THE ELECTRONICS, SCIENCE & TECHNOLOGY MONTHLY

APRIL 1991 £1.60

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APRIL 1991

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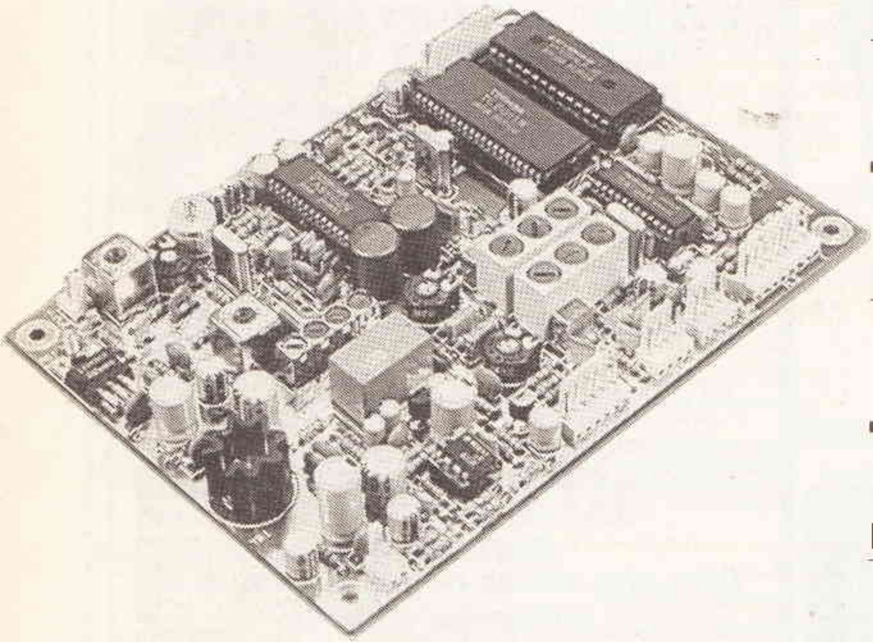

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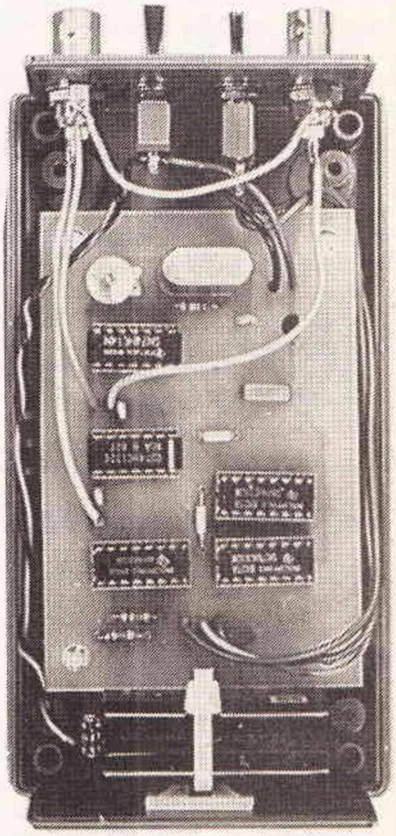

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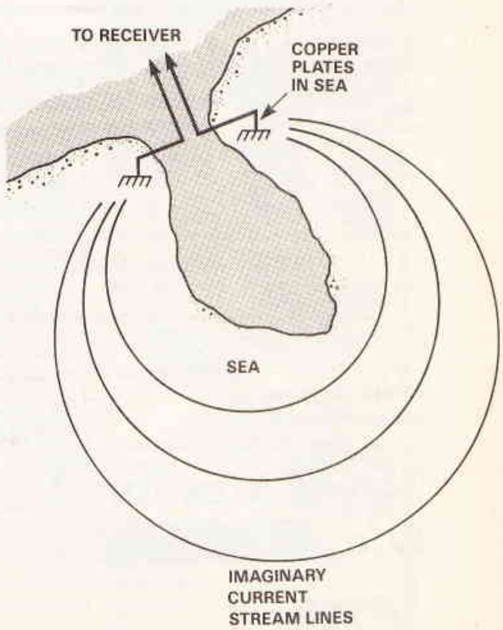

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READ\WRITE

ETI LETTERS

Loudspeaker Port

I was very interested to read the article for the construction of a high quality loudspeaker by Mr Mike Fox. I agree that for someone who is able to do some woodwork and soldering then constructing your own hi-fi loudspeakers can be rewarding and produce excellent results.

The design described would seem to be such a design. However it does appear that intending constructors will need to have some testing facilities of their own because Mr Fox does not give details of the drive units he uses. Drive units will more than probably have different characteristics, particularly the resonant frequency, and experimentation will have to be carried out. I also agree with Mr Fox's statement that the length of the port tube must not be altered in his design. Apart from the fact that he does not give a length, making his statement a little pointless, this dimension will be different for differing drive units.

It seems a nonsense to describe a design that has obviously been so well thought out and researched for home construction and leave out data so the proverbial wheel has to be invented all over again.

A. Lillie,
Middlesbrough.

Mike Fox replies:

Regarding the type of drive units employed in the K2 loudspeaker kit (ETI Feb 91) and also the lack of dimensions for the port tube which is of course critical to the design.

It was intended that the potential constructor would have to purchase the complete kit from Kord Audio Products, these details were not considered necessary as all the components, less the woodwork are included in the kit, also since the bass/mid drive units had to be carefully doped to produce the correct characteristics, this cannot be done by the home constructor.

To produce a truly professional hi-fi loudspeaker requires a long period of development and extended listening to produce a unit worthy of use in a high quality system. To ensure that end, it makes sense to produce a kit which ensures that all the parameters are correct.

A couple of errors crept into the article. Our telephone number should be 0522 595261 not 585261. The grille frame in Figure 3 lacks dimensions, they are from top downwards 153, 102, 152 and a total height of 407mm. In Figure 2, the back panel should read 186 (185.9).

Mike Fox,
Kord Audio Products.

The Answer lies in the soil

I would like to compliment you on your February Energy article. I refer especially to the ideas regarding heat extraction from hot waste water, being both informative, practical and probably very cost effective. However, I'd be very wary of releasing water containing biological type substances into the garden soil. The bacterial breakdown of manure and humus in the soil is inhibited by biological washing powders that such waste water would inevitably contain. I believe the cumulative effects of this regular treatment of the soil could be quite serious as proper soil nourishment depends upon the breakdown of organic nutrients.

To end, thanks again for the article, when's the next one?

Rohan Barnett,
Co. Cork, Eire.

Thank you for your comments. I agree, persistent use of chemical nasties running into the soil could kill the organic nature of the compost until such time that rain could dilute and precipitate the elements alien to organic growth. So what do we do? Stop using the chemical nasties and switch to agro-friendly detergents or maybe feed the liquid output through a filter.

My thoughts at the time of writing that section was to principally transfer the cool, less polluted bath or shower water to the garden. Perhaps two storage tanks are required for each type of water. The next instalment is when I can get the time — Ed.

LCD Module

Some readers interested in constructing the Remote Control Timeswitch have said they have experienced difficulty in obtaining the LCD module Type EA-D16015AR. They can be sourced from STC Electronics. Tel: 0279 626777 quoting part no. 029662B or from Hawke Components Ltd. Tel: 081 979 7799.

Kevin Browne,
Huddersfield.

New Chips for Old

I understand constructors of the Infra-switch and Infra-lock (Nov/Dec 90) are having difficulty in obtaining the ML924 chip. It looks as if Plessey have just stopped making these (Murphys Law) and they have now switched to a new chip series. The nearest compatible is the MV601, but is not pin compatible. I am working on an alternative design with some interesting variations in the use of infra red coded signals. Watch this space!

D Banham,
Romsey.

HDTV Praise

I must congratulate you on the most superb series of articles on HDTV. Please pass on to James Archer my appreciation of this timely treatment — a subject that is changing at a rapid pace both technically and politically.

I do hope that in some future edition you will be adressing the 'hot' subject of digital transmission and data compression which is being undertaken by companies like General Instrument and Tellestra. And that you will describe in the same easy to understand style of the rest of the series some of the concepts and algorithms particular to this new type of television - namely digital.

Full marks again for such an interesting and useful series.

Tony Salmon
TV Producer
Bristol

I'm glad you like the series. I'm afraid I cannot reveal whats to come but rest assured with a subject so new and topical, we will aim to bring you everything there is to know on the subject — Ed

Transformer

I was interested to read the articles by Simon Russell on Repailing Oscilloscopes in Dec 90/Jan 91.

Having started my electronic hobby in the days of Octal valves, I had no hesitation in buying an old valve 'scope; a Solatron CD1400. With a copy of the manual, I set about bringing it to life, but to no avail. The mains transformer had blown.

Please thank Mr Russell for his article and I wonder if he or anybody else knows the source of transformer for this 'scope.

D Lacey,
St Helens.

This sounds like a plea (I'm feeling charitable) for a possible replacemant. If you have any suggestions telephone Mr Lacey on 0744 53072 — Ed.

OPEN CHANNEL

Death Knoll

Last year's merger between Sky TV and British Satellite Broadcasting leaves a big problem somewhere up in the stars, to which there is no obvious solution. However, I am about to suggest an answer which could suit all parties.

British Satellite Broadcasting (BSB), for all its faults, had an advanced television transmission system which looked set to become the system of the future. What's more, Britain had the system last year, daring to tread where others dare not. For one reason or another BSB chose to develop and market a unique system known as DMAC. This was, and still is, in its bog-standard form capable of higher-quality audio/visual transmission which could improve the standard living-room pictures and sounds we've all had to suffer since the present 625-line terrestrial television system was developed. By transmitting luminance and chrominance video signals separately, coupling them with digital stereo audio transmission, an immediate improvement in picture and sound quality was available to those users with a BSB satellite dish and receiver, together with a suitable television. (A television set with RGB inputs via a scart connector, and stereo sound circuits was all that was needed to realise the improvements DMAC offered.)

Technically, picture quality is improved with such an arrangement simply because luminance (brightness) and chrominance (colour) signals which your television set needs to produce its picture are separate. In conventional terrestrial systems such as PAL they are transmitted side-by-side, almost separately but overlapping to some small extent. Thus, it becomes impossible for the television set to distinguish between high frequency luminance signals and low frequency chrominance signals. Result is spurious colour patterning on areas of fine detail — such as fine checks on clothing materials and so on. Transmitting these signals totally separately using one of the MAC systems overcomes this problem allowing much higher picture quality. (MAC is an acronym for multiplexed analogue components, which succinctly describes how the two analogue signals are kept separate, by multiplexing, while being transmitted.) Digital audio transmission means much improved sound — in stereo, too — although development of NICAM digital stereo sound accompanying terrestrial television transmissions has negated this benefit to a small extent.

All this aside, the biggest benefit of using a MAC-based television system is its potential for the future. So much has been argued about MAC's potential, especially in this column, that it hardly seems necessary to point out high-definition television (HDTV) systems can result: with 1250-line pictures, on a wide-screen (16:9) basis. Use of a MAC-based system rather than, say, the Japanese HDTV system maintains current compatibility with existing television sets, while giving all the future HDTV benefits — and keeps the system in European hands. What more could we want?

It appears BSB's choice (persuaded by a forceful IBA,) of DMAC, rather than D2MAC, together with an insistence that BSB-licensed equipment (dishes, receivers, LNBs and decoders) must be used to receive BSB signals from its satellite, became BSB's downfall.

In retrospect there are other reasons for BSB's demise. Its late entry on to the satellite receiver marketplace (more than a year after Sky TV's launch on the Astra satellite) is one.

Another is BSB's own marketing (or rather, lack of marketing). It's benefits were never properly extolled and, coupled with this, there seemed to be almost a conspiracy of silence to prevent people finding out! As a journalist I found it extremely hard to get relevant, meaningful, information out of BSB — what chance had Joe Public? Sky benefitted once again.

Disappearing rapidly up its own back end, BSB's DMAC now looks as though it will be defunct within months. European satellites using the D2MAC system (a close derivative of the MAC format), are building up forces in a colocated position in the satellite belt (19° west of south). These will ensure the future of D2MAC, and the resultant HDTV format, in a way promoters of DMAC could only have dreamed of.

Pig in a Poke

Meanwhile, the two Marcopolo satellites franchised to BSB hang out at 31° west. A complete satellite control centre is based at Chilworth, too. Rumours are, they are all extremely cheap to rent. Any takers?

Pigs Might Fly

It will be interesting to see what is to happen when the new Astra satellite is launched and becomes operational (at the beginning of April). Tests should, in fact, be under way as you read this. Astra 1B (as is the original Astra 1A) satellite is perfectly capable of transmitting signals to whatever system standard is required. Indeed, two channels on Astra 1A have always been transmitted in D2MAC. It's not impossible, therefore, that certain channels may use DMAC and BSB receivers may not be totally defunct, yet. By coupling two or three transponders on the satellite, a transmission power not dissimilar to BSB's marcopolo satellite transponders could be approximated. Those unfortunate souls who thought BSB was the next best thing to sliced bread, then need only reposition their dishes towards the Astra satellite colocation angle to enjoy superior quality pictures again.

Unless this scenario takes places, the whole BSB drama from initial concept, through development, manufacture and eccentric marketing, must be seen simply as a glorious bubble which has finally burst. That would be a great pity. Like many other British ideas (the hovercraft, the jet engine, the bouncing bomb, the computer, pogo sticks, crisps and so on) DMAC seems likely to highlight our brilliance in conceptual matters and dismal failure in the hard business matters of getting those ideas off the drawing board.

They've Flown

The IBA is no more, and if the Government had seen them off a year or so ago, BSB might not have been forced down the DMAC route; might instead have been able to develop its receivers in total cooperation with European D2MAC receiver manufacturers a year earlier; might have sold millions of systems; and might now be the only choice for British satellite television. It's a funny old world, isn't it?

Keith Brindley

ETI NEWS

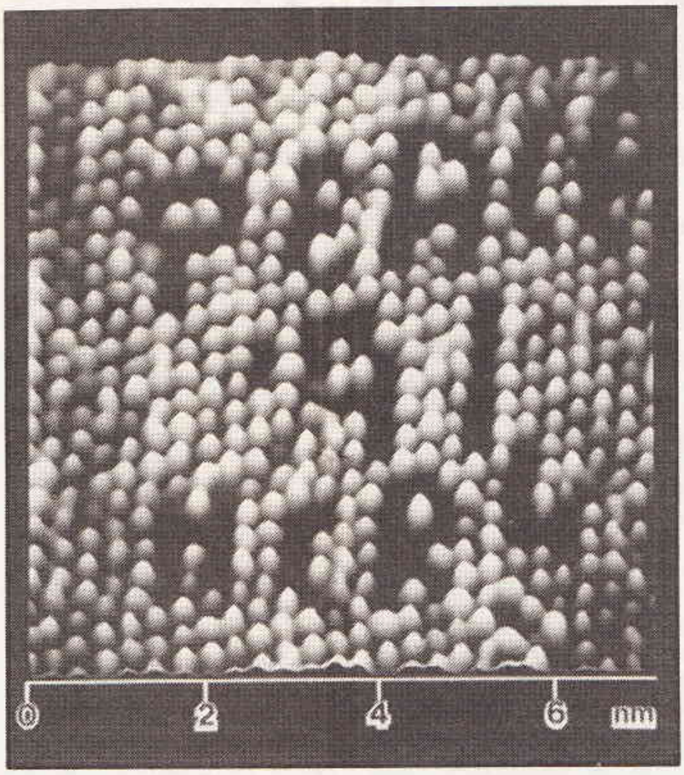
USING ATOMS TO WRITE WORLD'S TINIEST MESSAGE

Hitachi has developed technology that makes it possible to detach individual atoms from the surface of a solid. In one experiment, Hitachi's researchers formed characters of record-breaking smallness on a crystal by selectively removing atoms from its surface. The method can be conducted at room temperature — something not possible with other techniques developed up to now.

The technology was developed using scanning-tunnelling microscope (STM) techniques to 'see' the atomic-scale surface. Observation of the formed patterns with an STM showed that the individual atoms had been excised with high precision.

This ability to detach specific atoms can be expected to be highly useful in atomic manipulation, a field that has recently been attracting wide attention for its potential to enable the fabrication of atomic-scale devices and memories.

Observation of atomic-scale topography with an STM involves bringing a metal probe near the surface of the specimen and then scanning the specimen surface while applying a prescribed voltage between the probe and the specimen. During scanning, the distance between the probe and the specimen surface is maintained at about 10 Angstroms (10 hundred-millionths of a centimetre). For conducting their experiments, Hitachi scientists fabricated a processing device based on the principle of the STM.



Two techniques were particularly crucial to the success in removing individual atoms — variation of the applied voltage at the site of the atoms to be detached and use of a probe tip the size of a single atom. During scanning for observation, the tip of the probe was kept at the usual 10 Angstroms from the specimen surface. Then when it had come directly over an atom to be detached it was brought to within 3 Angstroms of the surface and an electrical pulse of a higher voltage than that used for observation was applied.

The experiments were conducted using a molybdenum disulphide (Mo52) specimen and a tungsten probe. By applying voltage pulses between the probe and specimen, sulphur atoms could be detached from the specimen surface one by one with high precision.

Although further studies will be necessary to work out the atom detachment mechanism, Hitachi researchers believe that the atoms are removed by field evaporation, a phenomenon in which atoms fly into the surrounding space when the interatomic binding energy is overcome by a strong electric field.

The mainstream of progress in the semiconductor field has been towards the realisation of finer and finer device features. It is generally accepted that further advances in this direction will eventually become possible through atomic manipulation — the ability to work freely with individual atoms. Once technology for manipulating atoms one by one has been established, the realisation of atomic-scale devices and memories will no longer be merely a dream.

By making it possible to excise individual atoms with high precision, the new technology is expected to serve as an extremely effective tool in the implementation of atomic manipulation. Through further research based on this technology, Hitachi will be working to develop technologies for selective insertion of specific atoms, in this way accelerating R&D in the field of atomic devices and memories.

SELF CHARGED SECURITY

For those who have ever been worried about leaving a caravan, lock-up, garage or boat unattended, then a new product by Multiple Connections Ltd, specialists in solar powered security products, will be appreciated.

The Vanguard Solaire Security System has a miniaturised passive infra-red detector (PIR) to sense unauthorised movement, which is kept fully charged all year round by a highly efficient solar panel. The alarm is therefore suited to unattended caravans, boats and sheds which have no power source.

Removing the key, the alarm system has a full 60 second exit delay and an 8 second re-entry delay. Its full microprocessor control guarantees virtually no false triggers.

The alarm system comes complete with an internal 150 × 150mm solar panel, an 85 dBA siren and external weatherroofed 90dBA siren, and a compact single unit housing the integral PIR sensors and rechargeable battery. The solar panel can be fixed to an inside window with a strip of velcro.

The Vanguard Solaire is priced at £99.95 including VAT.

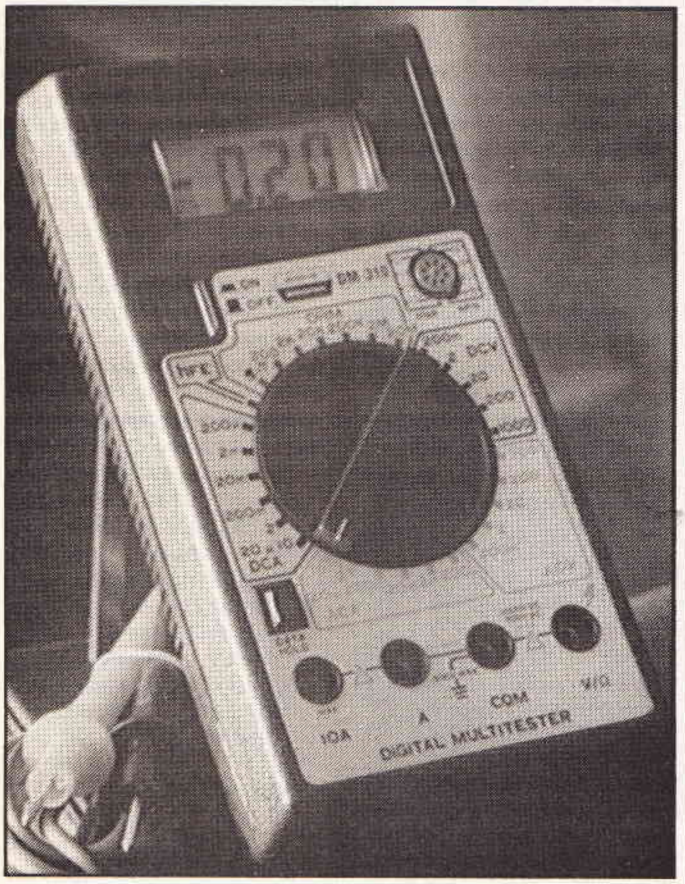
Further information contact: Multiple Connections Ltd on (0458) 210743.

REDUCING DAMAGE TO DISC DRIVES

Delicate electromechanical disc drives can be ruined by hostile environments and replacing disc drives with a totally electronic disc file system reduces susceptibility to damage or contamination. Compared with a floppy disc, the Star Card system from ITT Cannon, Santa Ana, California, is 1,000 times faster. The card is an internal memory device composed of bare polyamide flat-flex circuit with surface-mount components and a PVC frame.

This disc file system consists of a control board, adapter box, cable, and software, and offers up to 8Mbytes of memory on 8 cards. Supplied software emulates either a hard or floppy disc and allows an XT/AT or compatible user to access data. The software works with DOS versions 2.0 and higher. The disc file system fits inside a half-height 5.25-in floppy disc drive.

MULTI-TESTER



Now available from The Instrument Centre is a digital multitester with a single recessed rotary switch and colour coded front panel. DM 310 comes complete and ready for use with a battery, test leads, operating instructions and a sturdy carrying case that can be used as a tilt stand and enhance the extra wide viewing angle liquid crystal display.

The 0.5 inch high 3.5 digit display provides the usual information. Alternating and direct current are to 10A in 7 ranges with 0 to 20μA as the lowest. Resistance is to 20M together with an audible continuity buzzer for circuits of less than 30R. A separate socket is used to indicate automatically the gain of both PNP and NPN transistors. Other features include Diode Test, Data Hold, an input impedance greater than 10M on all voltage ranges and a basic DC voltage accuracy of 0.5% of reading. Further information contact TIC, Tel: 0633 280566.

WORLD DEMAND FOR ELECTRONICS TO INCREASE BY TWO THIRDS BY 1995

World demand for electronics equipment is expected to increase by over 66% between 1990 and 1995, reaching $1000bn and making the electronics industry the largest single branch of industry in many countries in the 1990s, according to a new Special Report published by the Economist intelligence unit. The industry is considered to be of great strategic importance as microchips, sensors, lasers and other components are at the heart of computers, telecommunications, consumer electronics and automated factory production equipment. The computer sector is expected to continue to dominate the market throughout the 1990s.

In the 1980s the industry was transformed by major advances in semiconductor technology, further improvements in production processes and a growing reliance on the semi-skilled low cost labour of East Asia. It is already the largest single industry in Japan, South Korea and Taiwan where government policy fostered its development in the 1980s. In these countries it is likely to contribute 7% of GDP by the year 2000 compared to 5% in West Germany and 3% in the USA.

Japan's increasing dominance of the world market is traced back to strategic government support from the 1960s onwards. This was based on a clear vision of evolving electronics technology and a coherent policy to focus on key areas such as optoelectronics and microchips and bringing products to the market much faster than the US or European industries. By 1988, the result of this strategy led to an $80billion surplus in electronics equipment and components with the rest of the world.

The electronics industry in the USA remains the largest in the world with substantial exports of computers, peripheral equipment and components. However, it faces the 1990s with a heavy reliance on imports of consumer electronics and is no longer in control of the semiconductor device production equipment industry that US companies first invented.

In western Europe, the electronics industry's strength lies in telecommunications, industrial and medical equipment. Government support for research and development was varied, but generally lacked the coherence and focus of the Japanese programme, being particularly weak in semiconductor component technology, and slow to switch to digital technology.

This gap in Europe's industrial base will be filled in the early 1990s as a result of a reorientation of the strategy of the few remaining European owned diversified electronics companies and plans by Japanese and American companies to manufacture locally for the largest single market in the world.

The report examines the corporate strategy of 30 major international companies and identifies 12 major trends affecting the industry's development during the 1990s, these are:

Computers and peripherals will continue to account for one third of the industry's output, increasing in power and speed while decreasing in size and cost;

Demand for software and systems engineering skills will grow rapidly causing a skills shortage;

Demand for telecommunications equipment will grow steadily. Mobile telephones and other new technologies may threaten the viability of existing networks in some countries;

World markets for semiconductors will increase fourfold in the 1990s, the key growth areas will be memory chips and ASICs (customised chips);

The industry preoccupation with miniaturisation of electronic components will continue;

High Definition TV (HDTV) will arrive by 1995 but with three different transmission standards;

Optoelectronics will receive much more attention and bring some major advances in technology;

Government support for R&D will move from defence to non-military uses or dual-purpose projects;

Governments will become more sensitive to foreign acquisition of high-technology companies;

The use of electronic components in automobiles will grow rapidly, doubling by 1995;

The international and co-operative nature of the industry will be developed by more strategic alliances between companies;

Growing overseas production by Japanese companies will reduce Japan's trade surplus with the USA and Western Europe.

The report concludes that, despite a re-orientation of strategy in Europe and the USA, Japan will continue to produce more than half the world's output of consumer electronics and increase its share in computer and industrial electronics.

CAR ALARM UPGRADE

Electronize now offer a Micro-pressure trigger module which can be added to any car alarm system using the volt drop triggering method. This small device provides an easy way to upgrade any existing volt drop type alarm to the standard of their system. It can also be fitted with the company's volt drop alarm in order to combine the benefits of both systems.

The micro-pressure system senses the changes in air pressure inside the car. As a door catch is released air is drawn out, causing a minute drop in pressure which is detected by the trigger module. All doors and the tailgate can be protected without the need for additional sensors or switches. The trigger module has a sensitivity adjustment and can be set to operate even with a window partly open. An LED indicator is included to make sensitivity adjustment easy. The risk of false alarms is minimised by an electronic filter making the device immune to loud noises and sensitive to the very low frequencies produced by door opening.

The trigger module requires no direct connection to the existing volt drop alarm, that normally detects loads on the electrical system such as the courtesy light. The trigger module simulates such a load, requiring just two supply wires.

The trigger module costs £14.90 including postage and VAT. Also available for the electronics enthusiast is a build it yourself parts kit at £10.85

INSTRUCTION BY VIDEO

With hobby electronics continuing to grow at a fast pace, Maplin Electronics has introduced a video starter kit to unravel the mysteries of electronics.

The kit is a complete educational 'Build-It-Yourself' kit with full step-by-step video instructions and is designed to assist the inexperienced hobbyist, and school pupil to construct a working loudspeaker radio receiver.

The video gives information on component identification, circuit board construction, soldering and testing.

The price is £11.95. (incl vat).

Also available from Maplin is a starter tool kit for the home hobbyist and school pupil. The kit includes: A snip cutter, a pair of long-nose pliers, a light-duty flat blade 75mm long screwdriver, a crosspoint screwdriver, a desoldering tool and a soldering kit containing a CS Iron, stand and pack of solder. Price £19.95 (including VAT)

Apology
Maplin Electronics are still awaiting delivery of the plier set featured in ETI News last month. They apologise for the delay.

UK INDUSTRY LACKS TRAINING

UK electronics engineers are at a significant disadvantage in terms of education, training and job opportunities, compared to their counterparts in Germany and France. They also tend to be less highly rated than their continental colleages.

These are the findings from a survey of 135 electronic engineers in the UK, France and Germany. The survey was conducted at Nepcon Europe, an electronics exhibition held at the NEC, Birmingham.

The findings confirm that the UK may lose the skills which would help it compete on an international scale, as its engineers take advantage of better training, increased job opportunities and enhanced social status in a more mobile labour market post 1992.

Germany leads the field in education and training, followed by France. The survey showed, for instance, that German and French engineers are more likely to have a first degree or equivalent than their British counterparts. One in five of those questioned in France and Germany reported that over 50% of their senior staff had a degree, compared to only one in ten in the UK.

Only German companies are heavily geared to providing formal apprenticeships, (78%), while the French and UK tend to stick to 'on the job' training, (91%) and (67%) respectively. However, both the French and UK respondents were more likely to involve staff in external courses on company time than the German respondents.

Only 10% of those questioned gave no training whatsoever but, disappointingly, over half of these were British. In addition, only 13% of all respondents were aware of the availability of any government or trade, training incentives or grants for foreign graduates. The highest awareness was among French companies, which generally quoted the tax deferrent scheme whereby 1% of taxes due could be spent on training instead.

When asked about the main problems faced in moving to work abroad, by far the most common answer was the language barrier. This was considered particularly disruptive for the family of the employee. Differences in the working environment, such as holiday entitlement, 'adapting to the local mentality' and 'integrating into society' were also frequently mentioned as barriers to mobility.

Despite the problems, however, a resounding 74% of the those questioned recognised that there will be greater job mobility in the Single European Market. Only in the UK did engineers feel that there would be a net loss of qualified staff. In Germany there was a strong feeling that there would be an influx of engineers from the UK, France, southern and eastern Europe, whilst the French were indifferent on this issue.

The popularity of Germany as a place to live and work was endorsed by 75% of the UK and French engineers because of the perceived quality of its engineers, its strong emphasis on training and its commitment to research and development. The social standing and status afforded to engineers in Germany was also felt to be higher than in the UK or France.

FIRST NICKEL-METAL HYDRIDE Cs CELL

Gates Energy Products has introduced the world's first NickelMetal Hydride Cs cell. By the end of this year the company will offer a family of Nickel-Metal Hydride cells in key sizes for the portable computer and portable communications markets.

The Gates Nickel-Metal Hydride Cs cell provides 2.3 Ah of capacity and by the end of this year the company will also have a Nickel-Metal Hydride AA 1100 mAh cell and a 7/5Af 2.3 Ah cell in limited production.

Nickel-Metal Hydride has been heralded as the rechargeable technology of the future for it provides twice the run-time of standard Nickel-Cadmium batteries of the same size and allows designers to create smaller and lighter portable products The alternative is to provide significantly longer runtime without increasing the size and weight of the existing battery pack.

The cell sizes were chosen for their use in the high-growth areas, such as cell phones and laptop and notebook computers as market research has found that consumers want products that are smaller and lighter. Consumers also express a desire for longer run-times between charges.

Samples are being provided to the leading portable computer and communications companies. Initially, Nickel-Metal Hydride batteries will cost about twice as much as Nickel-Cadmium batteries of equivalent amp-hour capacity but in time the prices will become competitive with Nickel-Cadmium types.

Gates are said to be the first and only full-scale producer of Nickel-Metal in America and intend to be one of the first suppliers in the UK and Europe. Their current Ultramax line is said to offer the highest capacities available in Nickel-Cadmium today.

LATEST HITACHI DEVELOPMENTS

Hitachi has successfully produced a 1-chip digital camera using LSI technology.

In the past it has been difficult to produce such a small-scale camera with a digital signal output because of problems relating to cost and power consumption. Hitachi has now made the camera cicuitry digital and as a result, can be realised on one chip.

The company hopes this new technology will make the camera-recorder even smaller and improve the picture quality.

The company has demonstrated the latest in video cassette recorder technology. The prototype laptop VCR has a 10inch colour LCD display-monitor with a high resolution of 920k pixels and will record and replay S-VHS tapes. In the race to produce high quality colour flat display systems, the Hitachi screen will reproduce 400lines on screen. The prototype uses the NTSC television system but no doubt will be reproduced in other TV standards as it goes into production. Initially, its intended use will be for business presentations.

Still on the audio/video front Hitachi can claim to be up front with their proto-type portable CD player that gives a combination of audio, video and data. Using the latest compression techniques, there seems to be no end to the amount of information that can be accommodated on a compact disc. With a 5inch colour screen and a 16bit micro-processor, the machine could offer up to 16hours of audio with varying degrees of bandwidth, 2000 pages of full colour picture information or 600MB of pure data. The player/viewer has two basic functions, the first is still picture presentation with a synchronised sound stream rather like a slide presentation or secondly an audio-visual card type data base retrieval system using cursor keys and a graphic menu.

Hitachi intend that this product would be highly suitable for business, education and entertainment.

MEASURING FLUX NOISE

A new instrument for measuring a phenomenon as "flux noise" in high-temperature superconductors incorporates a superconducting quantum interference device, or Squid. This is an electronic device that uses a quantum mechanical phenomenon known as the Josephson effect to convert magnetic flux to voltage.

The new flux noise instrument, called a McDLT incorporates a low-T_c super-conductor (warm on the other), separated by a 100-um gap.

A super-conducting compound emits a magnetic flux (known as the Meissner effect) when cooled below its transition temperature. Flux noise is a random disturbance caused by the motion of magnetic flux in a sample. It is related to the magnetic properties of materials. Detecting and measuring flux noise reveals details of a material's micro-structure that may be crucial to our understanding of high-temperature super-conductivity.

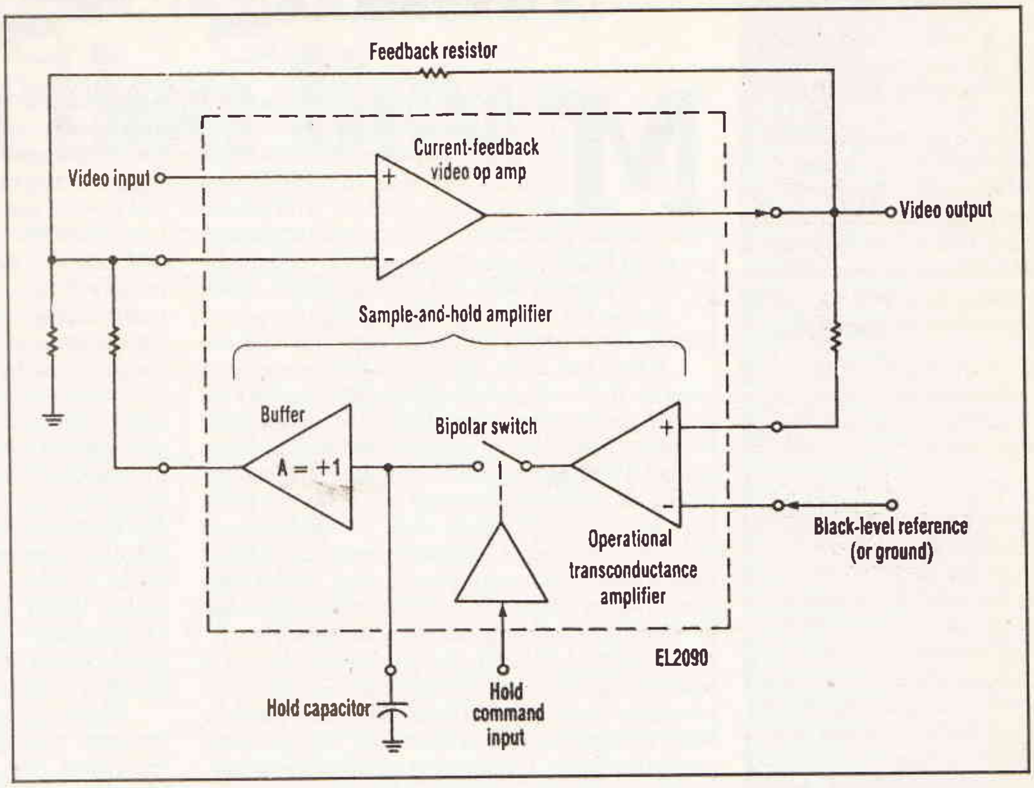
In the McDLT, the Squid sits on a sapphire substrate that is cooled by liquid helium to a temperature of 4°K. Across the gap, the sample of high-T_c material is kept at temperatures as high as 125°K. To minimise heat transfer from one side to the other, the entire apparatus is kept in a vacuum which limits heat transfer to radiation. Because the sample and Squid are so close to each other, they remain magnetically coupled, allowing flux noise from the sample to be recorded and measured in the Squid.

