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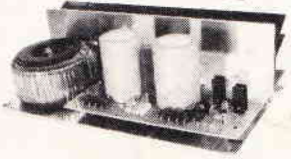

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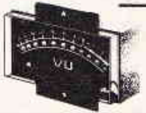

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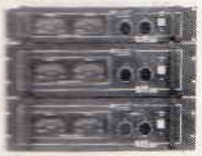

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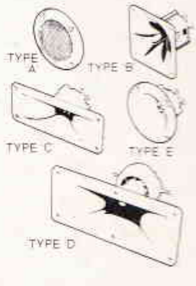

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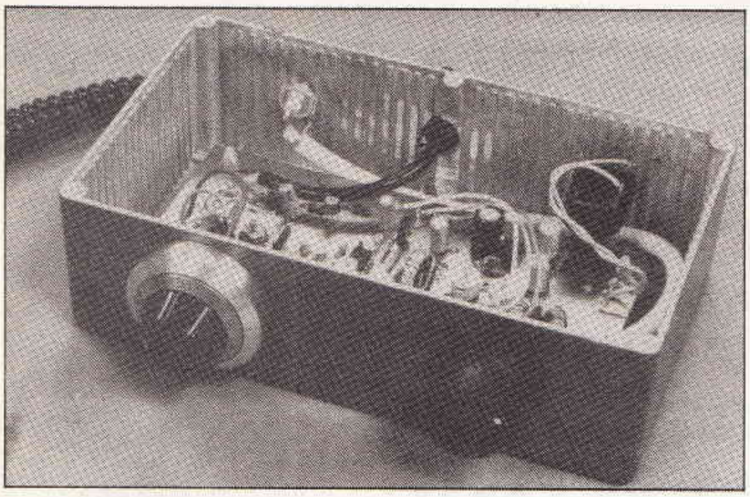

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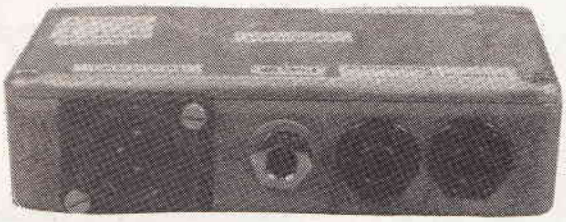

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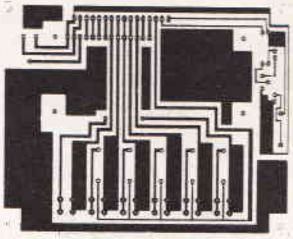

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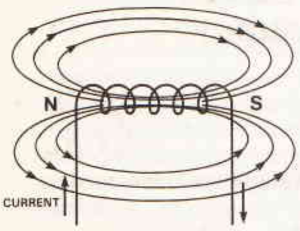

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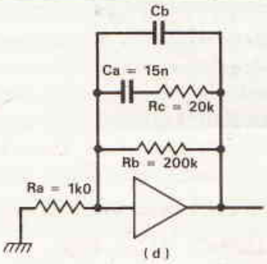

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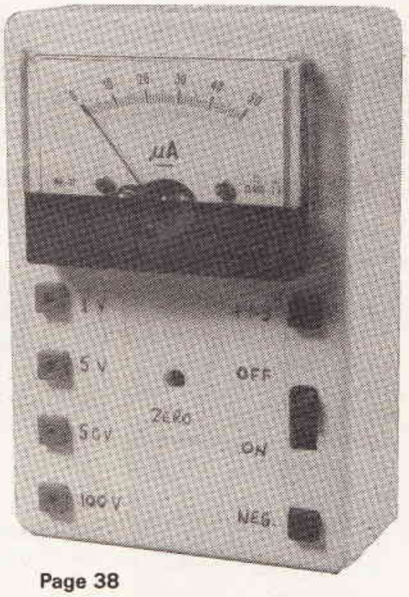

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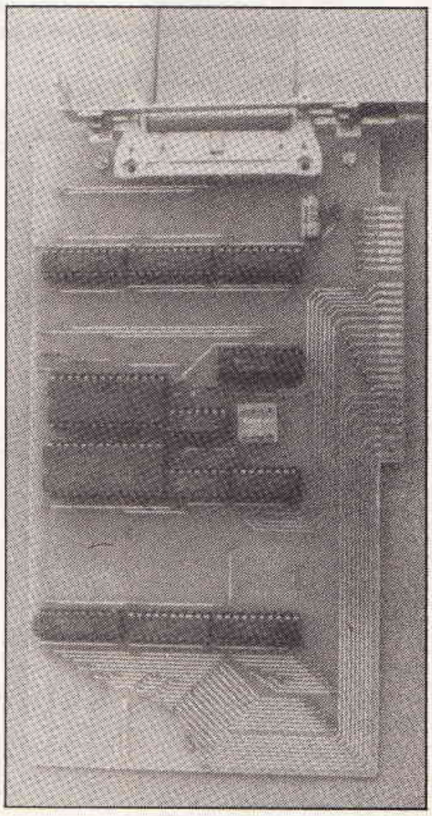

