signal and the tank circuit has largely given way to a bank of filters, as in Fig. 42. The filter design is usually based on Butterworth which is maximally flat or Chebychev which has equal ripple in the passband.

The requirement is for a wide passband and large harmonic attenuation so an elliptic filter is used. Elliptic filters are also called Cauer or m-derived and have a passband ripple with a rapid roll off. This is followed by a low pass filter. **PE**

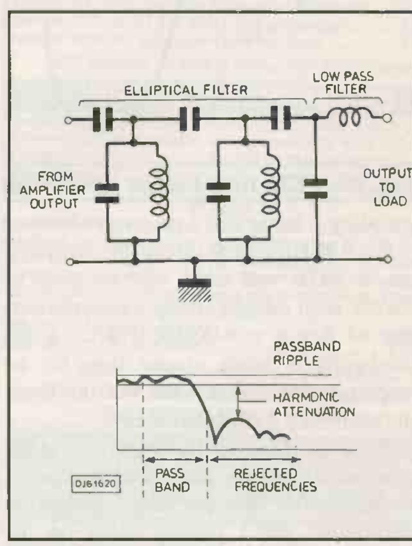
Fig.38. Stud mounted transistors
Fig.39. Flange mounted transistors





Fig;40; Bipolar RF transistor
Fig.41. VMOSFET RF transistor

Fig.42. Filter and frequency response



In part four we'll be looking at tuned and high efficiency amplifiers. Tune in next month!

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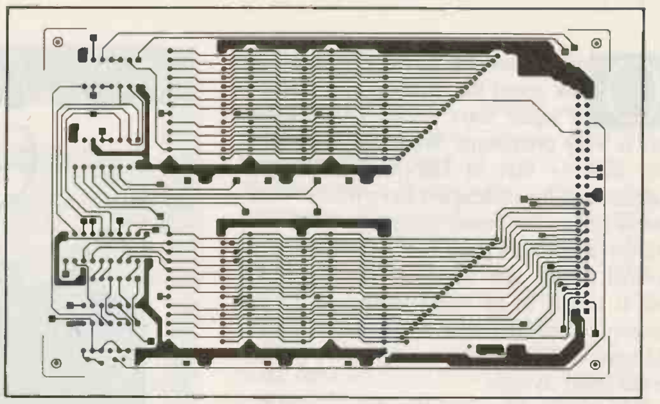

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SPACE

WATCH

BY DR PATRICK MOORE CBE

There's still no proof of planets orbiting other stars, nor of brown dwarfs, but there's good proof of stellar and commitee jet-sets!

Once again we have been hearing talk about the discovery of planets of other stars – and once again, this is very premature. What has happened this time is that at Harvard, Dr David Latham and his colleagues have traced what seems to be a low-mass companion of a star known as HD114762. The star itself is a normal dwarf, less massive than our Sun, and it seems to be being perturbed by an unseen companion with about eleven times the mass of Jupiter, the most massive planet in the Solar System.

Whether a body of this mass can be classed as a true star is doubtful. Certainly it cannot trigger off nuclear reactions inside it, and radiate in the same way that the Sun does. It could be what is termed a "brown dwarf", which is intermediate in time between a star and a planet – a sort of cosmical missing link. The distance from the parent star seems to be about the same as that between the Sun and its own closest planet, Mercury.

Brown dwarfs are very much in the news, but we have to admit that so far we have no positive proof of them. Perhaps the Hubble Space Telescope, now due for launching next spring, will tell us.

At La Silla in Chile, the Danish astronomer B. Relpurth has made a very interesting observation of a young star in the giant interstellar cloud of which the Orion Nebular is a part. The star, Haro-Herbig 111 (or HH 111 for short) seems to be sending out relatively narrow, high-speed jets in opposite directions; these supersonic jets penetrate far into the surrounding cloud before they are halted by collision with the particles, but they probably last for only a few hundreds of thousands of years, so that they are rare. HH 111 yields the largest and most perfect narrow Stellar jet systems ever seen. The emitting star is about 25 times as luminous as the Sun, and is about 1500 light-years away; it is still collecting material from its surroundings, and we may in fact be witnessing a true stellar birth. Monitoring it will tell us what is going on near the young star and its associated disc of 'collected' material.

Much nearer home, the mystery of Comet Brorsen-Metcalf continues. At the time when I write these words (July 3) it has simply not appeared, though its orbit was well known and it had been expected to reach naked-eye visibility later this autumn. Whether there has been some error in the calculated orbit (unlikely), whether it has been destroyed or has been dissipated (also unlikely) or whether we have simply missed it, remains to be seen!

THE PARLIAMENTARY SPACE COMMITTEE

So far as Space is concerned, parliamentarians have not always made the best possible decisions. (This extends back even to aeronautics; in the early 1930s the newly-designed jet engine was rejected as being no rival to the air screw-engine combination.) However, a Parliamentary Space Committee has now been set up, and has had its first meeting. The Chairman is Michael Marshall, MP for Arundel; Vice-Chairman, John McWilliam, MP; other members Spencer Batiste MP, Dr Michael Clark MP, Ernie Ross MP, and Gerald Birmingham. Non-parliamentary representatives are John Holt (British Aerospace), Dr Bruce Smith (Smith Associates), Barry Hargrave (Logica), Dennis Cummings (Marconi), Nigel Press, and Dr Adrian Lloyd-Lawrence (SD Scicon).

The committee has been formed from the All Party Space Committee together with various industrial concerns, the main aim being to promote Britain's role in space and broaden the interests of the British space community. Their first communique contained several points, all of which have been blatantly obvious for some time – such as the statement that "the lack of integration of military and civil earth observation activities is extremely wasteful of

THE SKY THIS MONTH

Various planets are on view this month. Venus is visible in the evening, though it sets not so very long after the Sun; telescopically it is still seen to be gibbous (that is to say, between half and full), and no details can be expected to be visible telescopically. Jupiter rises before midnight, and is a brilliant object in Gemini (the Twins) – far brighter than any star. The other giant planet, Saturn, is in Sagittarius (the Archer) and is low down as seen from Britain, though it is on view for much of the period of darkness. Of the other planets, Mercury and Mars are virtually invisible this month; the telescopic planets Uranus and Neptune are in Sagittarius, not far from Saturn, while Pluto remains near the border between Virgo and Libra.

The moon is at first quarter (half) on September 8, full on the 15th, last quarter on the 22nd, and new on the 29th. There are no eclipses this month, and neither are there any meteor showers of note. We had expected a fairly bright comet (Brorsen-Metcalf), but, as so often happens with comets, it has failed us miserably.

Among the stars, we still have the Summer Triangle of Vega, Altair and Deneb, but the evening sky is dominated by the Square of Pegasus, high in the south. It is easy to identify, though, as I have often said, maps tend to make it seem smaller and brighter than it really is; all its stars are between magnitudes of 2 and 3. One of them, Scheat (the upper right-hand member of the Square) is variable; it may be compared with the star to the lower right of the square, Markab (magnitude 2.5). Like many of its type, Scheat is orange-red, while the other three stars in the Square are white. Look at them with binoculars, and you will see what I mean.

During September, look for Fomalhaut in the Southern Fish, directly below the Square of Pegasus and not far from the southern horizon. This is one of the stars found by IRAS, the Infra-red Astronomical Satellite, to be associated with cool material which just could indicate a system of planets – though to claim this is a certainty would be most unwise!

In the east, the lovely star-cluster of the Pleiades or Seven Sisters is coming into view, marking the approach of winter; later we can also see Aldebaran, the bright orange star in the Bull, which is the "advance guard" of Orion's retinue.

technology, investment and resources." (Surprise, surprise!)

Whether the Committee will in fact be able to inject some new ideas (and, equally importantly, more money) into the space industry remains to be seen; we can only hope for the best. The official Press release ends with the statement that further information can be obtained either from Michael Marshall MP, House of Commons (telephone 01-219 4698 and 3462) or Dennis Cummings, Marconi Space Systems (0705 674409).

However the Committee evolves, it will find difficulty in beating one section of the Soviet Civil Service, which really surpassed itself earlier this year. In the USSR, young men are still liable for military service, and in March 1989 a call-up summons was sent by the Army draft centre to one young Soviet citizen, Sergei Krikalev. He was instructed to report to the draft centre to begin his military training. Unfortunately, at that precise moment he was unable to comply. He was, and had been for several months, on board the orbiting Russian space-station Mir!

This photograph shows the newly discovered large jet in the HH 111 complex and has been kindly made available by the European Southern Observatory.

The straight jet emerges from the surrounding interstellar cloud in the lower part of the picture. The outline of the cloud is vaguely visible by the brighter background near the right edge of the picture.

Also seen is a diffuse reflection nebula around the lower part of the jet. This nebula is illuminated by the light from the newborn star, hidden deep within the cloud. Because of the heavy obscuration, the star itself is not visible on this photo.

The jet produces a "bow-shock" nebula; this is the bright, mushroom shaped nebular in the upper part of the picture. The round points are background stars in the Milky Way.

The picture was produced as a composite of four 1 hour ccd exposures, obtained with the Danish 1.5m telescope at La Silla through a narrow optical filter. The light seen here from the jet is emitted by singly ionised sulphur atoms.