Developers of the McDLT probe, a joint research team from Lawrence Berkeley Laboratory and Stanford University, hope it will lead to a lightweight, nitrogen-cooled Squid instrument that can be carried into the field.

Applications of a practical Squid instrument include measuring tiny changes in magnetic fields that presage earthquakes, helping geologists pinpoint where to look for minerals or oil, and finding a material's critical current which is the amount of electrical current it can carry without losing its super-conductivity.

ETI NEWS stateside

Sample and hold amp helps broadcasting equipment



An innovative IC is claimed to improve the performance of conventional DC-restoration techniques, many of which introduce their own distortion, and cut PC-board space. Called the EL2090, it holds a video amplifier and a sample-and-hold amplifier. The chip is expected to help designers of electronic circuits for recording and broadcast-studio equipment.

DC restoration of video signals in these studios is mandatory. A typical signal is routed through as many as two dozen separate amplifiers and/or gain-control blocks before reaching its final destination: magnetic tape or the airwaves. Each point along that route represents a potential source of distortion. With so many of these sources in series, the output signal at each point must be exceptionally clean. Gain-control circuits, in particular, can be distortional. Therefore, extreme measures must be taken to optimize their performance.

The Elantec chip is built on a complementary bipolar dielectrically isolated process. Its video amplifier employs a current-feedback architecture and offers a 3dB bandwidth of 100MHz. Once per video line, during the 'back porch', or black period of the signal, the sample and hold amplifier compares the video amplifier's output level against a DC clamp (black-level) reference applied to the minus input which then stores the correction voltage that offsets the 'back porch' to the clamp level on the Hold capacitor. It restores a 1.4V output offset to zero in under 10us.

The chip is basically an auto-zeroed, video bandwidth DC amplifier. It can be used for that purpose in various applications and this is said to be the first time auto-zero techniques have been applied to a video or current-feedback amplifier.

Manufacturer of the EL2090 is Alantec Inc., of Milpitas, California.

Improving X-ray pictures

X-ray pictures are normally produced on a film placed close to the object so that the 'shadow' from a point radiation source produces an image without the need for focussing. A drawback of this arrangement is that secondary radiation scattered from the object clouds the film and reduces clarity.

An improved method places the object close to the radiation source with an imaging detector placed some distance away. With this arrangement only minimal scattered radiation reaches the detector, making the image sharper.

Because it is close to the object, the radiation source cannot be a point source. Instead, it is a raster scan that illuminates the whole object. A low-sensitivity imaging medium is replaced by a point electronic detector synchronized with the raster scan radiation to produce a digitized image not degrated by radiation scatter.

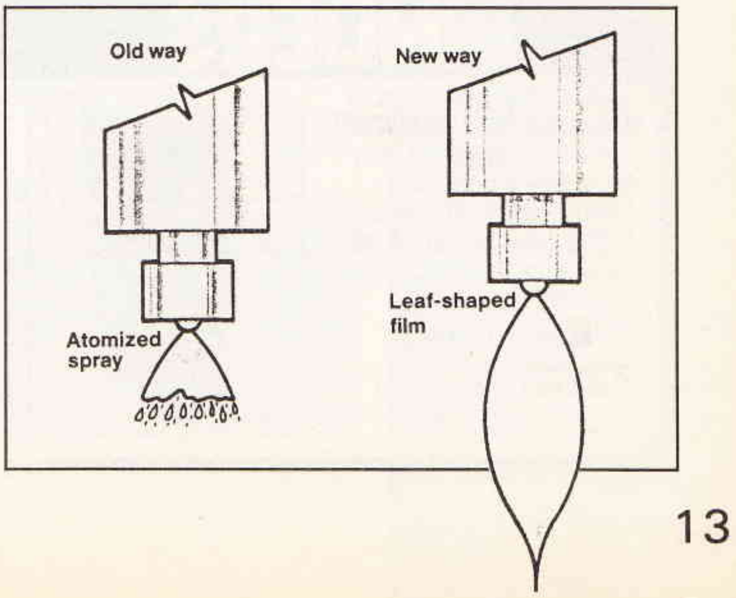
When beta testing is completed, Digiray Corp., San Ramon, California, plans to sell Neoscan systems.

Coating printed circuit boards

A waterproof or conformal coating is sometimes applied to printed circuit boards to reduce problems from moisture or humidity. When this coating is sprayed on, parts of the board that must remain uncoated have to be masked. A flat-pattern nozzle has now been developed that applies a coating without an atomized spray. This all but eliminates overspray so that masking is no longer necessary.

Called the Select Coat film coating process it uses a cross-cut nozzle with an orifice that provides airless coating. The designer reduced the dispensing pressure and altered the nozzle-to-board angle to eliminate splashing and thickness variations. Combining the nozzle with robotic equipment automates the coating process. The workcell model covers a 14.5 × 14.5inch area at 20 ips with a Z-axis travel of 3.5inches.

Nordson Corp., Amherst, Ohio.



Mixing Signals

J Asbery shows why tones mix differently electrically and acoustically.

Many people find modern electronic organs musically unsatisfactory. This is because the tones for all the notes and all the steps come from one single master oscillator. This usually runs at about 4 or 2MHz. An IC called a top octave generator simply divides the frequency to produce the tones for the top octave and highest register. Other ICs divide the frequency successively by two to provide the tones for the lower notes and registers.

When two stops are drawn and one note is pressed, the two signals are locked in phase as they come from the same source. Instead of sounding like two stops it sounds like one stop part way between the two. When two notes an octave apart are pressed, for the same reason it does not sound like two notes but rather like a different stop. The paired note frequency which are 19 semitones apart has an exact ratio of three to one and is phase locked, so that even when they are pressed it does not sound like two notes but like a different stop, one stop and one note.

In a good classical electronic organ there is a separate oscillator for every note and banks of generators for the different stops. When you draw two stops or press two notes it sounds like two stops and/or two notes. These organs are called free phase.

One problem with free phase organs is the mixing of the tones before passing to an amplifier and speaker. If two stops are drawn and one note pressed there will be a slight difference in frequency between the two oscillators. They will slowly change in phase and the sound will slowly decrease to the difference between the two. It will then increase to the sum of the two — a useless situation. The solution is to use two separate amplifiers and speakers. These are called channels. The resulting sound level then remains almost constant.

When only one stop is drawn and two notes an octave or 19 semitones apart are pressed the same slow beating effect of the fundamental upper note and the harmonic of the lower note occurs. Some free phase electronic organs have several hundred channels. One in Philadelphia is reported to use over 900. In the home organ it is not practical to have more than about four channels, and in the past one simply tolerated the beating between harmonies, the separate channels necessarily being used for different stops.

The reason why signals will not mix electrically is well known but the reasons why they will mix accoustically does not appear to be known amongst home builders nor even surprisingly amongst the organ building profession. The reason is that voltage and current are scaler quantities, that is they have magnitude and polarity only, and add or subtract arithmetically. Acoustic sound is a vector quantity, it has direction as well as magnitude. A vector can be considered as having three components mutually at right angles, in this case for example vertically, horizontaly along the room and across the room. The three components add or subtract the different sounds separately. The division between the three components statistically will be different for different sounds. One component will have a large contribution from one sound and only a little contribution from the other. There will be little cancelling or reinforcing to reduce the variation in sound level. In some cases one sound component will be of opposite phase to the other. When one component has maximum cancellation, the other will have maximum reinforcement and the total variation of sound level is further reduced.

Now that we understand the mechanics of accoustic mixing we can take advantage of this knowledge. We can simulate accoustic mixing by three channels each having a direct and a phase reversing input. In the case of home organs instead of feeding the whole of the keyboard on one stop into one channel and from another stop wholly into another channel, we can divide the keyboard into four semitone sections and feed different proportions into the three channels in some cases using one of the phase reversing inputs. In the case of very large organs we can replace many lower powered channels by considerably less higher powered channels using the above technique.

When choosing mixing resistors it is easier to work in conductance values. This is the reciprocal of resistance, and the unit is the mho. As power is proportional to the square of volts or current, the square root of the sum of the squares in mhos of the three resistors is the total 'sound'. For example to replace a 10k resistor to one channel = 100 micromhos with two equal resistors to two channels each should be

70 micromhos = 14k $\left(\sqrt{70^2+70^2}\right)$

PROJECT

Active Direct Injection Boxes

Another DIY DIB from Peter Kunzler

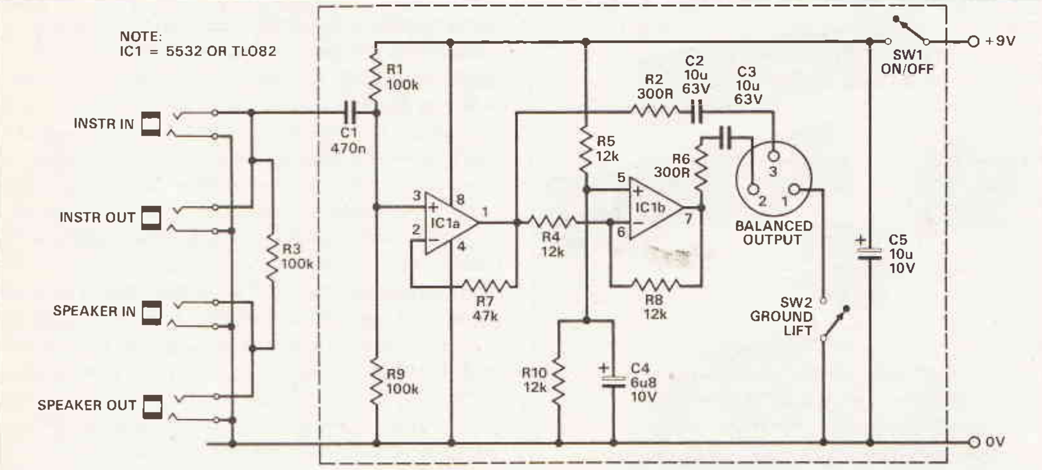


Fig.1 Circuit diagram of Active Injection Box

The active DI box does away with the need to use a transformer. Of course you can use a transformer if isolation is required, but an op-amp will give good common mode rejection at lower cost. In order to get the DI box to produce balanced outputs, there are many ways to do this. Some circuits even compensate for the loss in signal strength when one of the outputs is shorted to ground. For most applications, a simple buffered anti-phase pair will suffice. If we use a dual op-amp package, this will save space and reduce costs. The signal is fed into the non-inverting input of the first op-amp via a DC blocking capacitor. Each op-amp works as a unity gain buffer, with the second half working 180 degrees out of phase with the first. Each half of the dual op-amp IC drives one of the balanced outputs via a 300R load resistor to provide a 600R source impedance. This circuit has the advantage that it provides a small amount of gain. The main disadvantage is that it will distort the signal as the battery runs low. One big advantage is that the circuit can have a very high input impedance, preventing loading of the music signal. In addition, the circuit is relatively immune to magnetic interference.

Phantom Power DI Box

If buying batteries bores you, a phantom DI box is the answer. Just plug in and forget! Many audio mixers provide a 48V phantom power supply from the microphone inputs. Although this voltage is far too high for many small signal circuits, a three leg regulator can be used here to good effect. The LM317L can provide very good regulation when used properly. It is convenient that it already runs from a DC source. The LM 317L regulator has the job of reducing 48V to a more acceptable voltage for op-amp circuits, say 24V (which you can adjust according to preference) but bear in mind that the maximum voltage across the supply rails of most op-amps is 34V. The phantom power DI box works on the same principles as the battery DI box, with more thorough DC blocking on the balanced outputs and higher rated capacitors all round. Use the 48V supply carefully, or you might damage your mixer. Most of you are going to wonder why we don't recommend a 78 series regulator. Well, we are reducing 48V to 24, and that is too high a voltage differential for the 78 series. You have been warned! It is not easy to provide an effective ground lift because the DI box obtains its power via its output socket. As hum loops may occur, a switch is inserted at the input end of the ground line.

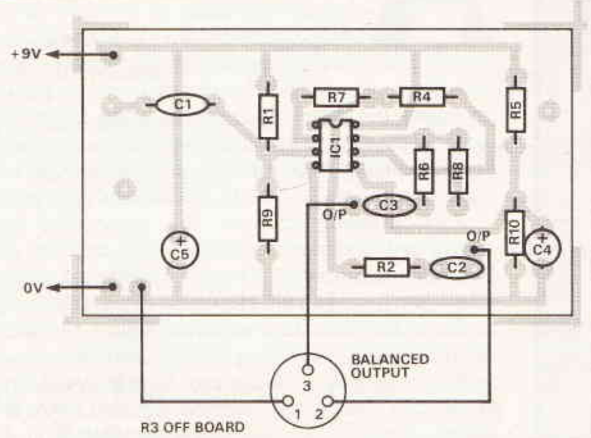


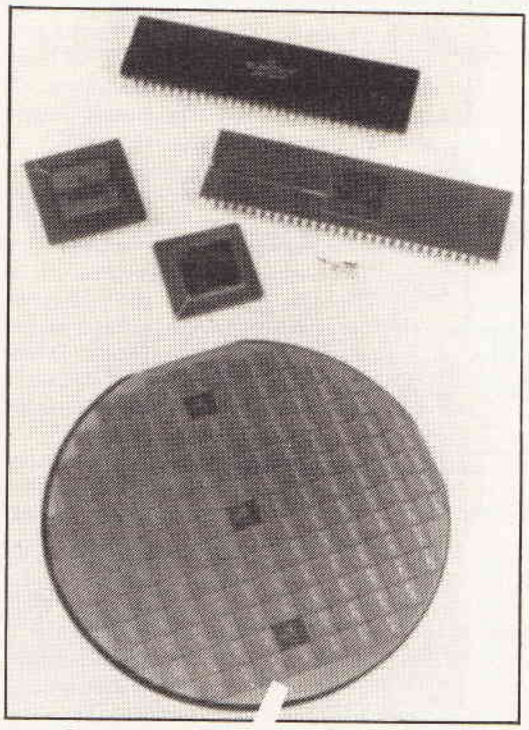
Fig.2 Component overlay for ADIB

PARTS LIST

RESISTORS		CAPACITORS	
R1,3,9	100k	C1	470n
R2,6	300R	C2,3	10μ/63V
R4,5,8,10	12k	C4	6μ8
R7	47k	C5	10μ/10V
SEMICONDUCTORS			
IC1	5532 or TL082		

Static Sensitive Devices

A company view on protecting sensitive electronic components by Magnus Cooke.



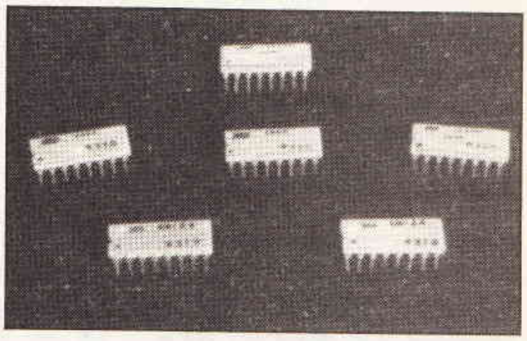
As modern electronic devices become smaller and more sophisticated, many become more sensitive to electrostatic charges and fields. A sensitive device when exposed to an electrostatic event may be immediately rendered nonfunctional or latent damage may occur which is not apparent on testing, and affects the lifetime and reliability of the device. The electrostatic voltage sensitivity levels are well defined for the majority of commonly available devices and can be as low as 20V for the most sensitive types.

Electrostatic charges are generated and discharged all around us and can give amusing and harmless phenomena such as the crackling of a nylon shirt when it is taken off. However, a direct discharge of this magnitude, to a sensitive device can easily degrade it, and even being in a transient electrostatic field can degrade some devices. Most materials tend to generate charge when rubbed or pulled apart, and people generally are the major generators in the vicinity of sensitive devices. Walking on a nylon carpet can charge a person up to 30kV, or moving about on a chair, 10kV.

So when sensitive devices are handled openly, special precautions should be taken to minimize the risks of electrostatic damage. It is common practice in the electronics industry to observe certain fundamental precautions which could be considered as being the minimum requirements. The first element of a static protected work area is the working surface on which the devices are laid or handled. It should have certain electrical properties which allow them to be held at a certain potential, namely earth. In practice the working surface materials have a finite conductivity which enables any charges placed on the surface to flow to earth. The working surfaces are commonly supplied as mats and are connected to earth via a cord. Connection to the mat is usually made by press studs, which enable the cord to be removed if necessary. The earth connection can be made to a water pipe or similar, but it is recommended to use the 13A ring main power supply earth, and convenient plugs are available to do this.

The next element of the protected area is the person who must work within its boundaries. The operator must be held at the same electrical potential as the working surface, so he or she is also connected to earth. This connection is achieved by a conductive wrist band and coiled cord, which is connected to earth. The wrist bands are normally elasticated and give a snug fit around the wrist, providing good electrical contact with the skin. The cords are coiled to allow them to extend with the movements of the operator. The cord must contain a 1M0 current limiting resistor for safety reasons. With the working surface and the operator connected to earth they are both held at this potential, and any charge generated or introduced to these elements will be discharged safely. Hence sensitive devices can be handled openly within the boundaries of this area.

If the sensitive devices must move from this area into uncontrolled conditions for example during transit, they should be enclosed in protective packaging. This packaging will protect the devices mechanically and electrostatically from external conditions and does not itself present a risk to the devices, (the majority of plastics like polyethylene and



polystyrene are prolific charge generators). Common forms of protective packaging are electrically conductive bags, boxes, pinning foams or various combinations. If you receive a device which is not in protective packaging (which will be marked as such), the device may be damaged even before you open it.

These simple precautions are easy to implement and generally very effective. Obviously it is hard to justify any expense on precautions if you believe that you have never had any static related problems. However, if you have experienced problems like unexplainable circuit faults or operational errors then static precautions are worth considering especially as device replacement can be very expensive these days. More information on static precautions can be found in BS5783:1987 "Code of practice for handling electrostatic sensitive devices", available from the BSI.

STATIC

High Definition Television

6

The ZENITH Spectrum Compatible HDTV system

Continuing the American theme, James Archer delves further into the multiplicity of technical ideas for an ATV system

Another frontrunner in the race to provide a compatible HDTV system for the United States of America is the Zenith Electric corporation, whose 'Spectrum Compatible HDTV System' adopts a different and original approach to the subject. According to the company's claims, its HDTV transmission and encoding system enables a 30MHz bandwidth HDTV signal to be transmitted through parts of the spectrum that are currently unusable because of the 'taboo' channel problems that were discussed earlier in this series. This could result in a second 6MHz wide channel being made available for every existing NTSC station to use, the extra channel being capable of carrying the HDTV information, whilst the existing channel continues to carry the standard NTSC signals, so giving a fully compatible HDTV system.

The energy spectrum of a typical television signal is most uneven, and virtually all the energy is concentrated in regular peaks around harmonics of the line frequency.

These peaks of energy could cause interference to other transmissions, and the amount of interference is proportional to the peak picture and sound carrier powers. Much of the interference is due to the high peak powers transmitted during the sync periods, whilst some is also related to the level of the radiated colour subcarrier. Zenith's engineers have designed a new type of television transmission system which has a more even distribution of energy over the complete picture signal, allowing peak energy levels to be vastly reduced, as compared with NTSC. This allows transmissions to be carried in 'taboo' channels that would normally be quite unsuitable for the carriage of standard NTSC signals, because of generated interference. The energy within these new transmissions is so evenly distributed that the overall mean level can be extremely low compared with NTSC, and Zenith claim that the average transmitter power needed for the extra HDTV channel is only 0.2% of that required by an NTSC transmitter with the same service area.

Figure 1 shows how the Zenith system would be compatible with existing NTSC systems, and the extra HDTV channel can be carried on otherwise 'taboo' channels makes this system practicable. It is most unlikely that the available spectrum would be sufficient to allow every NTSC transmitter in the USA to be given an extra 6MHz of bandwidth if the normal taboos have to be complied with.

The key to the Zenith idea is that if the energy spectrum of the signal is examined, it is found that most of the energy is concentrated within the first half megahertz from the carrier frequency, except for peaks which occur at the sound carrier and colour subcarrier frequencies. Figure 2 shows this clearly; it represents the average of an NTSC energy spectrum over a one-hour period (courtesy Zenith).

The Zenith system therefore separates the spectrum to be transmitted into two frequency bands, a low frequency band with a bandwidth of under 0.2MHz, and a high band containing most of the spectrum above 0.2MHz. From Figure 2 it can be seen that the low frequency band will contain virtually all the signal components with any significant power, whereas the high frequency band, although containing most of the spectral detail of the television picture, will have hardly any of the total video signal power. By treating the two bands separately with

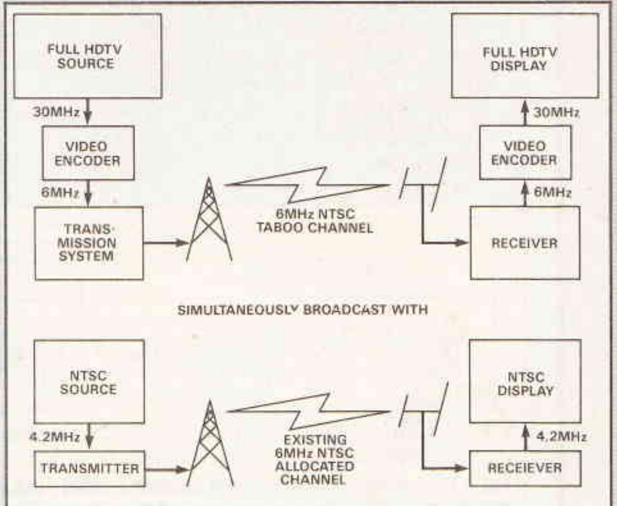


Fig.1 Zenith Spectrum Compatible HDTV System

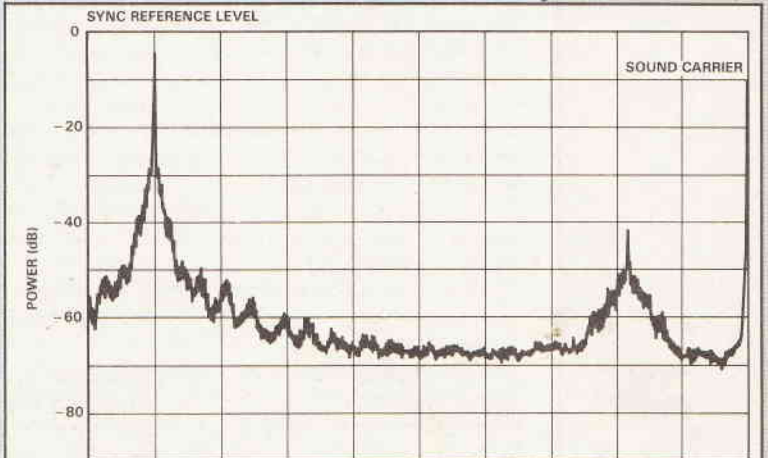


Fig.2 Power spectrum of an NTSC signal averaged over one hour.

(Courtesy Zenith)

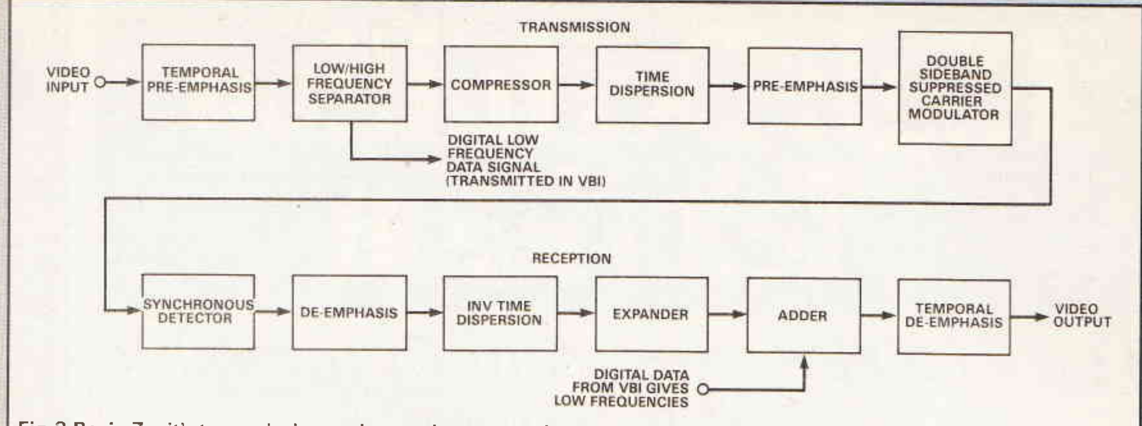


Fig.3 Basic Zenith transmission and reception processing system

different types of processing it is possible to generate a signal for transmission with an even spread of energy over the spectrum, and a much lower average level of spectral energy.

Figure 3 shows the basic transmission processing system and the receiving system used by Zenith. The video signals are first passed through a temporal pre-emphasis filter, a sort of combfilter which is designed to reduce the amount of redundant transmitted information, i.e. the amount of stationary picture information; this should lead to a reduction in the potential co-channel interference between the HDTV and NTSC signals. The signal is then subjected to another filtration process which separates the low frequency part of the signal from the high frequencies, and different processing is then used for each of the two signals.

High Frequencies

The average power of the video signal is much reduced by removing low frequency information, but high instantaneous power levels will still be generated on picture amplitude peaks. A compressor is used to reduce the level of high amplitude signals and increase the low level signals. This limits high amplitude signals and gives a narrower spread of levels over the picture. This has the incidental advantage of improving the signal to noise ratio, since the level of the lowest amplitude signals is increased before transmission. The high frequencies are then passed to a linear filter which disperses the energy of any remaining signal peaks over a period of time, a technique which again reduces the peak power of the signals. To improve the high frequency signal to noise ratio, pre-emphasis is applied. The raised level of high frequency components are then transmitted as suppressed carrier modulation on two carrier signals in quadrature at the centre of the channel.

Low frequencies

After being filtered,the low frequency signal has a narrow bandwidth, and it is digitally encoded at a low bit rate before transmission. The digitised signal and the synchronisation information is transmitted during the vertical blanking interval, in a similar manner to which teletext information is carried with conventional television pictures.

The result of separating the two parts of the signal gives a flatter energy spectrum and a lower average level.

Figure 4 shows the basic principles of the picture encoding and decoding system used by Zenith.

The number of scanning lines per picture is the somewhat peculiar number of 787.5, (525 x 1.5) which provides a display with 720 active lines, generally regarded as perfectly adequate for an ATV system. The video source is a 787.5 line, 59.94 FPS progressively scanned picture, which uses a horizontal scanning frequency of 47.2 kHz. This is exactly three times the NTSC system, and Zenith have shown that

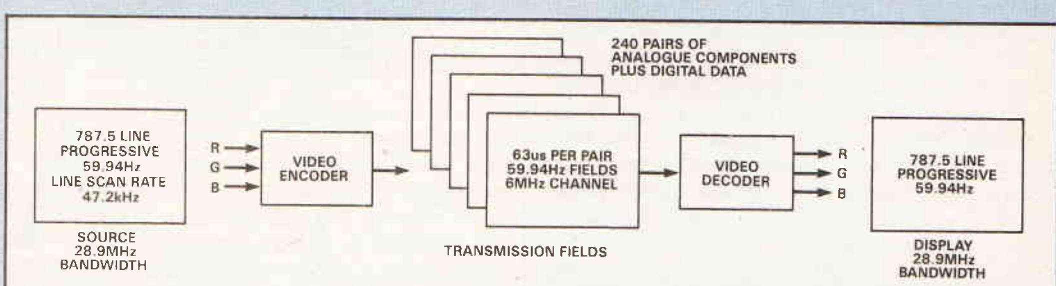


Fig.4 Principles of Zenith HDTV picture coding system

the 787.5 line signal can readily be obtained from a 1050 line 59.94 FPS source picture, as used in some of the other proposed ATV systems. Zenith say that there are no problems in designing the system to cope with wide aspect ratios.

The principle of the Zenith video encoding system is to split the spectrum of the source signal into components, and to analyse them in order to eliminate those which the eye doesn't actually need in order to recognise a satisfactory picture. The video encoder converts the HDTV 787.5/59.94 source signal into 480 analogue sampled components every frame period of 1/59.94 seconds. Each of these components occupies 63.56us and has a nominal bandwidth of 2.675MHz. The coding scheme is arranged so that parts of a picture which contain movement are sent at a fast rate, 59.94 FPS, whereas the static parts are sent less frequently, at only 11.988 FPS, a technique that we have encountered in other HDTV systems.

The 480 components are divided into 240 pairs, equivalent to 240 lines of an NTSC picture, and the pairs are eventually transmitted sequentially as suppressed carrier amplitude modulation on two carriers in quadrature, at the centre of the 6MHz HDTV radio frequency channel. Suppressed carrier operation is necessary so that the amount of interference produced will be small enough to allow the signal to be transmitted on 'taboo' channels. The various frequencies used in the Zenith system have been chosen to relate to the NTSC scanning standards. This allows the HDTV signals to use precision frequency offsets to be interleaved with the standard NTSC signals.

The processed video signals and the digital data carried in the frame blanking period are time-division multiplexed and then modulated onto the two carrier signals in quadrature. As the data is only transmitted during blanking, it should be completely invisible to anyone with a standard NTSC receiver.

The receiver has the complex task of decoding the analogue components and of using the incoming digital signal to restore the low frequency parts of the luminance signal. The analogue components are interpolated so they appear again on 720 lines, and the motion compensation circuitry in the receiver is controlled by additional data transmitted during the vertical blanking interval.

Other Applications of the Zenith System

Zenith claim that the reduced peak and average power requirements of its system will enable the 6MHz wide HDTV signals to be carried over standard cable systems, and since such a signal should be recordable using standard FM recording techniques, they feel that Super VHS recorders should, with small improvements in technology, be able to provide domestic viewers with the means of recording and playing back HDTV signals. The ideas which led to the reduced power requirements of the Zenith signal could have applications for many other future television transmission systems; anything that allows the massive power consumptions of the broadcasters to be cut back must be of interest, at a time when energy costs are rising and the environmental benefits of reducing energy consumption are becoming more apparent each day.

HD-NTSC The Del Rey Group HDTV System

The HD-NTSC system is designed to provide widescreen HDTV pictures to new ATV receivers via a standard NTSC 6MHz wide radio frequency channel, whilst still providing a compatible picture on standard NTSC receivers, without any form of adaptor. It uses a technique called 'TriScan Subsampling'. Although called HDTV, the basic proposal is for the transmission of a 525/60/2:1 picture, although this can be derived from a 1125/60 studio source if required. A straight forward method of understanding the Tri-Scan technique is to begin with the picture elements that can been utilised on a standard NTSC picture. Ignoring the interlacing that normally takes place there are 483 active lines available, so it is reasonable to say that the smallest vertical picture element will have a height equal to $1/483$ of the screen height. The maximum horizontal luminance bandwidth of an NTSC signal is 4.2MHz, which means that 220 cycles of a sine wave would be displayed during the 52.5μs active line time. If we assume that a complete cycle of a sine wave can carry two picture elements, one black, one white, perhaps, then a maximum of 440 pixels can be squeezed into a horizontal line, or to put this another way, each pixel will have a width of $1/440$ of the screen width. The Tri-Scan system effectively uses an original luminance signal of three times the horizontal resolution and twice the number of lines as the standard NTSC signal that we have been considering. To do this, the pixels, just described are subdivided into smaller elements that are known as sub-pixels, and each NTSC pixel is divided into three sub-pixels. Although pixels are usually considered to be rectangular, as in Figure 5a, the actual pixel shape displayed on a cathode ray tube is likely to have a Gaussian form, and for the purposes of our explanation of the system it is convenient to consider them as triangular, as shown in Figure 5b.

Figure 5c shows how in the Tri-Scan process each of the NTSC pixels is divided into three subpixels, numbered one, two, and three. If the scanning spot in the camera could be made to scan only the subpixels numbered one on its first pass,i.e. as it scans the first frame, and then on the next pass 1/30th second later, to scan pixels numbered two, and then on the third pass pixels numbered three, the amount of information transmitted through the system would be equivalent to that from three times as many pixels as the standard NTSC transmissions.

When these signals are received by a standard NTSC receiver, it cannot cope with subpixels, since it was never designed to do so, and it will therefore merely display subpixels one two and three on top of each other as they are received from subsequent frames, the end result being a picture that looks no different from a normal NTSC display.

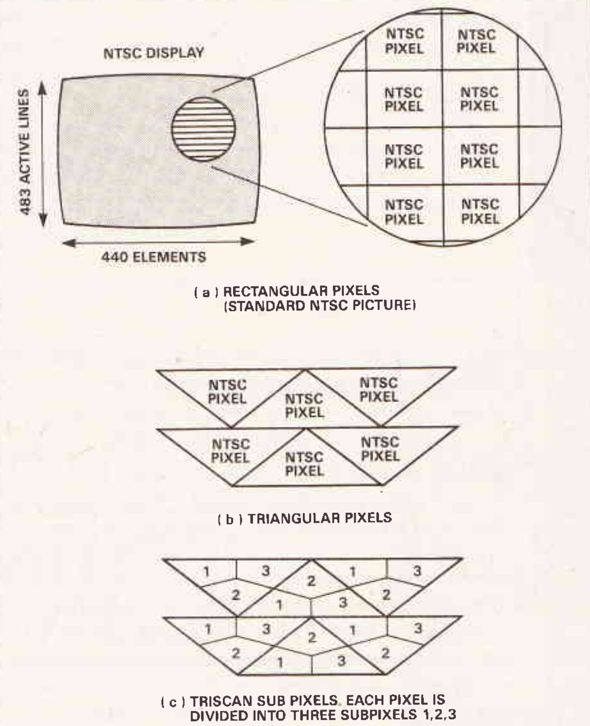


Fig.5 Pixel shapes for NTSC and for the Tri-Scan subpixel concept

If a special HD-NTSC receiver were used however, it could be constructed in such a way that the phosphor elements on the display tube were divided into three to correspond with the subpixels on the camera scanning tube, and thus could make use of the extra detail that has been transmitted. The scanning spot in the receiver must obviously have some means of synchronising its position with that of the scanning spot in the camera tube, and the normal line-sync pulses will not give enough information to synchronise to a third of a pixel, one subpixel. In order to overcome this problem a special TriSync pulse is transmitted every third frame, so that the receiver will know which of the three scans it is dealing with. This pulse could be transmitted in the vertical blanking interval, or as part of an extended VBI known as the Auxiliary Data Window. An incidental advantage of having the TriScan pulse is that its presence can indicate to receivers that HDTV signals are being transmitted; this could be useful in enabling HDTV receivers to switch back to standard NTSC processing when the pulse is missing.

Movement interpolation

We saw earlier that it takes three frame periods to actually transmit all the three subpixels that make up each pixel. These are necessary to build a complete high definition picture. Any movement in the HDTV image will cause problems as there is effectively a loss of temporal resolution because it takes three frame periods to transmit a complete HDTV picture. The standard NTSC picture rate of 30 FPS will take 3/30ths or 1/10th of a second before the screen image is completely refreshed. A frame store in the receiver can easily be used to recover the complete signal, but if moving parts of the image are not to appear smeared and blurred some form of motion correction must be applied. The blurring in the Tri-Scan system will be present on both vertical and horizontal motion. The system uses a motion adaptive processing system called Dual Resolution Processing (DRP), and other methods of improving the performance of the TriScan system are currently being worked upon.