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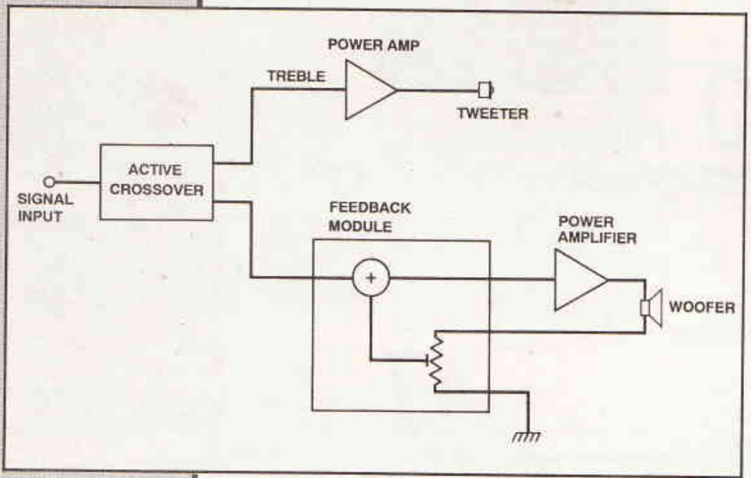
BLUEPRINT

Blueprint is a column intended to provide suggested answers to readers' electronics design problems. Designs are only carried out for items to be published, and will not be prototyped by the columnist. Circuits published in Blueprint are believed to work, but may need minor alteration by the reader after prototyping. Individual correspondence will not be entered into, save as necessary to prepare items for publication.

Just for a change, this Blueprint includes a project to construct a module which I hope readers will find useful. It uses a principle I have applied in the past, and which has given dramatic improvements in audio quality from modest sized loudspeakers.

One failing of almost all hi-fi loudspeakers is that they contain crossover units which add distortion, and permit the drive units to add their own distortion. the active loudspeaker project in ETI May 1990 did much to get around this problem, but more can be done to improve the situation.



First of all, to put this mini-project into perspective, let us examine the reasons why crossover units pose a problem. A crossover unit is a passive filter which divides the sound spectrum into two or three bands for the separate drive units. There is nothing wrong with this concept, and if the components forming the filter of high quality and if the loudspeakers present a resistive load then all will be well.

The first snag is that crossover components, no matter how good, will still fall short of perfect. Cored inductors cannot be made completely linear, and all but the very best capacitors have insanitary habits such as changing value slightly as a function of the voltage across them, which causes harmonic distortion.

Dielectric storage is distortion inducing another imperfection to which capacitors are prone.

The above refers, of course, to film dielectric capacitors. Crossovers using electrolytics are beyond the pale!

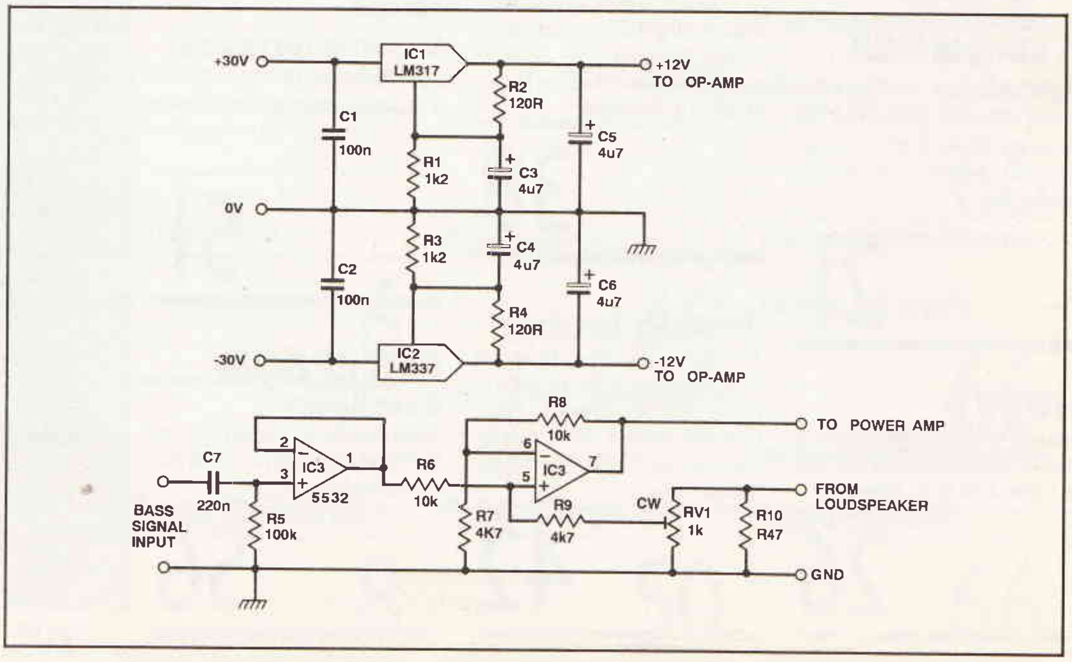
An active crossover using no inductors removes one source of distortion, but more can be done. It is easier to obtain high quality capacitors if the capacitance is lower, so the capacitors used in an active crossover should be chosen not to add distortion to the sound. Polypropylene or paper types are suitable.