PE

No. 3 LIST BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD152	1	Gas or liquid shut off valve, clockwork dial, setting can be on four up to 12 hours.
BD153	1	Same as BD152 but thermostatically operated.
BD154	1	12v operated drip proof relay, ideal for outdoor or in-car operation.
BD158	41	12 way 5amp screw down polythene bodied connector stips. Used to be called choc blocks when made of Bakelite
BD159	2	12 way 25amp connector blocks.
BD160	1pr	Plug together 12 way connector blocks, ideal for quick joins in leads.
BD168	2	Component mounting tag strips each with 50 stand up tags.
BD169	42	Short wave air spaced trimmers 3-30pf. Screw driver operated.
BD170	4	Assorted neon type numicator tubes made by HIVAC.
BD175	1	2watt mains motor driving gearbox, final speed 200rpm.
BD177	5	12v Lilliput bulbs.
BD178	3	Panel mounting slim line indicator lights with amber lens. These take Lilliput bulbs.
BD179	3	Oblong mains neon indicator lights, approx 1in x ½in.
BD181	100	PVC grommets for insulation through ⅜th hole.
BD182	1	25pf air spaced tuning capacitor, small hole fixing with ¼in spindle.
BD189	1	20amp double pole switch on flush plate which fits standard 3x3 electrical box, illuminated when on.
BD190	1	20amp dp switch but surface mounting, oblong shape.
BD191	6	Lamp holder adaptors which take two pin plug, also supplied.
BD200	1	10 digit switch pad, telephone type.
BD205	1	Very small 12v operated relay with one pair change-over contacts.
BD212	1	Mains transformer 230v primary and two 8v ½amp secondaries.
BD213	2	5 core curly leads, tinsel wire for phones, etc.
BD214	2	Sub-min toggle switches double polde double throw.
BD215	4	Mini dpdt slide switches with chrome dolly instead of the usual plastic toggle.
BD217	100	Standard wire ending push-ons for standard ¼in tags.
BD218	100	Ditto, but right angled.
BD219	100	Soldercon tags. With these you can make your own sockets for ICs etc.
BD223	4	1200 watt fire spirals, bright nickle chrome wire.
BD224	1	Battery operated motor made for 9v cassette players but speed controllable by lowering voltage.
BD227	4	50k quad pots. Standard ¼in spindle single hole fixing.
BD228	1	Ice stat thermostat. Ideal for controlling water pipe antifreeze coils
BD229	1	Instrument buzzer, variable low, medium or soft.
BD233	2	Eagle educational kits. One makes chemical balance with weights and the other has electricals for experiments.
BD234	4	500uf + 500uf 50v electrolytics.
BD236	1	Mains transformer with 9v 750mA secondary.
BD237	1	Computer grade electrolytic 3150uf at 40v.
BD243	2	8 x 4 16ohm loud speakers permanent magnet, 5 watts.
BD246	4	Standard size ½meg pot with ¼in spindle and dp switch.
BD247	1	The medium wave permeability tuner, couple this to a ZN414 and you have a radio.
BD248	1	A noise suppressor/mains filter.
BD249	1	13A socket on plate with spur, fits normal electrical box.
BD253	1	Oven thermometer – bimetal type, reads 200-500°F.

There are over 1,000 items in our Bakers Dozen List. If you want a complete copy please request this when ordering.

CAMERAS. Three cameras, all by famous makers, Kodak, etc. One disc, one 35mm and one instamatic. All in first class condition, believed to be in perfect working order, but sold as untested. You can have the three for £10 including VAT, which must be a bargain – if only for the lenses, flash gear, etc. Our ref 10P58.

EQUIPMENT WALL MOUNT It is a multi-adjustable bracket that could be used for mounting flood light, loud speaker, TV camera, even a fan and on almost any sort of wall or ceiling even between wall and ceiling. The main fixing brackets rotate such that an inward or an outward corner can be accommodated. Front panel also tilts upward or downwards to a reasonable angle and can be easily removed separately for wiring. A very useful bracket. Regular price would be around £6 each. Our price only £3. Our ref 3P72. Or 2 for £5. Our ref 5P152.

MICROPHONE LEADS 6m twin screened wire terminating one end with a standard ¼in mono jack plug and the other with the usual screwed on microphone connector. With coiled spring for lead protection. Price £1. Our ref BD714.

EXTRA SPECIAL CROC CLIPS Medium size, just right for most hook-ups. Normally sell for around 10p to 15p each. These are insulated and have a length of wire connected to them but this is very easy to snip off if you do not need it. 20 for £1. Our ref BD117A.

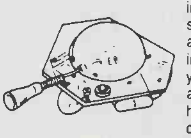
DON'T MISS THAT IMPORTANT CALL Fit an extension lead and take your phone in the other room with you. 5m long, one end has the standard flat BT socket and the other the standard flat BT plug so you don't have to interfere with the house phone wiring, you simply plug it in. Price £3. Our ref 3PP70.

COPPER CLAD PANEL for making PCB. Size approx 12in long x 8½in wide. Double-sided on fibreglass middle which is quite thick (about⅟₁₆in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

POWERFUL IONISER
Generates approx 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom, etc. Makes you feel better and work harder – a complete mains operated kit, case included. £12.50 plus £2 postage. Our ref 12P5/1.

LINEAR RECORD PLAYER Made by BSR, their ref VL315. Hailed as the most sophisticated of record players, is completely electonically controlled. Due to cancelled export order we are now able to offer these brand new, complete with cartridge and diamond stylus at only £15 plus £2 post. This is a 12v DC operated unit. Our ref 15P25. Two or more post free.

VIDEO TAPES These are three hour tapes of superior quality, made under licence from the famous JVC Company. Offered at only £3 each. Our ref 3P63. or 5 for £11. Our ref 11P3. Or for the really big user 10 for £20. Our ref 20P20.



ELECTRONIC SPACESHIP Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with really detailed instructions. Ideal present for budding young electrician. A youngster should be able to assemble but you may have to help with the soldering of the components on the pcb. Complete kit £8. Our ref 8P30.

THERE IS GOING TO BE A BURIAL! For several years now we have been offering mains operated clocks at only £1 each. These are cooker clocks which in addition to telling you the time wouls also switch things on and off at pre-set times. However, despite this silly price these have been very slow sellers and as we have still almost 10,000 of them in a store which we have to clear we are making one even sillier final offer before burying them. You can have 16 brand new clocks still in original packing for only £5. Our ref 5P151. Add £3 post if not collecting.

BUSH RADIO MIDI SPEAKERS Stereo pair, BASS reflex system, using a full range 4in driver of 4ohms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8½in wide, 14in high and 3½in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair plus £1 post. Our ref 5P141.

3½ FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £59.50, reference 60P2. Both are brand new. Insured delivery £3 on each or both.

ATARI 65XE COMPUTER

At 64k this is most powerful and suitable for home and business. Brand new, complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 insured delivery.

65XE COMPENDIUM Contains: 65XE Computer, its data recorder XC12 and its joystick, with ten games for £62.50 plus £4 insured deliver.

AGAIN AVAILABLE: ASTEC PSU Mains operated switch mode, so very compact. Outputs: +12v 2.5A, +5v 6A, ± 5v .5A, ± 12v .5A. Size: 7¼ long × 4⅜in wide × 2¾in high. Cased ready for use. Brand new. Normal price £30+, our price only £10 plus £1 postage. Our ref 10P34.

VERY POWERFUL 12 VOLT MOTORS. ⅓rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £15 plus £2 postage. Our ref 15P8.

PHILIPS LASER
This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £30 plus £3 insured delivery. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. Ditto for 12v battery, also £15. Our ref 15P22.

ORGAN MASTER Is a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers. We can supply information sheet. Brand new, only £15 plus £3 postage. Our ref 15P15.

FULL RANGE OF COMPONENTS At very keen prices are available from our associate company SGS COMPONENTS. You may already have their catalogue, if not request one and will send it FOC with your goods.

A REAL AIR MOVER Circular axial fan. It moves 205 cu.ft per minute which is about twice as much as our standard 4½in square fans. Low noise, mains operated, 6½in diameter. Ex computers. Regular price over £30 but yours for £10 if you order quickly. Our ref 10P71A.

HIGH RESOLUTION MONITOR. In black and white, used Philips tube M24/305W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. 5 and new. £16 plus £5 post. Our ref 16P1.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape 14½ x 4½ x 17in). The electronically run fuse not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc. or for a caravan. £8 each. Our ref 8P28.

FDD BARGAIN
3½in made by Chinon of Japan. Single aided, 80 track, Shugart compatible interface, interchangeable with most other 3½ in end 5¼in drives. Completely cased with 4 pin power lead and 34 pin computer lead £40. Plus £3 ins del. Our ref 40P1.

MINI MONO AMP on p.c.b. size 4" × 2" (app.) Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 13 for £12.00.**

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MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £1.50 service charge. Monthly account orders accepted from schools and public companies. Access and B/card orders accepted minimum £5. Phone (0273) 734648 or 203500.