Wide Aspect Ratio

The HD-NTSC system utilises a somewhat unusual method of providing a wider aspect ratio, 5:3 at present, although it may be possible to go to 16:9 using the same techniques. The idea is to keep the width of the pictures the same as with the normal 4:3 display, but to reduce the number of lines in the picture display from 483 to 414, thus giving a widescreen look to the display. In addition the visible NTSC picture is increased slightly by reducing the duration of the front and back porch of each line. A very slight horizontal compression, called an 'anamorphic squeeze' is also used. There is no question that the standard NTSC viewer will lose some of the picture, top and bottom. It might be thought this would rule out the proposed system on grounds of compatibility. Del Rey claim the average NTSC receiver is already overscanned and does not display more than about 435 out of the total of 483 active scanning lines transmitted. A reduction to 414 lines would only represent a vertical height reduction of less than 5%, evenly distributed as a black strip at the top and bottom of each picture.

The Auxiliary Data Window

The reduction in the number of active scanning lines in the NDNTSC system provides an extra 69 lines per frame which can be used for other purposes than transmitting video information. The extended vertical blanking period is called the 'auxiliary data window'. The data to be sent during this period, about 600kbit/sec, will be used for the transmission of several channels of digital audio, for teletext, and for 'digital assistance' to tell the decoder how to make the best of the transmitted picture.

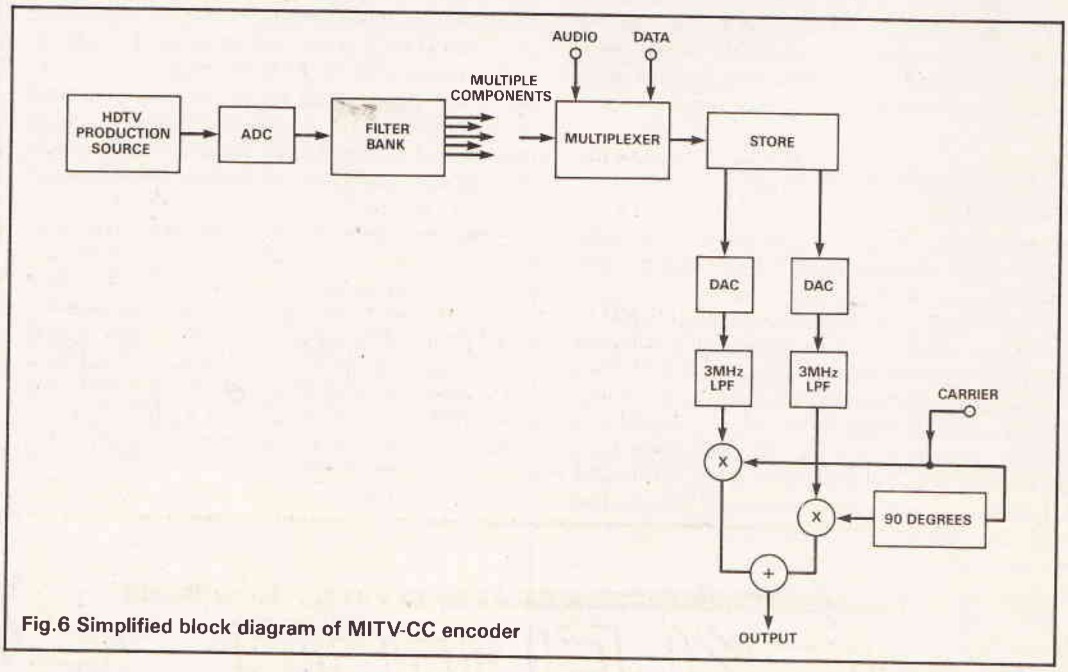


Fig.6 Simplified block diagram of MITV-CC encoder

MITV-CC and MITV-RC — two 'channel compatible' systems from the Massachusetts Institute of Technology

MITV-CC and MITV-RC are two ATV systems that have been proposed by researchers at MIT, and although they both claim to be 'channel compatible', meaning either signal can be transmitted within the bounds of a standard 6MHz NTSC channel, only MITV-RC, the RC standing for 'receiver compatible', can actually provide signals that are compatible in the sense that we have used before, in providing the ordinary NTSC receiver with a watchable picture and better pictures on ATV receivers.

MITV-CC

MITV-CC, the CC standing for 'channel compatible', claims to have resolution similar to the versions of the MUSE system that have been put forward for use in the USA, but it is not compatible with standard NTSC receivers in any way. The researchers seem to have looked for a method of making better use of a standard television channel, carrying the extra information necessary for HDTV. It might be thought compatibility with NTSC had not entered their minds, except that the MITV-RC system described in the next section can be used in conjunction with MITV-CC. Using double sideband quadrature modulation of a single carrier in the middle of the radio frequency channel makes better use of the channel. Further information is transmitted through sub-band coding. In a similar manner to other systems such as the Zenith system that has been described, the video spectrum is divided into several components which are selected according to the amount of movement information contained in them, and this ensures a better balance between spatial and temporal resolutions, at the cost of a lower frame rate for higher spatial frequencies, that is on fast moving parts of the image. Even more revolutionary, the sound carrier and the flyback periods are eliminated, wasting as little of the channel as possible, and the various picture, sound, and data components are modulated onto the single carrier at the channel centre. Yet another difference between the MITV-CC system and more conventional systems is that the usual wideband luminance and narrowband chrominance component signals are not used. Instead, a narrowband RGB signal carries the low frequency parts of the picture, and a luminance 'highs' signal, the luminance detail. Adaptive modulation of the various components is used, and this causes any noise in the channel to be suppressed, and advantage is taken of the better noise performance to allow the picture resolution to be improved.

The protagonists of the system claim that it has much better performance than existing television signals under conditions where the signal to noise ratio is poor.

Figure 6 shows the basic idea behind the MITV-CC coding system. Pictures from a high-definition source are digitised and then fed to a bank of filters which produce a number of components, up to forty-five, each one of which has a different spatial and temporal frequency content. RGB information is transmitted with a resolution of 400 pixels wide by 254 lines high, at a rate of twelve frames per second. The resolution of the luminance signals ranges from 1200 pixels wide by 762 lines at 12 FPS to 400 pixels wide by 254 lines at 60 FPS. Nine of the components are then selected, six of which are fixed, and three depending upon the content of the particular scene and the amount of any movement which it contains. The six fixed blocks correspond to the lowest resolution signals in R, G and B, and to the next highest horizontal, vertical, and temporal components. The three further components which are selected are signalled to the receiver by means of digital codes transmitted in the vertical interval.These components are then multiplexed together with digital audio and data signals, and then read into a buffer memory store. The data is read out from the store in two separate streams, one for odd lines, the other for even lines, and is then converted back to analogue form. The two signals are then filtered and quadrature multiplexed onto the carrier.

The MITV-CC system is the product of a research department that has tried to develop a completely new design of television system which attempts to extract the maximum possible picture and sound quality out of a standard NTSC 6MHz wide channel. Although we have seen that it cannot be considered technically compatible with existing NTSC receivers or video recorders, it can under the somewhat peculiar regulations for compatible HDTV that have been laid down in the United States, still count as a compatible system. This is because, as we saw earlier, the ATV rules allow for an extra 6MHz channel to be used alongside an NTSC channel, which would allow MITV-CC to be carried on one channel whilst the other 6MHz channel carried a standard NTSC picture to keep existing NTSC viewers happy. Somehow this seems almost cheating!

Lasers

A three part series on the theory, the practical and the application of LASERs by Kevin Kirk

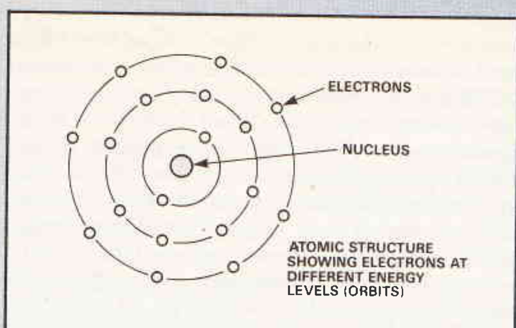


Fig. 1 Atomic structure showing electrons at different energy levels.

Lasers form an important and ever increasing role in today's world, yet the first successful laser was not developed until the 1960s. This article is intended as a practical insight into this emerging technology.

It is split into three sections, the first deals with how a laser works and we see it's application in the modern world, for example Laser Printers and CD players.

Part 2 describes a practical project to build a small lower power laser, which is ideal for experimentation. ETI has secured a source of low cost Laser tubes for use in this project.

Part 3 gives a series of practical uses of the laser, complete with circuit diagrams, such as a perimeter intruder alarm, light telephone etc.

The Theory

The term LASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. In actual fact it is not strictly true, it should be Light Oscillation by the Stimulated Emission of Radiation but the scientists developing the system didn't feel that calling the emerging technology a LOSER would help much in assisting it to become accepted so it became a LASER. It could have been called the Photon Originated TransmissioN Or pOwer Delivery by Light Emission (go on work it out!) which probably describes it's function a little better but sadly the acronym was already taken.

Prior to this century, light was always regarded as a wave with experiments by Young, Huygens, Fresnel and quantative equations by Maxwell backing these theories up. In fact in many respects light may well be regarded as a wave as it exhibits many of the properties of an electro-magnetic wave, which we know so well. In fact Maxwell proposed that it indeed was an electro-magnetic wave having a speed of 300,000,000 metres per second with frequencies around 500,000,000,000,000Hz.

On the face of it, this just about wrapped it up for light, if certain niggling little problems were ignored. Einstein came along and messed this up by proposing

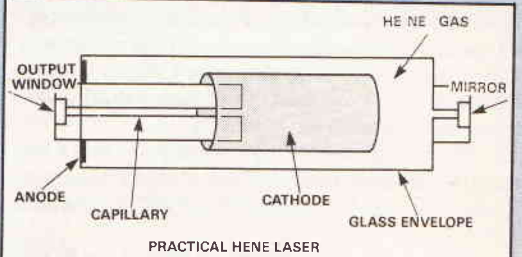


Fig. 2 Practical He Ne Laser.

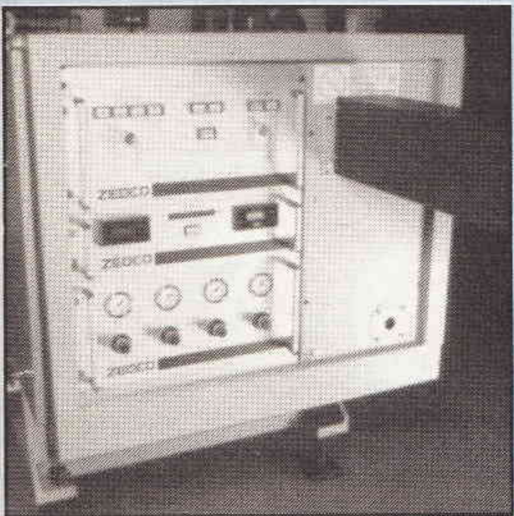
that light was made up of little packages of energy in the form of particles which he called photons. This helped to explain such problems with wave theory as the absorbtion and emission of light or the photo-electric effect. You can imagine all the wave scientists (?) of the day muttering about interfering so and so's and how does he explain what happens when light interacts with light.

In fact both camps are right, when light reacts with light then it can be regarded as being wave theory

and when it reacts with matter it becomes particle theory. This particle theory dove-tailed neatly into Planck's work on quanta of light which he introduced when trying explain the emission of radiation by black bodies. This then became known as quantum theory, which says in effect that all atomic systems have different and discrete energy levels. So now you know all about quantum mechanics, particle physics and wave theory; we will now press on.

As you all know an atom consists of a nucleus and a number of free electrons which orbit the atom at a given distance. Each atom type has a different number of electrons, for example hydrogen has 1 and oxygen has 8 (the number of electrons is represented by the number in the periodic table and also represents how 'heavy' a material is, for example lead is 82). These electrons can't all orbit at the same distance. Only 2 electrons may orbit at the lowest level closest to the nucleus, with 8 in the next level or orbit and 8 in the next and so on.

These orbits may be regarded as energy levels (as in Quantum Mechanics), so that if an electron can be induced into leaving it's present level and orbitting at the next higher one it can be regarded as being at a higher energy state. It can't be stable at this level though and must be kept there by the application of energy. If it is allowed to decay back then it releases



the energy in the form of a photon. In most lasers, the electrons will go up by 3 or 4 energy levels, but we can ignore this at this stage as we have created our photon, which is what we have been after.

Well there we have it, a photon! As it stands it is not a lot of use, it needs to be induced to form up with others in a coherent manner to perform work. Coherent light is basically light (photons) of one frequency and in phase. Incoherent light is a mixture of different frequencies, white light is the prime example.

To produce this coherent light we introduce the photons into a cavity which has mirrors at each end. Thus the light oscillates backwards and forwards (see it is a LOSER!) picking up more energy as it goes. One of the mirrors is a near perfect reflector and the other allows a certain amount of light to pass through, which can be used to do some work. Obviously to keep the laseing action going then energy must be continually fed into the cavity to ensure the electrons are continually stimulated into going to higher levels, dropping back and producing photons. This may be done in a variety of ways such as an external flash tube, but usually it is achieved using a (high) voltage.

Types Of Laser

The first successful laser was the 'ruby' laser which was made of aluminium oxide and was operated by

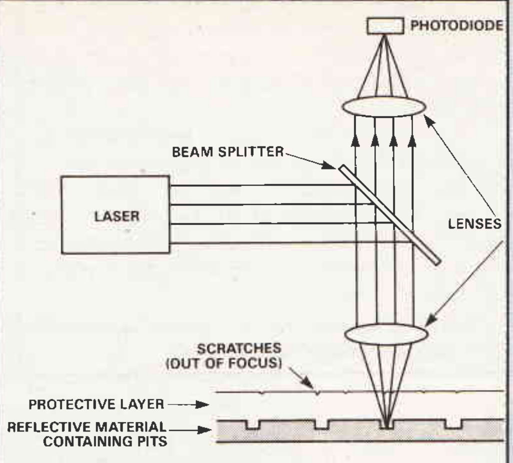


Fig. 3 Optical disc reading mechanism.

obtaining it's energy from an external light source, usually a high pressure mercury lamp. It operates at a wavelength of 694nm and it is seldom used today.

The YAG or yttrium aluminium garnet laser is used in commercial cutting and engraving operations as it can yield over 1000 watts. It is usually stimulated using a quartz-halogen lamp as the peak output of this lamp at 1μm is fairly close to the frequency of the laser which is 900nm. It is very inefficient with a maximum output of less than 2% of the input power.

The Helium Neon laser or HeNe is probably the most common laser at present (laser diodes are rapidly catching up). The laser consists of a small bore glass tube containing a mixture of helium and neon in a ratio of 10:1. It is electrically excited by raising the voltage across the tube to around 5kV, when it 'strikes', the voltage should be reduced to allow an operating current of a few milliamps. If too high a current is used then the laseing ceases, which effectively ensures that only low power levels may be achieved. However this is not regarded as too much of a problem as it's beam quality and reasonable stability coupled with it's relative ease of use and it's output in the visible light spectrum make it an ideal laser for use in low power applications.

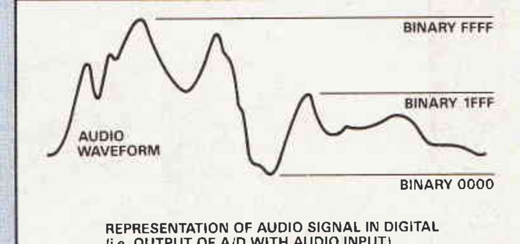


Fig. 4 Representation of Audio signal in digital.

The CO_2 Laser is probably the most efficient laser at present with efficiency levels of up to 30% and power capabilities of several kilowatts. It consists of a mixture of 3 gases, helium, nitrogen and carbon dioxide which are continually replenished as a rule because the CO_2 tends to break down to CO (in small lasers water may be added to help restore the CO_2 thus making sealed systems a possibility), so if it was not replenished it would stop laseing after a few minutes.

It is excited by a high voltage and may be current modulated. It is used for metal cutting and welding and for industrial engraving, as well as in medical applications.

It suffers from one major drawback in that it operates at 10.6μm which is not in the visible spectrum. Therefore it requires special optics such as silicon, germanium or zinc sulphide as it would burn through a glass lens. It would use an aluminium metal mirror (a good reflector) that is usually water or forced air cooled. The optics being special are normally expensive.

There are other types of laser, which use different types of excitation from the laser stimulated by another lower powered laser to the 'star wars' laser which explodes a nuclear warhead in the cavity to create a 'once and for all' stream of photons (how do they test this?), but the ones mentioned above cover most of the common lasers.

The exception is the Semiconductor laser, I've left this until the last because it is possibly the type of laser you will become most familiar with over the next few years and also because it is the most difficult one to explain the operation of. The main problem is that they follow different rules to the rest of the laser society (like Electronic Engineers really). For a start, instead of individual atoms having enhanced energy levels, semi-conductors' electrons occupy broad bands of energy levels, so they can't be associated with any single atom but with the material as a whole. For a start I must assume that you know and understand how a semi-conductor PN junction works and that under certain circumstances it may emit light (AKA an LED).

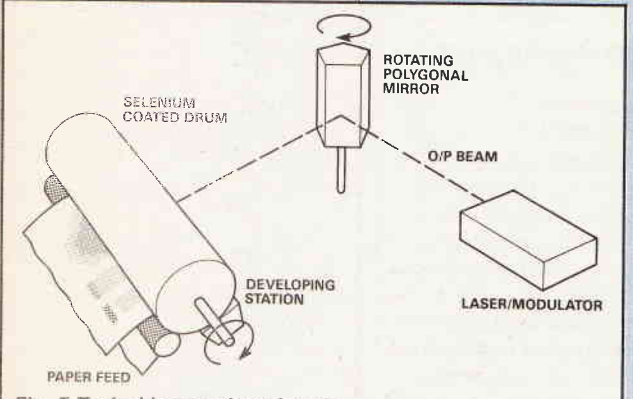


Fig. 5 Typical Laser printer layout.

If a semi-conductor junction is forward biased then carriers may pass through the junction fairly easily. Once through they become minority carriers and will recombine with the opposite carriers which will give rise to a change in energy levels. This action takes place in a very small area of the diode junction (about 1µm out of a total size of 200-400µm) so at present the laser powers will be small, less than 1 Watt generally.

The ends of the diode are formed into mirrors to permit the laser action — not very efficient mirrors it has to be said but good enough for the purpose.

Certain semi-conductor materials make very poor emitters of light, for example silicon and germanium are very very poor emitters. Usually they have to be heavily doped with other materials to increase the efficiency such as gallium and arsenide.

One area where the semiconductor laser differs greatly from conventional lasers is that the beam diverges, which I was always lead to believe was a benefit of lasers, to the tune of 40% on some lasers. Gallium Arsenide operates at a wavelength of 0.9µm which is not ideal for fibre optic communications so compound lasers are used such as lead salt lasers but this is straying into heavy physics so we will discretely draw a veil over the further goings on in the semi-conductor laser family.

Applications

After denigrating our friend the semiconductor laser, the first couple of applications are using this type of laser as any other type would be impractical.

The Compact Disc Player

As I write this I am sitting listening to my CD player (Fleetwood Mac if you must know), this has revolutionised music reproduction in the home and incidentally radically increased the poor old record companies' profits as they are re-releasing all the old records. The same basic technology is used in the optical discs for storing huge amounts of data on Computer Systems.

Figure 3 shows the set up for a typical optical disc system, the information (or data as audio is in fact a digital system, whereas video, curiously, is analogue as digital requires too much bandwidth!) is stored as a series of 'pits' in the surface.

The information is obtained by 'scanning' the original audio at a rate of 44.1kHz (at greater than twice the frequency of the original audio to avoid aliasing in the A/D convertor!), the resultant level is converted to a 16 bit binary number by an A/D convertor (see Figure 4). This is then added to various error correcting bits and stored on the disc at a rate of 4.3218MHz.

When reading this information a low power laser is used to 'light' up a very small area (something like 0.29µm is typical) if this area is not a pit then we will get a reflection which is treated as a digital '1', a pit on the other hand will produce a '0'. This stream of 1s and 0s is converted to an analogue signal suitable for listening to by a Digital to analogue convertor.

Note the use of a lens to both focus the beam and to ensure that scratches on the protective surface do not effect the sound. All scratches and dust is actually out of focus and so will not effect the output.

This is basically the same system as used in computer systems, although eraseable discs are now available. These use a ferrous material which uses a laser to heat a spot up above the material's curie point so it loses it's polarity. This can be read magnetically so it can be regarded as a sort of cross between optical and magnetic disc technologies. This whole area of optical discs is a fairly large and interesting one and really needs an article devoted solely to it.

Laser Printers

These are the products that made the word laser famous (with the possible exception of sci-fi movies). They offer a faster printing speed (although a very slow page make up time) and lower noise than impact printers with a high quality output. They have helped to transform printing from a complex, capital and labour intensive industry to something that may be performed using virtually any desk top computer.

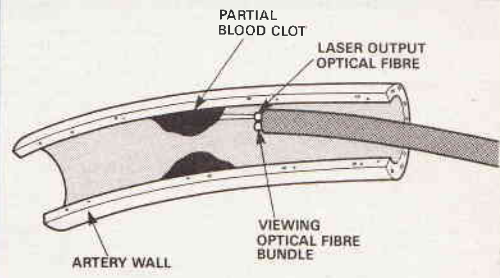


Fig. 6 Medical Laser burning away blood clot.

The operation is not complicated if you know how a photocopier works! Essentially it consists of a selenium coated drum which is highly charged using a corona discharge (lots of ozone, good for the environment, chop down all the trees and replace with laser printers!). When the laser beam strikes the surface, then the charge at that time bleeds away (in a photocopier it is the reflection off the paper that has this effect, using the powerful light as it scans across the page to be copied! This is basically the only difference between a copier and a laser printer, so why can't we buy combined laser printer/copiers?)

So as the drum rotates an image is formed on the drum of either charged or not charged areas. Meanwhile a box of black plastic particles (called toner) is charged up in the same polarity as the drum. When the drum rotates these particles are attracted to the area where no charge remains and are repelled by the charged area. The image is now a 'real' black and white image.

The paper is charged to an opposite polarity and when it comes into contact with the drum at the transfer station, the toner is highly attracted to it and leaves the drum. The particles are now fixed onto the paper using a combination of heat and fuser oil. The paper passes a 'tinsel' arrangement on the way out to disipate the charge on it.

The laser image is scanned across the page using a polygonal mirror and is switched on and off (modulated) by using an acoustic/optic modulator as HeNe lasers can't be switched on and off as quickly as required. Maybe some enterprising reader can come up with a way of modifying a photocopier, which if used with our project can be made into a laser printer. I wait with bated breath.

These are not the only lasers used in the printing industry, laser scanners also used to scan artwork produced by graphic artists and laser engravers are used to engrave printing plates from hard rubber and ink transfer (anilox) rollers from high tech ceramics such as chrome oxide.

Medical Lasers

This is probably one area where lasers are actually contributing greatly to the quality of human life. CO_2 lasers are the ones you are most likely to find in medicine, this is because the wavelength of 10.6μm is absorbed by the water molecules found in human tissue. This water then evaporates with the subsequent destruction of the tissue, it also has the effect of sealing the cut and of course it is totally hygenic unlike a conventional scalpel. The downside is the fact that

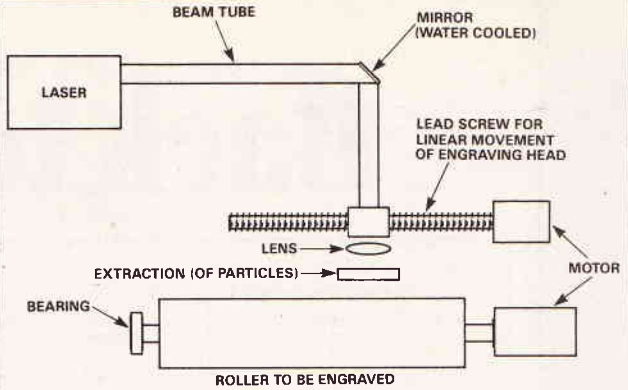


Fig. 7 Typical Laser engraver.

10.6μm cannot be carried on conventional fibre-optics as it tends to melt both plastic and glass. So a system of mirrors is used in some form of arm which tends to be a little cumbersome. YAG lasers may use conventional fibre optics and may be used for intra-artery work (see Figure 6) and for removing blood clots etc.

An exciting development is the destruction of cancer cells using lasers. There are various ways of doing this but the method that is finding most favour is by injecting the tissue with a dye (usually HpD) which is absorbed by the cancerous tissue but rejected by the healthy tissue. The laser wavelength is then tailored to destroy any tissue containing the dye.

Eye surgery (like that practised by the hospital 'factory' ship currently in Cyprus, doing eye surgery on a production line basis) uses argon ion lasers which emit a green light which is strongly absorbed by the red blood cells and the resultant heating re-attaches the retina.

There are of course many other applications for lasers but they are too numerous to describe in a single article.

3 Back to Basics

This month, Paul Coxwell looks at series/parallel resistance combinations

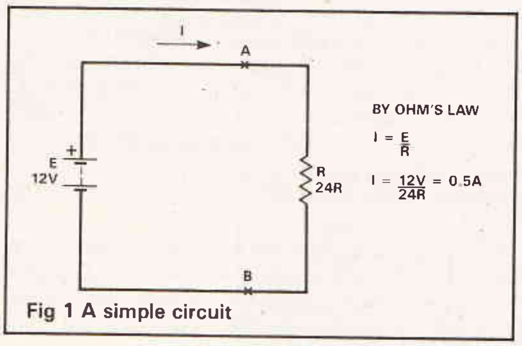


Fig 1 A simple circuit

So far, we have seen how chemical or magnetic energy may be used to generate electricity, and that there are two important conditions that must be met in order for electric current to flow: There must be a source of EMF and there must be a complete loop, or circuit.

The way in which resistance affects the current flowing in any circuit has been examined, and you should now have a good knowledge of Ohm's Law. It is now time to look at DC (direct current) circuits in more detail.

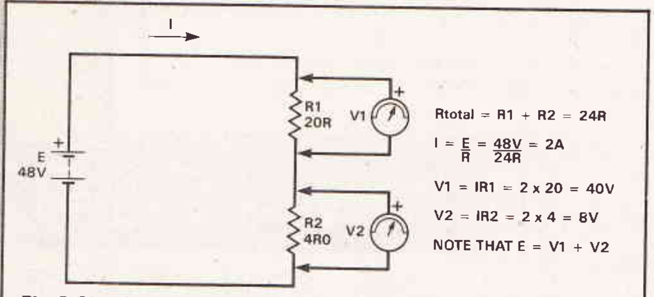


Fig.2 Simple series circuit

The Series Circuit

The current, resistance, and voltage in a simple circuit consisting of a battery and one resistor are easily calculated (Figure 1). The examples in this article will show different resistors, but in practice, circuits use lamps, motors, and many other devices. Because these devices all exhibit a certain amount of resistance, they can be considered to be resistors for our purposes at present.

The circuit consists of a battery delivering an EMF of 12V and a resistance of 24R. Application of Ohm's Law shows that the current flowing will be 0.5A. As there is only one path for the current to take, the value of current flow is the same in all parts of the circuit. An ammeter inserted at the point marked 'A' would show the same current as a meter inserted at point 'B'.

When a circuit consists of more than one resistance, as most practical circuits do, the calculation of current flow requires a second step. Figure 2 shows two resistors connected in series across a battery. Once again, there is only one path for the current to take, so the same value of current must flow through every part of the circuit. The current meets two sets of resistance — the 20R resistance of R1 and the 4R resistance of R2. Both these resistances reduce the flow of current, and the total resistance may therefore be calculated by simple addition. Once the overall resistance (often represented as Rtotal or Rt in calculations) has been determined, Ohm's Law can be used to calculate the current flowing in the circuit.

Also shown are two voltmeters, measuring the voltage appearing across each of the two resistors. The voltages can be calculated by applying Ohm's Law to the part of the circuit of interest. Remember that in a series circuit the same current flows through every component, so the current through both R1 and R2 is 2A. The voltage across each resistor can therefore be found by multiplying this current by the value of the resistor in question, and the results are shown in the diagram.

The results of these calculations lead to Kirchoff's Second Law, which states that the sum of the voltages across each resistance in a series circuit is equal to the total voltage applied to the circuit. In any series circuit, the total voltage will divide between each resistance such that the sum of each individual voltage equals the total voltage applied. Figure 3 shows some examples of series circuits.

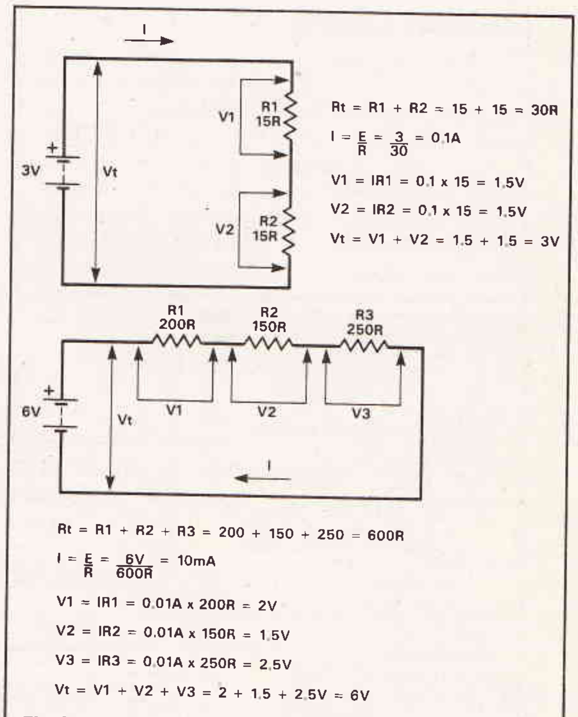


Fig.3 Series circuits and Kirchoff's Second Law

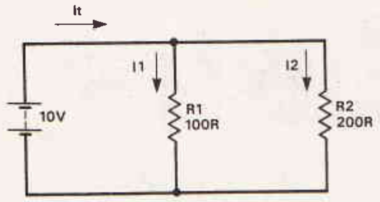
The Parallel Circuit

A parallel circuit (Figure. 4) provides more than one path for the electric current to take. Because the ends of each resistor are joined together, whatever voltage appears across R1 must also appear across R2. Both resistors in the example therefore have a potential difference of 10V across them. Ohm's Law can be used to calculate the current flowing through each resistor (I1 and I2).

The parallel circuit gives rise to Kirchoff's First Law, which states that the sum of all currents flowing into a junction is equal to the sum of all currents flowing out of that junction (Figure.5). In the parallel circuit shown, the total current I splits two ways through R1 and R2. Total current is therefore equal to the sum of I1 and I2, and Ohm's Law can be used to determine the overall resistance of R1 and R2 combined.

It is not necessary to determine the current flow

ELECTRICITY



$I1 = \frac{E}{R2} = \frac{10V}{100R} = 0.1A$ (100mA)

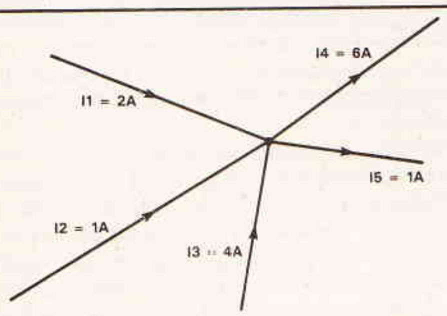
$I2 = \frac{E}{R2} = \frac{10V}{200R} = 0.05A$ (50mA)

$It = I1 + I2 = 100mA + 50mA = 150mA$

$Rt = \frac{E}{It} = \frac{10V}{150mA} = 66.67R$ (TO 2 DECIMAL PLACES)

Fig.4 Simple parallel cicuit

to calculate the total resistance, however. Figure 6 shows how Ohm's Law and Kirchoff's First Law can be used to develop a formula for calculating parallel resistance. This formula can be employed to calculate the total resistance of any number of parallel resistors. A useful point to remember is that if several resistors of the same value are connected in parallel, the total resistance is equal to the value of one resistor divided



CURRENTS FLOWING INTO JUNCTION:

$I1 + I2 + I3 = 2 + 1 + 4 = 7A$

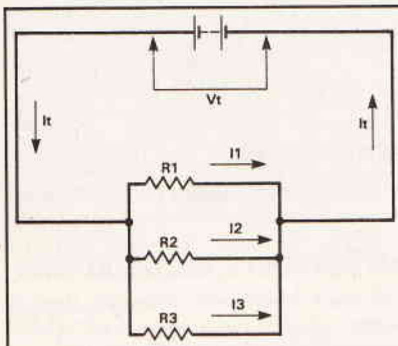
CURRENTS FLOWING AWAY FROM JUNCTION:

$I4 + I5 = 6 + 1 = 7A$

Fig.5 Kirchoff's First Law

by the number of resistors. Two resistors of 100R connected in parallel, for example, give an overall resistance of 50R. Three resistors of 30R each would give a total resistance of 10R, and so on.

The key points to remember about series and parallel circuits are summarized in Figure 7.



$It = I1 + I2 + I3$ (KIRCHOFF'S FIRST LAW)

$It = \frac{Vt}{Rt} \quad I1 = \frac{Vt}{R1} \quad I2 = \frac{Vt}{R2} \quad I3 = \frac{Vt}{R3}$ (OHM'S LAW)

BY SUBSTITUTING OHM'S LAW EQUATIONS IN KIRCHOFF'S FIRST LAW:

$\frac{Vt}{Rt} = \frac{Vt}{R1} + \frac{Vt}{R2} + \frac{Vt}{R3}$

THEREFORE:

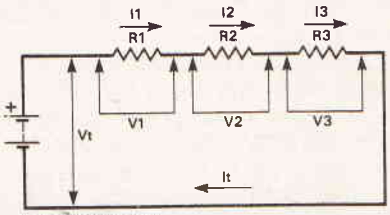
$\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$

Fig.6 Calculating parallel resistance combinations

A Practical Application

Last month it was mentioned that a micro-ammeter is often used to measure voltages by using a series multiplier resistance. The laws we have seen in this part of the series are all that are needed to calculate such resistances, and Figure 8 shows an example.

The meter itself registers full scale when 50μA of current flows. The coil has a resistance of 4000R which because it is inside the meter movement is called the internal resistance of the meter (Rinternal). Rm represents the multiplier resistance, the value of which must be calculated.