Frequency Response

The second obvious snag with passive crossover units is that the loudspeakers do not present a clean resistive load, so the frequency response of the crossover unit will not be as smooth as it should be. A loudspeaker has an inductive component of impedance, and the resistive part of the impedance depends partly on the cabinet in which the drive unit is mounted.

Even worse, the drive unit stores energy in mechanical form, and cabinet resonances can also store energy and then return it to the cone of the loudspeaker later. It is likely that the cone of a bass drive unit will vibrate at frequencies outside its normal range of operation.

What should happen is that movement of the voice coil imposed mechanically generates a voltage which causes a current to flow which strongly opposes the movement, heavily damping any resonance. The magnitude of the current is only limited by the total



resistance in the circuit.

The presence of a crossover unit increase the impedance seen by the loudspeaker, specially at frequencies just above the crossover region. This prevents the low output impedance of the amplifier from damping unwanted vibrations properly. An active loudspeaker can avoid these problems as well, but the damping of the bass drive unit is not as good as it could be because the DC could somehow be cancelled out, the bass driver would respond more accurately to the signal from the amplifier. Note that the resistance to be cancelled is not the apparent resistance of the loudspeaker when it is in opertion, because part of this represents power transferred to the air.

Negative Resistance

Here is a project to do just that. What it does in effect is to impose a negative resistance in series with the resistance of the voice coil, giving a much more powerful damping effect. It is designed to fit in as an extra module in any active loudspeaker project, including the ETI one.

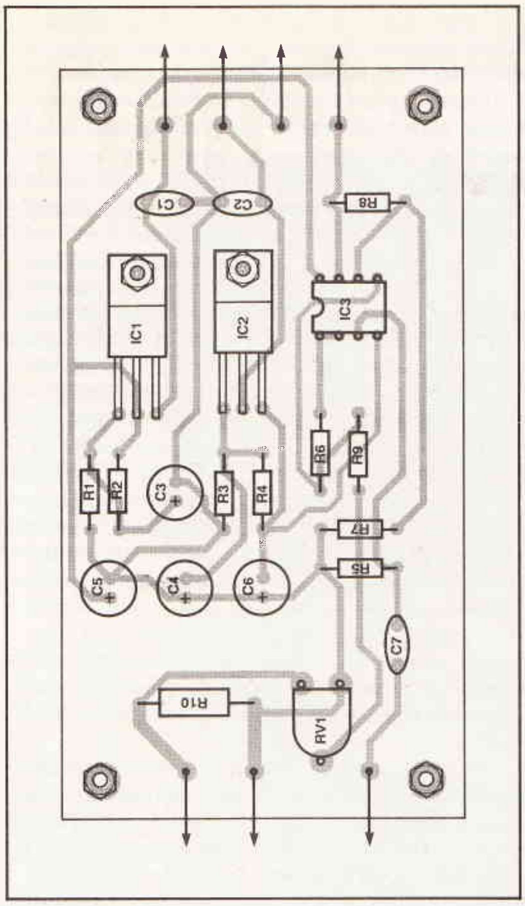
What it does in essence is to measure the current flowing through the loudspeaker, and increase the voltage drive in response to an increased in current. Application of Ohms law shows that this is indeed negative resistance.

Of course, if the voltage drive increases too much in response to increasing current, the resulting increase in current will increase the voltage drive even more, and the whole system will try to latch up. To prevent any possibility of this, the module must be adjusted to cancel most but not all of the negative resistance, and any extra contribution of resistance due to connectors (which could vary) should not be cancelled.

In most active loudspeaker systems, there are no connectors between amplifier and loudspeaker, and only a short length of wire. In these conditions, most of the negative resistance can safely be cancelled, giving a substantial improvement in damping. The principle is illustrated in Figure 1. Almost any non-inverting power amplifier can be used, and of course in inverting one could be used if the signal output from the module were inverted. The main requirement for the power amplifier is that it should have a wide enough bandwidth, and a smooth enough roll-off.

The circuit diagram is shown in Figure 2. The input is coupled via C7 to remove an DC offset which may be present. If the output from the frequency splitter has no DC offset, C7 may be omitted.

The input amplifier is used as a buffer, in case the previous stage cannot conveniently drive a 10k load. In most cases this will not be a problem, but the buffer will not be a disadvantage.



The following stage works as a simple non-inverting mixer, adding a small proportion of feedback signal to the main signal.

The power supply uses LM 317 regulators to provide approximately +/−12V. These were chosen in preference to 7800 series regulators both because the regulation is better, and because they can operate at higher input voltages than the 35V maximum for 7800 series.

When the module has been built, it should be connected to draw its power from the main amplifier power supply. The loudspeaker should initially be connected via a fuse in case there is a fault which could cause damage. Assuming that all is well, remove the fuse unless the extra precaution is required anyway, and adjust the potentiometer RV1 for the best sound. If in doubt, set the wiper a little lower than optimum to allow a stability margin.

PARTS LIST

RESISTORS	
R1,3	1k2
R2,4	120R
R5	100k
R6,8	10k
R7,9	4k7
R10	0R47
RV1	1k preset

CAPACITORS	
C1,2	100n
C3,4,5,6	4μ7
C7	220n

SEMICONDUCTORS	
IC1	LM317 Regulator
IC2	LM337 Regulator
IC3	5532

MISCELLANEOUS
PCB from ETI PCB Service

OPEN CHANNEL

It's remarkable in such days of worldwide, instantaneous electronic communications that we depend so much on the vagaries of the weather.