NEW THIS MONTH

POPULAR ITEM AGAIN AVAILABLE Twin 0005 tuning capacitor with normal ¼in spindle now listed by many firms at over £10 each. We have them brand new and in perfect condition at £2 each. Our ref 2P40.

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole. PCB mounting. Three for £1. Our ref BD688.

CARTRIDGES for the Double Microdrive. Price 4 for £5. Our ref 5P146.

NICAD CHARGER UNIT Metal pronged, plastic case contains mains transformer and rectifiers with output lead and plug – mad to charge two cells but no doubt adaptable or wonderful spares value. Only 50p each, two for £1. Our ref BD385.

EDGEWISE PANEL METER If you are short of panel space then this may be the answer. It has a FSD of 100uA and a nice full vision scale. It fits through a hole approx 1¼in x ½in. Another feature is that it has an indicator lamp behind the scale which you could light up, it would then serve as an on/off indicator. Price £1. Our ref BD700.

AA CELLS Probably the most popular of the rechargeable NICAD types. 4 for £4. Our ref 4p44.

COMPUTER SPECIAL The Perex 16meg Byte tape streamer. These are brand new and really an exceptional bargain. A few only so hurry. Only £15. Our ref 15P29.

20 WATT 40 OHM SPEAKER With built-in tweeter. Really well made unit which has the power and the quality for hi-fi reproduction. 6½in diameter. Price £5. Our ref 5P155. It is heavy so please add £1 to cover postage if not collecting.

MINI RADIO MODULE Only about 2in square with ferrite aerial and solid dia tuner with its own knob. It is a superhet and it operates from PP3 battery and would drive a crystal headphone direct but be better with our mini mono amp. Price £1. Our ref BD716.

BULGIN MAINS PLUG AND SOCKET The old faithful 3 pin with screw terminals. The socket mounts through a 1½in hole and the mains is brought in by the insulated plug. Used to be quite expensive but you can have 2 pairs for £1 or 4 of eigther plug or socket for £1. You could make yourself a net and compact bench panel with these. Our ref BD715, BD715S or BD715P.

MICROPHONE If you want a low cost microphone then just arrived we have a very small hand-held dynamiuc mic withon/off switch in the handle, its lead terminates with one 3.5 plug and the other a 2.5 plug for remote control. Price only £1. Our ref BD711.

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and to look tidy. It is 4 core so suitable for telephone, bell, burglar alarms, etc. 50 yard coil for £5. Our ref 5P153.

BATTERY OPERATED TRAVEL MECHANISM On a plastic panel measuring approx 9in × 3½in. Is driven by a reversible 12v battery motor, fitted with pulley and belt which rotates a threaded rod and causes a platform to travel backwards and forwards through a distance of approx 5in. Price £5. Our ref 5P140.

MAINS OPERATED WATER VALVE with hose connection for inlet and outlet suitable for low pressure. Auto plant watering, etc. Only £1 each. Our ref BD370.

20 VOLT 4 AMP MAINS TRANSFORMER Upright mounting with fixing feet. Price £3. Our ref 3P59.

16OHM PM SPEAKERS Approx 7in × 4in. 5 watts. Offered at a very low price so you can use two in parallel to give you 10 watts at 8 ohms. £1 for the two. Our ref BD684.

EHT TRANSFORMER 4kv 2mA Ex-unused equipment. £5. Our ref 5P139.

4 CORE TINSEL COPPER LEAD As fitted to telephones, terminating with flat BT plug. 2 for £1. Our ref BD639.

EHT TRANSFORMER 8kv 3mA. £10. Our ref 10P56.

VERY USEFUL MAGNETS Flat, about 1in long, ½in wide and ¼in thick. Very powerful. 6 for £1. Our ref BD274(a).

ACORN COMPUTER DATA RECORDER REF ALF03 Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. £2 special packing. Ref 10P44.

SOLAR POWERED NI-CAD CHARGER 4 Ni-Cad batteries AA (HP7) charged in eight hours or two in only 4 hours. It is a complete, boxed ready to use unit. Price £6. Our ref 6P3.

METAL PROJECT BOX Ideal size for battery charger, power supply etc.; sprayed grey, size 8in x 4¼in high, ends are louvred for ventilation other sides are flat and undrilled. Price £3. Order Ref. 3P75.

13A PLUGS Good British make complete with fuse, parcel of 5 for £2. Order ref. 2P186.

13A ADAPTERS Takes 2 13A plus, packet of 3 for £2. Order ref. 2P187.

28V -0- 20V Mains transformers 2½ amp (100 watt) loading, tapped primary. 200-245 upright mountings £4. Order ref. 4P24.

CAPACITOR BARGAIN – axial ended, 4700μF at 25V. Jap made, normally 50p each, you get 4 for £1. Our ref. 613.

SINGLE SCREENED FLEX 7.02 copper conductors, pvs insulated then with cooper screen; finally outer insulation. In fact quite normal screened flex. 10m fo £1. Our ref DB668.

3-CORE FLEX BARGAIN No. 1 – Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 10 amps. 15m for £2. Ref. 2P190.

3-CORE FLEX BARGAIN No. 2 – Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 25A. 10m for £2. Ret. 2P190.

ALPHA-NUMERIC KEYBOARD – This keyboard has 73 keys giving trouble free life and no contact bounce. The keys are arranged in two number pad, board size is approx. 13" x 4" – brand new but offered at only a fraction of its cost, namely £3 plus £1 post. Ref. 3P27.

⅛TH HORSEPOWER 12 VOLT MOTOR Made by Smiths, the body length of this is approximately 3in, the diameter 3in and the spindle ⁵⁄₁₆th of an inch diameter. It has a centre flange for fixing or can be fixed from the end by means of 2 nuts. A very powerful little motor which revs at 3,000 rpm. We have a large quantity of them so if you have any projects in mind then you could rely on supplies for at least two years. Price £6. Our ref 6P1, discount for quantities of 10 or more.

3 VOLT MOTOR Very low current so should be very stuiable for working with solar cells. £1 each. Our ref BD681.

STEREO HEADPHONE AMPLIFIER Very sensitive. A magnetic cartridge or tape head will drive it. Has volume control and socket for stereo headphones. 3v battery operated. £1 each. Our ref BD680.

FET CAPACITOR MICROPHONE EAGLE CI.200 Output equivalent to a high class dynamic microphone while retaining the characteristics of a capacitor microphone. Price £1. Our ref BD646.

SUM-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly fixing nuts. 4 for £1. Our ref BD649.

SUB-MIN PUSH SWITCH DPDT. Single hole fixing by hexagonal nut. 3 for £1. Our ref BD650.

CONSTRUCTION

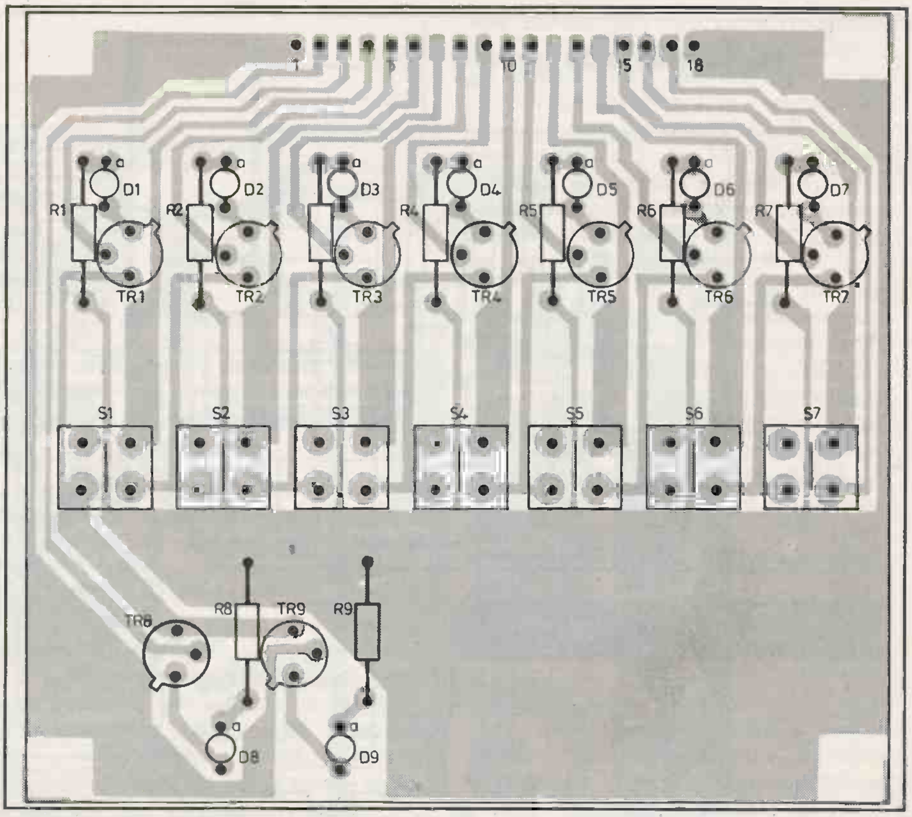
The usual method of circuit board assembly is suggested, starting with the smaller components, resistors and diodes, and leaving the ics until last. It is recommended that good quality sockets be purchased for the ics as some cheaper sockets have reliability problems caused by oxidisation of the contacts.