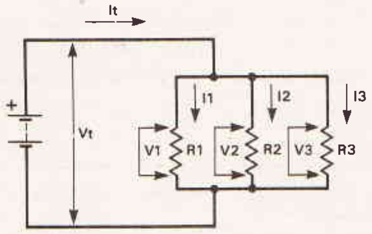


(a) SERIES CIRCUIT

$Vt = V1 + V2 + V3$

$It = I1 = I2 = I3$

$Rt = R1 + R2 + R3$



(b) PARALLEL CIRCUIT

$Vt = V1 = V2 = V3$

$It = I1 + I2 + I3$

$Rt = \frac{1}{(1/R1) + (1/R2) + (1/R3)}$

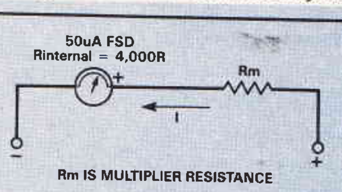
Fig.7 Series/parallel circuit summary

Ohm's Law is used to determine the total resistance that the meter and Rm must offer in order that 50V at the positive and negative terminals causes 50μA of current to flow. You have learned that the total resistance of two resistors in series is equal to their sum, so the required value of Rm is the difference between the total resistance required and the internal resistance of the meter. Another example is shown in Figure 9, this time using a 1mA meter instead of a 50μA type. This meter will indicate voltages up to 50V just as effectively as the circuit of Figure 8, but there is an important factor which gives the first circuit better sensitivity. You have seen that when a resistance is placed in parallel with another, the overall value of resistance is lowered. A voltmeter using a series multiplier resistor looks just like another resistance to the circuit under test, so the meter's resistance can affect the circuit be tested. The total resistance of the first voltmeter is 1M0; the resistance of the second meter is only 50k.

Figure 10 shows how the low sensitivity of a meter can give misleading results. R1 is a resistor in a circuit which must be tested, and has a value of 100k. To measure the voltage across R1, a meter is clipped to each of its wires. The 50V meter using a 50μA movement has a total resistance of 1M0, which is effectively placed in parallel with R1. This resistance upsets the normal resistance of 100k, and actually results in an overall resistance of slightly under 91k. The circuit under test should have a resistance of 100k between points 'A' and 'B' on the diagram, but the presence of the meter changes this value.

If the meter using a 1mA movement is used, the meter resistance is 50k. When this is combined with R1 the overall resistance is only 33k, or one third of the value it should be. With such drastic changes to circuit resistances, it is quite probable that the voltage across R1 will drop much lower than its normal value, and the meter will therefore give a misleadingly low reading.

Voltmeters, being connected in parallel across existing circuits, should therefore be designed to have as high a resistance as possible so they do not adversely affect the circuit being tested. Voltmeter sensitivity depends upon the FSD current rating of the meter movement used, so the lower the current needed for FSD the better. Sensitivity is usually specified as so many Ohms per Volt. The 50μA movement always has a sensitivity of 20,000 Ohms per Volt, for example. This means that a 1V range on the meter would give a total resistance of 20k, a 2V range would have a total meter resistance of 40k, and so on. The figure of 20k/V for sensitivity is typical of many good multi-range meters.



METER TO READ FULL SCALE WHEN 50V APPLIED TO TERMINALS

FOR FSD:

I = 50uA = 0.05 mA

USING OHM'S LAW, TOTAL RESISTANCE:

$Rt = \frac{50V}{0.05mA} = 1{,}000k\ (1M0)$

Rt = Rinternal + Rm

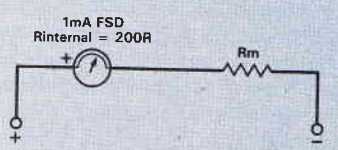
THEREFORE:

Rm = Rt − Rinternal = 1,000k − 4k0 = 996k

Fig.8 Multiplier calculations for a voltmeter

The voltmeter provides a practical demonstration of a simple series circuit, and the ammeter can provide an example of a simple parallel circuit put into practice.

Figure 11 shows how a shunt resistance can extend the range of an ammeter. The example shows a 1mA meter which must be converted to read currents of up to 10mA. The meter cannot carry more than 1mA, so a resistor is shunted across so that some current bypasses the meter movement. If 1mA flows through the meter then Kirchoff's First Law tells us that 9mA must flow through Rs. In order to use Ohm's Law to calculate the value of Rs, we must also know the voltage that appears across it at full scale. A 1mA meter with an internal resistance of 200R requires 0.2V for full-scale deflection, and because R_s is in parallel the same voltage must appear there. R_s can then be calculated by dividing the voltage across the meter by the current (9mA) which must flow through the shunt.



METER TO READ FULL SCALE WHEN 50V APPLIED TO TERMINALS

FOR FSD:

I = 1mA

USING OHM'S LAW, TOTAL RESISTANCE:

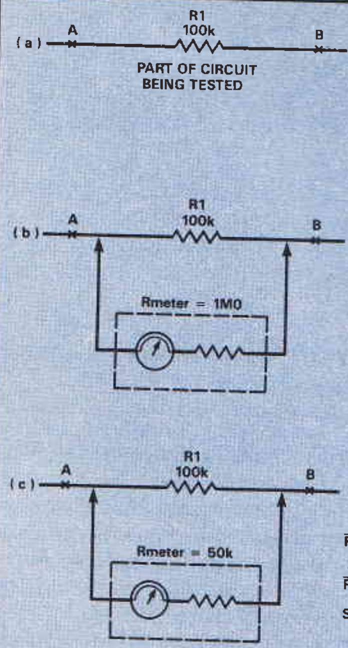
$Rt = \frac{50V}{1mA} = 50k$

Rt = Rinternal + Rm

THEREFORE:

Rm = Rt − Rinternal = 50k − 0.2k = 49.8k

Fig.9 A less sensitive voltmeter



(b) $\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{Rmeter}$

$\frac{1}{Rt} = \frac{1}{100} + \frac{1}{1{,}000}$

SO, Rt = 90.9k

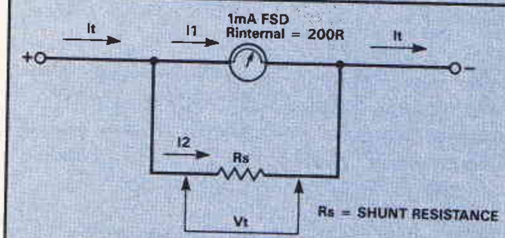
(c) $\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{Rmeter}$

$\frac{1}{Rt} = \frac{1}{100} + \frac{1}{50}$

SO, Rt = 33.33k

Fig.10 Effect of meter sensitivity

Because an ammeter is connected in series with an existing circuit, it should have as low a resistance as possible so as not to affect the circuit under test too much. When the meter is not connected, the two points in the circuit are joined together, and have a resistance of zero ohms (or as near to zero as possible). Any resistance in the ammeter is therefore resistance which is not normally present, and may reduce the current which flows in the circuit.



METER TO READ 10mA AT FULL SCALE

It = 10mA AND I1 MUST BE 1mA

I2 = It − I1 = 10mA − 1mA = 9mA (KIRCHOFF'S SECOND LAW)

Vt = I1 Rinternal = 1m A x 200R = 0V2 (OHM'S LAW)

FROM OHM'S LAW:

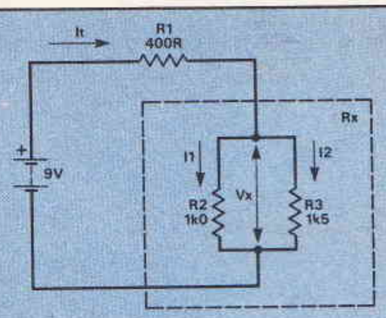
$Rs = \frac{Vt}{I2} = \frac{0V2}{9mA} = 22.22R$ (TO 2 DECIMAL PLACES)

Fig.11 Shunt resistance calculations for ammeters

Series and Parallel Combinations

Most circuits do not conveniently fall into a simple series or parallel category, and consist of many branches of each type. Figure 12 shows a simple combination.

The key to calculations in such combination circuits it to analyse each section of the circuit separately. Start with the parallel combination of R2 and R3. If we call their combined resistance Rx, the parallel resistance formula can be used to give an overall value of 600R. The parallel branch has now been simplified, and the circuit becomes Rx (value 600R) in series with R1 (value 400). The total resistance is therefore 1,000R.



CALL COMBINED RESISTANCE AT R2/R3 Rx

$\frac{1}{Rx} = \frac{1}{R2} + \frac{1}{R3} = \frac{1}{1k0} + \frac{1}{1k5}$

Rx = 600R

Rtotal = Rx + R1 = 600R + 400R = 1k0

It = $\frac{9V}{1k0}$ = 9mA

VOLTAGE Vx = It x Rx = 9mA x 600R = 5.4V

I1 = $\frac{Vx}{R2} = \frac{5V4}{1k0}$ = 5.4m

It = I1 + I2

SO, I2 = It − I1 = 9mA − 5.4mA = 3.6mA

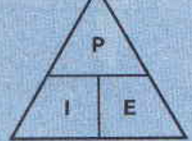
Fig.12 Series/Parallel combinations

With the total resistance known, I_{total} can be calculated (9mA). Suppose that the current through each of the resistors R2 and R3 needs to be determined. We know that the 9mA of I_t must split between I1 and I2. If we call the voltage across the resistors Vx, Ohm's Law can be used to calculate this voltage from the total current I_t, and the parallel resistance, Rx. It is then a simple matter to calculate the value of I1, as shown. The value of I2 must be the difference between the total current and I1 (Kirchoff's First Law). The same results could have been achieved by using Ohm's Law to calculate I2 and then taking I2 from the total current to give I1. In many practical circuits you will find that there are several routes to the same answer. These examples emphasize the importance of learning the basic electrical laws, particularly Ohm's Law.

POWER = VOLTAGE x CURRENT

SO VOLTAGE = $\frac{POWER}{CURRENT}$ AND CURRENT = $\frac{POWER}{VOLTAGE}$

LET E = VOLTAGE, I = CURRENT, AND P = POWER IN WATTS



P = I x E I = $\frac{P}{E}$ E = $\frac{P}{I}$

Fig.13 Calculation of power

Power

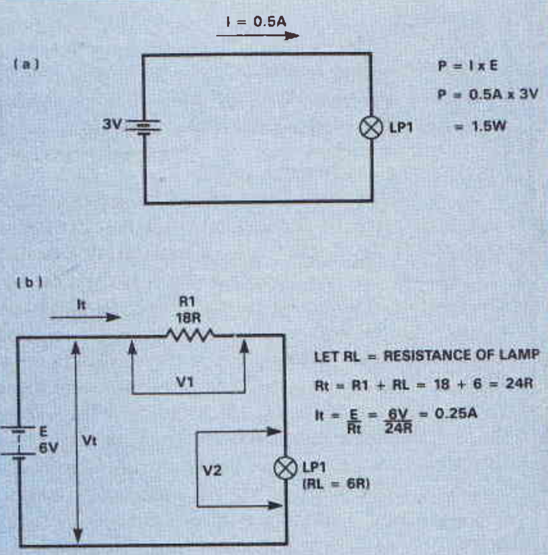
So far, you have been dealing with three main electrical quantities: voltage, current, and resistance. Power is the actual amount of work that is done in moving electrons along a conductor. Much power is dissipated as heat, sometimes intentionally as in an electric fire. The primary purpose of a lamp is to give off light, but it also radiates a certain amount of heat. However, the power is consumed, be it light, heat or motion, it is measured in Watts (written as the symbol 'W') and is directly proportional to both the voltage and the current flowing in a particular circuit. The formula used for calculating power is very similar to that used for Ohm's Law, and a triangle arrangement may be used to aid calculations (Figure 13). Just as with Ohm's Law, the formula may be applied to an entire circuit or just a section of it. Figure 14 shows how to go about calculating the power dissipated by a circuit.

By rearranging the formula it is possible to calculate voltage or current when given the power. The current drawn by a 48-watt, 12-volt bulb, for example, may be calculated by dividing the power by the voltage (the answer is 4A).

It is important to be able to calculate the power dissipated by each part of a circuit, for many components can only handle a certain amount of power. If that power rating is exceeded, the component overheats and may be damaged.

In Figure 14b the resistance of the bulb was known, but not the amount of current of passing through it. The power triangle requires voltage and current to be known. By simple formula rearrangement it is possible to write two further formulae (Figure 15) to aid calculations. Power can be calculated directly so long as two out of three quantities (current, voltage, and resistance) are known. Try the new formulae in the examples and confirm that the answers are the same. Note that in a circuit with constant resistance, if the supply voltage is doubled the power is quadrupled, because the current is also doubled.

Next month we examine AC circuits and phase.



Ptotal = E x It = 6V x 0.25A = 1.5W

V1 = ItR1 = 0.25A x 18R = 4V5

SO POWER DISSIPATED BY R1 = ItV1 = 0.25A x 4V5 = 1.125W

AND POWER DISSIPATED BY LP1 = It x (Vt − V1) = 0.25A x 1V5 = 0.375W

NOTE THAT Ptotal = PinR1 + PinLP1

Fig.14 Power combinations in simple circuits

P = I x E

OHM'S LAW PROVES THAT I = $\frac{E}{R}$, SO BY SUBSTITUTION:

P = $\frac{E}{R}$ x E OR P = $\frac{E^2}{R}$

OHM'S LAW ALSO SHOWS THAT E = I x R, SO BY SUBSTITUTION:

P = I x (I x R) OR P = I^2R

Fig.15 Some more power formulae

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VLF Earth Loop Antennas

What are these mystery earth signals? George Pickworth returns to report on his investigations with VLF communication

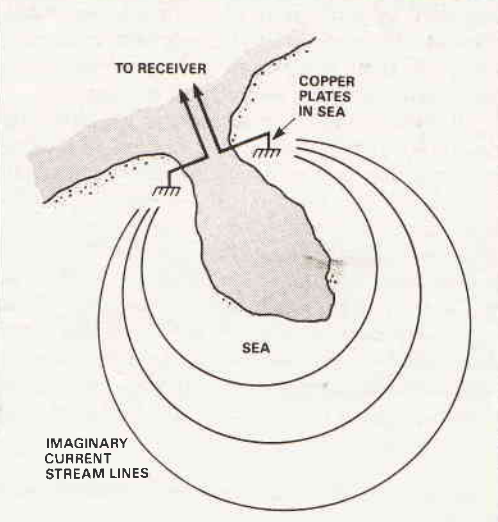

Fig. 1 A 'Penisular' VLF/ELF Sea Antenna.

During experiments with simulated World War 1 untuned earth current signalling equipment, the author encountered interference from strong earth currents which subsequent experiments confirmed as originating as VLF electromagnetic (Hertzian) waves on 80kHz (navigation), 60kHz (time), and 16kHz (MOD submarine communication signals). In addition, signals of unknown origin were found to be present as earth currents, from 3.3kHz down to 250Hz, the lower limit of the authors tuner, but there is no evidence of the signals below 3.3kHz being present as Hertzian waves. Signals on 3.3, 2.2 and 1.8kHz were particularly interesting as their waveform sometimes appeared to be frequency modulated, sometimes amplitude modulated, and other times an almost perfect copy of a damped wave generated by a spark transmitter. In these articles we discuss the philosophy of earth current loops and how these could possibly explain the phenomena of naturally occuring, man-made and Hertzian waves being converted into earth currents. The articles also include notes on my equipment, some of the experiments conducted, and my thoughts on the subject. It is a field wide open for investigation by amateur scientists.

The study of earth loops and currents involves a 'base' formed by inserting a pair of earth rods, spaced 30 to 150m apart, into the soil and connecting these to a simple receiver. Having said that, I am fortunate in having a moderate size garden adjoining open farmland into which I can extend the experiments. Those not so fortunate should not dispair, as the equipment can be made completely portable and is therefore well suited for 'field day' experiments.

However, experience has shown that an oscilloscope is the only device that will give meaningful information by displaying waveforms, moreover, it allows frequency measurements to be made. A battery powered oscilloscope is therefore required for field experiments. Other desireable, but not essential instruments include an audio signal generator and a multi-purpose DMM. The actual tuners were home made from variable capacitors and ferrite rods salvaged from valved, high quality domestic radios.

A simple inductance/capacity tuner, used in conjunction with an oscilloscope, has the advantage over the usual heterodyne converter type receiver as spurious signals are not generated. Indeed, a single tuned stage was found adequate and be so selective as to limit reception of modulation sidebands unless its 'Q' was reduced by a loading resistor.

Natural And Man-Made

Strange sounds, originating as naturally occuring electromagnetic waves, had been heard over telephone lines, especially those employing an earth circuit, since Bell invented the telephone receiver and were discussed by Sir William Preece during an address given to the Society of Arts on February 23rd 1894 when he gave rein to his imagination, and said: *"Although this short paper is confined to a description of a simple practical system of communicating across terrestial space, one cannot help speculating as to what may occur through planetary space. Strange sounds are heard on long telephone lines when the earth is used as a return, especially in the stillness of night. Earth currents are found in telegraph circuits when the aurora borealis lights up our northern sky when the sun's photo-sphere is disturbed by spots. The sun's surface must at such time be violently disturbed by electrical storms and oscillations are set up, and radiated through space in sympathy with those required to affect telephones, it is not a wild dream to say that we may hear on this earth, thunderstorms on the sun."*

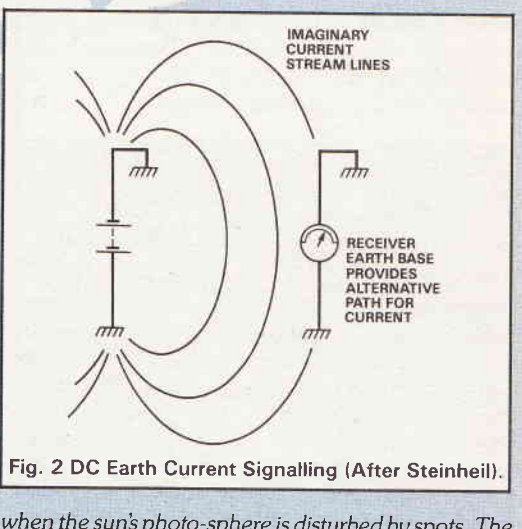

Fig. 2 DC Earth Current Signalling (After Steinheil).

During the First World War, when earth current signalling played a very important role by maintaining communication with the men in the trenches when land-lines were destroyed by shellfire, operators frequently heard sounds which originated as naturally occuring electromagnetic waves; they were described by Barkhausen in 1919, and subsequently named after him, although the most common sounds are generally refered to as 'whistlers'. However, triode

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valve amplifiers made WW1 earth current receivers infinitely more sensitive than the passive telephone earpiece employed by Preece.

Around 1950, 'Barkhausen Sounds' aroused considerable scientific interest. Investigation of this phenomena was mainly with elevated antennas although 'sea loop' antennas were used occasionally. 'Sea Loops' were most successful on peninsulars where salt water, having a lower resistance than the land, resulted in the incoming ELF Hertzian waves inducing current stream lines around the peninsular, which effectively created a very large closed loop antenna (Figure 1.)

Natural electromagnetic waves are a subject in their own right, so in these articles the author considers principally man-made Hertzian waves, but the conversion of both naturally occuring and man-made Hertzian waves into earth currents is the same. Indeed, during WW1, in addition to interference from naturally occuring Hertzian waves, spark transmitters also caused, considerable interference with earth current communication. As no elevated wires were used with the earth current system, the inference was that the earth itself acted as an antenna and picked-up the Hertzian wave signals.

Notwithstanding the 'sea loop', information on how electromagnetic waves are converted into earth currents is not readily available, so, let us follow the sound scientific approach of first going back to basic principals, and having said that, there is no better start than with earth current signalling. Steinheil, the father

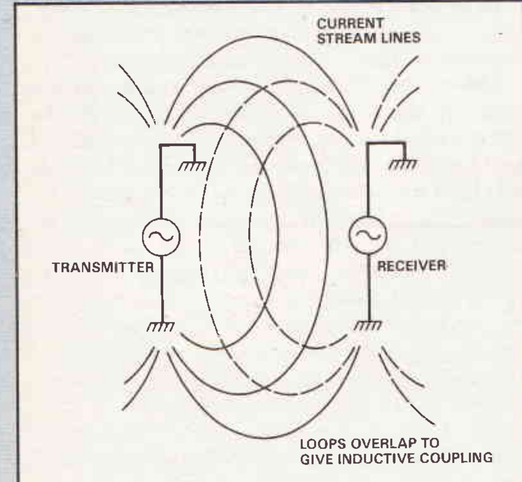

Fig. 3 AC Earth Current Signalling (After Stanley).

of the system, demonstrated in 1838 that a current does not take a direct route between two distant earth rods but that the stream lines spread out in a pattern similar to the lines of force of a bar magnet to form an infinite number of loops on each side of an imaginary line, connecting the two earth rods. The earth base of the distant receiver, aligned along a stream line provides an alternative path and thus intercept some of the current (Figure 2).

Inductive Coupling

With DC earth current systems, coupling can only be by conduction, however, Rupert Stanley, chief wireless instructor to the British Army in France during the First World War, came to the conclusion that with 1.0kHz AC, or pulsed DC generated by a 'Power Buzzer' communication was not simply by conduction, but also by inductive coupling between the transmitter and receiver earth loops. This made signalling possible at distances up to 8.0km. Indeed, Stanley's own calculations indicated that long range earth current signalling would be impossible by conduction alone and this may help to explain why AC earth current communications systems were found to have much greater range than DC systems. Having said that, one may ask how a receiver earth base forms an earth loop when no current emanates from the receiver: it is analogous to an ordinary transformer where no current flows in the secondary winding unless the primary is energised (Figure 3).

Stanley's philosophy was however forseen by Preece as early as, 1880, by his demonstration during 'wireless' communication experiments with earth currents and magnetic induction. Preece showed that a current was induced in either of the earth loops by an elevated, large diameter and completely insulated horizontal wire loop, located over an earth loop, and energised with AC or pulsed DC. By the same token, Preece found that by energising the earth loop, a current could be induced in the elevated loop. As both the earth loops and the elevated loop responded to a changing magnetic field is reasonable to assume that

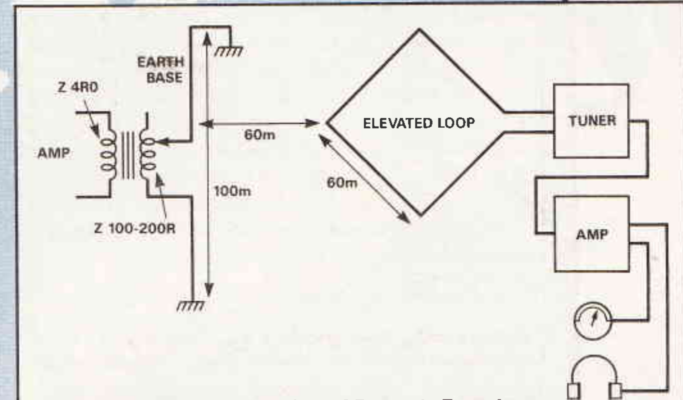

Fig. 4 Small Scale Replication of Preece's Experiment.

an earth loop will similarly respond to the changing magnetic field component of an electromagnetic wave, as is the case with a ferrite rod antenna.

It would seem that the magnetic field component of an Hertzian wave induces a current in an earth loop and, as the earth loops extend to infinity, their circumference would theoretically allow standing waves to develop and become resonant. Moreover, if the loops are resonant, they may well respond to the 'total' electromagnetic wave, similar to a resonant elevated horizontal loop antenna generally known as a 'Sky Loop' and not just their magnetic field. This is discussed in Part 2.

Tuned Earth Current Receivers

It was logical to adopt and modify the receiver used with the earth current signalling experiments for the study of earth loop antennas, but let us first briefly look at how the tuners evolved. My original earth current experiments with simulated WW1 untuned equipment were inconclusive because of interference from 50Hz leaking from power lines and VLF electromagnetic waves. However, a simple inductive/capacity tuner was found to eliminate both 50Hz pollution and interference from VLF transmitters. The first tuner was designed for a frequency of 1.5kHz, so that the asynchorous 20W DC to AC power converter used to replicate a WW1 'Power Buzzer' could continue to be used as the transmitter. The advantage of an inductance/capacity (LC)tuner over earlier trials with resistance/capacity type filters was immediately apparent in that it responded to square waves generated by the DC/AC power converter and gave an output to the oscilloscope, or amplifier, that was virtually a pure sine wave.

Subsequent earth current communication experiments involved a 150W audio amplifier, driven by an audio frequency signal generator acting as the transmitter, and matched to the typical 150R DC

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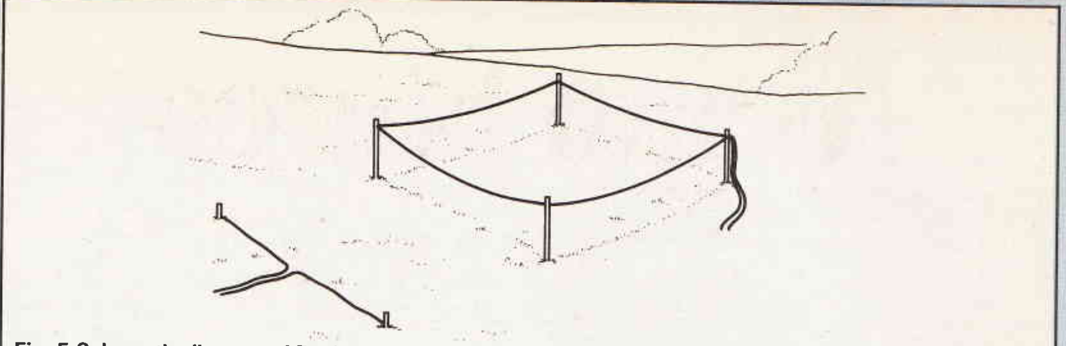


Fig. 5 Schematic diagram of Replication of Preece's Experiment.

resistance of a base by means of 220/30-50V 2VA mains transformer. To take advantage of the wider range of operating frequencies possible with an amplifier, a bank of selectable capacitors were incorporated in the tuner to give 5 'spot' frequencies between 1.5 and 9.0kHz; actual frequency was not critical as the transmitter frequency could be readily adjusted to correspond to any selected frequency. 'Spot' frequencies were employed simply because of the difficulty in simulating a capacitor that was infinitely variable from 1.0µ to 15n to give continuous coverage from 1.0kHz to 10kHz with a 20mH inductor. The experiments showed that frequencies up to 10kHz can be used for earth current signalling and with 150W a range of 15km is feasible. Sometime in the future, the equipment will be used to confirm Stanley's coupled earth loop philosophy.

Replication

Of more immediate interest were the author's small scale replications of Preece's experiment which involved a 100m earth base and a completely insulated horizontal rhombic wire loop with sides 60m long and elevated about 1.0m. When the earth base was energised with audio frequencies, a current was induced in the elevated loop. Conversely, by energising the elevated loop, it was found that a current could be induced in the earth loop.

In the former mode, the earth base was connected to the 150W amplifier via matching transformer employed for earth current signalling while the elevated loop was connected to the tuner and a battery powered amplifier, or alternatively a DMM. In the latter mode the elevated loop, which had a DC resistance of about 4.0R, was connected directly to the amplifier's loudspeaker terminals, while the earth base was connected to the tuner and battery powered amplifier. A battery powered amplifier was used to eliminate the possibility of mutual coupling with the transmitter amplifier through the power supply line. (Figure 4).

In the unlikely event of either of the loops generating electromagnetic waves, experiments were restricted to frequencies below 10kHz. However, a Hertzian wave can only be efficiently generated by causing standing waves to develop linearly along a conductor and at 10kHz this would need to be about 15km long. Such waves are very difficult to create. Nonetheless for experiments with earth loop antennas a stable Hertzian wave was essential.

VLF Transmitters

As the 2.2 and 3.3kHz signals were not reliable or consistent enough to be used as signal source, the logical approach to was to employ the powerful and consistent VLF Hertzian wave transmitters. So, a second tuner was constructed with a 15mH inductor tuned by a double gang 500p tuning capacity with both gangs in parallel. The tuning coil is in two sections, one to cover the 200 to 100kHz sector, which includes Radio 4, but with the two sections in series, covers 90 to 40kHz and was therefore also used for reception of the 80kHz navigation, and the 60kHz time signals. This is referred to as tuner 'B'.

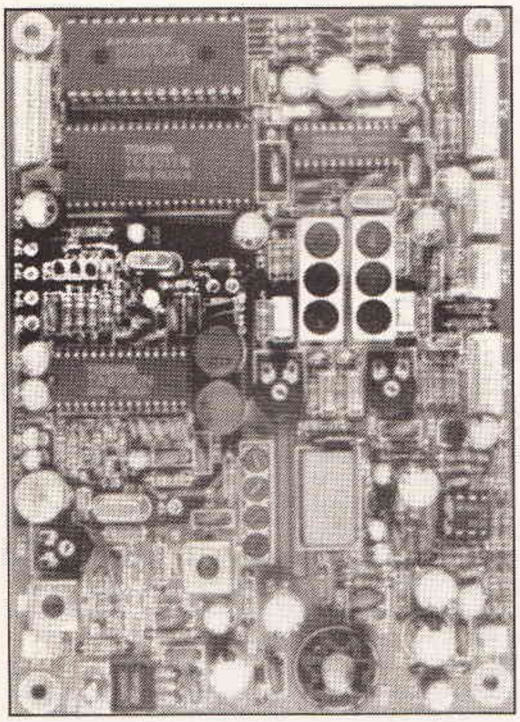
Meanwhile, the matter of adapting the original tuner 'A' to give continuous coverage received attention, and was solved by employing a capacitor decade box to provide unbroken coverage from less than 1.0kHz to more than 15kHz and thus include the 16kHz MOD 'submarine' communication transmitter; it was calibrated with the aid of the audio signal generator. However, capacity boxes are expensive and not readily available to experimenters, moreover, to accentuate the problem, 'decade' capacitors are not available either. By careful choice of 'preferred' values, there is no reason why a suitable capacity box cannot be made from 5% polystyrene capacitors.

In addition, a separate portable ferrite rod antenna/tuner 'C' covering 200kHz to about 40kHz was constructed as a direction finder, to give some indication of signal strength obtainable with this type of antenna.

In part 2, the equipment is described in more detail and the results of some experiments are reviewed.

Nicam Stereo

A TV Conversion using the Maplin NICAM Decoder by Geoff Cox



The last few years have seen tremendous changes in Television. Satellite and cable transmission, teletext, specific audience broadcasting and now the prospect of high definition and wide screen television. Most of these changes have affected the picture quality. The latest change is to provide high quality stereo sound. The UK stereo sound system is called NICAM 728. In this article we look using one of these boards to convert a recent vintage TV set to receive the latest digital sound broadcasts. The receiver is based on the Philips K35 chassis. This chassis was used in some 'Stereo' televisions sold in the mid 1980s under the Philips and Telefunken labels. Similar receivers were sold under the Ferguson and Baird labels.

Safety First

The inside of a television set is a dangerous place so unless you are very confident about what you are doing get your local TV dealer to make the modifications for you. If you wouldn't know a line output transistor if it got up and bit you, it probably will, so leave it to an expert.

If you still feel confident about proceeding contact the manufacturers service department who will be able to supply you with a service sheet. Alternately you may find the circuit diagram in the reference section of your local library. It is vital that you ensure that the chassis is isolated from the mains. Most isolated chassis receivers have large transformers fitted somewhere but the presence of a transformer does NOT mean an isolated chassis, it could be an autotransformer.

Basic Television Layout

Figure 1 shows a basic television layout. In this case the NICAM IF signal will be available at point A following the video trap. Digital Audio can be reinjected into the system by making a break at point B and using a switch or relay to select either FM or NICAM audio source.

The availability of low cost integrated circuits led to the development of the Quasi parallel IF amplifier used on better quality receivers. Figure 2 shows a typical Quasi parallel receiver with appropriate NICAM connection points. The K35 receiver falls into this class.

The NICAM decoder

The NICAM decoder board used in this project was the Maplin Electronics device. This is available in kit form or ready built and aligned.

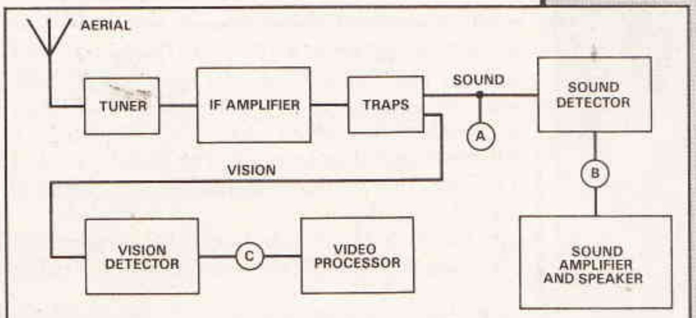


Fig.1 Basic Television receiver

The NICAM board has a number of connections to the outside world, see Figure 4. The function of these connectors is detailed in the documentation accompanying the decoder so we won't go into too much detail here. At present only the standard 'stereo' mode is being broadcast so it was decided to hard wire the mode selector for the time being. Pins 2 and 3 of PL4 were thus linked with a 1k resistor to provide two mono channels if bilingual mode signals are broadcast. The receiver in question had a mute on the audio output so the NICAM mute was left unconnected.

The four mode LEDs were connected to PL3 by

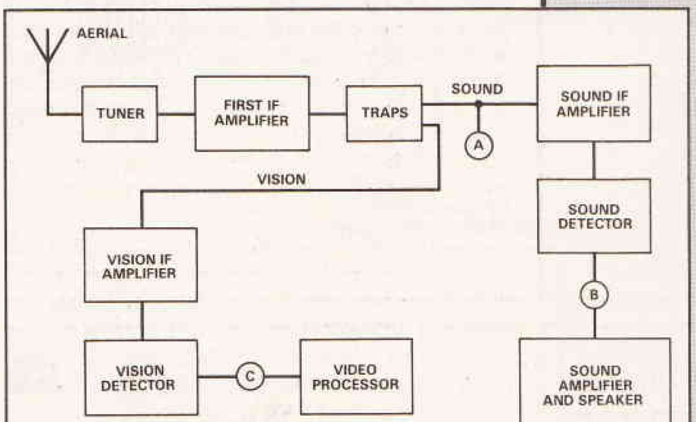
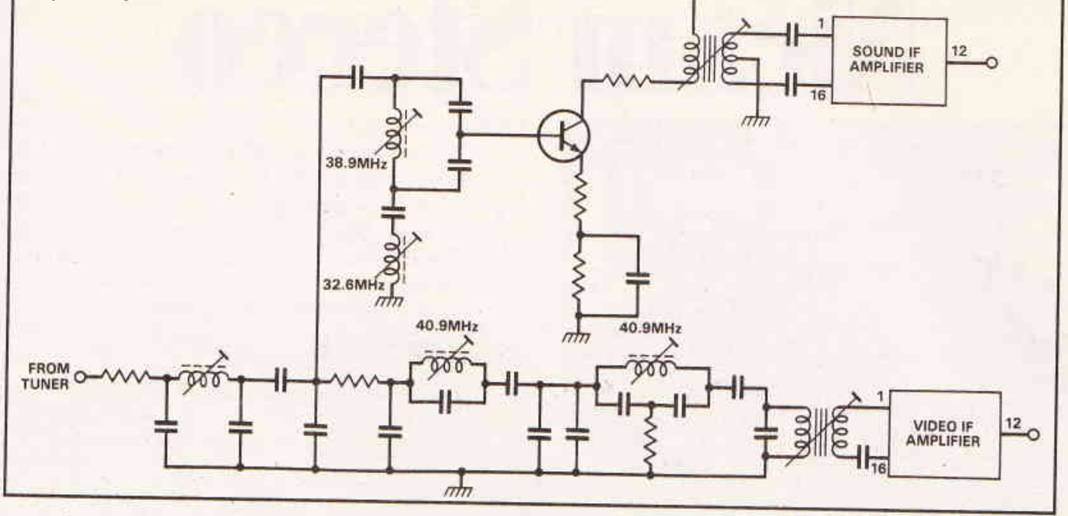


Fig.2 Quasi parallel receiver

short leads and left inside the set. At present they serve no useful purpose but this may change in the future. At present the stereo and C4 LEDs are permanent illuminated in NICAM mode.