Let me explain. I live in the East Midlands; where one day early in December last year we had a fall of snow. Well, let's be more precise: although you are reading this in the March issue of ETI, sometime in February, I am actually writing these very words exactly three days after the said same fall of snow.

Now, if you get my drift (pun intended), this fall of snow caused terrific disruption to everyday services in the region. First, it felled main high-voltage electric lines from the local power station, Second, these high-voltage lines fell on many other lower voltage electric lines with the result millions — yes, literally millions — of people were cut off from their electric supply.

This wouldn't have been so bad in itself. After all, being without power for a few hours is no big deal. But it did turn into a big deal. Other lines went down too, in remote areas after this. These were difficult to trace. Couple this with the snow which made getting to the faults extremely hazardous and the result is a total regional power cut.

But that is not all. As power was simultaneously cut fron water pumps at treatnent stations throughout the region, fresh water was lost as well. Three days after the initial problen there appears to be no immediate letup.

This, I appreciate, is largely irrelevant to the majority of readers. However, bear with me, there is a link. I mentioned earlier writing this column and that indeed, is what I am doing — writing; long-hand, in pencil, with aching fingers and multiple crossings out. You see, for over six years I have word processed just about every word I write in magazines, papers, books and letters. Since availing myself of a word processor I have almost forgotten what it is like to really write — that is, with pencil and paper. My trusty computer, which has only once let me down over these years (a trivial speck of dirt on the keyboard circuit board) bridging two parallel tracks), just could not cope with a decided lack of juice, and so here I am relying on daylight hours to produce my scribblings.

First point behind all this, is that modern communications are only as good as mother nature allows them to be. It's perhaps as well to remenber this. Second point, I suppose, is I need a new, battery-powered portable computer. Any offers from computer manufacturers who need a decent and reliable field-trial?

Your morning Disc, Sir

Starting early this year past editions of newspapers will start to be available in compact disc form. The Sunday Times, The Times, The Independent and The Independent on Sunday are the first newspapers available in archived quarterly and yearly CDs, specifically for researchers in libraries.

Many readers will be familiar with The Times' nickname — The Thunderer, and this is the inspiration for the name of the system' Thor. It is, naturally, more convenient and considerably faster to access specific information than microfiche versions which give similar facilities

Wire We Doing This?

It's just a little while until the Government decides who will be running our electronic communications systens. A number of companies and organisations is expected to bid. One, British Waterways is tipped to have a good chance of succeeding and is in an ideal position to build its network more quickly and more cheaply than most of its expected rivals. key to its potential success in the field is the fact its network will be cabled not in a field. Where most of its rivals networks must effectively be made underground, British Waterways network will be totally above ground — but under water. BW plans to lay cable along its 2000 miles of canals.

Cheapness and ease with which this could be done (an estimated £40m undertaken in a matter of just months) will launch British Waterways into being a key player in the telecommunications field, allotting it to create very cheap customer services in comparison with others.

Looking to another side of the telecommunications liberalisation story, British Telecom is disappointed to learn it will not be able to provide television services for another 10 years. Whether this is a correct Governmental decision or not depends on your point of view. BT is in the ideal position to be able to pipe television channels along with telephone services, and doubtless could provide such a network fairly easily and quickly. However, if telecommunications markets are to be liberalised, allowing significant competition to build alongside BT, then holding back the possibility of BT doing the job gives potential competitors a chance to succeed. If they don't succeed, and after all, we only have the startling growth of BT's only other major telephone rival; Mercury — which over the last five years has achieved the incredibly magnificent, even staggering, vast market share of around *one half of one percent of all telephone business* — to compare the vast majority of customers won't see a decent cabled television network in conjunction with telephone services. Most cable franchises are currently either materialising incredibly slowly or not materialising at all.

And Now For Something...

While we're on the subject of BT, it's interesting to note a recent directive to its 240000 employees, banning the consumption of alcohol at work. 'Operator shervishes, can I be of any asshishtence.'