The relays are the 'ultra miniature' type (6V operation) and may be soldered direct to the pcb.

A heatsink is required for IC5 and can be made from a piece of aluminium cut to fit vertically along the side of the box.

The terminal blocks for the alarm circuits are fitted to a piece of plastic sheet which is supported above the upper part of the main pcb with spacers. The terminal blocks are then wired to the pcb as shown in Fig.12.

A miniature micro switch can be mounted inside the case with two small screws. The alarm wiring to connection 9 can be diverted through the switch, so when the lid of the alarm controller is removed the micro switch will break the circuit and set off the alarm.



HOME SECURITY CONTROLLER

PART TWO
BY KEVIN BROWNE

Details of the construction and hex listing for the project designed to assist you in your own crime watch scheme.

The display pcb may be a slightly awkward section to assemble. First fit all the resistors, and then fit the transistors as close to the pcb as possible. Next fit the switches, ensuring correct orientation and checking alignment and clearance between each one. Then fit the led clips to the front panel and insert the leds the correct way up, but without using the securing collars. Thread the leds onto the pcb and mount the pcb in place on the front panel, ensuring that the switches protrude evenly through it. Finally, solder the leds in place. The wiring of the display panel to the plug PL1 is shown in Table 1.

The standby battery and siren control is a straightforward assembly. However, since this board is designed to be mounted within an external siren housing it will need protection from damp by a coating of lacquer or varnish on both sides. A heatsink is required for TR2. This transistor should be mounted in the centre of the heatsink and insulated from it. It should be wired to the pcb. The pcb itself can be mounted on the heatsink spaced by 10cm spacers. The connecting block can also be mounted on the heatsink (see Fig.12 last month) and wired to the pcb as shown. The standby battery is connected to the pcb with two spade type terminals on the end of flexible leads.

TESTING

A thorough check of all wiring and soldering should be undertaken before connecting any power to the circuit. Links should be inserted to form the closed loop circuits. Option switches S1 and S2 should be set as required, as in Table 2.

Without IC3 inserted or any battery connected, connect the psu to the circuit. A check should then be made of all the power supply voltages. Using a wire link in the socket of IC3 connect each of pins 12 to 19, 35 and 36 to 0V turn and check the appropriate led or relay operates. See Table 3. Check also that pin 1 is 0V and pin 40 is +5V. Check that operation of each of the keys in turn take the appropriate pin 27–34 to the 0V line.

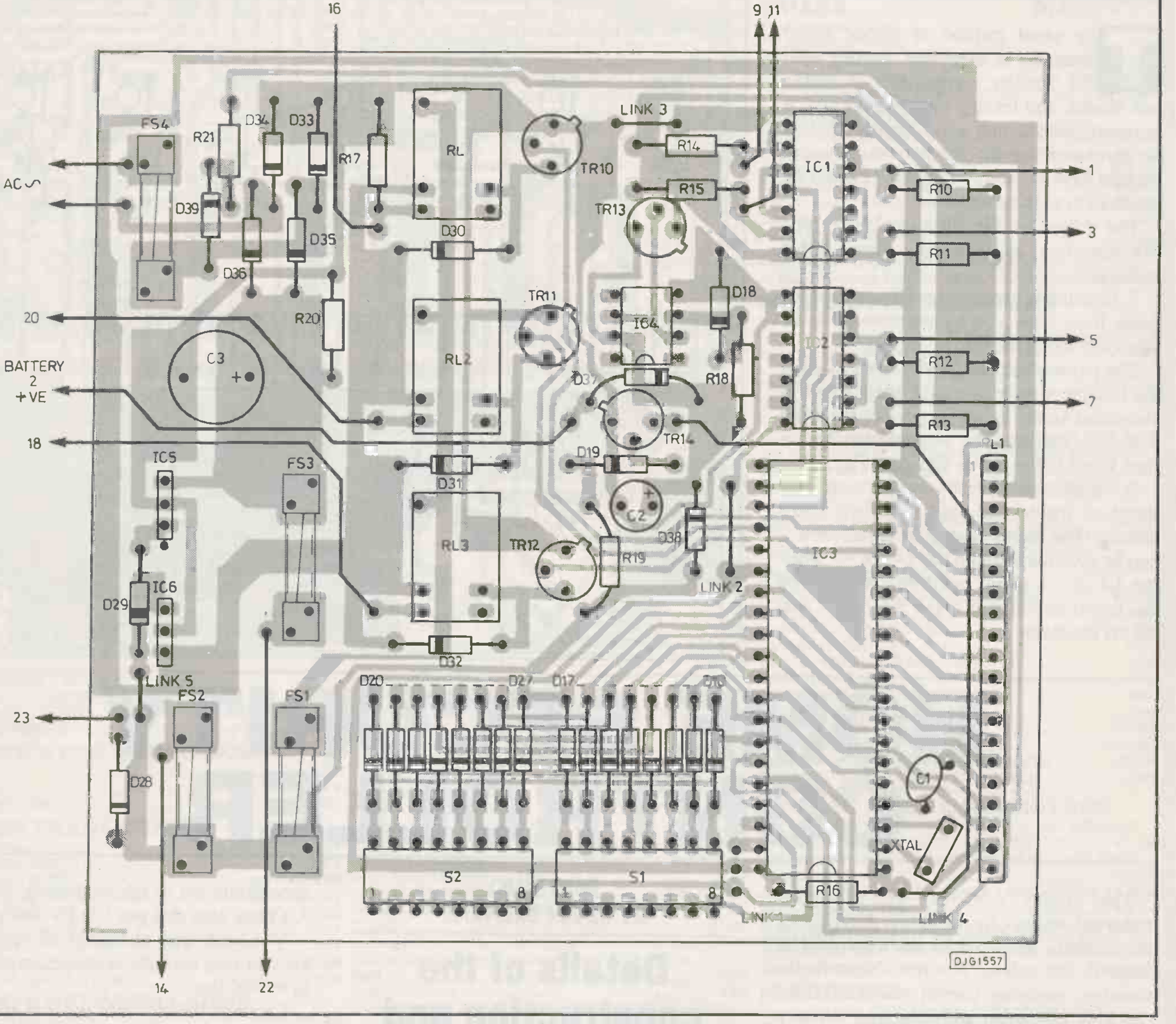
Connect battery B2, remove the mains power, and check that 5V is maintained at pin 40 of IC3. Finally disconnect all power.

Now insert IC3, reconnect the power and run a check on all facilities of the alarm unit.

The standby battery control board can now be connected and tested. First connect a 120 ohm 1W resistor in place of the standby battery. Connect the control board to the Alarm Control Unit and adjust VR1 until a voltage of between 13.5V and 13.8V is measured across the 120 ohm resistor. Increase the current drawn from the charge supply ensuring that the current limit operates at around 800mA. Replace the dummy load with the standby battery and check that it is charging satisfactorily.

Next, check that the alarm relay will operate when an alarm condition is sent from the main control unit, and that the charge supply to the battery is removed. Then disconnect the mains from the control unit and check that the standby battery takes up the load. Finally, check that disconnecting the alarm input lead will operate the alarm relay for approximately five minutes before resetting.