The receiver has a row of five LEDs on its front panel, only three of which are ever used. the other two were isolated by removing the appropriate panel and cutting the correct tracks. Four conductors of a six way ribbon cable were used to connect the isolated LEDs to PL7. The broadcast Stereo LED being used to indicate NICAM reception, the I-II LED was used

Fig.3 Simplified IF cicuit



to indicate External Audio (FM) reception. The receiver also has a redundant front panel switch mounted close to the LEDs. There were two spare contacts on this which were used to provide a NICAM/External audio switch. This was wired to pins 1 and 2 of PL7 via the two remaining conductors of the ribbon cable.

Finally a 11-13v supply capable of providing 300A was needed. The set under conversion had an

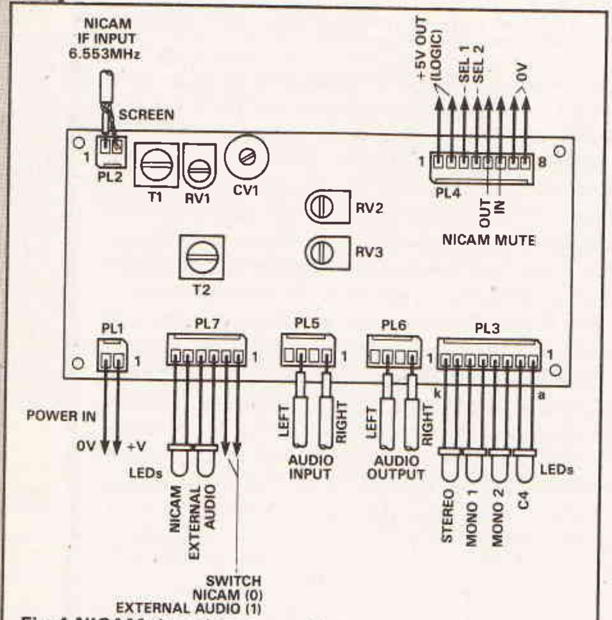


Fig.4 NICAM decoder connections

auxiliary power supply which filled the bill nicely but almost any stabilised supply will do. A 5W 47R resistor is useful here. Measure the voltage from the power supply, clip the resistor across the supply and check there is no significant drop in voltage. If there is look again. If you've got a choice use a power source as close to the NICAM board as you can get. If all else fails you should be able to fit a small transformer and voltage regulator into the case somewhere. There have been many circuits published for this type of simple power supply so I won't describe one here. Remember to take the mains power for the transformer primary from a point in the circuit after the main fuse.

Locating the NICAM signal

This is definitely the hardest part of the conversion. If we look at the circuit of Figure 3 we can see that the output of the Sound IF amplifier would be a good place to extract the NICAM signal. Unfortunately this is probably inside a screened box. If the receiver is not of the quasi parallel type The sound part of the circuit shown in Figure 3 will be missing. In this case you may have to drill the screening case to take the NICAM output from the output of the combined IF amplifier, especially if ceramic filters which can attenuate the NICAM carrier are used.

You might find that the input of the sound demodulator is a more convenient tapping point. This is true of the K35 receiver which is modular with the demodulator and unused stereo matrix decoder on a single plug in board marked U7. All the NICAM connections can be made to this board which can be removed from the set to make life much easier. Figure 5 shows a simplified version of the first half of this board. The L-Y channel is redundant.

SW1, SW3 and SW5 form a 6.242MHz filter but there is usually enough adjustment to realign these to peak at the NICAM IF frequency of 6.552 MHz. You can do this with an oscilloscope, signal generator and frequency counter, or you can obtain a 6.552 MHz signal from CV1 on the NICAM board. If you don't have an oscilloscope don't worry the adjustment is not critical.

Remove C4 and solder a short length of high quality video cable between the junction of SW1 and SW3 and pin 1 of PL3 on the NICAM board. Connect the cable screen to pin 2 of PL3 and the 0v line of the demodulator board. The most convenient 0V points are the screening can of SW5 and pins 1 and 12 of IC2. This IC can be removed and discarded if you wish.

Other Receivers

If you are converting a standard TV the NICAM signal could be tapped from the junction of C1 and C3. In this case the rest of the circuit should remain intact. Many mono receivers use ceramic filters which may attenuate the NICAM signal and make it unusable. Better results are often obtained by taking the IF signal directly from the IF amplifier IC.

There is one final pitfall which may apply to some mono receivers, especially those which do not use the quasi parallel approach, Surface Active Wave (SAW) filters. These are electromechanical devices with a frequency response which is designed to match the required IF profile. Some SAW filters have very sharp cut off points and thus can make the NICAM signal unusable. In this case you may find it better to replace the whole IF amplifier. More on this later.

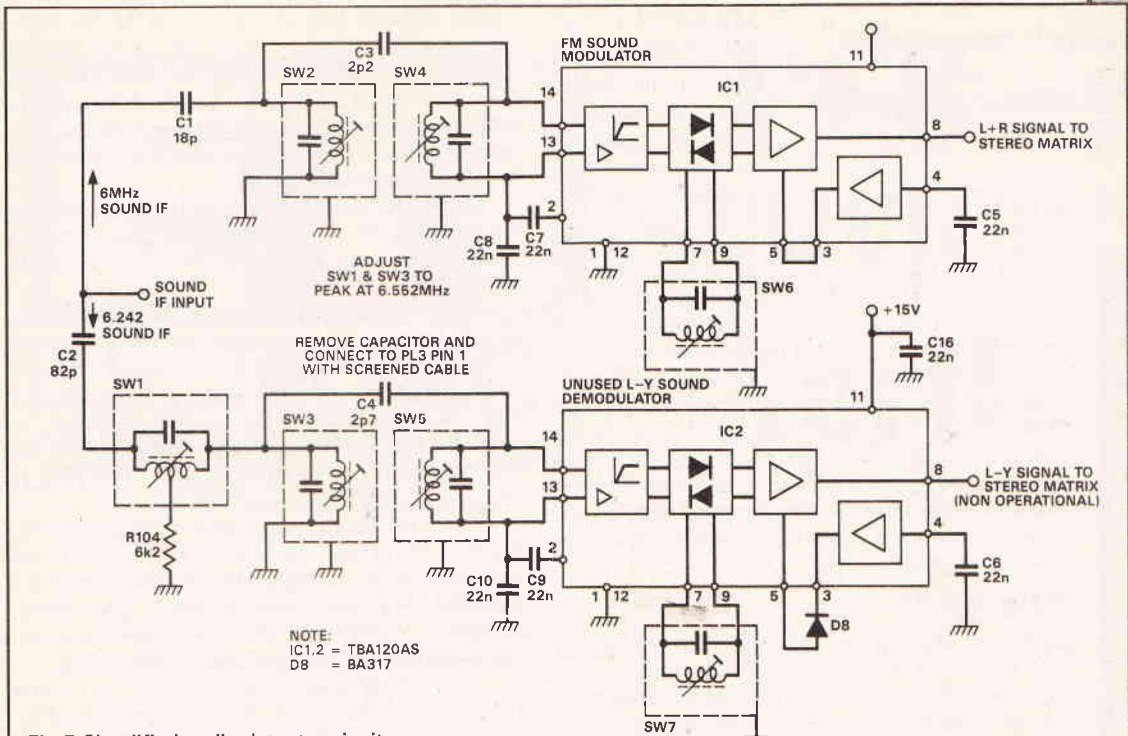


Fig.5 Simplified audio detector cicuit

The Audio Link

The Audio link connections depend on whether the television receiver is a mono or a Stereo type. Mono types will need a stereo amplifier and two speakers either internally or externally mounted. In either case an Audio and/or a speaker connection to the outside world will be required. Some means of turning off the internal audio will also be needed. The volume control can be used if you don't want to fit a switch. You should take the audio from a point in the circuit before the volume control. The output of the sound demodulator is the probably the best place. A screened cable is used to connect the audio take off point to pin 2 and 4 of PL5 on the NICAM decoder board.

Stereo televisions are somewhat easier to convert as they have amplifiers, speakers and, usually, audio output connectors. Figure 6 shows the audio arrangement of our K35. This circuit is also found on the U7 board. The grey area to the left of the circuit is the stereo decoder matrix with left and right channel outputs on pins 18 and 19 respectively. To the right is the audio output to the on board stereo amplifier, Audio output DIN socket, Peritel and Headphone sockets. All we need to do in this case is to break into the circuit between C23 and R11 and C24 and R10. High quality audio lead is used for the connections to the NICAM board. C23 and C24 go to pins 3 and 1 respectively of PL5. PL6 pins 1 and 3 are connected to R11 and R10 respectively. If a suitable Audio outlet does not exist on the television receiver, now is a good time to add one. Use a 5 pin DIN socket with pin 5 going to the left and 3 to the right channel. The use of a good external amplifier and speakers makes a tremendous difference to the quality of the sound produced, even in mono. There is little point in having a CD quality sound source and passing it through a 2 watt amplifier into a three inch speaker in a acoustically terrible enclosure such as the inside of a TV set!.

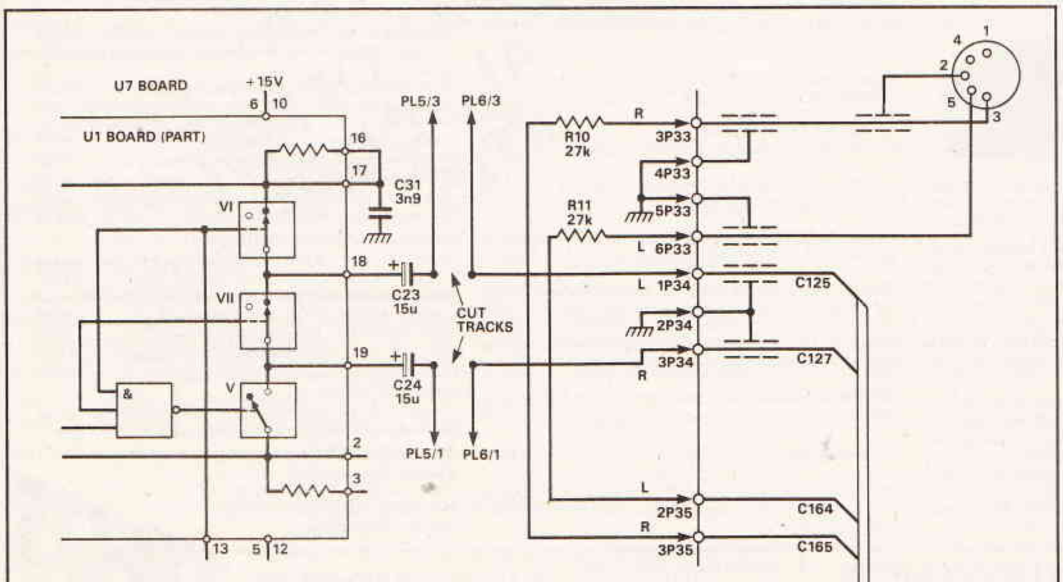


Fig.6 Part audio detector cicuit

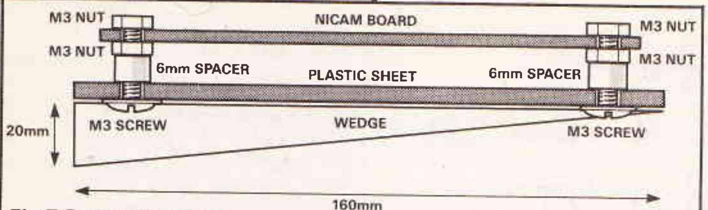


Fig.7 Board Mounting

Mounting the NICAM board

The NICAM board must be securely mounted, preferably on the extreme left, looking from the rear, of the cabinet well away from HT and other noise sources. The set being converted had a teletext decoder mounted on the left wall, this was removed and mounted a couple of inches higher, leaving room for the NICAM Decoder to be fitted at the bottom of the cabinet. A piece of 3mm plastic sheet was used for this purpose. Four holes were drilled to match the decoder mounting holes. M3 screws, spacers and nuts Wooden wedges were glued to the case and the plastic sheet to angle the decoder board slightly away from the wall of the cabinet to allow the shaped rear cover to clear the board.

Alignment

Before starting alignment you should contact a local TV dealer or the BBC and IBA engineering departments to confirm that your local transmitter is operating digital audio. You should also check that your aerial is correctly aligned for the local transmitter. The NICAM board should be either ready aligned or roughly aligned using the instructions supplied with the board.

If you are not converting a 'stereo' TV you can ignore the following paragraph which deals with setting up the IF filters on the audio detector board.

Adjust SW1 and SW3 on the Audio detector board for maximum 6.552 MHz signal at TP1 on the decoder board. If you do not have an oscilloscope use a short piece of wire to short circuit S1. Tune the television to a strong local station that is transmitting digital Audio. The NICAM LED should illuminate. If it does not adjust SW3 so that it is. Find the range of adjustment over which the LED is illuminated and set the core to this position. Remove the short circuit from SW1 and repeat the operation.

Adjust RV2 and RV3 on the decoder board so that there is no change in sound volume when switching between digital and FM sound using the switch connected to PL7.

Check that digital audio is available on all four local TV stations. If you find that one or more station is not available adjust RV1 followed by T1,T2 and CV1. If you still cannot get digital sound on one or more channel you may have a suitable SAW filter in the TV IF amplifier. The easiest way to deal with this is to replace the whole amplifier with a unit such as that supplied by Maplin Electronics.

The exact mechanics of the conversion will very much depend on the television receiver being converted, but it is unlikely that any serious problems will arise. You may need to obtain a ventilated aluminium box to house the tuner board if you see any patterning on vision or buzz on FM sound.

Converting a television receiver to receive NICAM broadcasts is well within the capabilities of the average amateur. The resultant sound quality is remarkable both in Mono and Stereo.

Component sources:
NICAM IF Decoder Maplin Electronics £60 —£129
NICAM Tuner Maplin Electronics £40
0702 554161

Philips Croydon Surrey 081 689 2166
Thorn (Ferguson) Service Enfield Middlesex 081 363 5353
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E9011-4 Four-track cassette recorder (record/playback one channel) .... F
E9011-5 Four-track cassette recorder (Bias/erase oscillator board .... K
E9012-1 Infra Switch .... F
E9101-1 Remote Control — Main Board .... J
E9101-2 Remote Control — Display Board .... H
E9101-3 Remote Control Timeswitch — Transmit board E
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E9101-5 SBC Practice Interface Board .... F
E9101-6 5 in 1 Remote Sensing Switch .... E
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Voltage-Reference Generator Circuits

1

Ray Marston takes an in-depth look at modern voltage-reference generator principles and circuits.

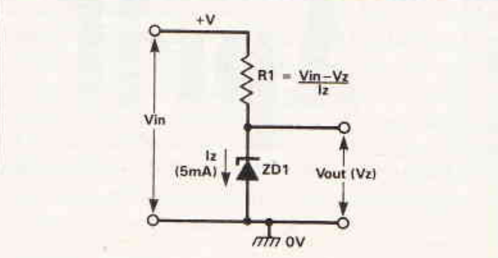


Fig. 1. Basic zener voltage reference circuit.

The electronic voltage-reference generator is a vital element in many modern pieces of test and measurement gear and A-to-D converters, etc. Medium-accuracy voltage-reference generators can be easily and cheaply built using nothing more than one resistor and an ordinary zener diode, and high-accuracy versions can be built by combining a zener diode with an op-amp and a constant-current generator. Alternatively, generators with very high accuracy and excellent long-term stability can be built by using a dedicated voltage-reference generator IC. This article looks at the various options, and shows practical versions of each type of circuit.

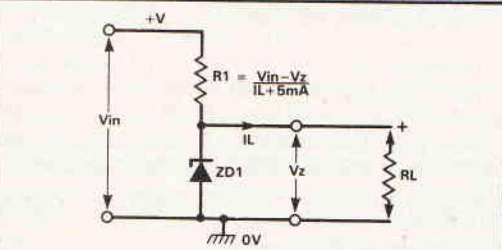


Fig. 2. Basic zener voltage regulator circuit.

Vz (VOLTS)	TEMP COEFF (mV/°C)	DYNAMIC IMPEDANCE (OHMS)	Vz (VOLTS)	TEMP COEFF (mV/°C)	DYNAMIC IMPEDANCE (OHMS)
2.7	−1.8	120	6.8	+2.7	15
3.0	−1.8	120	7.5	+3.7	15
3.3	−1.8	110	8.2	+4.5	20
3.6	−1.8	105	9.1	+6.0	25
3.9	−1.4	100	10.0	+7.0	25
4.3	−1.0	90	11.0	+8.0	35
4.7	+0.3	85	12.0	+9.0	35
5.1	+1.0	75	13.0	+10.5	35
5.6	+1.5	55	15.0	+12.5	40
6.2	+2.0	27	16.0	+14.0	40

Fig. 3. Typical parameter values of 500 mW, 2.7V to 16V zener diodes.

Zener-Based Circuits

The easiest and cheapest way of generating a reasonably accurate and stable reference voltage is to use an ordinary zener diode and a series resistor in the configuration shown in Figure 1. The zener's output voltage is not greatly influenced by modest variations in zener current (I_Z), which is normally set at about 5mA; the R_1 value is found from the formula;

$R_1 = (V_{IN}/V_Z)I_Z$

Note that this circuit can be made to act as a simple voltage regulator, which can supply a few milliamps of output current, by selecting the R_1 value on the alternative basis shown in Figure 2.

Practical zener diodes are available with a variety of voltage values and power ratings, and usually have a basic voltage tolerance within ±5% of their specified value. Figure 3 lists the typical major parameter values of a popular 500 mW range of zeners with standard voltages between 2.7V and 16 V. Note that all except the 4.7V device have significant temperature coefficients (causing the zener voltage to vary with temperature), and that all devices have a substantial dynamic impedance (causing the voltage to vary with changes in zener current). Thus, the basic Figure 1 and 2 circuits give a performance that is adequate for many simple applications, but can not be relied on to give good accuracy if used in a hostile environment in which the supply voltage, load current, or operating temperature vary significantly.

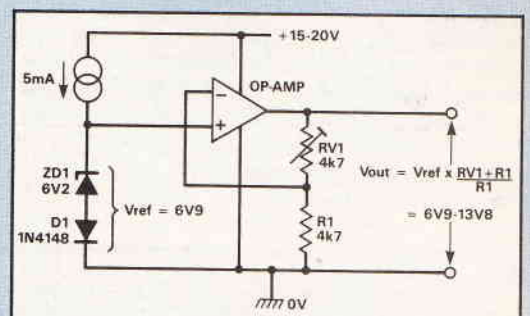


Fig. 4. Precision variable-value voltage-reference generator.

The best way to generate a high-precision zener-derived reference voltage is to drive a zero-temperature-coefficient zener diode via a constant-current source, to generate a basic reference voltage that is independent of variations in temperature and supply voltage, and to take this reference to the

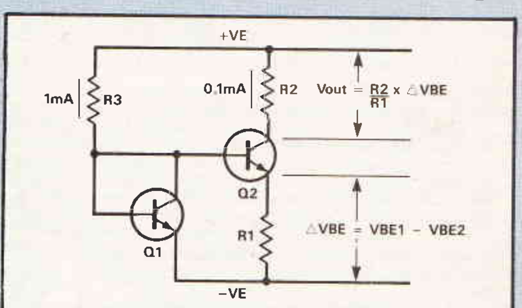


Fig. 5. Basic ΔV_{BE} voltage-reference generator.

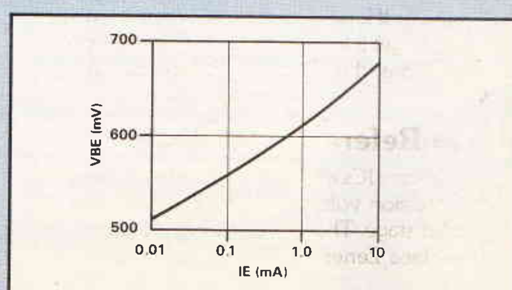


Fig. 6. Typical V_{BE}/I_E transfer characteristics.

CIRCUITS

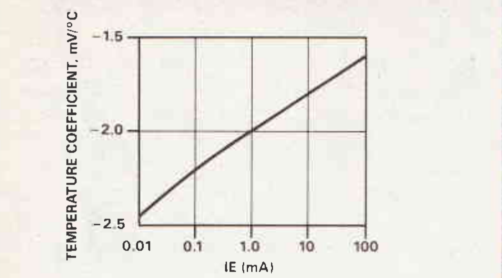


Fig. 7. Typical V_{BE} thermal characteristics.

outside world via a non-inverting buffer stage that has its gain set to give the precision reference output voltage that is required. Note that the basic zener reference voltage can be derived via either a single 4.7 V zener diode or via a 6.2 V zener plus a series 1N4148 silicon diode (thus giving a 6.9 V reference in which the +2mV/°C coefficient of the 1N4148); Figure 4 shows a practical circuit using the latter option.

Note that the Figure 4 circuit gives a low-impedance output voltage that is variable over a 2:1 range via RV_1, and that the circuit has two important defects that are common to all conventional zener-based designs, but are not obvious in the diagram. The first is that all zener diodes inherently act as white noise generators, and thus produces a 'mushy' output; this defect can easily be overcome by wiring a low-pass filter between the zener output and the input of the op-amp in Figure 4. The second defect is more serious, and can not be overcome; it is that all conventional zener diodes have poor long-term voltage stability. If long-term stability is important, the easiest way to get it is to replace the Figure 4 circuit with a design based on a special 'Reference-Voltage' IC.

Voltage-Reference IC Basics

Voltage-reference ICs are simple units that, in essence, house a precision voltage reference device and an output buffer stage. The reference may take the form of a 'subsurface Zener' that generatees a precision output of about 6.9 volts with excellent long-term stability, or it may be of the 'band-gap' type, which generates a stable low-noise output of (usually) about 1.22 V. The output buffer acts as a current-boosting (and sometimes voltage amplifying) regulator, and may be of either the shunt or the series type; ICs with shunt outputs can normally be used in exactly the same way as a simple Zener diode, and are often represented by a zener diode symbol.

Note that the poor long-term stability of the conventional discrete zener diode is caused by the field effects of the semiconductor material's mobile surface ions; in the modern zener-based voltage-reference IC this effect is eliminated by siting the zener below the die's surface, i.e., by using a sub-surface zener. The subsurface zener is usually combined with a series diode, to form a voltage reference that has a temperature coefficient of less than 100 PPM/°C (i.e. below 0.7mV/°C).

The basic operation of the second type of precision voltage reference, the 'band-gap' type, can be understood with the help of Figures 5-8. Figure 5 shows the first stage in the development of the circuit.

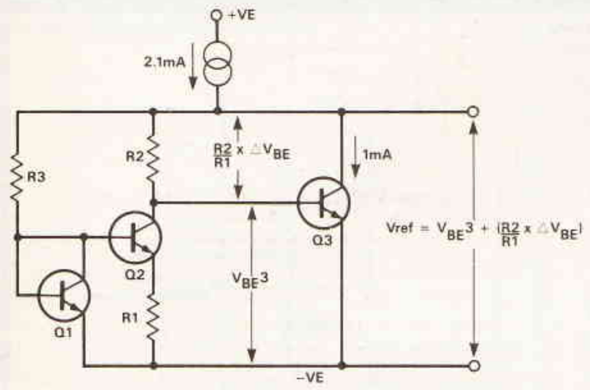


Fig. 8. Simple band-gap voltage-reference circuit.

DEVICE NUMBER		Vref	VOLTAGE TOLERANCE AT +20°C	DRIFT PPM/°C (MAX)	REFERENCE OPERATING CURRENT	OUTPUT TYPE
LM329B		6V9	±5.0%	50	0.6-15mA	SHUNT
LM336B	-2.5	2V49	±2.0%	54	0.4-10mA	"
"	-5.0	5V0	±4.0%	54	0.4-10mA	"
LM368	-2.5	2V5	±0.2%	30	0.55mA(IQ)	SERIES OUTPUT CAN
"	-5.0	5V0	±0.1%	30	0.35mA(IQ)	SUPPLY UP TO 10mA
"	-10.0	10V	±0.1%	30	0.35ma(IQ)	
LM385		ADJUST (1.235-5V3)	±2.0%	54	13uA-20mA	SHUNT
LM385	-1.2	1V235	±2.4%	150	15uA-20mA	SHUNT
"	-2.5	2V5	±3.0%	150	20uA-20mA	"
LM3999		6V95	±5.0%	5	0.6-10mA	"

Fig. 9. Voltage reference IC selection chart (National Semiconductor 'commercial grade' devices, with 0°C to +70°C operating range).

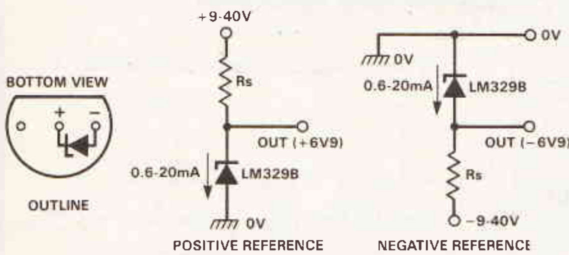


Fig. 10. LM329B outline and basic reference circuits.

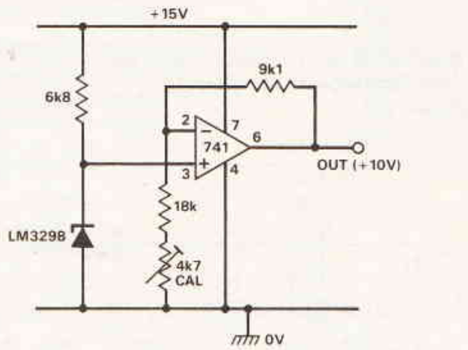


Fig. 11. Buffered 10.0V reference with single-ended supply.

Here, Q_1 is used as a diode that is forward biased at 1 mA via R_3, and Q_1's V_BE voltage. Figures 6 and 7 show the typical V_{BE}/I_E transfer and V_{BE} temperature coefficient (TC) characteristics of these two transistors. From Figure 6 it can be seen that Q_1 and Q_2 develop V_{BE} values of 600 mV and 550 mV respectively, and that a set reference voltage of 50 mV is thus generated across R_1. From Figure 7 it can be

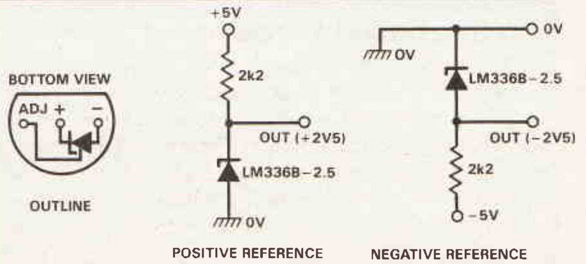


Fig. 12. LM336B-2.5 outline and basic reference circuits.

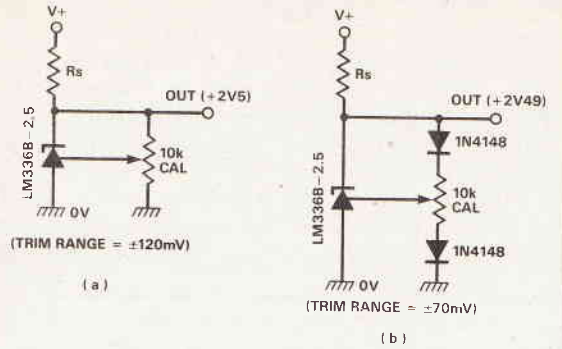


Fig. 13. LM336B-2.5 'trim' circuits to give (a) voltage and (b) temperature coefficient compensation.

seen that Q_1's V_{BE} has a TC of -2mV/°C and Q_2 has one of -2.2mV/°C; consequently, the R_1 voltage has an aggregate TC of +0.2mV/°C. Figure 5 shows that the circuit's final output voltage is taken from across R_2, and is R_2/R_1 times greater than the R_1 voltage. Thus, if R_2/R_1 have a 10:1 ratio, the final output voltage has a value of 500 mV and a TC of +2mV/°C.

Figure 8 shows, in simplified form, the complete band-gap reference circuit, which is similar to the circuit in Figure 5 except for the addition of Q_3 and also that the entire circuit is driven via a 2.1 mA constant current generator that ensures Q_3 operates with a 1 mA collector current. The final output (V_{REF}) voltage is equal to the sum of the R_2 voltage (which has a positive TC) and the V_{BE3} voltage (which has a negative TC); in practice the R_2/R_1-controlled gain is set during manufacture to ensure that these two TCs cancel out and give a V_{REF} output of about 1.22 V. Practical band-gap reference generators give output voltages that are very stable, have near-zero TCs, and generate negligible noise.

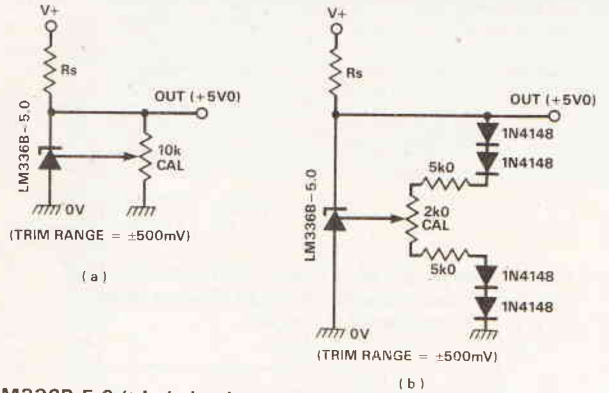


Fig. 14. LM336B-5.0 'trim' circuits to give (a) voltage and (b) temperature coefficient compensation.

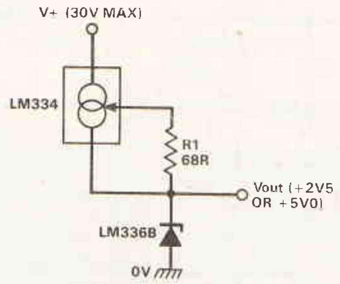


Fig. 15. LM336B-2.5 or -5.0 voltage reference, using wide supply voltage range.

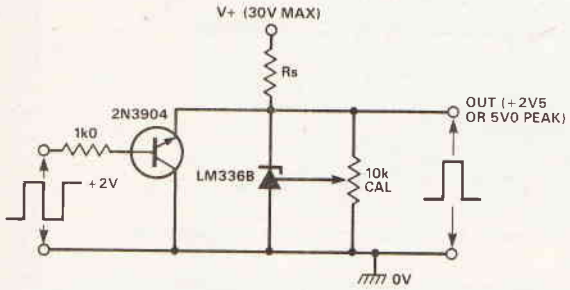


Fig. 16. LM336B-2.5 or -5.0 square wave calibrator circuit.

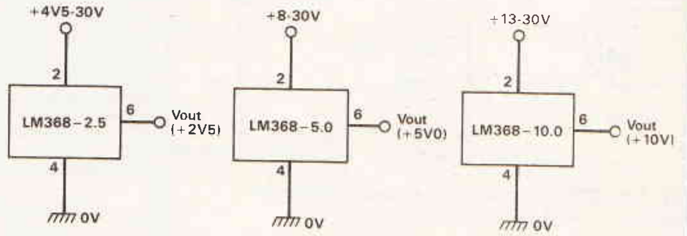


Fig. 17. Basic LM368 voltage-reference application circuits.

Practical Voltage-Reference IC

Several companies manufacture excellent voltage-reference ICs, but the most widely available types are those manufactured by National Semiconductors. Figure 9 gives basic details of ten popular 'commercial grade' voltage reference ICs manufactured by this company; most of these devices are also made in 'industrial' and 'military' grades, with greratly enhanced specifications. Some of the listed ICs use a subsurface zener reference, and others use a band-gap reference.

Details of these ICs are as follows:

The LM 329B

The LM329B is a low cost Zener-based precision 6.9 V reference that can operate over the 0.6 mA to 15 mA current range; it is usually housed in a 3-pin plastic package, as shown in Figure 10, which also shows basic ways of using it as a positive or negative 6.9 V reference; the R_S value is chosen to set the desired operating current, as in a normal Zener diode. Figure 11 shows a simple way of boosting the LM329B output to make a 10 V reference generator (a precise 10 V can be set by trimming the CAL control).

The LM336B-2.5.

The LM336B-2.5 is a low-cost band-gap based

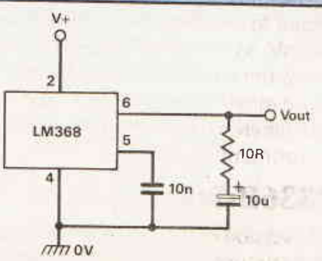


Fig. 18. Low-noise version of the voltage reference circuits.

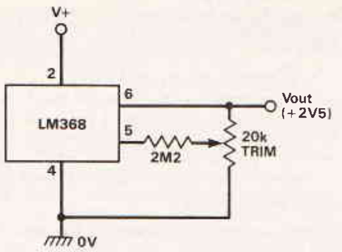
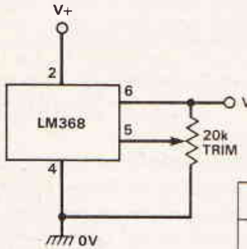


Fig. 19. Narrow-range trimmable (±1%) version of the voltage reference circuit.



IC TYPE	MINIMUM Vout 'TRIM' RANGE
LM368 – 2.5	2V2 TO 5V0
" – 5.0	4V5 TO 6V0
" – 10.0	6V0 TO 15.5V

Fig. 20. Wide-range trimmable version of the LM368 voltage reference circuit.

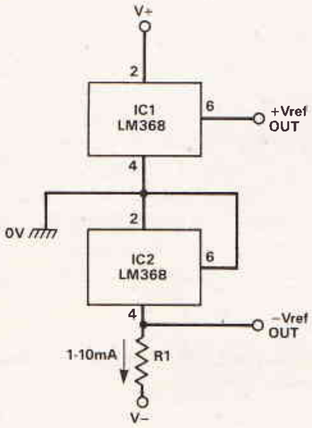


Fig. 21. LM368 dual-polarity voltage reference.

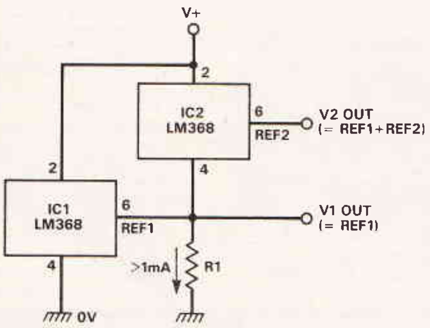


Fig. 22. LM368 multiple voltage reference.

precision 2.5 V (nominally 2.49 V) reference and is housed in a 3-pin TO-92 plastic package; Figure 12 shows its outline and basic usage circuits. The IC's third pin can be used to either trim the output voltage by about ±120 mV, as shown in Figure 13a, or to trim the IC for minimum temperature coefficient (in which case the output must be set to 2.490 volts), as shown in Figure 13b (where D_1 and D_2 must share the same thermal environment as the IC).

The LM336B-5.0.

This is a 5.0 V version of the above IC; it has the same outline and basic usage connections (allowing for variations in circuit voltages) as already shown in Figure 12, its third terminal allows voltage or thermal compensation to be made (see Figure 14).

Note that the LM336B-2.5 or -5.0 can be operated from widely variable supply voltages (up to 30 volts maximum) by feeding it via an LM334 constant-current generator IC (to be described next month), as shown in Figure 15 (where R_1 sets the constant-current value at 1 mA). Figure 16 shows how these LM336 ICs can also be used to make a square-wave calibration generator, for use in oscilloscopes and the like.