Keith Brindley

ETI NEWS

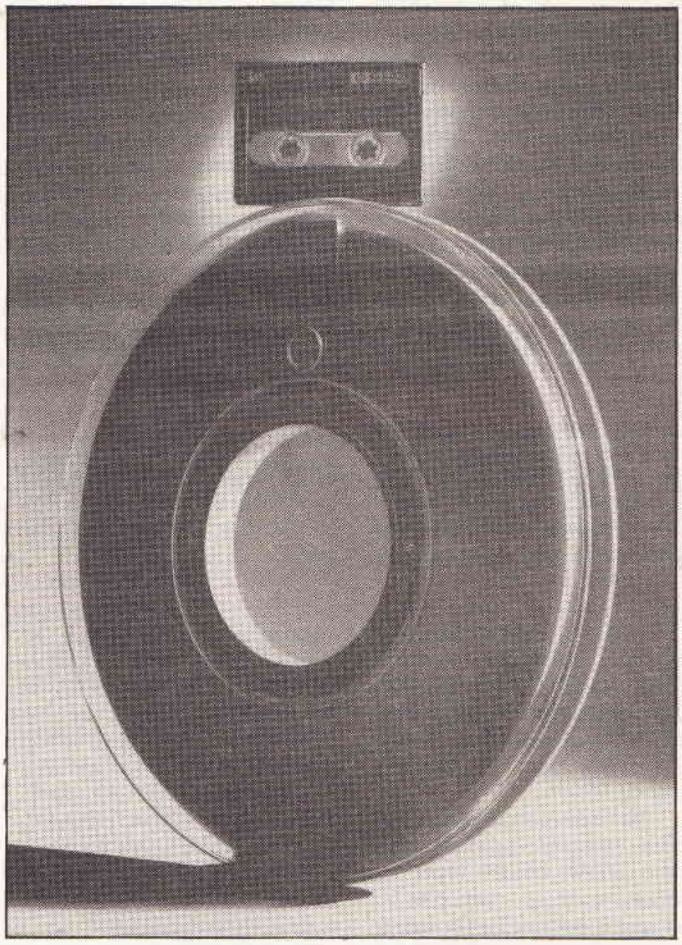
8 GIGABYTES ON A DAT TAPE

Hewlett-Packard has announced the available of two 3½-inch DAT drives — the HP 35470A and NP 35480A — with a potential storage capacity of a massive 8 Gigabytes per $10 tape. HP believes that it is the first system manufacturer to integrate the DAT tape drive into a computer system, and that it has shipped more DAT drives than any other DDS manufacturer in 1990.

The DDS standard has been adopted by the European Computer Manufacturers Association (ECMA) as an industry-standard format. It has been submitted to the International Standards Organisation (ISO) for a vote by ballot for adoption as an ISO standard and publication of this is expected in mid 1991. It is also intended that there will be an American National Standards Institute (ANSI) standard and the technical development for this is complete. The DDS data compression format has been accepted by the DDS manufacturers group as the standard method of storing compressed data on DDS tape drives.

The two new developments in the HP 35470A, previously unseen in DAT products is a 3½ inch package for standard PC boxes and 2 Gigabytes of storage capacity on a single 90m tape. Data transfer rate is at 183 kbytes/s for the HP35470A. The '80A drive is in the same 3½ inch package but is the first drive to incorporate data hardware compression giving up to 8Gbytes of data per cassette at a transfer rate of 732 kbytes/s.

The systems were developed and are manufactured at NP's Bristol operation. Each drive features a built-in small-computer-systems-interface (SCSI) controller and will be marketed to original equipment manufacturers (OEMs). Unlike other DAT drives, which rely heavily on the mechanisms designed for use in the audio industry, the new HP drives use a mechanism that was conceived and designed specifically for use in the computer industry.



The combination of high performance and small size make the DAT drives ideal solutions for unattended backup of networked workstations. PC network servers, high-end PCs and multi-user systems are other areas in which massive storage capacity in a small package is particularly valuable.

The tapes will cost about $10.

A NEW LEARNING EXPERIENCE

E & L Instruments have produced 'CompED', a new series of teaching programmes for Electricity and Electronics. CompED is available as a complete course or in individual modules that include Basic Electricity, Electrical Circuits, Wiring & Diagrams, Test Equipment, Magnetism, Generating Electricity, Control & Protection Devices, Solid State Components and Computer Controls. Text, single images, and two or three dimensional animation is brought together as a single display. Control of text can be stopped, stepped or scrolled.

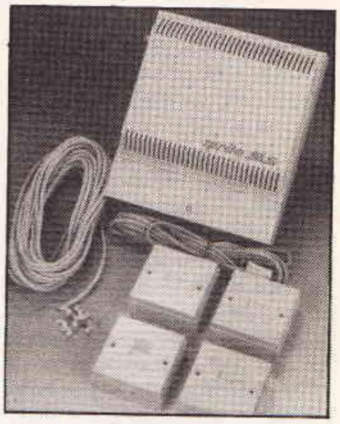
Developed for the European Market by E & L in the UK, each module can be practised. The last chapter is a series of review questions and an incorrect answer to a question automatically recalls the correct graphic and text. Each programme comes complete with a set of examination questions so the lecturer can grade and watch the progress of each student. If required the results can be printed out.

A user-friendly manual produces easy computer based learning. Hardware requirements are an IBM PC or compatible with 640k RAM, Hard Disk, EGA or higher graphics. Copy is from an install programme to the hard disk.

Individual modules are from £199.00 (exc. VAT).

Further information contact: Justin Stanyard at E & L or Fred Hutchinson of Quiswood Ltd on (0756) 799737.

HOME AND BUSINESS TELEPHONE EXCHANGE



The Maplin telephone exchange system could make the best use of your telephone. Any one of up to four extensions can make an external call in privacy, and if the exchange line is busy you can tell it to let you know when it becomes free.

Incoming calls can be answered from any extension and transferred to another if required. Intercom calls can be made between extensions even if the outside exchange line is in use. In addition, any extension can be used as a baby phone to monitor a sleeping child. If required, extensions can be barred from making external calls.