Fig.14. Main PCB layout



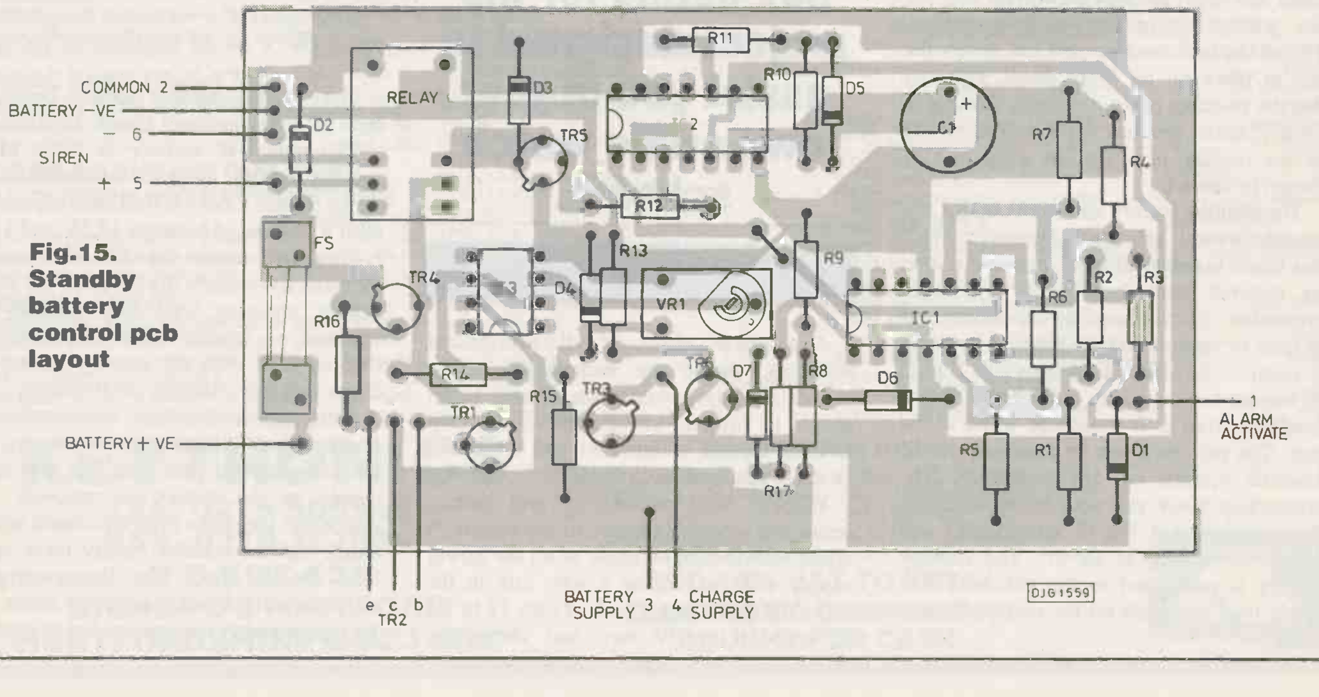
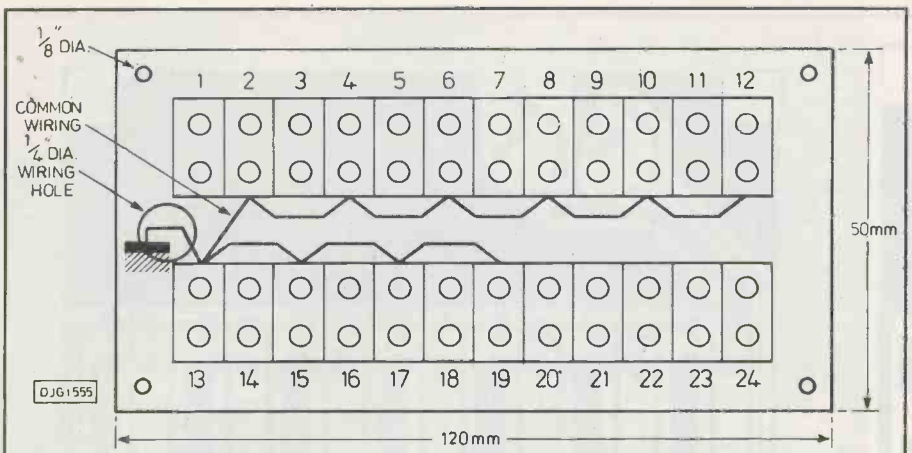


Fig.15. Standby battery control pcb layout



1 ZONE 1 closed loop.
2 ZONE 1 closed loop.
3 ZONE 1 open loop
4 ZONE 1 open loop.
5 ZONE 2 closed loop.
6 ZONE 2 closed loop.
7 ZONE 2 open loop.
8 ZONE 2 open loop.
9 FIRE ZONE closed loop.
10 FIRE ZONE closed loop.
11 FIRE ZONE open loop.
12 FIRE ZONE open loop.
13 - external feed.
14 + external feed.
15 - main siren/common.
16 + main siren/alarm activate.
17 - entry.exit buzzer.
18 + entry /exit buzzer.
19 - strobe light.
20 + strobe light.
21 spare.
22 + charge supply.
23 + batt supply.
24 spare.

Notes. Connection 9 can be wired through a microswitch to provide anti-tamper protection for the Alarm Controller Case. Connections 15 and 16 alternative use will depend upon a standby battery control option being fitted or not.

Fig.16. (above) Alarm controller connections.
Fig.17. (below) PCB track for main board.

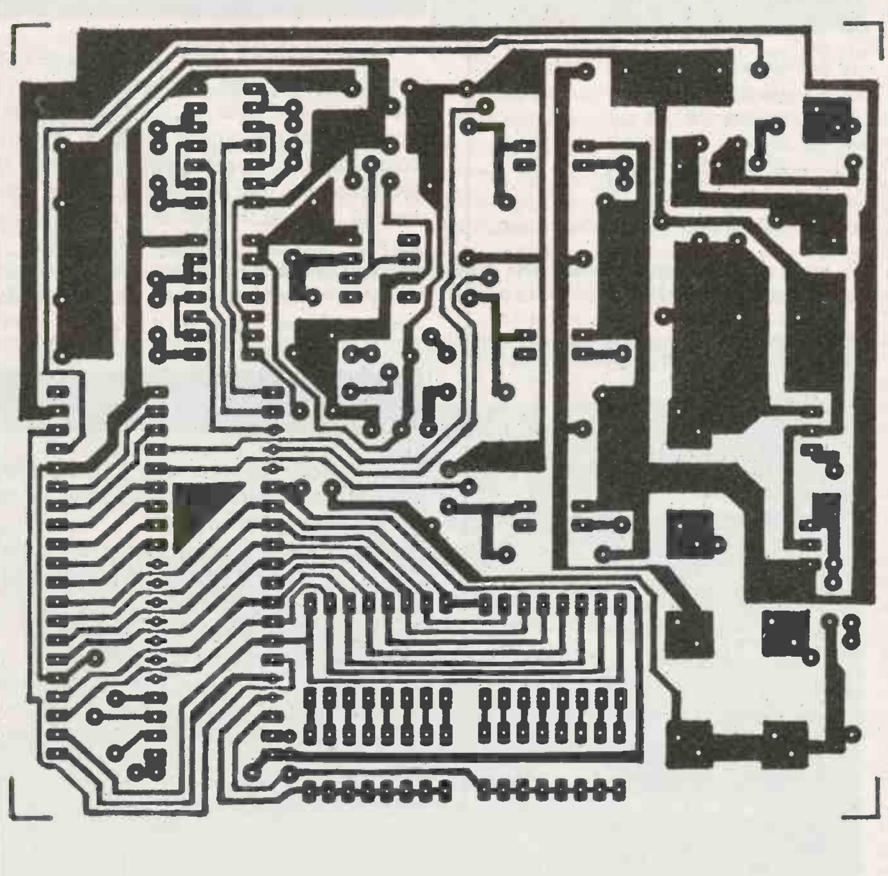


Table 1 Plug P1 to Display PCB Wiring.

PLUG PIN	DISPLAY PCB	Use
1	–	not used
2	18	+5 volts
3	11	Battery low led
4	13	Power led
5	17	Ground
6	1	Zone 2 off led
7	2	Zone 1 off led
8	15	System on led
9	7	Zone 2 alarm led
10	5	Zone 1 alarm led
11	9	Fire zone alarm led
12	10	Key switch '1'
13	12	Key switch '2'
14	14	Key switch '3'
15	16	Key switch '4'
16	–	Ground
17	4	Key switch 'Test'
18	6	Key switch 'Zone 1'
19	8	Key switch 'Zone 2'
20	3	Fault led

Table 2 OPTION SWITCH SETTINGS

SWITCH BLOCK 1 (UPPER)				SWITCH BLOCK 2 (LOWER)	
8	Grey	Main alarm time	b	1st key of code	a
7	Purple	Main alarm time	a	1st key of code	b
6	Blue	Entry delay	c	2nd key of code	a
5	Green	Entry delay	b	2nd key of code	b
4	Yellow	Entry delay	a	3rd key of code	a
3	Orange	Exit delay	c	3rd key of code	b
2	Red	Exit delay	b	4th key of code	a
1	Brown	Exit delay	a	4th key of code	b

MAIN ALARM TIME

'b'	'a'	
on	on	5 minuits
on	off	10 minuits
off	on	15 minuits
off	off	20 minuits

SECURITY CODE

'b'	'a'	
on	on	one
on	off	two
off	on	three
off	off	four

ENTRY AND EXIT DELAYS

'c'	'b'	'a'	
on	on	on	nil
on	on	off	10 seconds
on	off	on	20 seconds
on	off	off	30 seconds
off	on	on	40 seconds
off	on	off	50 seconds
off	off	on	60 seconds
off	off	off	70 seconds

Table 3 8748 PORT ALLOCATION

'BUS'

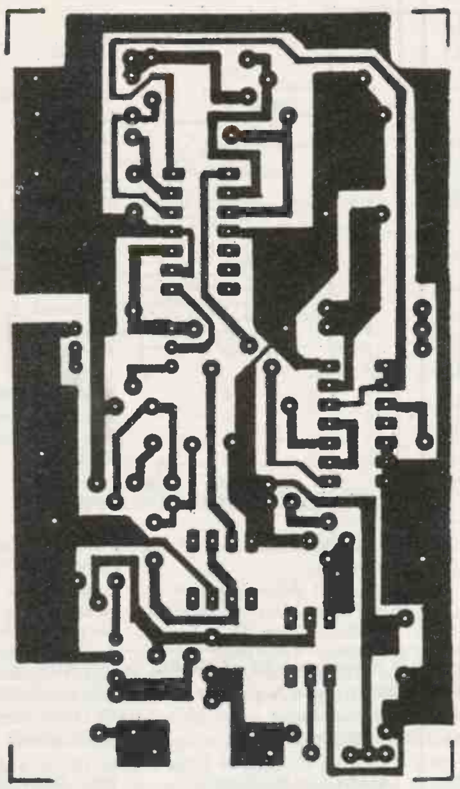
0	(12)	Fire zone alarm indication output	LED 4
1	(13)	Zone 1 alarm indication output	LED 2
2	(14)	Zone 2 alarm indication output	LED 3
3	(15)	System on indication output	LED 7
4	(16)	Entry/Exit sounder output	RL 3
5	(17)	Main siren output	RL 2
6	(18)	Zone 1 off indication output	LED 8
7	(19)	Zone 2 off indication output	LED 9