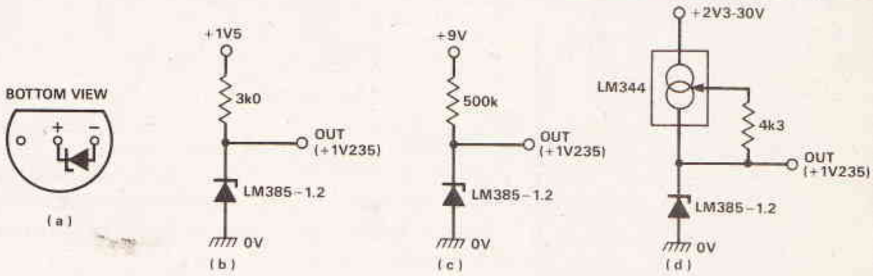


Fig. 23. LM385-1.2 outline (a) and basic circuits showing (b) reference from 1.5 V battery, (c) micropower reference from 9 V battery, and (d) reference from wide range supply.

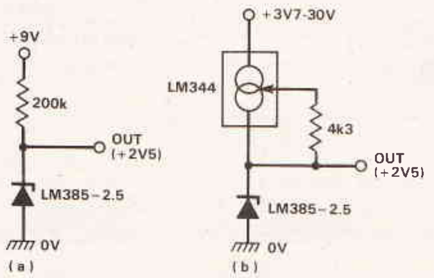


Fig. 24. Basic LM385-2.5 circuit showing (a) micropower reference from 9 V supply and (b) reference from wide range supply.

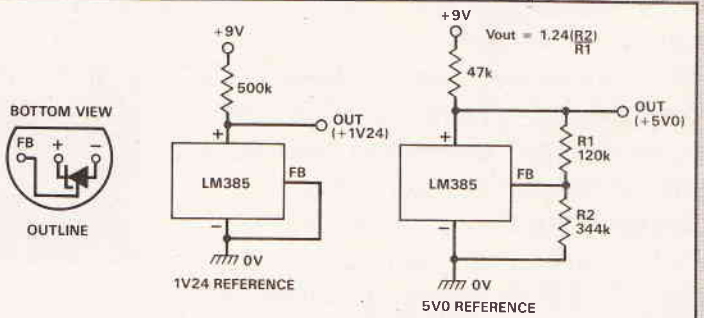


Fig. 25. LM385 outline and basic application circuit.

The LM368- Series

The LM368 series of ICs combine a band-gap reference and a fixed-gain series-pass booster stage that can supply output currents of up to 10 mA, to make a precision 2.5 V, 5.0 V, or 10.0 V voltage reference, as indicated by the Ic's suffix number. The LM368 is available in 8-pin DIL or metal can packages, but only pins 2 (V+), 4 (V-), 5 (ADJUST), and 6 (OUTPUT) are used. Figure 17 shows the basic way of using each version of the IC, and Figure 18 shows how the circuit can be modified for minimum noise generation.

The LM368 is provided with a TRIM terminal (pin 5), to adjust the output voltage over a useful range, as shown in Figures 19 and 20. Another useful

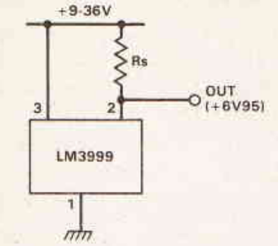


Fig. 27. Standard LM3999 application circuit.

feature is that the IC can be operated in the 'shunt' mode (like a normal Zener diode) by shorting pins 2 and 6, as shown in IC2 in the dual-polarity voltage reference circuit of Figure 21. Finally, Figure 22 shows how a pair of LM368 ICs can be used to make a multiple output reference in which V_2 is equal to the sum of the two reference voltages.

The LM385-Series

The LM385-series of ICs combine a band-gap reference and a shunt booster to make 'micropower' devices that can operate at currents ranging from a few microamps to 20 mA. There are three basic devices in the series; the LM385-1.2 is housed in a TO-92 package and generates 1.235 V; Figure 23 shows the ICs outline and basic application circuits. The LM385-2.5 is housed in the same TO-92 package and generates a fixed 2.5 volts output; Figure 24 shows two basic usage circuits. Finally, the plain 'LM385' is a 3-pin version that can be adjusted, via its FB terminal, to give a precision 'micropower' reference in the range 1.24V to 5.3V; Figure 25 gives details of the device.

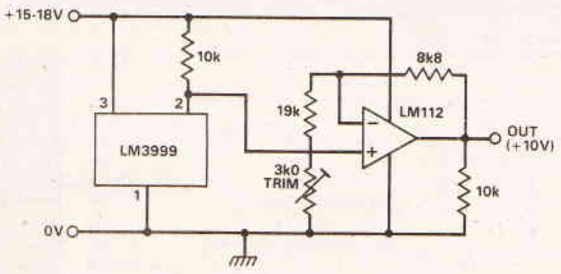
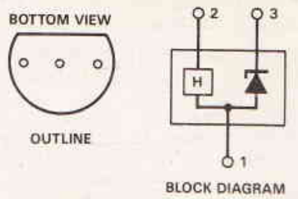


Fig. 28. Precision 10 V reference.



TYPICAL SPECIFICATION	
REFERENCE VOLTAGE	= 6V95 ±5%
ZENER CURRENT RANGE	= 0.6-10mA
ZENER TEMP COEFFICIENT	= 0.0002%/°C
PIN 3 CURRENT	= 12mA (AT 25°C AT 30V)
PIN 3 VOLTAGE RANGE	= 9V-36V
IC WARM UP TIME	= 5 SECONDS (TYPICAL)
INITIAL PIN 3 TURN-ON CURRENT	= 140mA (AT 25°C)

Fig. 26. Basic details of the LM3999 precision voltage reference IC.

The LM3999

The LM3999 is a precision temperature stabilised voltage reference that houses a conventional shunt-type Zener reference and a heater circuit in a single 3-pin package, giving a reference temperature coefficient of better than 0.0002%/°C. The Zener section of the IC generates 6.95 volts and can be used over the 0.6 mA to 10 mA current range; the heater section can operate from supplies in the 9 V to 36 V range, draws an initial switch-on current of about 140 mA (to give rapid IC warm-up) but this rapidly reduces (within about 5 seconds) to a niminal value of 12 mA. Figure 26 shows basic details of the device, and Figure 27 shows its basic applicatiion circuit. Finally, to complete this look at voltage-reference generator circuits, Figure 28 shows how the LM3999 can be used in conjunction with an op-amp to make an ultra-high-precision 10.00 V reference that can be used as a calibration laboratory standard.

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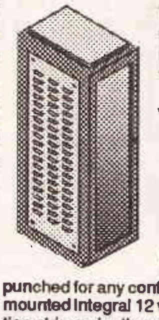

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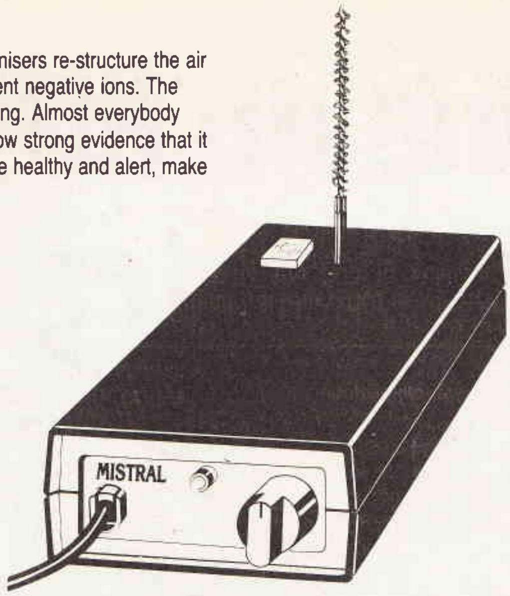

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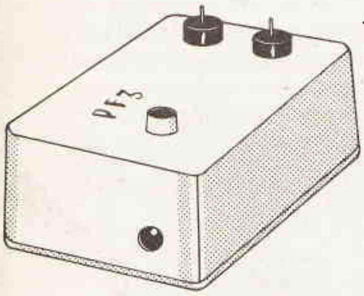


◁ PROPHET PF3

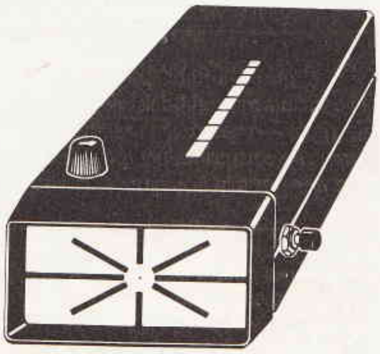
The Prophet performs its own special miracle on the dashboard of your car. First reports are most impressive: driving becomes a positive pleasure, easier to stay alert on long motorway journeys, a child cured of travel sickness. The ion effect is not to be underestimated. Don't forget the experiments either: there's the smoke trick, triffids, the living emitter, and more. The Prophet can be used anywhere with a supply of 9V to 12V DC, so don't restrict it to the car alone!

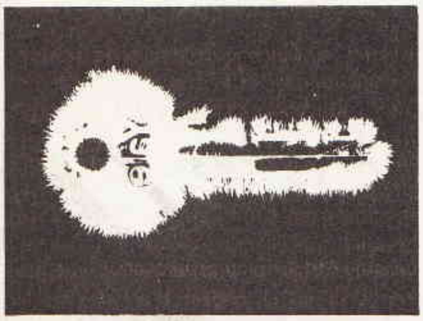
PROPHET PF3 PARTS SET **£21.39** ☐

THE Q-ION ▷

Check out the ion levels around your house. The Q-Ion will measure the output of any ioniser, test the air to see where the ions are concentrating, help you set up fans and position your ioniser for best effect, and generally tell you anything you want to know about ion levels in the air. The readout is in the form of a bar graph which moves up and down as the Q-Ion sniffs the air in different parts of the room. Readings up to 10^{10} ions per second, positive or negative.

Q-ION COMPLETE PARTS SET **£21.16** ☐





◁ KIRLIAN CAMERA

Bioplasmic fields, auras, or just plain corona discharge? No matter how you explain them, the effects are strange and spectacular. Can you really photograph the missing portion of a torn leaf? Can you really see energy radiating from your finger tips? Most researchers would answer 'yes' to both questions.

Our Kirlian photography set contains everything you need to turn the Mistral into a Kirlian camera, your bedroom or spare room into a darkroom, and to expose, develop and print Kirlian photographs (photographs made with high voltage electricity instead of light). The set includes exposure bed, safelight bulb, developing and fixing chemicals, trays, imaging paper and full instructions. A Mistral ioniser parts set is also required.

KIRLIAN CAMERA SET **£19.78** ☐

IONISER EXPERIMENTS

* The Vanishing Smoke Trick

Light up a cigarette and gently puff smoke into a glass jar until the air inside is a thick, grey smog. Carefully invert the jar over the ioniser so that the emitter is inside. Within seconds the smoke will vanish! This is one of the best demonstrations of an ioniser's air cleaning action and with a large jar the effect is quite dramatic.

* Triffids

Connect a length of wire from the ioniser emitter to the soil in the pot of a houseplant. One with sharp, pointy leaves is best. Hold your hand close to the plant and the leaves will reach out to touch you! In the dark you may see a faint blue glow around the leaf tips – this works better with some plants than with others, so try several different types. The plants don't object to this treatment at all, by the way, and often seem to thrive on it.

* The Electric Handshake

Wear rubber soled shoes. Touch the ioniser emitter for a few seconds until your body is thoroughly charged up. When your hair stands on end, that's just about enough. Then give everyone you meet a jolly electric handshake. Just think, you could lose all your friends in a single evening! (A meaner trick still is to charge up a glass of water or a pint of beer. Even your family won't speak to you after that!)

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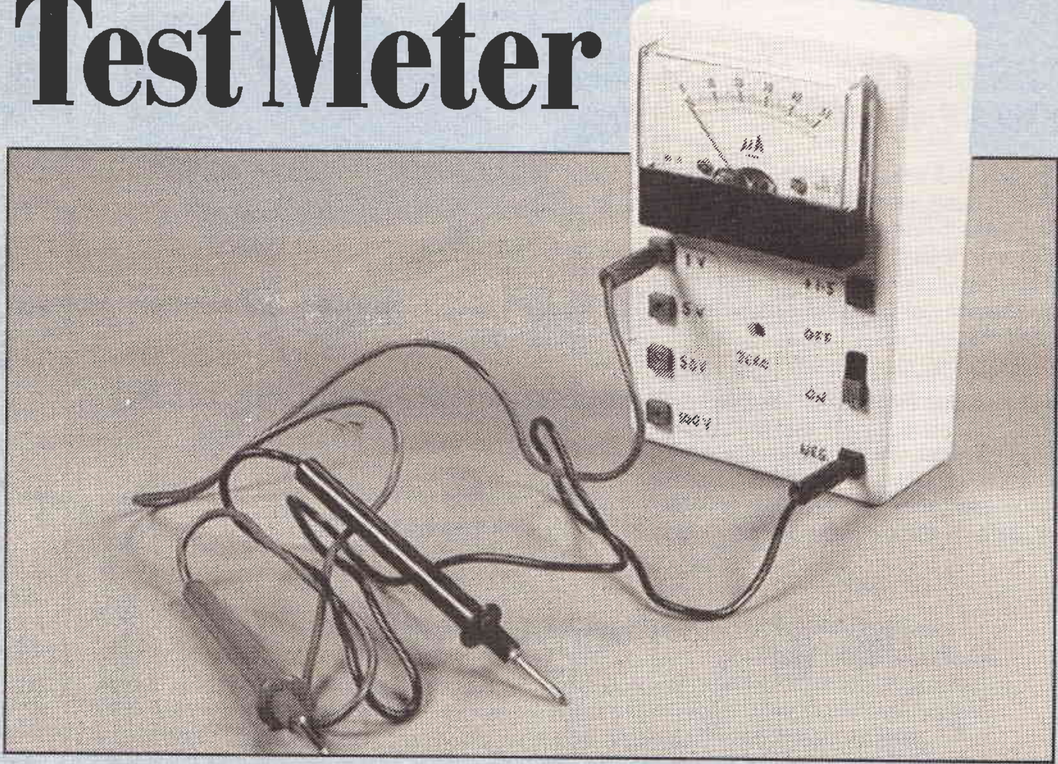
Designing an Electronic Test Meter

2

John Smith now turns the circuit design into a working voltmeter



Last month, a final design was produced for an active multi voltmeter. Now we turn our attention to the construction, but just before that you'll notice that Figure 1 shows the full theoretical circuit with the inclusion of the range resistors, and the various FSD inputs. Rmsh is placed across the meter and its value will depend on the meter type — more of that later.

Construction

Referring to the view shown in Figure 2, looking into the rear of the Plastic Box. Make board 'A' from plain copper-clad PC material, with the copper on the upper surface. Cut a 'U' notch in the centre of the lower edge as shown in Figure 3. Check that this board is a snug fit into the lower part of the plastic box. Cut board 'B' as with board 'A' to make a 'U' notch in the centre of the lower edge. Align the two boards and ensure that the excess width of board 'A' is equally 13mm either side of board 'B'.

If this is satisfactory, mark and drill the two 6 BA holes through board 'A'. Again with board 'A', drill the 3mm holes for the switch mounting, and cut the slot for the switch 'tang'.

Assemble the two boards, using 6 BA bolts and spacers and then add the switch, using 3mm bolts,

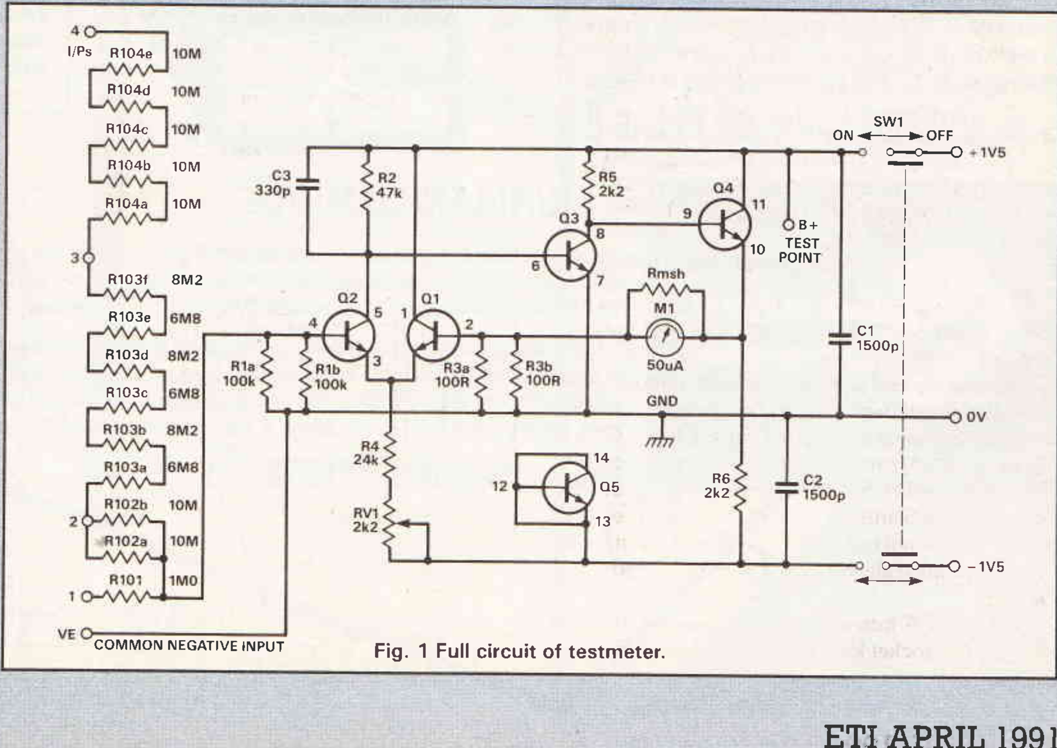


Fig. 1 Full circuit of testmeter.

PROJECT

to see that everything is fitting so far.

Dismantle and make the 5mm holes in board 'A' for the sockets, being careful with alignment, as the appearance of the completed instrument will be affected by this. Still with board 'A', countersink the 6 BA and the 3mm holes on the plain side.

Mount RV1 on the copper side of board 'B', so that it is a little less than 6mm proud, and set exactly along the centre-line of the board.

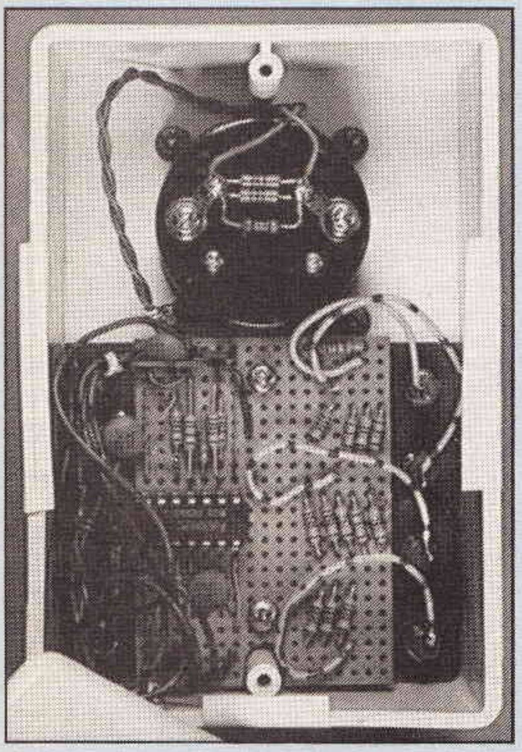
Drill a *pilot* hole in board 'A' to coincide with adjusting slot of RV1. Assemble the two boards and check that this hole will give access to RV1. If this is satisfactory, enlarge this hole. Complete the work on board 'B', noting that R_{1b} and R_{3b} are mounted on the copper side, for convenience.

Also fit and solder the IC. the chip contains only normal silicon transistors so, although care must be taken, it is not so easy to damage as a FET. The IC may be mounted on a holder, if desired.

Leave all outgoing leads over-length.

Using board 'A' as a template, make the 5mm holes, the slot for the switch 'tang', and the access hole for RV1 in the front panel of the Plastic Case.

DO *NOT* DRILL THE 6 B.A. OR THE 3mm HOLES THROUGH THE FRONT PANEL. The large hole, and the four small (2.5mm) holes for the meter may now be made. Check that the dimensions in Figure 2 agree with the information given with the meter. Also check that the meter will fit between the top of board 'A' and the protruding plastic moulding at the top of the box.



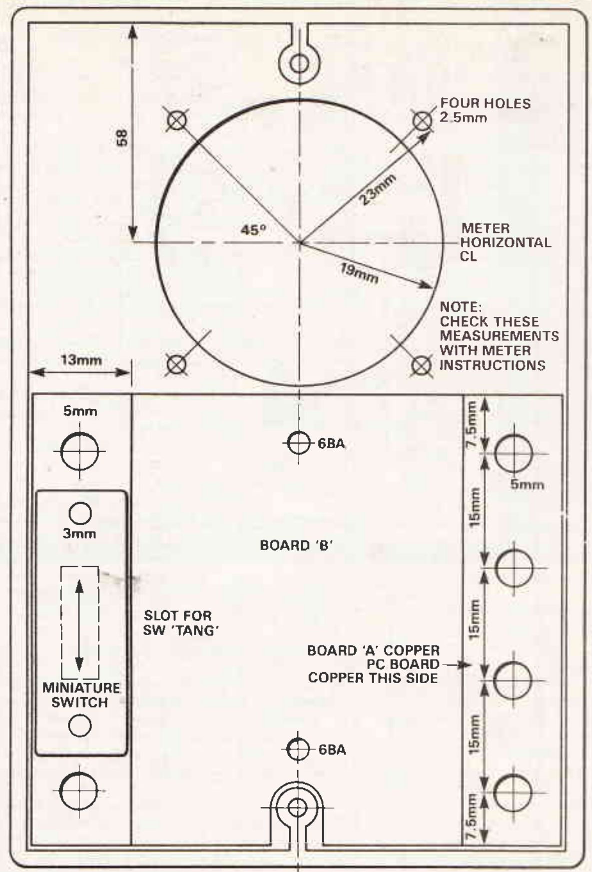


Fig. 2 Detail inside box.

If all is well so far, the meter may be fitted and held in place with the 2.5 mm nuts and washers supplied.

Fit spacers and switch to board 'A', remembering to use the shortened c/s bolts for the spacers. Wire the switch as shown in detail in Figure 5, fitting C1 and C2 from the ± terminals of the switch to the copper surface of board 'A'. Select the value of R_{msh} from the chart in Figure 6 and solder the resistor(s) directly to the meter terminal tags, this will convert any meter to one of 1mA full scale. Connect the ± meter leads from board 'B'.

Fit board 'A' into lower part of the case, holding it in with the socket locking nuts. Fit board 'B' on to spacers.

Check that the switch is OFF and temporarily connect the battery, noting that the '0' volts wire should go between the two cells.

Switch on, and see that the meter can be zeroed by RV1, then apply 3 or 4.5 volts to input two. (Remember that a new alkaline cell will give more than 1.5 volts.) The reading obtained should be accurate to 1%, but if a check meter is available — so much the better!

If things are not going too well at this stage, switch OFF, disconnect the battery, and check:

That the i.c. is the right way round. (!)

That the correct value components are in the correct places.

If the instrument works, but the ranges are badly in error, check that R_{msh} is the correct value for the meter in use, and that the high value range resistors are right — high value colour codes can be confusing!

Assuming that all is now OK, check that the battery box will fit in the corner of the lid, without the

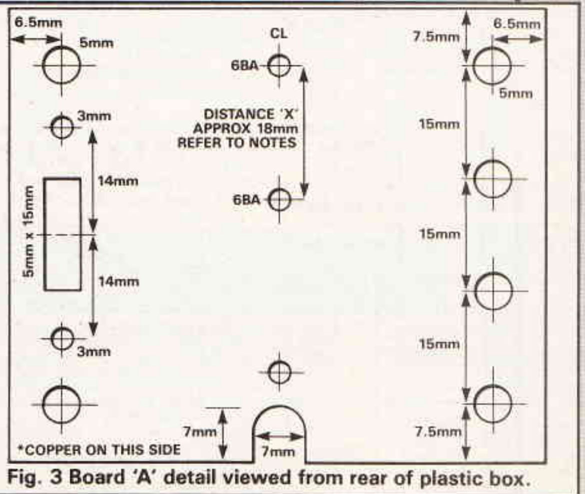


Fig. 3 Board 'A' detail viewed from rear of plastic box.

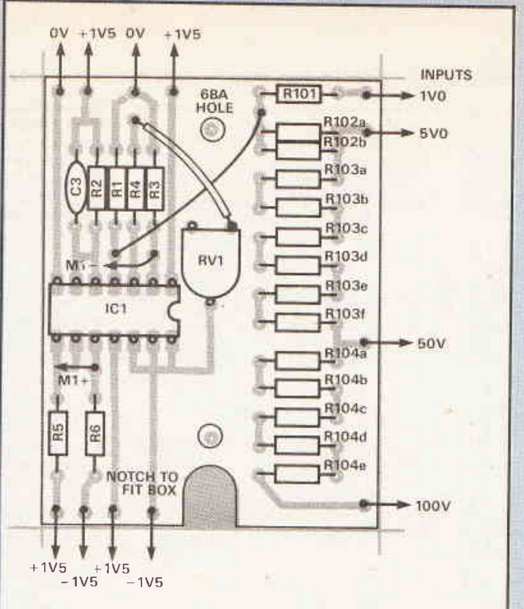


Fig. 4 Component Overlay for Testmeter.

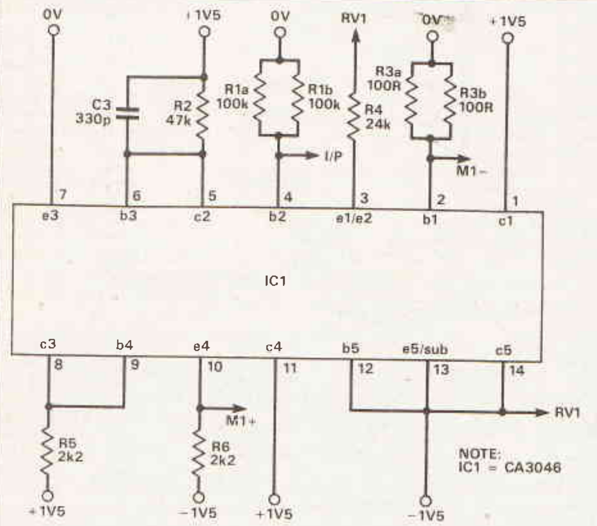


Fig. 5 IC wiring detail.

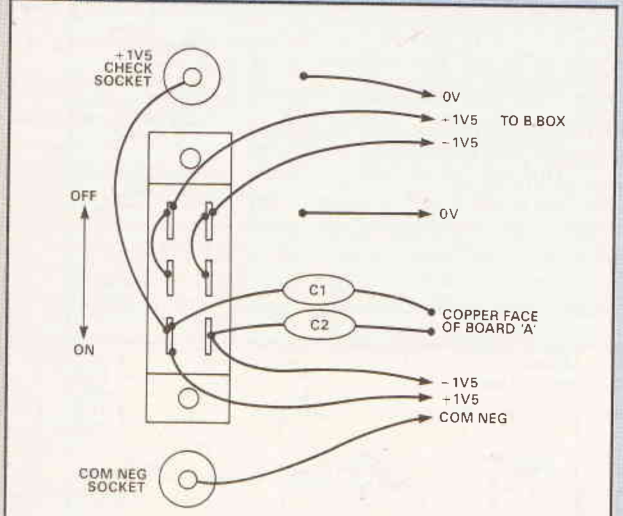


Fig. 6 Switch wiring detail.

Fig. 7
Values of meter shunt resistors R_{msh} for various meter movements.

Panel Meter Maplin Code	Full Scale Current	Internal Resistance	Shunt for 1mA	Made from Two Resistors in Parallel.
FM 98 G	50 uA	4300R	226.3R	910 & 300R
RW 92 A	100 uA	3750R	416.7R	1600 & 560R
RW 94 C	1 mA	200R	not req.	—— ——

metal cases of the cells touching any components, or exposed wiring, and then stick the battery box in place. Make the battery connections using a solder tag under the spring in the battery box — be careful that this tag doesn't touch anything else. Fix the lid with the screws provided — if you haven't lost them — and away you go !

The instrument only take about 1½mA quiescent, to 2½mA full scale — so you shouldn't need to change the batteries very often. A battery check socket has been provided, if the volts fall much below 1.5v., change both cells.
Values of meter shunt resistors R_{msh} for various meter movements.

PARTS LIST

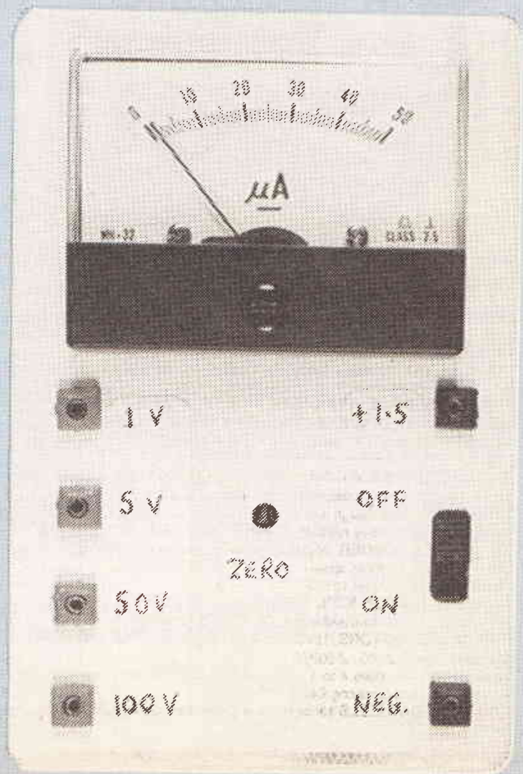
RESISTORS – Metal Film – 1%

R1	50k (or R1a, R1b – 100k each)
R2	47k
R3	50R (or R3a, R3b – 100R each
R4	24k
R5	2.2k
R6	2.2k
RANGE RESISTORS	
R101	1M
R102a, 102b	10M
R103a, c, e	6.8M
R103b, d,f	8.2M
R104, a to e	10M
RV1	2k2 horiz preset
Rmsh	Value depends on meter used (see Table)
CAPACITORS	
C1,2	1,500p
C3	330p
SEMICONDUCTORS	
IC	CA3046

MISCELLANEOUS
Box (white). Meter (50 uA). Switch (Double Pole). Skts 2mm RED, BLACK Battery Holder

Copper Board	71×60mm
6 BA Tapped Spacers	(¼ inch)
6 BA c/s Bolts	(¼ inch)
6 BA Rnd. Head	(¼ inch)
M3 c/s Bolts	(6mm)

Connecting wire
Solder tag – about 6 BA – for extra battery connection.
Two A.A.A. cells – Alkaline preferred.
Set of Test-Prods with 2mm. Plugs.



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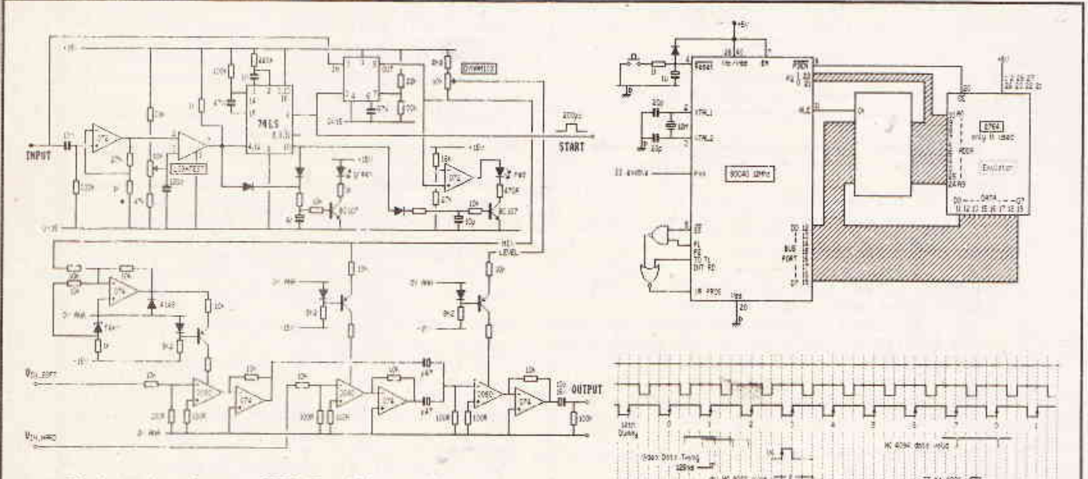
Micro Design 2



Printed using a HP-Deskjet printer

A review of a DTP package from Creative Technology for engineers by Herbert Ward.

For every engineer and budding boffin, there comes a critical moment when that brilliant idea or clever implementation must finally be transferred from a plate of matrix-board spaghetti onto a piece of paper. You may be submitting a dissertation report, writing an exam paper or a manual, or even documenting your latest phone-bill-fiddler for Hacker's Monthly: whatever line of business you are in, you will eventually have to produce some kind of technical document which can be read and understood by other engineers, or even by real people.

There are a number of computer programs for producing circuit diagrams, and some combine these diagrams with PCB design, but a proper technical report is not merely a set of diagrams: it is a text document with illustrations. Yet when it comes to adding text to circuit diagrams, it seems that existing packages offer the ability to label components, and very little else. Proper reports have to be compiled using word-processor printouts with gaps left for the diagrams, or using a very expensive WYSIWYG word-processor with diagrams imported from an equally expensive CAD package.

But the need for a more sensibly-priced solution now appears to have been filled by MicroDesign2, a program which combines technical drafting with a basic text processing and typesetting system. It incorporates features of word-processing, desktop-publishing, graphic design and CAD, and while it does not do any of these specific jobs well enough to replace a dedicated package completely, it does provide all the facilities you need for writing technical reports. What's more, it does it in a single, totally integrated and RAM-resident program, for a very reasonable price.

Integrated What?

MicroDesign2 calls itself an Integrated Page Processor, and it has been a major player in the Amstrad PCW market for some time: the new PC version was released in December 1990. According to Creative Technology, it is deliberately intended to be compatible with the most basic PC hardware: the program will run on a CGA machine with only 512K of RAM, and the program produces surprisingly good-looking results from a standard 9-pin printer, although it includes drivers for 24-pin, inkjet and laser printers too.

The Integrated Page Processor label sounds like a piece of marketing hype, but when you start using the program, it does start to make sense. Unlike word-processor and 'proper' (ie 200) DTP programs, which deal primarily with documents, MicroDesign2 operates on only one page at a time. You might imagine that this would impose certain limits with multi-page documents, but the manual which accompanies the program would seem to disprove this: about 180 A5 pages, all designed and printed using the program.

Finding Your Way Around

The program's different functions are separated into six sections which can be accessed from a single main menu. The page layout section of the program is straightforward enough: the current page is displayed on the screen at reduced size and detail, and any part of it can be picked up and copied, moved or erased. Typesetting and printing are also controlled from the layout section: typesetting is limited by a rectangular 'window', but once the text is on the Page, it can easily be moved around. Printing is simple because the MicroDesign2 Page is assembled as a bit-image, there are no Postscript-style disagreements between computer and printer about what it should look like.

Text is dealt with primarily in the text editor section. This is a little word-processor in its own right, albeit a fairly limited one, and it can import text from any ASCII file. It can also import some word-processor files complete with control codes (for Bold, Italic, Centred text and so on): WP-packages supported in this way include Wordstar, Wordperfect5, Protext, and even (showing MicroDesign2's PCW origins) Locoscript PC. This compatibility is probably intended to compensate for the limitations of the MicroDesign editor, which has basic 'cut-copy-paste' facilities and very little else: any text file longer than a page or two is easier to prepare using a proper word—processor, and then load into MicroDesign for illustrating and typesetting. The MicroDesign2 manual appears to have been produced in this way, and the quality is certainly good enough for most applications.