Installation is said to be simple requiring no special tools. The unit is an advanced microcomputer controlled system that combines a combination of telephone control and premises security. Advantage is taken of the special features to set the alarm from any telephone and automatically dial a local number should an intruder break in or a fire start — in this respect the system acts as a fire alarm.

Features include: ● Compactness ● Accepts any Approved BT 'phone ● Call Hold, Enquiry & Transfer ● Baby Alarm and Call Diversion The Home & Business Exchange costs £199.95.

ANTI-STATIC BREAKTHROUGH

A revolutionary plastic compound that virtually eliminates static and could save the international electronics industry millions of dollars has been developed by a Hong Kong company.

The new compound has been created by Statpack Systems Ltd whose managing director John Dalton created a unique formula after visiting a major Korean electronics manufacturer last year.

"We were called in to help solve a chronic problem with static which meant that the Koreans ware rejecting up to 50 per cent of the moulded housings that they were producing for radios, televisions, and CD players," Mr. Dalton explained. "The Koreans weren't alone either, as static was a problem that had been plaguing electronics companies throughout the world".

Static is acquired by many materials, especially synthetic ones as a result of friction, air movements and relative humidity. This build up of electrostatic charges causes materials to attract and collect foreign matter such as dust from the surrounding air due to to differences in electric potential. The dust accumulates on electronic housings and components, ultimately causing malfunctions such as short circuiting.

"Anti-static sprays and dips that are often used in an attempt to remove static from shipping tubes and static sensitive devices weren't solving the problem in Korea as they didn't allow manufacturers to print over them," Dalton explains. "Our challenge in Korea was to come up with a long-term solution that would not only slash static reject rates by preventing dust attraction but which could also be readily incorporated into the manufacturing process and allow for easy screen printing."

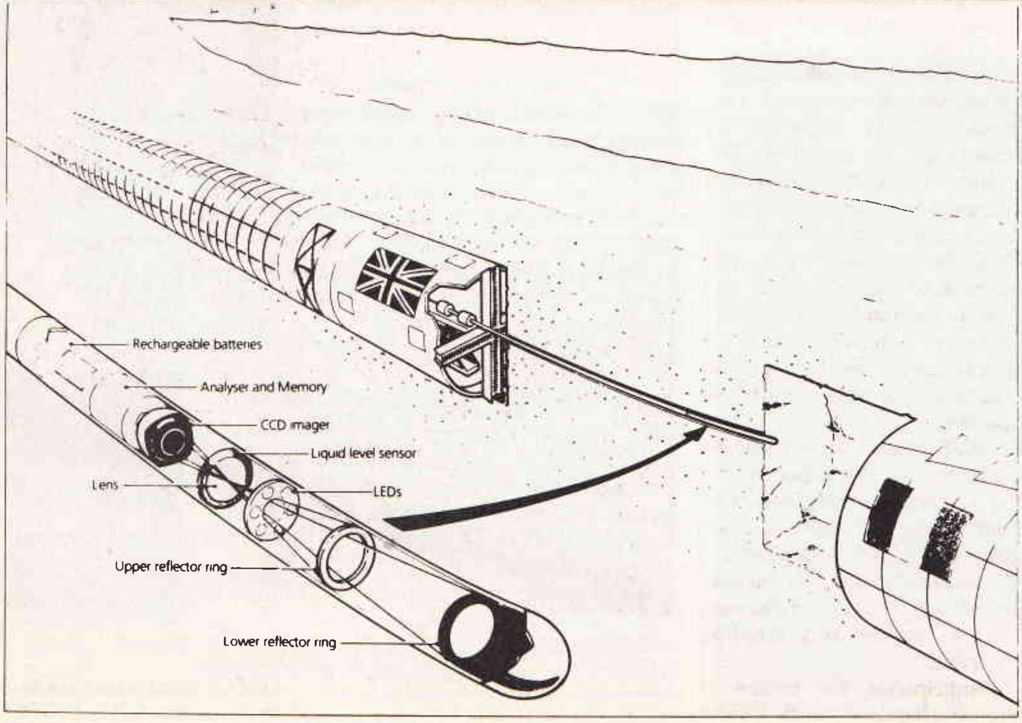
Mr Dalton decided that the best way of reducing static build-up in electronic equipment housings was to remove it at source by developing an anti-static plastic masterbatch. Although this had never been done before, chemists in Statpack eventually came up with a compound which solved the Koreans' problems.

The results were very impressive, with static-related reject rates being cut from as much as 50% to less that 5%." Mr Dalton explains.

The anti-static masterbatch developed by Statpack requires no new machinery and can easily be incorporated into the existing manufacturing processes. It can be used in any shape or form for plastic items produced by injection moulding, blow moulding or extrusion.

Further information contact: John Dalton, Statpack Systems Ltd. 903 Kowloon Centre, 29 — 39 Ashley Road, Tsim Sha Tsui, Kowloon, Hong Kong. Tel: 010 852 311 7980. Fax: 010 852 724 2360

TUNNEL ALIGNMENT USING OPTICS



When the British and French sections of the Channel Tunnel were connected for the first time on 30 October 1990, a new and sophisticated electro-optical probe was used to determine the relative positions of the two tunnel faces.