'Port 1'

0	(27)	Key 1	Exit data 0	4th code 1
1	(28)	Key 2	1	0
2	(29)	Key 3	2	3rd code 1
3	(30)	Key 4	Entry data 0	0
4	(31)	–	1	2nd code 1
5	(32)	Test/clear	2	0
6	(33)	Zone 1 on/off	Alarm time 0	1st code 1
7	(34)	Zone 2 on/off	1	0

'Port 2'

0	(21)	Fire zone alarm input	
1	(22)	Zone 1 alarm input	
2	(23)	Zone 2 alarm input	
3	(24)	Strobe indicator output	RL 2
4	(35)	Battery low indicator output	LED 5
5	(36)	Fault indicator output	LED 1
6	(37)	Interrogate dil switch 1	
7	(38)	Interrogate dil switch 2	
T0	(1)	Mains power present input	
T1	(40)	Aux (B2) battery in use input	



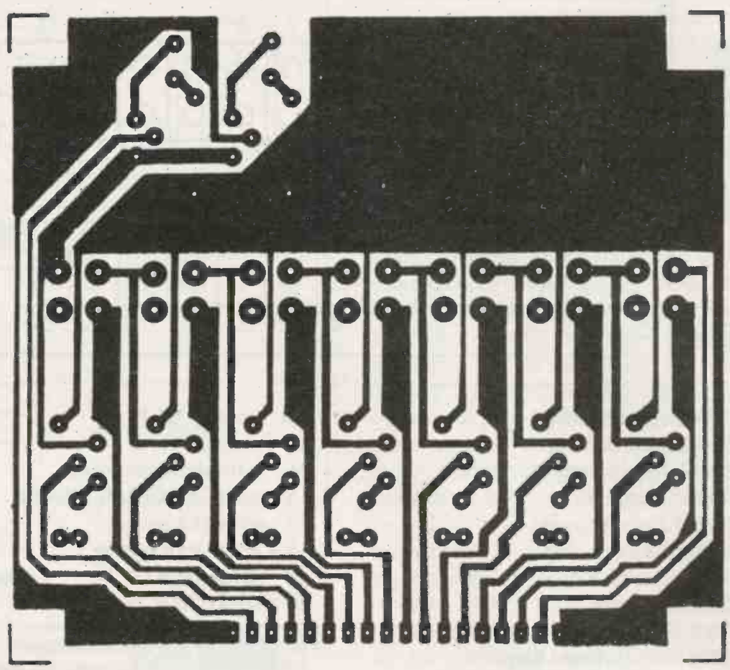


Fig.18. (left) Standby battery track.
Fig.19. (above) Display pcb track.

```
0000  - 04 42 00 00 00 00 00 d5 af fa c6 0d ca fb c6 11  - (33)
0010  - cb fc c6 17 cc ff 93 bc 32 cd fe 96 21 c5 54 c6  - (51)
0020  - d5 b8 28 54 95 c5 fa d5 f2 15 b8 2a 54 95 96 3e  - (d8)
0030  - b0 04 b8 2c 54 95 96 15 23 10 14 be 04 15 36 32  - (b2)
0040  - 04 15 b8 02 b9 3e 27 a0 18 e9 46 54 b5 23 ff 14  - (17)
0050  - c5 14 aa 54 a7 ba 07 bd 07 54 d0 25 55 14 79 c6  - (f4)
0060  - 65 14 cb a5 b5 54 2f 96 6e 23 20 14 c5 27 5d c6  - (8b)
0070  - 73 54 09 54 58 34 f1 04 5d 09 37 53 ef a9 96 85  - (48)
0080  - af d5 aa a5 93 df c6 91 f9 af d5 ba 03 be 0a 27  - (c5)
0090  - 93 d5 4a c6 97 27 73 4e c6 75 c5 27 76 9f f9 93  - (ff)
00a0  - a8 96 a5 27 93 27 69 e8 a6 93 b8 23 40 02 a0 83  - (8e)
00b0  - b8 23 37 50 02 a0 83 d5 ad 27 4d 96 b9 93 b8 24  - (3b)
00c0  - 37 50 3a a0 83 b8 24 40 3a a0 83 a9 fa 72 ef b8  - (19)
00d0  - 23 f0 37 92 ef b2 ef 23 0f 59 c6 df 14 ff 83 23  - (55)
00e0  - c0 59 c6 e7 34 3f 83 23 20 59 c6 ee 34 51 93 23  - (47)
00f0  - 0f 59 c6 f7 34 a8 83 23 20 59 c6 fe 54 cc 93 54  - (eb)
0100  - 2f c6 08 23 20 14 be 83 bd 07 23 10 14 b0 b8 20  - (28)
0110  - f0 53 07 b9 0a 14 a0 b8 28 a0 14 79 96 1a 14 79  - (0b)
0120  - 53 0f 96 29 b8 28 f0 96 1e 23 10 14 aa 54 2f c6  - (df)
0130  - 36 23 20 14 be 83 23 08 4a aa 23 08 14 b0 83 b8  - (17)
0140  - 23 a9 d0 a0 02 53 c0 e7 e7 e7 a9 23 f9 5a 49 aa  - (18)
0150  - 83 b8 24 f0 72 5b 23 08 14 c5 83 54 b5 54 d0 23  - (f3)
0160  - 07 14 b0 23 0a 14 b7 23 07 14 aa 54 2f c6 74 23  - (8b)
0170  - 20 14 be 83 23 10 14 b0 23 05 14 b7 23 10 14 aa  - (50)
0180  - 23 08 14 be 23 05 14 b7 23 08 14 c5 54 2f c6 95  - (d2)
0190  - 23 20 14 be 83 23 20 14 b0 23 03 14 b7 23 20 14  - (e7)
01a0  - aa 36 90 23 20 14 c5 83 b9 ff 19 67 e6 aa fc e7  - (ba)
01b0  - e7 49 ac 1b 23 04 db c6 ba 83 b8 21 f0 dc 18 96  - (4f)
01c0  - c4 34 d3 83 10 bc 00 bb 00 23 03 d0 96 d2 23 01  - (57)
01d0  - 54 09 83 23 08 14 c5 54 2f 53 01 37 53 07 ad 85  - (7e)
01e0  - 23 38 14 aa 54 c6 27 b8 29 a0 c8 a0 23 f7 5a aa  - (61)
01f0  - 83 23 07 dd c6 fd d5 23 07 5d c5 c6 fe 83 54 2f  - (38)
0200  - a9 fd 37 59 37 53 07 ad 83 b6 2e b8 20 a9 07 c6  - (29)
0210  - 28 fa 37 72 2e f9 5a c6 2e 52 28 23 38 50 77 77  - (53)
0220  - 77 b9 0a 14 a0 b8 28 a0 23 10 14 b0 85 95 83 0a  - (0c)
0230  - 53 07 a9 96 3e d5 ab c5 23 07 14 aa 27 93 de c6  - (62)
0240  - 48 f9 ae d5 bb 03 27 93 d5 4b c6 4e 27 93 c5 23  - (12)
0250  - 07 14 aa f9 14 b0 f9 93 b6 5b 83 b8 29 f0 96 88  - (91)
0260  - c8 f0 96 88 b8 23 f0 92 89 23 10 14 aa 23 20 14  - (04)
0270  - b0 23 08 14 be b8 20 23 c0 50 e7 e7 17 a9 23 2c  - (95)
0280  - 14 a0 b8 28 a0 f9 18 a0 93 23 20 14 aa 85 54 2f  - (81)
0290  - 37 53 07 ad 83 f0 c6 9c 07 a0 17 83 18 f0 c6 a6  - (c8)
02a0  - 07 a0 17 c8 b0 ff 83 b8 2d b0 ff c8 b0 ff c8 b8  - (43)
02b0  - 04 c8 b0 00 83 b8 20 23 bf 3a 09 a0 18 23 7f 3a  - (90)
02c0  - 09 a0 23 ff 3a 83 f8 b8 22 b0 00 a8 27 ab ac 83  - (b3)
02d0  - b9 80 46 db 23 bf 3a 56 db b9 00 23 ff 3a 23 7f  - (5e)
02e0  - 5a 49 aa 83 00 00 00 00 00 00 00 00 00 00 00 00  - (d0)
```

The full hex dump for the home alarm microcontroller is shown on the left.

INSTALATION

This is where I leave you to your own devices. It is worth mentioning, however, that it is advisable to spend some time planning the positioning of alarm sensors, control unit, etc, paying careful attention to protection of your house and at the same time to some of the problems of wiring the various sensors together. Remember, a successful alarm system gives a potential thief no chance to attack or disable the system without triggering it first.

REFERENCE

Two useful reference books are available for anyone interested in more detail on the 8748 microcontroller.