On the drafting and design side, standard electronic component symbols are available as sets of 'icons': these are small graphic images which can be defined, edited and saved using the Icons section of the program. Three sets totalling 66 icons can be recalled instantly, and rotated or reflected as required. For the artistically inclined, the icons system can also be used to define fill patterns, and brushes for 'painting'.

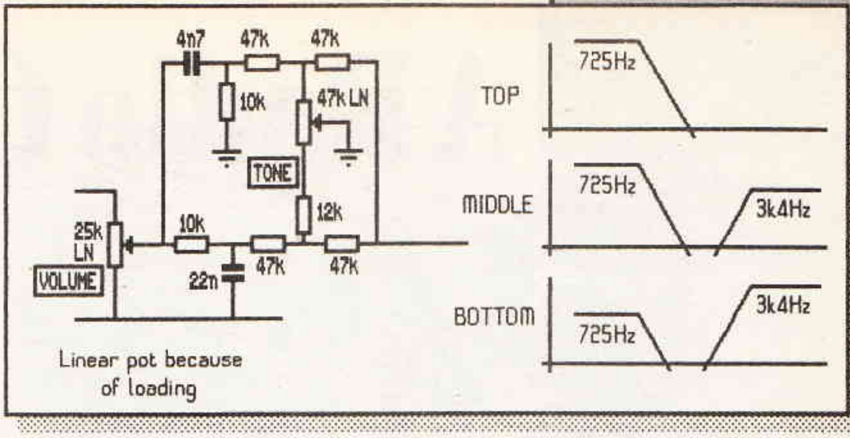
The diagrams are assembled in the Design section, where a portion of the page is shown at full size: symbols are simply 'picked up' from a menu and 'stuck down' on the diagram. As well as circuit symbols, there is a good range of graphics facilities including circles, rectangles, ellipses and triangles, as well as the right-angled lines which are essential for any electronics application. Text can be 'written' directly onto the page in any position or direction, so component labelling could not be easier. Graphics files can also be imported from other packages using a conversion utility: .TIF, .PCX, .IMG and .CUT are among the formats supported.

When the diagrams are complete, the text in the editor can be typeset above, below, around or even over it. 25 'Fonts' (or ASCII sets of characters) are supplied with the package, and the program includes a font design section: this is very useful if you want to incorporate special mathematical or scientific symbols in the text of your report, and it is a feature which is often overlooked in budget DTP programs. Extra fonts discs are also available, and the complete range of typefaces is large and varied.

Finally, the finished page can be saved on disc and printed. Although each page is a complete bit-image, data-compression keeps the file—size down to around 50K for a full, detailed page, or about 5K for an almost empty one. Print quality is good, but printing time is a little painful: an A4 page takes about 15 minutes using a Star LC-10 9-pin printer, or about 10 minutes using an HP Deskjet. Both these tests were conducted using an Amstrad PC1640: a faster processor should speed things up.

'Not Just a Program, More a Way of Life'

One strong impression that I have, both from using MicroDesign2 and from talking to the authors, is that this program was written by people who use it. (And when I say that I spoke to the authors, this is not a reviewer's privilege: there is a free technical support service for MicroDesign2 users, available between 4-7pm five days a week.) Creative Technology seem to regard it as a point of honour that all their manuals, catalogues, and even headed notepaper and front-panel artwork are produced using MicroDesign2. This means that all the little problems which might irritate you also irritate them, and they have found ways around them. The printing time is a case in point: if you want to print a number of pages in sequence, you can simply type their file-names into a 'print queue', press Return, and go away for the weekend.



Printed on a Star LC-10 9-pin printer

Moans

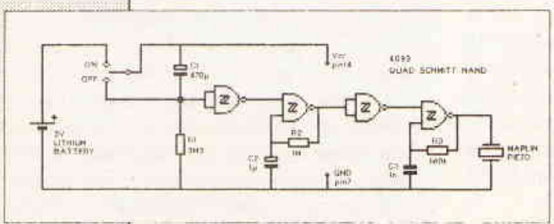
There are certainly some features of the program which are not as well implemented as I would like. Specific moans, apart from the printing time, include the fact that the text editor is rather slow, and that even those lucky people with Super-VGA cards will still only see monochrome CGA-quality screen graphics. But these are minor drawbacks: MicroDesign2 is not intended to replace word-processors or colour art programs.

Summary

One aspect of MicroDesign2 which makes it very difficult to judge is that it does not seem to have any competitors. There is a trend in the software industry to convince users that they need a 386 processor to tie their shoelaces, so a technically-biased DTP-type program which does not even require a hard disc is something of a novelty. While I would not like to suggest that this program is a professional-quality publishing tool, I am genuinely impressed with the results, especially considering the price tag of £69.95. Moreover, the package is tailored specifically towards an application which I need to use, and I have not seen any other program which fits the job of report-writing quite as well as this one. So I have to say that I like it, and if I hadn't acquired it for free, I would probably go out and buy it.

Tech-Tips...

This circuit is a simple timer originally designed to help a friend who wears soft contact-lenses! Apparently some types of lens have to be 'boiled' in a special appliance for about twenty minutes each morning before they are worn. The problem is that if they are left boiling for too long they dry out and are irreparably damaged.



The complete circuit was built into a small potting box and hung on a string so that it could be worn around the user's neck whilst in use. Once switched on the unit 'waits' for about 20 minutes and then bleeps continuously until switched off again.

The delay time can be altered by changing values of R1 and C1 (C1 should be a low-leakage type otherwise the charging current could be less than the leakage current and the device will never 'trigger' the schmitt input of the 4093). By experiment I found that a 30-minute delay is about the maximum possible.

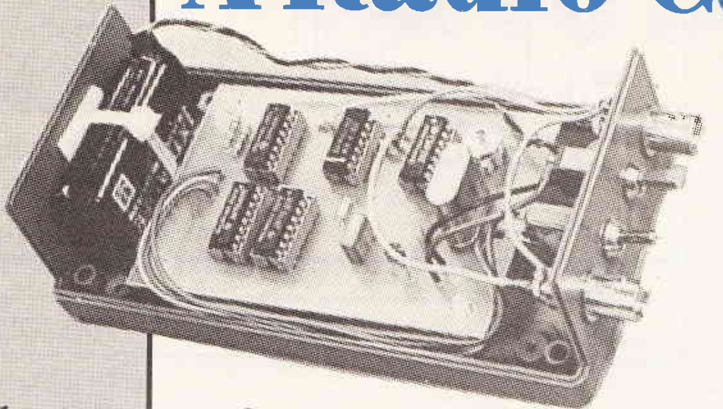
The rate and pitch of the bleep can be altered by changing R2/C2 (bleep rate) and R3/C3 (bleep pitch); the values shown give a high pitch bleep similar to a digital watch alarm.

The bleeper itself is a 27mm piezo transducer available from Maplin. On the prototype this was glued to a cardboard washer then glued to the top of the battery! (The piezo mounting effects the volume of the bleep you can experiment with this).

The unit draws a tiny current from the 3V lithium memory battery, and original unit has been used every day for ***three years*** on the same battery - I fully expect it to go for another five!

This panel was designed, typeset and printed using MicroDesign2.

A Radio Calibrator



David Silvester constructs a calibrator for the SSB receiver published last month

Amateur radio construction projects provide an introduction to both radio and electronics. One of the first projects that can be attempted is the construction of a simple low cost receiver for both SSB and morse transmissions. In a low cost receiver it is unlikely that a frequency read-out will be fitted but a calibrator will allow the read-out of the tuning dial to be converted into a frequency that is being received. Whilst it is very interesting to be able to set up the receiver frequencies no real problems will be seen if the receiver scans outside of the range of the amateur band. However if the constructor moves on to transmitting then the onus is on the amateur to prove that he or she is operating within the allotted bands and at that time the calibrator becomes essential if not a legal requirement.

The initial aim was to build a device suitable for providing frequency market points for a 20 metre radio that the author had constructed. With a little design thought it is in fact possible to extend the useful range from the medium wave frequencies into the VHF bands. Thus the unit will cover most bands that the newcomer to radio will be interested in.

Construction

The only circuit components not on the board are the selector switch SW1, an on/off switch not shown in Figure 1. There is an optional 78L05 regulator IC6 that will be needed if a 9V battery forms supply source but will be left out if the unit is run from a 5V supply. In this case a link wire will be needed to short across where the regulator would have fitted. In the description it will be assumed that a battery supply is used.

Initially fit and solder in all 5 IC sockets as these give a good indication of the locations for the other components. Take care to ensure that the solder does not form a bridge to the tracks passing between the pins as serious problems could occur if that happens. If the constructor decides to solder the IC's into the circuit directly then this stage should be skipped at present. Sockets are to be recommended as it is easy to damage CMOS chips. Fit CV1, the resistors and capacitors using Figure 2 as a guide to their location. Next install the crystal followed by the regulator chip if used. Connect the battery or power supply and check that 5V can be found across all of the ICs. Pins 7 or 8 will be negative and pins 14 or 16 will be positive. If this is OK install IC1 only or solder in IC1 if using that construction method. This will allow the unit to produce a 1MHz square wave and this can be detected on pin 6 of IC1 using a logic probe and can be detected as a signal on a medium wave receiver. If this is satisfactory and wires for the output connections and for the switch SW1. Install the rest of the ICs. The unit can now be retested using the receiver and the logic probe.

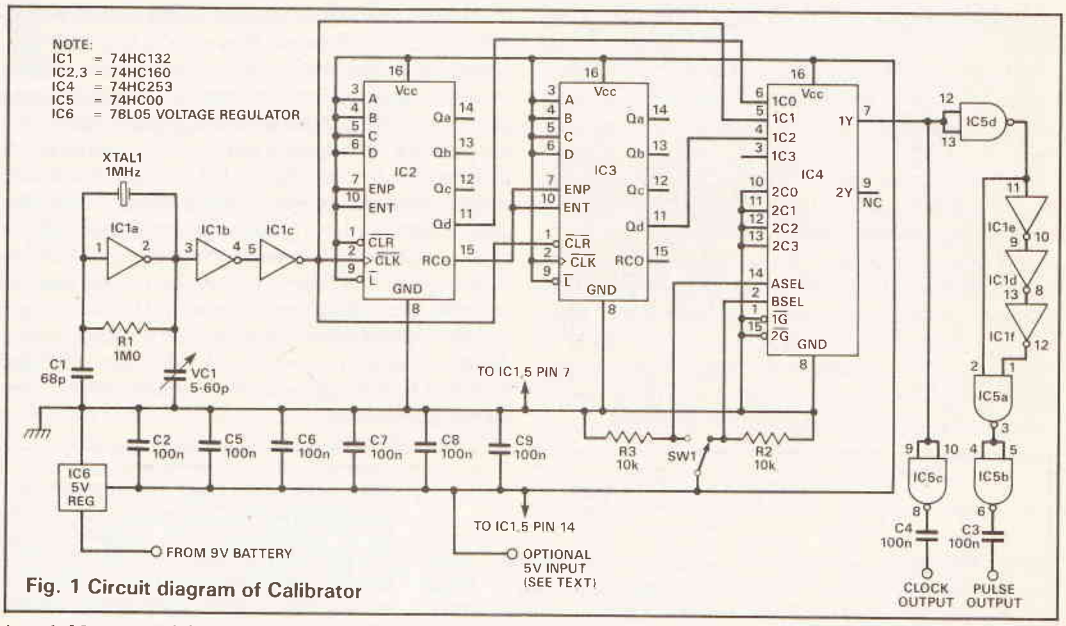


Fig. 1 Circuit diagram of Calibrator

In the authors prototype the unit was mounted in a '100 series Verobox'. Holes were drilled in one end for the two BNC connectors, the select switch and an on/off switch. These need to be kept close together or they will interfere with closing the box. The PCB itself was fitted with four plastic standoffs that were stuck into the box thus holding the board securely. A PP3 battery was fitted to the other end of the box using a single tywrap and a stick down strap holder. Although the battery can move slightly from side to side when the box is secured it will be unable to fall out of the tywrap and rattle around in the box. When the battery needs changing it is a simple matter to open the box, slide the old battery out sideways and install another in the same tywrap.

Final assembly consists of connecting the battery wires to the on/off switch, shortening the selector switch wires if they were made overlong during testing and to connect the output wires to the sockets as shown in Figure 2.

HOW IT WORKS

Fourier anaylysis of a waveform shows that if we generate a simple square wave then this will have all of the odd harmonics in its frequency spectrum. Now a 555 timer running at 1kHz will generate frequencies into the low RF bands and the author has used such a generator to locate faults in domestic radios. But as a calibration signal the 555 timer it totally unusable as no reliance can be placed on it's output frequency fine though it may be as an uncalibrated signal source. For a frequency standard we have to use a crystal as the reference element so that the output will be of a known and stable frequency.

A second problem now comes from the use of the square wave signal in a calibrator. In this type of signal the level of the harmonics generated falls rapidly with the frequency and at high frequency the signal level may be too low to be of any use. The alternative is to use a high speed pulse with a repetition rate controlled by the crystal. If we use a 1MHz crystal we can produce an output with signals at 1MHz steps over the full RF bands up to VHF. If we add a pair of ten times dividers then signals at 100kHz or 10kHz steps can be fitted into the 1MHz steps using the divided crystal output. Thus the full circuit is shown in Figure 1.

The crystal oscillator consists of IC1a and the associated components X1, R1, C1 and CV1. XTAL1, the crystal controls the oscillator frequency although there is a slight adjustment provided by CV1. This variability is to allow the crystal to be set to oscillate at exactly 1MHz if a reference better than the crystal tolerance is available. In some cases this will not be possible and in this situation the capacitor CV1 is set to half capacitance with the vanes half meshed. The oscillator stage is buffered by IC1b and IC1c before passing to the rest of the circuit. Since all inputs to a CMOS circuit must be connected to something or they may break into self oscillation it was decided to use IC1c stage as a second buffer. The input could equally have been connected to ground or positive supply, the output left open circuit and the rest of the circuit connected to the IC1b buffer at pin 4.

The two 74HC160 ICs are connected as a pair of divide by ten stages with outputs at frequencies of 100kHz and 10kHz at pin 11 of IC2 and IC3 respectively. All of the three signals at 1MHz, 100kHz and 10kHz pass to the selector chip IC4, the 74HC253.

It was felt that it was extremely unwise to have three high frequency signals floating around on wires off of the board as these may make the unit unstable especially as we are trying to build a high frequency signal generator. The 74HC253 allows a DC signal at TTL levels to select one of the three signal frequencies we have already generated. Thus the three signals go to the selector input IC4 pins 4, 5 and 6. The DC control signal comes from the single pole centre off switch SW1 with pulldown resistors R2 and R3 passing to the IC's select pins 2 and 14. Thus the three switch polsitions can select one of the three signals. Some readers will notice that there is a fourth input allowed by two binary inputs and this is indeed provided as pin 3. However since this is not a selection allowed by SW1 the spare input is connected to ground. There is in fact a complete second selector in the chip but this is also unused. The outputs are always enabled. Thus in IC4 pins 1, 3, 8, 10, 11, 12, 13, and 15 connect to ground. The output of the selected frequency is from pin 7.

One output is taken through a buffer of IC5c and out via a capacitor C4. This is a form of clock signal although it is not an exact square wave.

The problem remains that the square signal does not contain the high frequency components that will allow use at VHF. To get higher levels of these high frequency components we need to produce a high speed pulse at the selected repetition rate. These high speed pulses are derived from the square wave train using a circuit that in normal logic circuits produces glitches that lead to false operations. In the calibrator these giltches are the high speed pulse that we need.

The square wave output from IC4 passes to the 'glitcher' through a second buffer IC5d. The output is a rising and falling signal opposite to that of the counter. This square wave passes to a NAND gate IC5a on input pin 2 but to the other input on pin 1 through three buffers.

Now consider the situation where the input to IC5d is low. The output of IC5d will be high, one input to IC5a will be high but because of the three inverter stages IC1 d, e and f the other input is low. Now with one input low IC5a output is high and thus the output of IC5b is low. When IC5d input is high it's output is low and IC5a output is forced high and the transition is not seen at the output of IC5a.

The interesting effect occurs when IC5d output goes high. Immediately pin 2 of IC5a goes high but because of the propagation delay in the three inverters IC1d to IC1f the output of IC1f will remain high for typically 33 nanoseconds. At the end of this period IC5a input pin 1 flips low and it's output rises. Thus for every clock cycle the circuit produces a single 22ns pulse at a repetition rate controlled by the clock. From the clock frequency we have the basic reference signal but the high speed pulse provides the harmonics to give us signals into the VHF region. IC5b provides a buffer for the 'glitcher' and the output signal goes via a capacitor C3 to protect the calibrator from any external adverse voltages.

The only remaining components to mention are the five capacitors, one across the power pins of all of the ICs to keep oscillations on the power supply lines to a minimum. The actual PCB has in addition a 78L05 regulator chip to allow the circuit to be run from a 9V battery as a self powered unit. These components are not needed if the calibrator is powered from a 5V power supply.

PARTS LIST

RESISTORS (all 0.25W metal film)

R1	1M0
R2,3	10k

CAPACITORS

C1	68p ceramic
C2 to C9	100n ceramic
CV1	6 to 60p trimmer

SEMICONDUCTORS

IC1	74HC132
IC2,3	74HC160
IC4	74HC253
IC5	74HC00
IC6	78L05 voltage regulator

MISCELLANEOUS

Single pole change over centre off switch
Single pole on/off switch
BNC sockets (2)
Verobox 100 series
Battery, Battery connector, tywrap, tyrap securing pad.

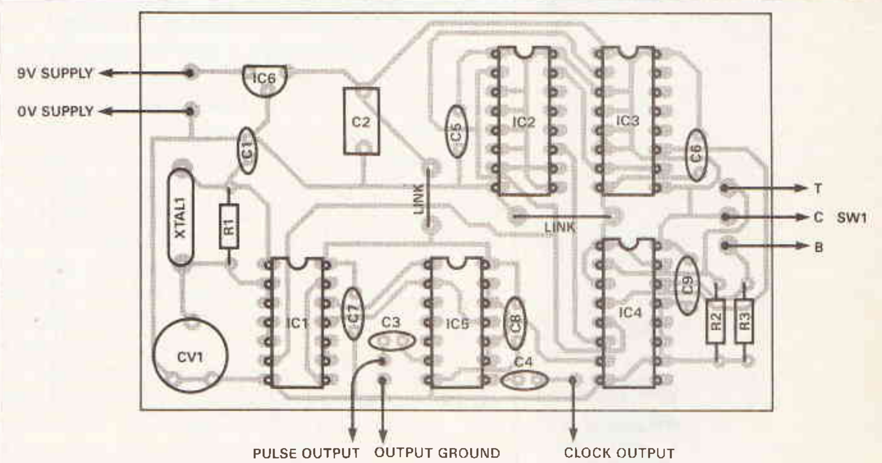
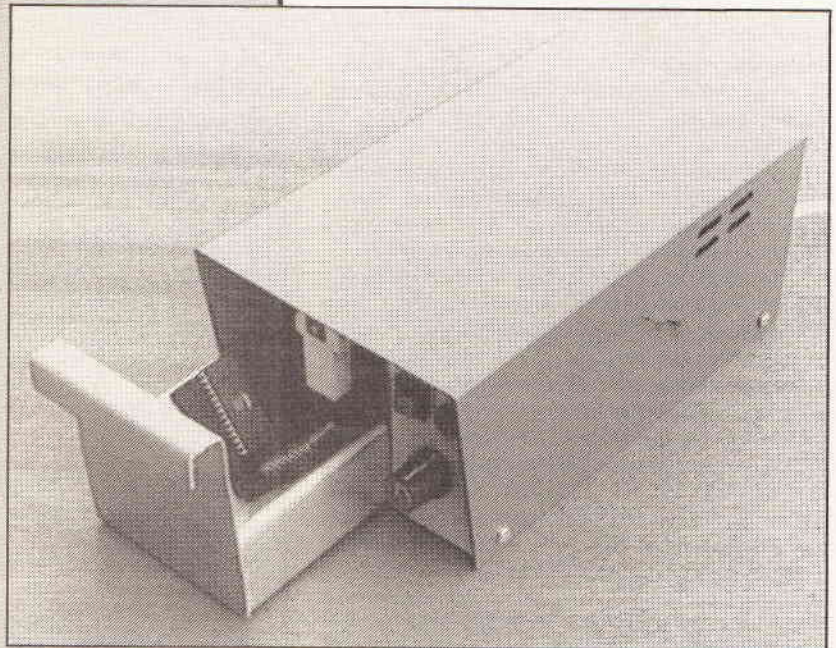


Fig. 2 Component overlay for the Calibrator

As mentioned earlier if a reference with a better accuracy than the crystal is available this should be used to set the crystal frequency using CV1. If this is not available the CV1 should be set to mid position with the vanes half meshed. The unit is now ready to be used to calibrate that receiver.

An Electronic EPROM Eraser



Mike Bedford shows you how to wipe out your EPROMs without wiping out your eyes.

An EPROM eraser is one of those pieces of equipment which has a price tag of such a magnitude as to make me wonder how the manufacturers can possibly justify it. No doubt many electronics enthusiasts have had similar thoughts and have accordingly bought just a replacement UV tube for an eraser and used this in conjunction with a miniature fluorescent fitting. To anybody who has taken such a course of action, we now address the warning that this is a dangerous practice. EPROMs require exposure to ultra violet radiation with a wavelength of 2537 Angstroms for maximum erasure efficiency. This is quite short wave ultra violet and unlike the radiation of black light UV tubes found in discos, which is of a longer wavelength, is potentially hazardous. The eyes are the most vunerable part of the body and can suffer great damage, resulting even in blindness. Even exposure to the skin is potentially dangerous, ultimately leading to skin cancer. In order to protect the health of our readership, ETI now presents the design of an EPROM eraser complete with electronic timer. This follows on to the series of articles describing the construction and programming of the SBC-09, a 6809 based micro controller, as it describes the construction of the final piece of equipment necessary for firmware development.

An EPROM eraser normally consists of a small UV fluorescent tube in a light tight cabinet. There is a removable drawer which, in the case of the smaller units, can take up to 10 EPROMs. Removal of this drawer causes the tube to be extinguished thereby preventing accidental exposure of the skin or eyes to ultra violet radiation. There is also a timer, usually of the mechanical run-back type, which allows exposure times in the range 0-60 minutes. In this design we have kept fairly much to this basic framework but since mechanical timers are quite expensive this has been replaced by a less expensive electronic counterpart. It could be argued that the amateur could do without a timer at all and, on cost grounds, this was the approach taken on my last project which included a UV tube namely a PCB exposure unit. However, unlike photo-resist PCB laminate, EPROMs cannot be over exposed (unless really over- doing it) and so, unless the user is eagerly awaiting an erased EPROM, the eraser could easily be left on and forgotten about for long periods drastically reducing the life of the expensive UV tube. Commercial EPROM erasers cost in the region of £100 + VAT — the one presented here can be built for about £35 + VAT including the

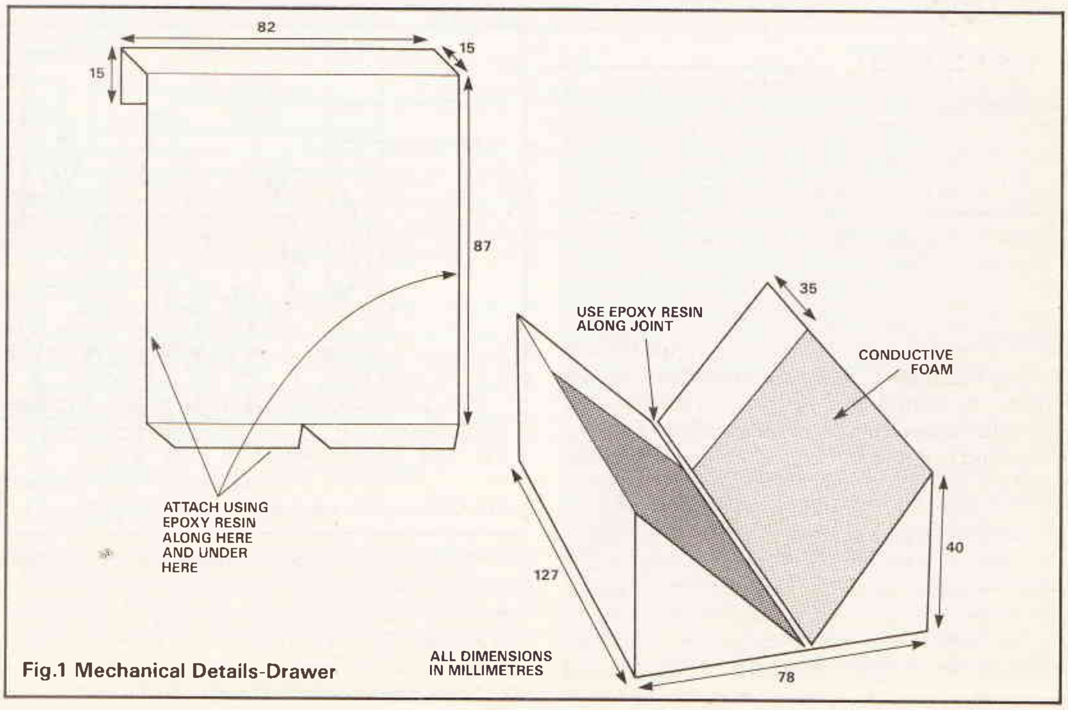


Fig.1 Mechanical Details-Drawer

PROJECT

case and tube or significantly less if using surplus fluorescent fittings and making the case.

Construction

The electronic part of the construction is quite straightforward, everything goes on the single PCB except for the fuseholder on the rear panel, the neon, push button and potentiometer on the front panel and the fluorescent tube, choke and starter which are positioned at various places within the case. The majority of the time taken on this project will be concerned with mechanical aspects and in particular the construction of the EPROM drawer and bracket for the tube and then the assembly of the various components (this word is not necessarily used in its electronic context). As always, it is much easier to illustrate than to describe and accordingly Figures 1, 2 and 3 should be referred to for the mechanical

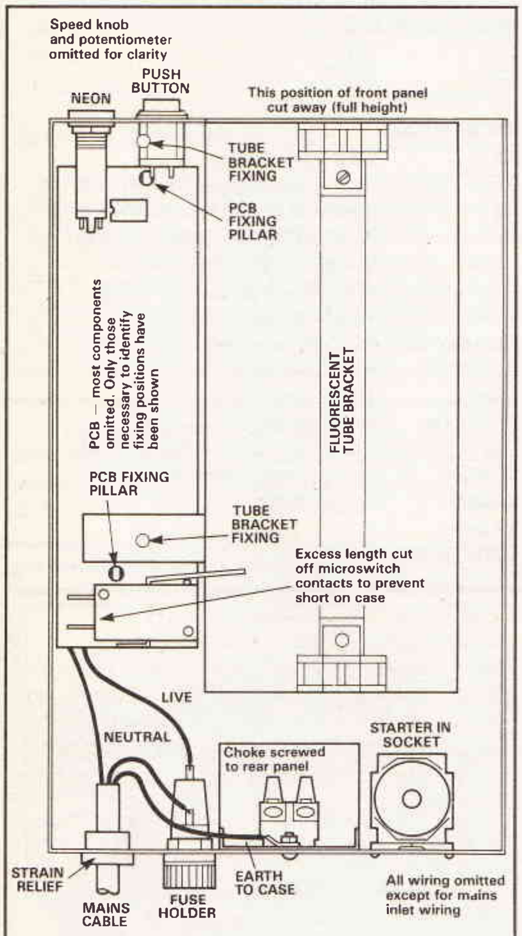


Fig.3 Overall view of component parts

details. The following will be kept as brief as possible.

Both the EPROM drawer and the tube bracket are made out of aluminium sheet which will require cutting to size and then bending. On the assumption that most readers won't have access to professional bending equipment, it is recommended that the bending is carried out by firmly clamping the aluminium between two blocks of wood along the line of the bend in a vice and then effecting the bend by use of a further hand held block of wood along the length of the bend. Clearly this will only allow bends of up to 90 degrees to be made so the drawer will have to be bent by hand once removed from the vice to create the two acute bends. The front of the drawer is made out of a separate piece of aluminium and attached to the main part of the drawer using Araldite. This front piece is deliberately over-sized compared to the hole cut in the cabinet front panel in order to prevent UV light from 'leaking' out. The top surface of the drawer has conductive foam attached to it using contact adhesive. The foam should only be placed on that part of the drawer indicated on the drawings as the remaining parts do not receive acceptable UV exposure. Whilst on this topic, the recommended case has ventilation slots in both side panels which need to be blanked to prevent UV spillage. Offcuts of the conductive foam used on the drawer are used for this purpose as limited ventilation will then be still possible.

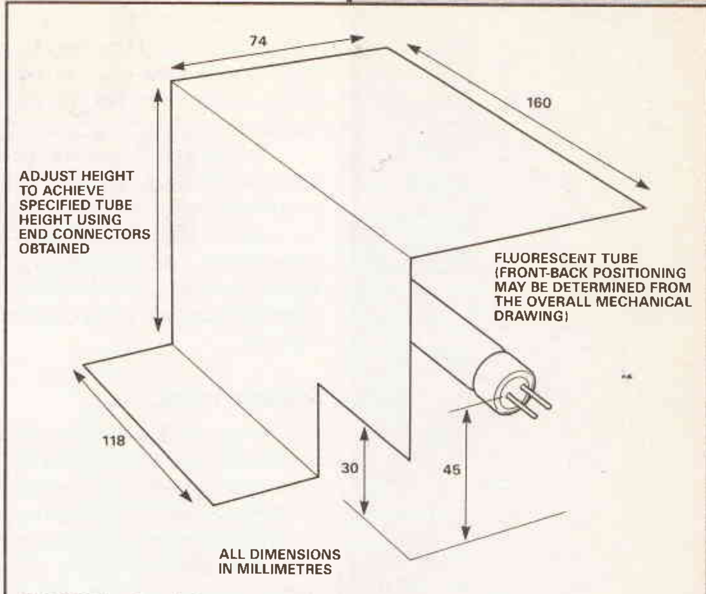


Fig.2 Tube Bracket

The bracket for the tube is quite a simple construction but it is not made until the fluorescent tube lampholders are obtained. The lamp holders for the prototype had steel brackets attached thereby requiring the aluminium bracket to be quite tall. There is no reason to believe that lampholders are of identical dimensions from other manufacturers and so the aluminium tube bracket should be made to position the tube at the height shown in Figure 2. This bracket requires the back right hand corner to be cut out to allow the micro-switch lever on the PCB to spring forward (switch open) when the drawer is removed.

The way most of the bits fit together is clearly seen in Figure 3. The bracket for the UV tube doubles as the right hand guide for the drawer and since the aluminium bending method recommended is not super accurate, the drawer should be completed and put in place before the tube bracket is finally bolted to the base of the case. Care should still be taken with the construction of the drawer since if it comes out significantly over width, the PCB won't fit in the case. The left hand side of the case makes up the left hand drawer guide but the front self tapping screw used to fix the top cover to the case would cause problems here. This will need reducing in length using a file in order to prevent it from fouling the drawer. Coming now to the circuit board, this is critical in its positioning in the front to back direction since the micro-switch needs to switch off as soon as the drawer starts to be removed. The best way to do this is to drill fixing holes in the PCB and make corresponding oval holes in the case base hence allowing some adjustment. A further slight adjustment in the micro-switch's trigger point can be achieved by wrapping insulating tape around the lever. Remember that board has mains voltages on its tracks and if fixed too close to the base could result in a rather loud bang.

Now a word about wiring up the constituent parts of the fluorescent circuit, namely the lampholders, the choke and the starter socket (and starter). The terminals on these will almost certainly not be of either the solder or the screw types we are familiar with on electronic components but will be of the push-on grab type. To make contact, insert the stripped end of the wire into the terminal and push. It would be wise to get it right first time as once these terminals have 'grabbed' it can be difficult to persuade them to release although poking around with a thick needle or very small screwdriver whilst pulling the wire usually does the trick eventually. This sort of terminal only works with solid conductor wire. The stranded variety can only be used if the end has been tinned. This can be tricky as the remaining non-tinned portion is too flexible to push with sufficient force.

To give a professional appearance, a few legends are appropriate on the front panel. The push button is labelled 'Start' and the potentiometer 'Time'. It would be a good idea to calibrate the time control by experiment, perhaps indicating 10,15,20,25 and 30 minute positions. The labelling could be done using transfers and then applying a protective coat of matt lacquer.

Operation

For those who haven't used an EPROM eraser we'll outline the steps to erase an EPROM. The drawer is removed and between 1 and 10 EPROMs of the 24 or 28 pin variety are secured in the drawer by pushing their pins into the conductive foam which covers the top surfaces of the drawer. These must be lined up with their longest dimension across the width of the drawer hence causing all the windows to be in line and close to the tube when the drawer is inserted.

Although not designed for use with larger EPROMs, in the unlikely event of needing to erase 40 pin devices, 2 could be accommodated but these would have to be aligned with their longest dimension along the length of the drawer and positioned along the centre of the upper drawer faces. Once loaded up, the drawer is pushed fully into the eraser. The potentiometer is then set to the time required. If using it for the first time, an exposure of 20 minutes is recommended but this may be adjusted in the light of experience. Now press the 'Start' push button. The neon will light, indicating the EPROMs are being erased, and will remain on the for time period selected. If the drawer is removed before the timer has expired, the light will go out and the timing will have to be re-initiated using the push button when the drawer is pushed back in.