The probe, a new borehole surveying tool from Reflex Instrument AB of Sweden, was used to measure the exact path of a small diameter hole drilled in the 100 metres of chalk still remaining between the two halves of the tunnel.

The Reflex Maxibor, as the probe is known, was created for Reflex Instrument by Chardec Consultants Limited of Brighton, a UK based research and development company, which offer expertise in electronics and associated fields.

Chardec Consultants was asked to design and develop a surveying tool that would be simple to use, yet give accurate results in harsh environments. Their solution was the Haxibor system which met and exceeded these original specifications.

In principle, the Maxibor makes borehole measurements in exactly the same way as a surveyor uses a theodolite to make surface measurements — by taking a series of readings of angles and distances.

Inside the hollow steel casing of the Maxibor, two optical reflector rings are positioned at three metre and six metre distances from a CCD area image sensor and high intensity LED light source. The CCD picks up images of the two rings and tracks their relative positions as the tube bends to follow the line of the borehole. A circular liquid level sensor also forms an image on the CCD and provides essential information regarding the roll angle of the tool.

Supporting the CCD is a compact but powerful set of image processing electronics based on a 40MHz DSP chip from Texas Instruments. Ring images received by the CCD are analysed using a mixture of spatial and frequency domain algorithms providing ring centre location to sub-pixel accuracy and high noise rejection. Images from the level sensor are handled in a similar way yielding angular resolutions to fractions of a degree.

Data from these two sources are accumulated for the whole survey and stored in the 256K of on board battery-backed RAM. Once back at the surface, the data is uploaded to a hand held field computer where it is formatted and presented in graphical form almost immediately.

In tests the Maxibor achieves survey accuracies exceeding 1:1000. It is powered from a rechargeable battery pack, providing up to 16 hours of continuous surveying and housed in rugged steel tubing measuring 45mm in diameter.

Chardec Consultants provided the complete design for the Reflex Maxibor including the optics, electronics and image processing software. The company was formed in 1986 by Technical Director, Richard Parfitt and has experience in all areas of analogue and digital electronics, and offers a complete range of design functions.

Commenting on the Reflex Maxibor, Richard Parfitt said: "This device combines video and optical technology with some of the most powerful electronics available. Only a few years ago it would have been impossible to use the sophisticated algorithms at work inside the Maxibor, simply because the computer necessary to support them could not be housed within the small dimensions of a borehole instrument."

For further information contact: Richard Parfitt, Chardec Consultants Limited. Tel: 0273 305763, fax 0273 300488.

CQ CQ

Would-be radio amateurs searching for a way to gain their Radio Amateur Licence A can study with a distance learning college RRC (Rapid Results College) to sharpen their skills before taking the Radio Amateurs' Examination.

Enthusiasts will be aware that the Home Office requires all Radio Amateur Licence applicants to have passed the Radio Amateurs' Examination. The RRC City and Guilds programme covers both Parts 1 and 2 of the course and prepares students for the examinations which are held in May and December of each year.

The RRC programme covers the following subjects: Licensing Conditions; Transmitter Interference; Operating Practices and Procedures; Electrical Theory; Solid State Devices; Radio Receivers; Transmitters; Propagation and Aerials and Measurement.

For further details contact, RRC, Tuition House, 27/37 St George's Road, London, SW19 4DS. Tel: 081 947 2211.

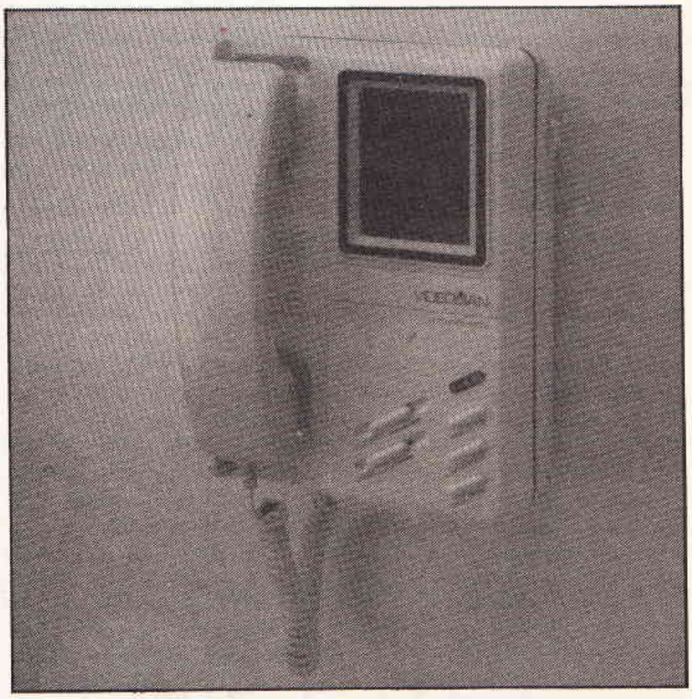
BUDGET VIDEO DOOR PHONE

With crime still on the increase in Britain, security is a major concern for the home or business premises. People are not always who they say they are, but with the launch of a new video door entry system, it is now possible to see and speak to your caller before answering the door.