1. *Practical Electronics* Microfile October 1983 A brief guide to the 8748 microcontroller.
2. Embedded Controller Handbook. A detailed handbook covering all aspects of MCS-48, MCS-51 and MCS-96 microcontrollers and peripheral devices. (Available from Intel 0793 696000 price £17.00.)

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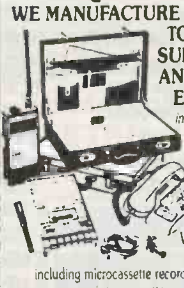
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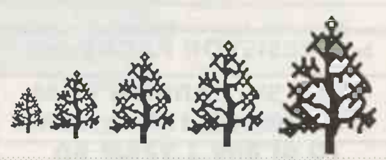

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INDUSTRY NOTEBOOK

END OF A LOVE AFFAIR

BY TOM IVALL

Thorn EMI is packing its bags and selling off the kids – the muse Electronice must find another swain in the UK.

Thorn EMI recently announced that it is getting out of electronics altogether. As reported in this column, the group has already disposed of its consumer electronics manufacturing business (Ferguson) and vlsi semiconductor company (Inmos). Now Thorn EMI Electronics is up for sale. This means largely computers, military electronics equipment, special tubes and the American subsidiary Systron Donner.

It's all part of the general restructuring and consolidation of the electronics industry now going on, which I've mentioned previously. This firm, like many others, has realised it must gird up its loins to face intensifying competition in an international market – and in particular the coming of the European single market in 1992.

Colin Southgate, the man who has been revitalising the group since his appointment as managing director in 1985, has decided that the company is too weak in electronics to stand up against the big guys in the world. This doesn't mean weak technologically but in the commercial sense of sales, market shares, economies of scale and other such factors which I discussed last month.

So electronics manufacturing is being sold off (along with food mixers and gas meters) to leave the company free to concentrate on what it considers to be its main strengths: lighting, music products and domestic equipment rental.

To me this final break seems like Thorn EMI coming to the end of a long love affair with electronics. The affair has had its great moments but has never settled into a really stable relationship. Over the years the changing management seems not to have fully recognised the importance of electronics technology on the world scene nor the brilliance of some of its own people in this field. Consequently, through lack of interest or imagination, it has lost tremendous opportunities for technical and commercial development in this industry.

The first 'great moment' in the love affair was in the early 1930s. Isaac Shoenberg, leading a brilliant research team at EMI, became convinced that mechanically-scanned television was doomed and that the future lay with all-electronic television. His work, and in particular that of his colleague McGee, led to the development in 1933 of the first UK television camera tube, the Emitron.

Out of this came the Marconi-EMI television system, with EMI providing mainly the electronic picture generation and Marconi the transmitting equipment. The system was adopted for Britain's first tv broadcasting service in 1936.

An extremely prolific member of the Shoenberg team was A.D. Blumlein. He was first with many important inventions in circuits and systems.

After the 1939–45 war EMI started to manufacture tv transmitting equipment on a regular basis. But after producing what was undoubtedly the best studio tv camera in the world the firm inexplicably lost faith in this winner as a commercial venture and abandoned the camera field to the Americans, Germans and Japanese.

In the intervening years Thorn EMI – mainly through the EMI side – has had a go at practically everything else you can think of in the electronics sphere. Offhand I can remember automation equipment, digital computers, measuring instruments, transducers, radar, magnetic recording, audio equipment, electronic tubes and medical instruments – not forgetting the recent dalliance with integrated circuits.

Another 'great moment' and lost opportunity was the computer-assisted tomograph – or cat scanner as it's often called! This machine, for automatically constructing three-dimensional X-ray images of the human brain, was developed almost single-handedly, on a string-and-sealing-wax basis, by an EMI engineer called Godfrey Hounsfield. He had joined the firm to work on radar and later specialised in computers, being the project engineer responsible for one of the UK's first solid-state machines, the Emidec 1100.

Hounsfield's idea for computer-assisted tomography came out of work he was doing on pattern recognition by computer. The resulting EMI scanner, first used at the Atkinson Morley Hospital, Wimbledon, was a technological sensation in the medical world. As a result Godfrey Hounsfield (who did not have a university degree) was awarded the Nobel Prize for Physiology and Medicine and was later knighted by the Queen.

What happened? Again the EMI management of the time (before Thorn had come on the scene) got commercial cold feet. After manufacturing a few scanners and selling them successfully to hospitals at home and abroad they abandoned the whole business and sold out to General Electric in the USA.

I sometimes wonder if the unsatisfactory outcome of Thorn EMI's love affair with electronics was really due to an early identity crisis. Thorn, founded in 1928, was always straightforwardly electrical, but perhaps Electric and Musical Industries Ltd couldn't make up its mind whether it was really an electrical company or a gramophone company.

It all started with that revered name The Gramophone Company, formed in 1892. Others involved were an American office boy called David Sarnoff, who had arrived in the USA as an immigrant in 1900, and a British radio set manufacturer, the Marconiphone Company.

Sarnoff was an office boy with the American Marconi Company. He eventually became its boss, after it was transformed into the Radio Corporation of America (RCA) in 1919. The Marconiphone Company was launched in 1923 to make domestic radio sets now that broadcasting had just started in the UK. But by 1929 Marconi's were having financial problems as a result of the economic depression and decided to dispose of this set manufacturing business. As RCA already owned The Gramophone Company, Sarnoff thought it would be a good idea to buy Marconiphone and another record company, Columbia Graphophone, and merge all three to form an organisation that would have a strong position in home entertainment by encompassing both recording and radio reception.

This he did by a series of deals and the resulting new company was named Electric and Musical Industries Ltd. A lot of properties were brought together, like the Marconi and RCA domestic receiver patents. Another outcome, which confused everyone for decades, was that EMI found itself using the trade-name 'Marconiphone'. People thought there must be a financial link between EMI and Marconi, while in fact there was no such connection. PE

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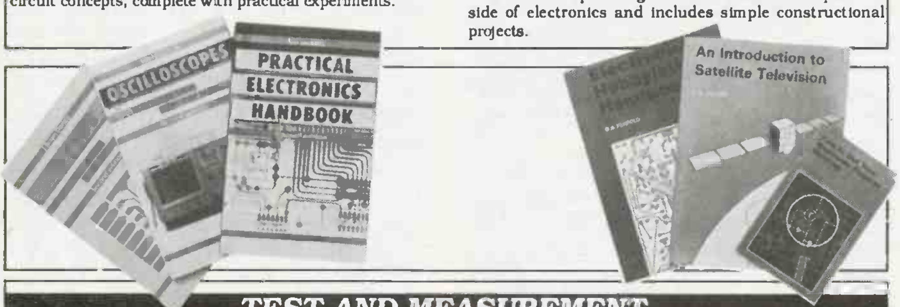

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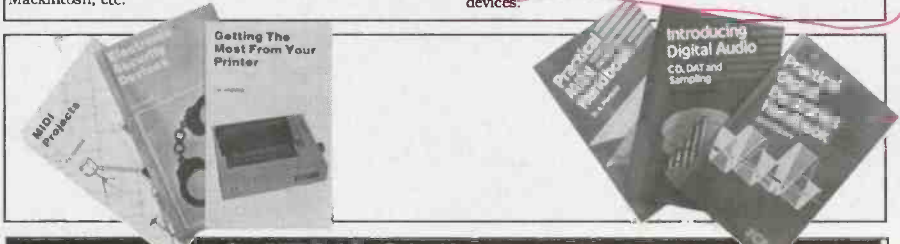

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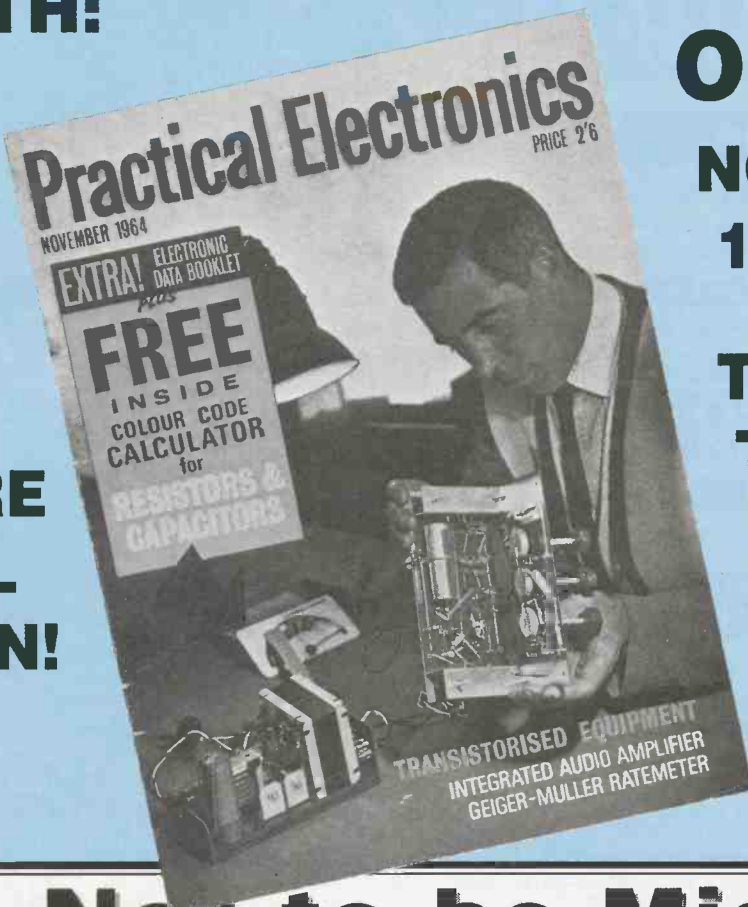