PARTS LIST

RESISTORS (all ¼W 5%)	
R1	1k
R2	10k
R3	560k
RV1	2M2 variable, linear
CAPACITORS	
C1	1000µ, 25V, axial electrolytic
C2	20n
C3	470n,
C4	10µ 25v, tantalum
C5	10n, ceramic
C6	470µ 25v, axial electrolytic
SEMICONDUCTORS	
B1	1A bridge rectifier
D1,2	1N4001
INTEGRATED CIRCUITS	
IC1	7815
IC2	NE555
MISCELLANEOUS	
FS1	20mm panel mounting
SW1	Miniature V3 type microswitch with lever
PB1	Mains rated, momentary action, N.O.
RLA1	Miniature SPDT, 10A contacts, 12V/270R Omron G2R117PV or Fujitsu FBR611
T1	3VA, 0-15, 0-15@0.1A, PCB mounting
N1	Red panel mounting neon
Flourescent tube	4W, 150mm, 2537 Angstrom U.V. tube
Lamp holders	mini bi-pin (2 off)
Choke	4W/6W/8W type
Starter socket	screw mounting, Starter 4-40W
Case	220mm long x 125mm wide x 95mm high
Aluminium	18 swg, 295mm x 195mm (2 off)
Grommet	To fit mains cable
13A plug	
Conductive foam	high density

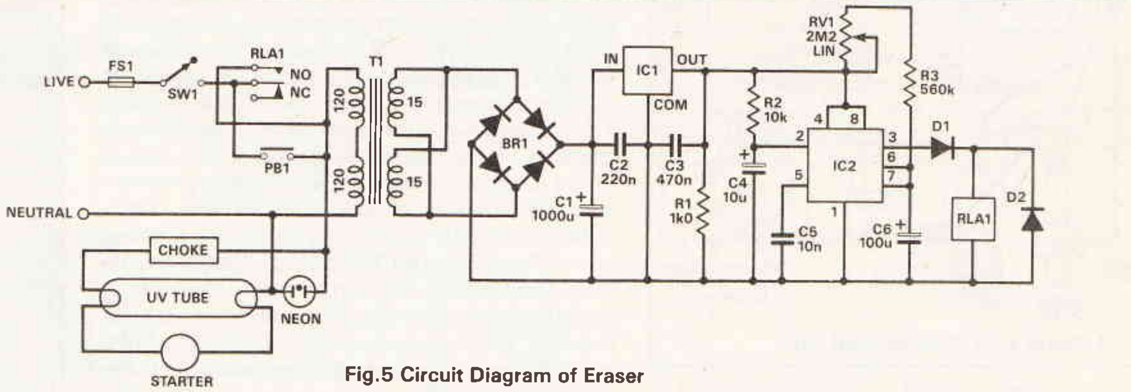


Fig.5 Circuit Diagram of Eraser

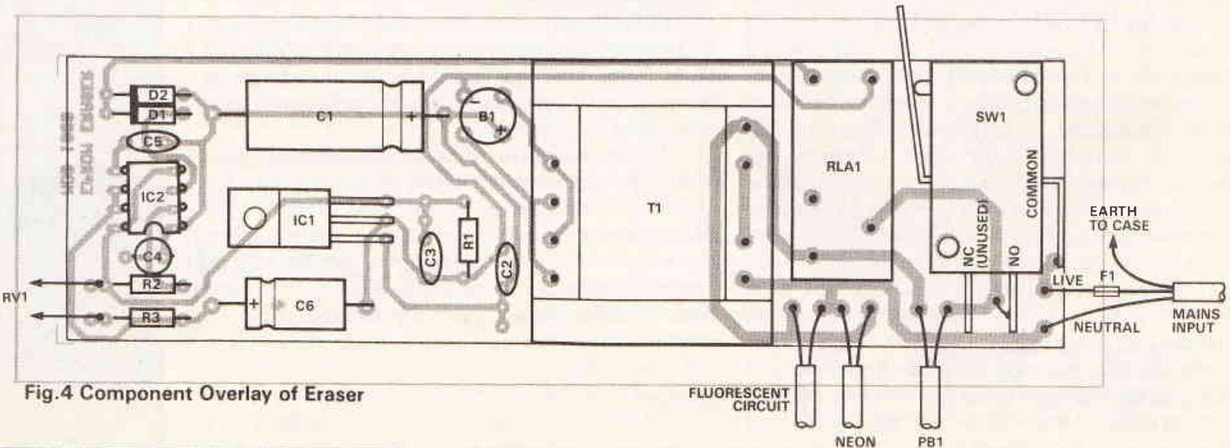


Fig.4 Component Overlay of Eraser

HOW IT WORKS

The unit needs an electronic timer. Furthermore, the circuitry should draw no mains current once the timer period has expired since it should be possible to set the unit to erase and then forget all about it without running the risk of overheating. Also the unit must be forced off when the drawer is removed. The circuit to do this is very simple.

SW1 is a normally open microswitch positioned at the rear of the unit and will be closed when the drawer is inserted. Once closed, the circuit is completed by pressing the momentary action push button, PB1 and applying power to the neon (which indicates that the UV tube is on), the fluorescent circuitry and the transformer. The transformer, T1, together with the bridge rectifier B1, smoothing capacitor, C1 and regulator IC1 together with stability capacitors C2 and C3 make up a conventional low current 15 volt power supply which feeds the NE555 timer. This has an RC network consisting of R2 and C4 connected to its trigger input and so starts timing as soon as power is applied. During the timing period, the NE555 output goes high, energising the relay. The normally open contacts parallel the push button and maintain the circuit. The timing period is controlled by C6 and the R3/RV1 combination and will allow times in the range 10-30 minutes.

BUYLINES

The transformer, relay and microswitch are available from Rapid Electronics. The case and choke are RS/ Electromail. Electromail is on 0536204555. The UV tube is from Farnell under part number 170-133 but if you don't have an account this will have to be obtained from Trilogic (0274691115). Aluminium sheet comes from Maplin (0702554161) as part LH12N. Conductive foam is Maplin part FA82D. The PCB is available from the ETI PCB service and all the other components are available from just about anywhere.

The following test program is a corrected re-run from ETI Feb 91. The 64k EPROM Emulator last month should have displayed Fig 2c 2564 pod Fig 2d 2532 pod.

ETI SBC-09 control computer test program

```
.equ     IOarea,    X'8000       ;I/O area
.equ     PIA,       IOarea       ;6821 PIA
.equ     PortA,     PIA          ;Port A
.equ     DDRA,      PortA        ;Data direction register A
.equ     CRA,       PortA + 1    ;Control register A
.equ     PortB,     PIA + 2      ;Port B
.equ     DDRB,      PortB        ;Data direction register B
.equ     CRB,       PortB + 1    ;Control register B
;
.equ     EPROM,     X'C000       ;Start of 27128 EPROM
;
.equ     RAM,       X'0000       ;Start of RAM
.equ     Stack,     RAM+X'100    ;Top of stack
.equ     Running,   Stack+1      ;Counting in progress
;
.org     X'FFF0                  ;Vectors — end of EPROM
;
         .dw        Init         ;Reserved
         .dw        Init         ;SWI3 (unused)
         .dw        Init         ;SWI2 (unused)
         .dw        Init         ;FIRQ (unused)
         .dw        IRQ          ;IRQ
         .dw        Init         ;SWI1 (unused)
         .dw        Init         ;NMI (unused)
         .dw        Init         ;Reset
;
.org     EPROM                   ;Code — start of EPROM
;
IRQ:     TST        PortA        ;Read PortA to clear IRQ
         COM        Running      ;Complement counting flag
         RTI                     ;Return
;
Init:    LDS        # Stack      ;Initialise stack pointer
         CLR        Running      ;Running not enabled
         CLR        CRA          ;Select DDRA instead of PortA
         CLR        DDRA         ;Set PortA to all inputs
         LDA        # X'05       ;Code for PortA instead of
         STA        CRA          DDRA and interrupt on CA1
         CLR        CRB          ;Select DDRB instead of PortB
         LDA        # X'FF       ;Set PortB to
         STA        DDRB         all outputs
         LDA        # X'04       ;Code for PortB instead of
         STA        CRB          DDRB and no interrupts
         CLR        PortB        ;Turn all LEDs off
;
         ANDCC      # X'EF       ;Enable interrupts
;
Count:   TST        Running      ;Counting flag enabled?
         BEQ        Count        ;If not loop
         INC        PortB        ;Increment the LEDs
         BSR        Delay        ;Wait a while
         BRA        Count        ;Loop back to start
;
Delay:   LDY        # X'2000     ;Delay loop initial value
Delay1:  LEAY       -1,Y         ;Decrement
         BNE        Delay1       ;Loop if not zero
         RTS                     ;Return
;
end
```

A Digital Tachometer

Harbanse Deogan describes an easy-to-read angular speedometer for the car

Every year new cars are brought out with improvements in performance and economy. To gain the maximum benefit from this the driver needs to know as much as possible about the car's behaviour and response while driving. One of the most useful is the speed at which the engine is turning. Horsepower and fuel consumption are related to the engine speed measured in revolutions per minute. On some models a rev-counter or tachometer is fitted in the dashboard to provide this information. These instruments can also be brought from car accessory shops and are almost invariably of the analogue type (dial type) with a needle pointer. For those who want something a little different this article describes a digital tachometer you can build yourself. And if that isn't enough, you will find that it is cheaper to build too.

A digital rev-counter offers a number of advantages over the analogue type. Digital readouts can be read accurately more easily than is possible using a dial and pointer. In digital form 2200 rpm means just that. In analogue form same reading is merely just over 2000. Also an average value rather than the instantaneous value is displayed. This is because in an analogue device the pointer used to display rpm has some inertia which prevents it responding to rapid changes in the input signal. The pointer cannot keep up with rapid changes in engine rpm. At low engine speeds another problem arises as the pointer begins to follow the changing input signal. It is seen to oscillate around an average value. As the revs drop lower, the oscillations become increasingly apparent. The digital rev-counter counts the number of input pulses over a fixed period of time and this value is latched onto the display. No pointer inertia, no oscillations at low engine speeds.

The digital tachometer displays the engine speed from 100 to 9900 rpm in multiples of 100 rpm on an LED display. The design is compact and will fit into a remote control case to produce a neat finished unit.

Construction

Using a PCB a compact unit can be produced quickly and relatively painlessly. When mounting the components on any PCB a logical sequence should be followed to avoid any difficulties with component mounting as the assembly nears completion.

Begin by installing those parts with the lowest profile first like the wire links, resistors and diodes. Leave R2 to one side for now. Take care with the orientation of the diodes. The resistors feeding the seven-segment displays are mounted vertically to save space. One diode is also mounted vertically. These parts should be fitted later. Fit the IC sockets, capacitors and the preset RV1. Use of IC sockets is recommended as the CMOS logic chips are sensitive

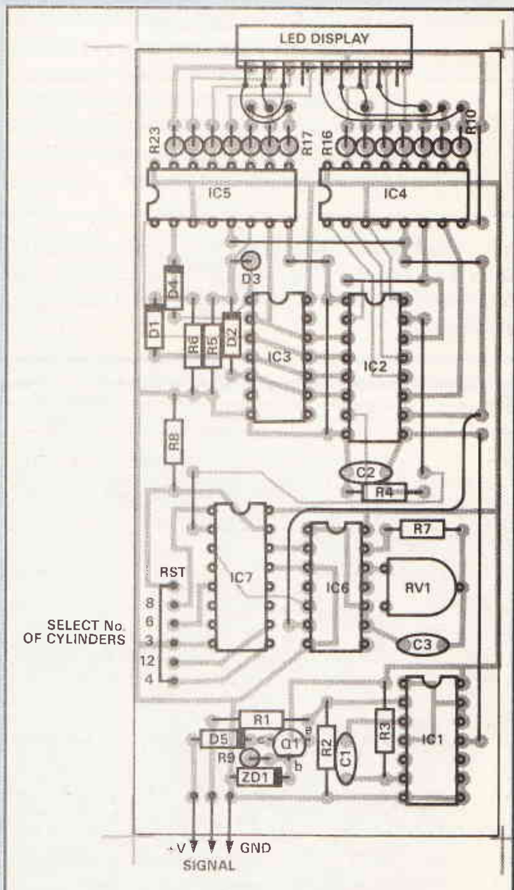


Fig. 1 Component Overlay of Tachometer.

to overheating during soldering and easily damaged if proper handling precautions are not exercised. They should be carefully plugged into the correct sockets last of all, after the soldering has been checked. Then mount the resistors and diode which are to be fitted vertically. Again check the polarity of the diode before you install it and snip the wires. Finally fit the two 7-segment displays. Make sure they are the right way up by checking the position of the decimal points. They should be positioned away from the board. Bend the pins on the upper side so that the display can be mounted vertically on the PCB. When correctly inserted it will be possible to read the display

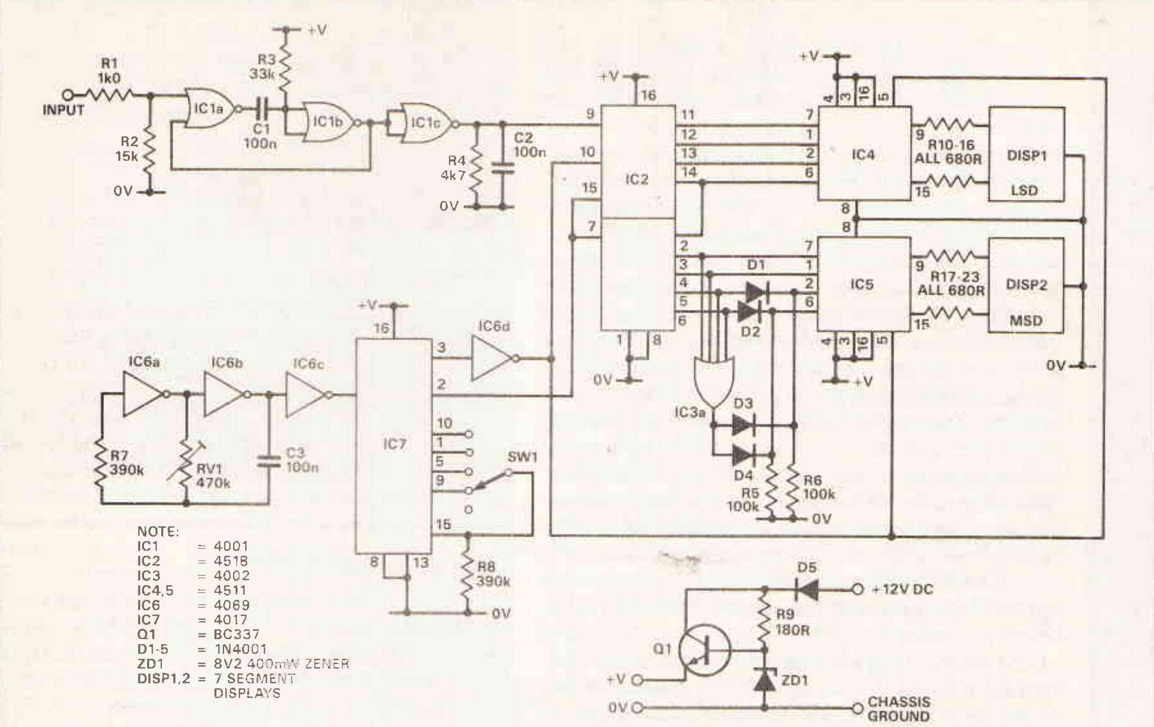


Fig. 2 Circuit diagram of Tachometer.

from the end of the board with the component side facing downwards. The PCB assembly is completed by soldering the wire links between the top of the display and IC4-5. Leave the links to IC7 open and R2 in a safe place until the tachometer has been calibrated. Connect a red lead to the positive terminal and a black lead to the ground terminal. Use flexible PVC covered wire for the pickup. Make sure the pick-up wire is about 4 feet (1.3m) in length as it must extend from the passenger compartment to the ignition coil in the engine bay. Only strip the wire at one end, that which is to be soldered to the PCB.

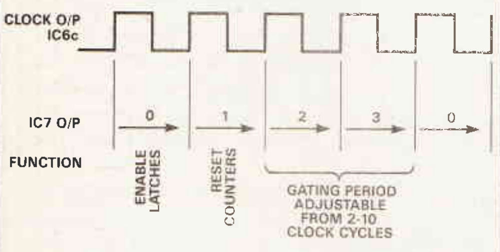


Fig. 3 Timing diagram.

Setting Up

A 12V DC supply is required for testing and calibration. Read this section carefully before switching on. For calibration a known frequency is fed to the tachometer and the preset adjusted until the correct reading is displayed. The mains frequency is perfectly adequate as a calibration reference for this project. With R2 disconnected, the input of the tachometer is very sensitive. The pickup wire behaves as an antenna and picks up the 50Hz mains field radiating from any nearby power lines. Now switch on. The tachometer will display a random number between 0 and 99. Connect the pickup wire to the ground rail temporarily. The display will now read 0. The leading zero should be suppressed. Disconnect the pickup wire from the ground rail and note the reading. If it is 20 then you are in luck and no adjustment is necessary. Otherwise adjust the preset until a steady reading of 20 is obtained. As the correct setting is approached the display will fluctuate between 20 and 21 or 19 and 20. Fine control of the preset will establish a steady reading. That completes the calibration procedure. Switch off the power and solder in R2, which will protect the CMOS inputs from any build up of static charge. Now program the tachometer on the PCB for the number of cylinders in your car. The majority of cars have four cylinders. A switch can be installed to allow the tachometer to be used with a very wide range of cars.

The layout of the PCB will require a case with a window or aperture at one end so that the LED displays can be seen. If there is no aperture one must be made. Carefully cut away part of the end section and smooth down the edges with a file. A coloured display filter is necessary for good contrast when viewing in bright light. A remote control type of case having sufficient height to accommodate the vertically mounted displays would be most suitable, with the display LEDs situated where the infra-red LEDs would have been located. Cut or drill an opening at the far end of the case to allow the power and pickup wires to be taken out.

Locate a suitable ground point to attach the ground wire. This will usually be where a screw is affixed to a metal part of the car or the ground can be shared with equipment already fitted such as a radio/cassette player. The positive rail should be taken to point in the wiring which is "live" when the ignition is switched on. This is to ensure that the tachometer does not remain on when the car is left parked. Just identify the connections to the car's electrical system for now. Do not make any connections just yet.

Place the tachometer on the dashboard where it can be easily read by the driver without taking his/her eyes too far off the road. Use some sticky tape to hold it in place temporarily. Make sure the ground and power lines can easily reach the connection points you have selected. The pick-up wire must now be taken into the engine bay. Find a cable or a bundle of wires which are carried from the engine bay into the passenger compartment. These are usually located under the dash. The pick-up wire can be passed through one of the holes already made by the manufacturers. Identify the hole you intend to use from the engine compartment and make sure that it can be reached easily. Back in the passenger section, pass the wire through the hole past the cable or wires. When a few cm have been pushed through, locate the wire in the engine bay and pull it through gently. Do not tug too hard and pull the tachometer off the dashboard. There should be ample length of wire to reach the ignition coil HT lead. Route the wire carefully, avoiding the engine and any moving cables. Following the original wiring in the car is the safest route. Wrap the pickup wire around the thick HT lead between the coil and distributor. Two or three turns are sufficient. Any excess wire can be trimmed off.

From the driving seat, check that the wiring cannot become entangled anywhere for example by the pedals, driver's feet or steering mechanism. With the ignition off, complete the power and ground connections. If you are in any doubt about the ground and power points chosen then disconnect the car battery before wiring in the tachometer. Those of a nervous disposition can use a cigar lighter plug to terminate the power and ground wires of the tachometer. This is simply plugged into the cigar lighter socket.

After double checking all the wiring, turn on the ignition but do not start the engine. The tachometer should come on and display a single zero. Now turn on the engine. The tachometer will display the engine rpm in multiples of 100. Typically the readout will be in the range of 600 to 1500 rpm when an engine is started from cold. As the accelerator is depressed the reading will increase as the engine speeds up. Conversely the revs will fall when the pedal is released.

When all is well affix the tachometer to the dash where the driver can easily read it without casting his or hers eyes too far away from the road. As the unit is very light it can be fixed in place using sticky pads or Velcro strips if you do not want to (or cannot) drill holes in the dashboard. Otherwise use self-tapping screws and mounting brackets for a really permanent installation. When drilling holes in the dash or the case check that there are no components or wires to damage where you intend to start drilling.

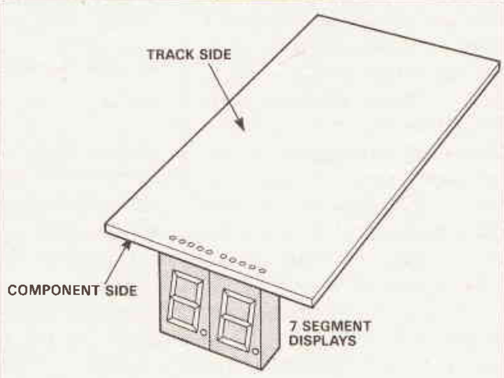


Fig. 4 Orientation of seven-segment display.

HOW IT WORKS

Essentially this is a digital frequency meter which is calibrated to read revolutions per minute directly instead of cycles per second.

CONTROL OF TIMING PERIODS

IC6 is arranged as an astable with RV1 used to adjust the frequency. The output drives IC7 which is a decade ring counter. IC7 controls the rest of the circuit. Refer to the timing diagram. There are three distinct stages performed in sequence.

- The display is latched.
- The counters are reset.
- A new counting cycle is commenced.

When IC7 is at 0 (zero) the count on IC2 is frozen and the internal latches of display/drivers IC4 and IC5 are enabled. When IC7 counts 1 (one) the latches of IC4 and IC5 are disabled. At the same time IC2's counters are reset. As IC7 is advanced to 2, reset is released and IC2 is able to begin counting. The display shows the count which was in IC2 when it was stopped. According to the number of cylinders for which the unit is set, IC7 will reset when it counts 4,5,6 or 8. The time between IC7 counting 2 and resetting itself is the gate time. For a 4 cylinder engine this time is 300ms.

SIGNAL CONDITIONING

IC1 is configured as a monostable to shape the incoming pulses for the dual BCD counter IC2. R1 limits the current that can flow into IC1 if it is connected to the low tension side of the coil directly. The two counters on IC2 are cascaded so it can count from 0 to 99. IC3 is used with D1-D4 to suppress leading zeros. This means that a count of 7 is not seen as 07 or 0 seen as 00. The display is much tidier this way. How is this done? The display driver 4511 will not display anything if it is presented with a number greater than 9 on its inputs. IC3 is used with D1-D4 to convert a 0 (zero) to a 12 so that DISP2 reads blank. Any other number is sent to IC5 unchanged. R5 and R6 are necessary to pull down the input of IC5 which are being driven by the diodes.

Power Regulation

A car's power line is not steady at the best of times and the astable's frequency output changes with supply voltage, some measure of regulation and protection against voltage spikes is needed. This task is performed by the PSU. This is a straightforward regulator circuit with the output voltage set by ZD1. D5 is included to protect against reverse polarity connection which would damage Q1 and ZD1.

PARTS LIST

RESISTORS – min. 0.25W 5% or better	
R1	1k
R2	15k
R3	33k
R4	4k7
R5	100k
R6	100k
R7	390k
R8	390k
R9	180R
R10-23	680R
RV1	470k horizontal preset
CAPACITORS	
C1	100n
C2	100p
C3	100n
SEMICONDUCTORS	
D1-5	1N4001 gen. purpose
ZD1	8V2 499mW 5%
Q1	BC337
IC1	4001
IC2	4518
IC3	4002
IC4,5	4511
IC6	4069
IC7	4017
DISP 1,2 13mm 7 seg. LED display.	
MISCELLANEOUS	
14 pin IC sockets ×3	
16 pin IC sockets ×4	
Case	
PCB ETI PCB Service	

BUYLINES

A full kit of parts is available from the author at £14.95 + £1.95 postage: send to 59 Croxteth Rd, Liverpool L8 3SF.

Circuits For Free

Ian March has delved into the patent office archives for some interesting circuits.

The successful electronics engineer is the one who is better informed about what is possible in the present state of the art than his colleagues and rivals. Keeping abreast of technology is of vital importance to us all, analogue and digital engineers alike. This means attending seminars and conferences whenever possible and keeping an eye open for important papers in the relevant sections of the Proceedings of the IEE (not forgetting Electronics Letters), the IEEE and of course, until recently, the IERE. The pages of ALL the technical magazines, such as ETI, must also be religiously scanned.Even magazines aimed at the amateur market should not be neglected — for instance I recently came upon a most useful article in one of these (ref. 1), quite by chance.

However, there is another storehouse of useful circuit techniques which rivals in importance all of the above sources put together: I refer to published patent applications. It is true that some of these cannot be used without paying a royalty or risking a prosecution for infringement, but with many others the period of validity has expired, or the provisional application has never progressed to a final form, or the patent has been granted abroad and only applies to the country of origin. In all these and certain other cases, the circuit arrangements are now free for all to use. With the help of a lifelong friend in the electronics department of the Danish Patent Office, I have been following the electronics patent scene for many years. I am continually astounded by the rich and varied harvest of extremely useful but little known circuits that circulate through the patent offices of the world and at the editor's request I have selected just a few of these for inclusion in this article. They are all free of patent restrictions in the UK, or have never been progressed to a final, or are now out of validity, so that any of them may be used with confidence in designs for the home market, and also for export except where stated.

1) Buffer Amplifier. (Inventor S McGomez, assigned to Bovine Corning S.A.

Buenos Aires, provisional application No. 2P718281828 lodged June 1985, no final application received)

This RF buffer amplifier is designed to provide exceptionally high reverse isolation, as is commonly required in synthesisers with high spectral purity. It may be described as a 'cascascode' where the upper pair of transistors are complementary. This latter aspect is not new (ref 2), having appeared as long ago as 1965. The really novel aspect is the additional intermediate stage, the presence of which is claimed to increase the reverse isolation at VHF to in excess of 195dB. My friend in the Danish patent office has constructed the circuit (see Figure 1) and measured its performance. The forward gain was not evaluated, but a 100MHz signal at +20dBm was applied at the output and a sensitive receiver used to measure the resultant signal at the input. There was no measurable response, so the signal applied at the output was raised to +20dBW; however the test had to be terminated before a measurement could be taken. Nevertheless the circuit undoubtedly provides reverse isolation of a very high order, though another colleague (Dr. Mustafa Berriberhi, late of the Bangalore Technical College) is of the opinion that this is due at least in part to the unusual decoupling arrangements.

2) Improved switch arrangement. (Inventor G Sullivan, assigned to the B.S.A. Medical Co Ltd of Rochdale, final patent no. 2236067977LRF granted October 1959)

This patent has now expired, so the arrangement described may be used with impunity for both home and overseas sales in any territories. As can be seen from Figure 2, it covers the use of a diode in parallel with the on/off switch of an equipment powered from a DC supply. When the switch is ON the load is powered via the low resistance of the metallic switch contact whilst when it is OFF, the flow of current is blocked by the diode.

The claims section also covers the application of the invention to particular types of medical apparatus and in particular to life support equipment, which must in no circumstances be turned off. This requirement is simply met by reversing the polarity of the supply and interchanging terminals A and B of the load.

Interestingly, no mention is made of use of this circuit with an AC supply. Had this been covered, Mr Sullivan might have made a fortune, for it is universally employed in filter coffee makers and other household electrical appliances to provide a choice of full or half heat. However the loss was not his since, like most of us, he had to assign his invention and any rights in the patent to his employers.

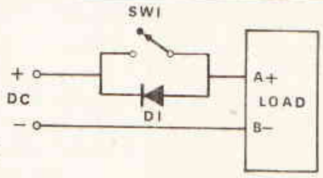
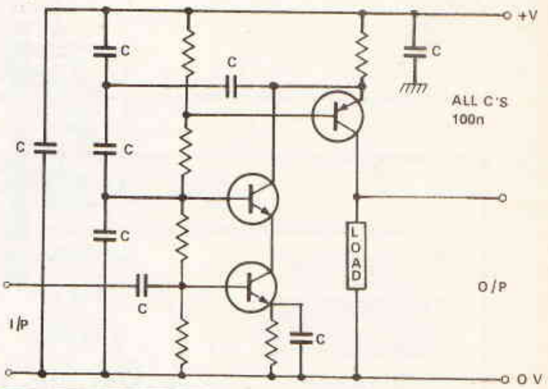


Fig. 1

Fig. 2



5) Fourier Filter. (Inventor J Harrisontwistle, assigned to Scottish Rubber and Kamptulicon Co Ltd, Darlington. Provisional lodged April 1985, no final application made.)

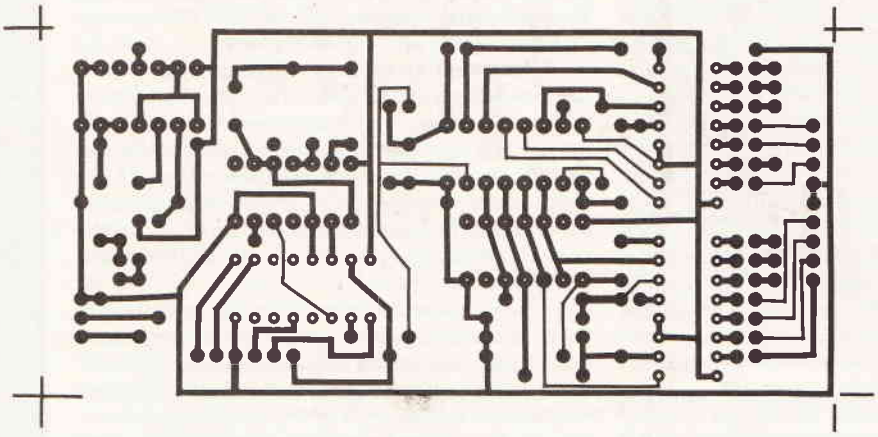
This invention demonstrates vividly how, in certain circumstances, an analogue solution can prove more economical than a DSP based one, such as FFT. It describes a filter which makes available at its output all of the Fourier components of the signal present at its input terminal. Unlike a spectrum analyser, which provides information only on the relative amplitudes of the components and throws away the phase information, the components at the output of a Fourier Filter are all correctly aligned in phase. It took me a little while to grasp just how simply this can be accomplished, but on reflection it is clear that such a filter can be constructed for not a great deal more than the cost of a screening box and two good quality coaxial connectors. If several of these filters were to be cascaded, a signal could be propagated for a considerable distance with minimal degradation, the Fourier components all being available at the output of the last filter in the chain.

REFERENCES

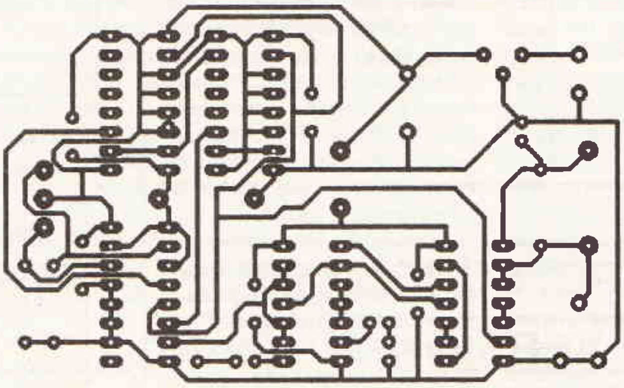
1) Simplified Filter Design Routine. B Sullivan. Practical Wireless, p.28 April 1989. (CAD program in Basic for the design of allstop filters).

2) A Complementary-Pair Cascode for H.F. Amplification. M D Wood, Electronic Engineering Feb. 1965, p 110 (Vol. 37, No 444).

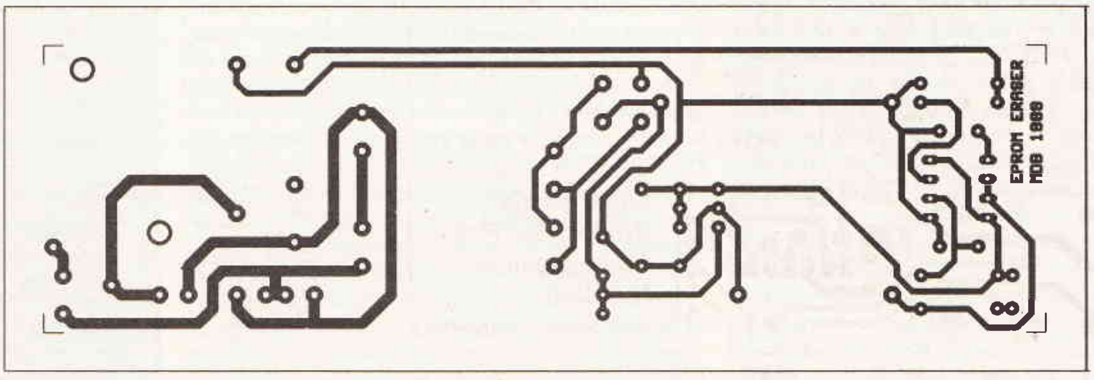
PCB Foils



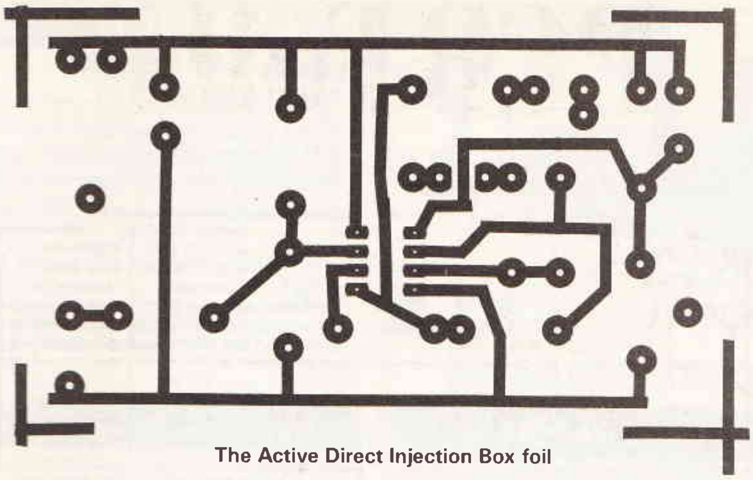
Tachometer foil



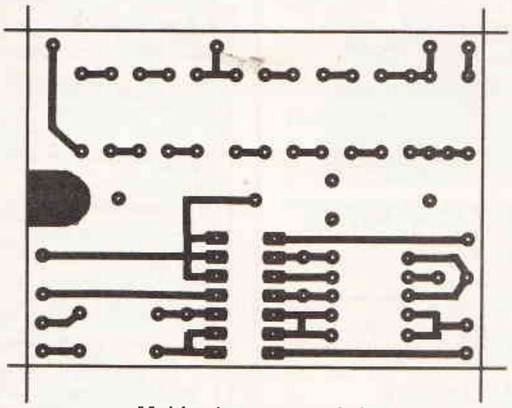
The Radio Calibrator foil



EPROM Eraser foil



The Active Direct Injection Box foil



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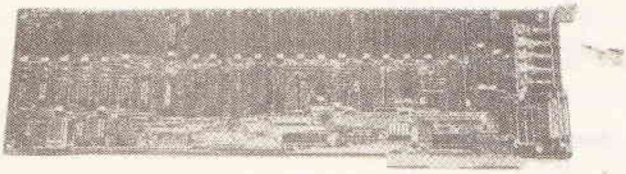

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In next months thrilling installment of ETI we bring you more on detecting the strange VLF waves within the ground, some other ideas in America for the production of High Definition Television in the future and more on our circuit file series on constant current generators from Ray Marston.

How's your image? Now we do mean stereo image and not your face or your ego. The reason we ask is because your acoustic image might not be as you thought it was. This feature looks at the physics of what we hear and how we hear it. Back to Basics looks at the analysis of some simple AC circuits.

On the construction side we build a circuit around a laser tube to modulate the beam output for a possible 101 uses, a thyristor tester and a frequency plotter to test the response of audio and speaker circuits on the oscilloscope screen.

All this and more in the May issue out in your newsagents on April 5th.

The above articles are in preparation but circumstances may prevent publication

LAST MONTH

Our March issue saw projects on a versatile micro-controlled light display called Arienne's Lights, the amateur radio enthusiasts took joy in seeing a construction of an SSB Receiver and the computer freaks wallowed in the delights of a 64K EPROM Emulator.

Features included Designing a Testmeter, RIAA Characteristics and the last of our long running series, Testing Testing. A limited number of back copies are available from Select Subscriptions (address on contents page).

ADVERTISERS' INDEX

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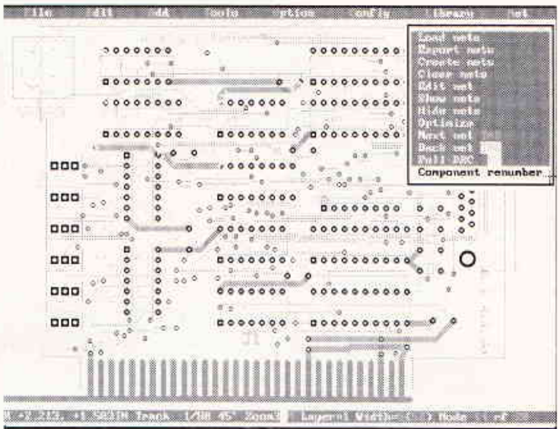

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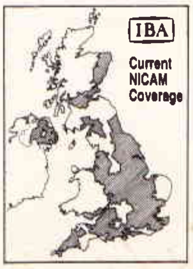

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