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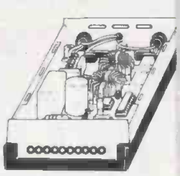

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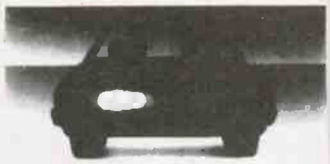

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Matchbox Bridge Amplifier (50w)	£8.90 + VAT
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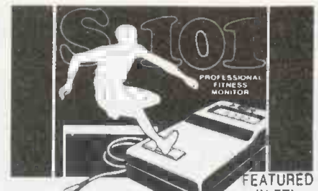
TACHO/DWELL METER (ETI January 1987) Turn your Metro into a Porsche!	£16.40 + VAT
HI-FI POWER METER (ETI May 1987) Measures Hi-Fi output power up to 100W – includes PCB, components, meters	
Mono power meter	£3.90 + VAT
Stereo power meter	£7.20 + VAT



FEATURED IN ETI AUGUST 1988

There's nothing quite so encouraging as having a quantifiable result to show for your training efforts. If you are not particularly fit, your resting heart rate will be around 80 beats per minute. As your jogging, aerobics or sport strengthens your heart, the rate will drop dramatically – possibly to 60bpm or less. With the S101, you can watch your progress day by day.

Breathing is important too. How efficiently do you take up oxygen? How quickly do you recover from 'oxygen debt' after strenuous activity? The S101 will let you know.

The approved parts set consists of: case, 3 printed circuit boards, all components (including 17 ICs, quartz crystal, 75 transistors, resistors, diodes and capacitors), LCD, switches, plugs, sockets, electrodes, and full instructions for construction and use.

PARTS SET £33.80 + VAT

Some parts are available separately. Please send SAE for lists, or SAE + £2 for lists, circuits, construction details and training plan (free with parts set)

THE DREAM MACHINE

FEATURED IN ETI DECEMBER 1987

Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a peaceful, refreshing sleep.

For many, the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take lucid dreams, for instance. Imagine being in control of your dreams and able to change them at will to act out your wishes and fantasies. With the Dream Machine it's easy!

The approved parts set consists of PCB, all components, controls, loudspeaker, knobs, lamp, fuseholders, fuse, mains power supply, prestige case and full instructions.

PARTS SET £19.80 + VAT

Ben Sweetland's best seller GROW RICH WHILE YOU SLEEP is now in stock. £2.95 (NO VAT)

THE MISTRAL AIR IONISER

The best ioniser design yet – this one has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters. For the technically minded, it has nine main drive stages, five secondary drives, and a four section booster to give an output capability of almost fifteen billion (1.47×10^{13}) ions every minute, or 2.45×10^{11} ions per second. With extra emitters this can be increased still further!

PARTS SET £28.40 + VAT

The parts set includes case, printed circuit boards, 126 top grade components, all controls, lamps, hardware, a multi-point phosphor-bronze emitter and full instructions.

Some parts are available separately – please send SAE for lists, or SAE + £1 for lists, circuit and construction details and further information (free with parts set).

READY-BUILT MISTRAL

The Mistral Ioniser (and most of our other projects) can now be supplied built, tested and ready to go. For details, please contact *Peter Leah at P.L. Electronics, 8 Woburn Road, Eastville, Bristol BS5 6TT. Tel: 0272 522703.* Evenings Only

INTERNAL EMITTER £2.80 + VAT

Can be used in place of the P-B external emitter, or both can be used together for the highest ion output. Parts set includes PCB, ion emitters, components and instructions.

IPA BOARD CLEANER £0.98 + VAT

Essential for removing grease and flux residues from the Mistral PCB to achieve peak performance. Applicator brush supplied.

ION FAN £9.80 + VAT

An almost silent piezo-electric fan, mains operated, to pump ions away from the emitter and into the room. Increases the effectiveness of any ioniser by five times!

ION DISPERSION METER

FEATURED IN ETI FEBRUARY 1989

The Q-ion is a hand-held meter which sniffs out ions in the air. It can tell the good ones from the duds if you're thinking of buying a commercial ioniser, check the efficiency and output of one you've made yourself, help you set up fans and position the ioniser for best effect, do an ion-survey of your house or office — in short, it will tell you anything you want to know about ions in the air.

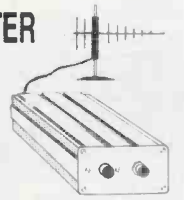
In direct mode the bar-graph readout will detect the presence of negative or positive ions and measure neg-ion strengths from 5×10^7 to 10^{10} ions per second, which covers the levels you can expect when an air ioniser is in use. For the smaller concentrations of natural air ions, integrate mode will increase the sensitivity as far as you like.

Our approved parts set comprises: case, ion collector, printed circuit board, all components (including six ICs, schottky diode, cermets, VDR, zener, 37 resistors and capacitors, LEDs, plug, socket, earth lead, etc.) and full instructions.

PARTS SET £18.40 + VAT

Some parts are available separately — please send SAE for lists, or SAE + £1 for lists, circuit, construction details and further information (free with parts set).

TV BOOSTER



Good TV pictures from poor aerials is what this project is all about. Keith Brindley's Aerial Booster gives a massive 23dB gain to ensure good viewing for campers and caravanners, from indoor aerials, or wherever a properly positioned high-gain antenna is not practical.

Based on the OM335 hybrid amplifier, the booster has specifications to rival the best: wideband operation from 10MHz to 1.4 GHz, mid-band gain of up to 26dB and a wide supply range of 9V to 26V (it will run from car batteries for caravanners, dry batteries for campers, or a mains 'battery eliminator' in the home). No special UHF construction skills are needed — the project could be made by a careful beginner.

There are two parts sets for the project. AA1 contains the printed circuit board, OM335 hybrid amplifier, components and instructions. AA2 is the optional case set: rugged screened box, front and rear panels, waterproofing gaskets, feet, sockets and hardware.

AA1 PARTS SET £12.80 + VAT

AA2 PARTS SET £4.80 + VAT

AA3 OPTIONAL MAINS POWER SUPPLY PARTS SET £6.80 + VAT.

BIO-FEEDBACK

FEATURED IN ETI DECEMBER 1986

Bio-feedback comes of age with this highly responsive, self-balancing skin response monitor! The powerful circuit has found application in clinical situations as well as on the bio-feedback scene. It will open your eyes to what GSR techniques are really all about.

The complete parts set includes case, PCB, all components, leads, electrodes, conductive gel, and full instructions.

PARTS SET £16.80 + VAT
BIO-FEEDBACK BOOK £4.50 (no VAT).

Please note: the book, by Stern and Ray, is an authorised guide to the potential of bio-feedback techniques. It is not a hobby book and will only be of interest to intelligent adults.

POWERFUL AIR IONISER

FEATURED IN ETI JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build . . . and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs 'about a third of the price of the individual components'. What more can we say?

Instructions are included

PARTS SET WITH BLACK CASE £12.60 + VAT
PARTS SET WITH WHITE CASE £12.80 + VAT

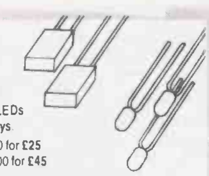
BURGLAR BUSTER

Be safe from intruders with our Burglar Buster alarm system! It has all the features you'd expect from a high-tech alarm: entry and exit delay, anti-tamper loop, delay warning and control-box protection.

The parts set includes *all four* PCBs and all components to go on them. Other parts (case, switches, etc.) are available separately, if you haven't got anything suitable in your spares box. Set contains 4 PCBs, ICs, transistors, relays, capacitors, resistors, diodes, regulator, piezo sounder and full instructions.

BB1 PARTS SET £12.80 + VAT

LEDs



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100 for £6 1000 for £45

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BRAINWAVE MONITOR

FEATURED IN ETI AUGUST 1987

The most antonishing project ever to have appeared in an electronics magazine. Similar in principle to a medical EEG machine, this project allows you to hear the characteristic rhythms of your own mind! The alpha, beta and theta forms can be selected for study and the three articles give masses of information on their interpretation and powers.

In conjunction with Dr. Lewis's Alpha Plan, the monitor can be used to overcome shyness, to help you feel confident in stressful situations, and to train yourself to excel at things you're 'no good at'.

Our approved parts set contains case, two PCBs, screening can for bio-amplifier, all components (including three PMI precision amplifiers), leads, brass electrodes and full instructions.

PARTS SET £39.80 + VAT ALPHA PLAN BOOK £2.50
SILVER SOLUTION (for plating electrodes) £3.80 + VAT

Parts set available separately. We also have a range of accessories, professional electrodes, books, etc. Please send SAE for lists, or SAE + £2 for lists, construction details and further information (free with parts set).