Although the concept of video entry phones is not new, the Videoman, supplied by MVS Marketing Limited, is a fraction of the price of similar systems on the market and the Videoman is unique, in that it can be installed using ordinary bell wire. The tamper-proof camera unit needs no special power cable and can be fitted up to 150 metres away from the interior unit. If a greater distance between the two is required, co-axial cable can be used and the distance extended up to 400 metres. The Videoman can also be installed using an existing bell or intercom system and power for all units is supplied by an ordinary 13 amp socket.

The Videoman is activated by the visitor pressing a button on the small, discreet exterior unit concealing the camera, which even in low light will pick up the image of the caller using an infra-red detector. A chime will sound on the interior unit and the visitor will immediately be visible on the screen for 15 seconds. The 'monitor on' button allows the occupant to view the caller for a longer period without their knowledge. Should the occupier wish to speak to the visitor, they can pick up the handset and a conversation can take place. A remote door release button is also available for remote control door opening.

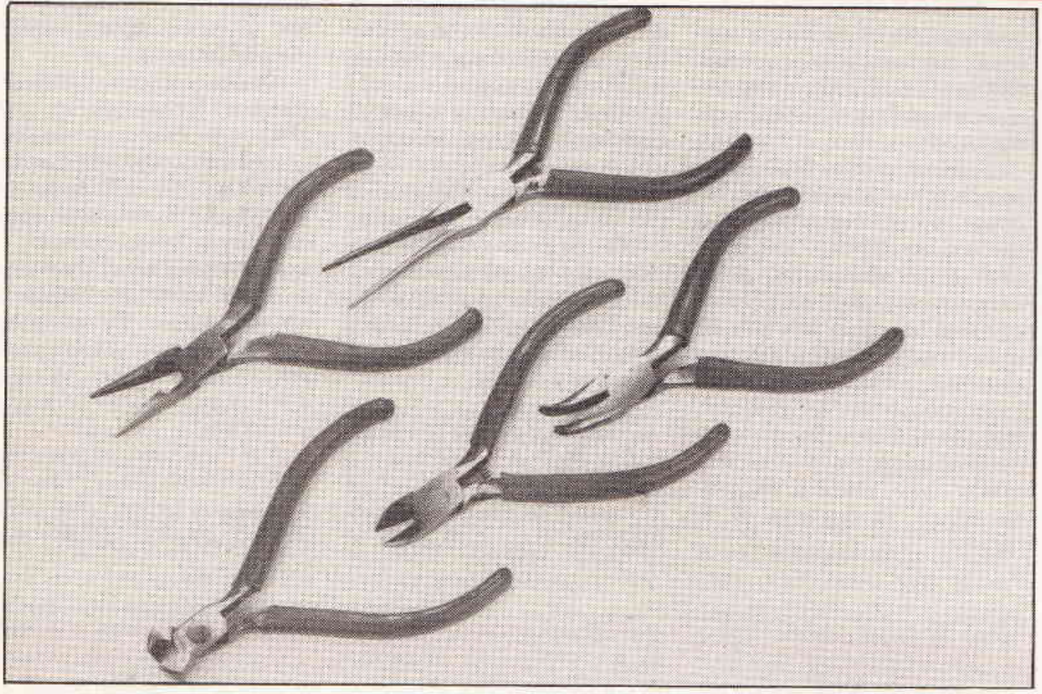
MVS Marketing are said to have considerable experience in the security industry and their basic Videoman system costs from £399. The Video system can be installed into flats, houses, residential homes, warehouses, offices, banks and building societies.



Anticipating the review of licencing legislation by the DTI for television transmittion, the company has designed a microwave transmitter that can be fitted to the Videoman and other surveillance equipment, when the laws are relaxed.

Further information contact: MVS Marketing: 0705-593043.

A CUT ABOVE THE REST



New this year from Maplin is the 5 Piece Plier/Cutter Set which are a cut above the rest.

This set of five useful pliers and cutters, all of which are lap-jointed and have insulated handles comprise:

- A pair of long-nosed pliers with serrated jaws and integral wire cutter.
- A pair of extra-long nose pliers with smooth jaws and spring return.
- A pair of curved long-nosed pliers with smooth jaws.
- A pair of side cutters with spring return.
- A pair of end cutters.

The catalogue number for this set is YZ45Y and costs £8.95 (including VAT).

VOICE MESSAGING LINK TO JAPAN

British Telecom has extended its international voice messaging service to Japan. The move follows an agreement between British Telecom and Japan Voicemail and means that the voice messaging service is now available in the United Kingdom, the United States and Japan.

Services to Australia, Hong Kong, France and Germany will be launched by British Telecom early next year. Japan Voicemail customers will also have access to these countries. The latest additions bring British Telecom's investment in international voice messaging to more than £10 million.

Voice messaging allows users to store and forward spoken messages via a computerised message-taking exchange to other users' "mailboxes". A voiced message can be sent to one person just as easily as it can to a dozen or more.

Messages can be sent and received from any telephone, anywhere in the world, at any time. Customers can phone a special telephone number, enter their personal identification number and at the press of a couple of buttons send, receive, add to and return, or redirect messages.

The capacity to 'store' messages makes voice messaging ideal for business people who spend a lot of time away from their desks and is of particular benefit where time zone differences are encountered.

The average cost per mailbox is £35 per month.

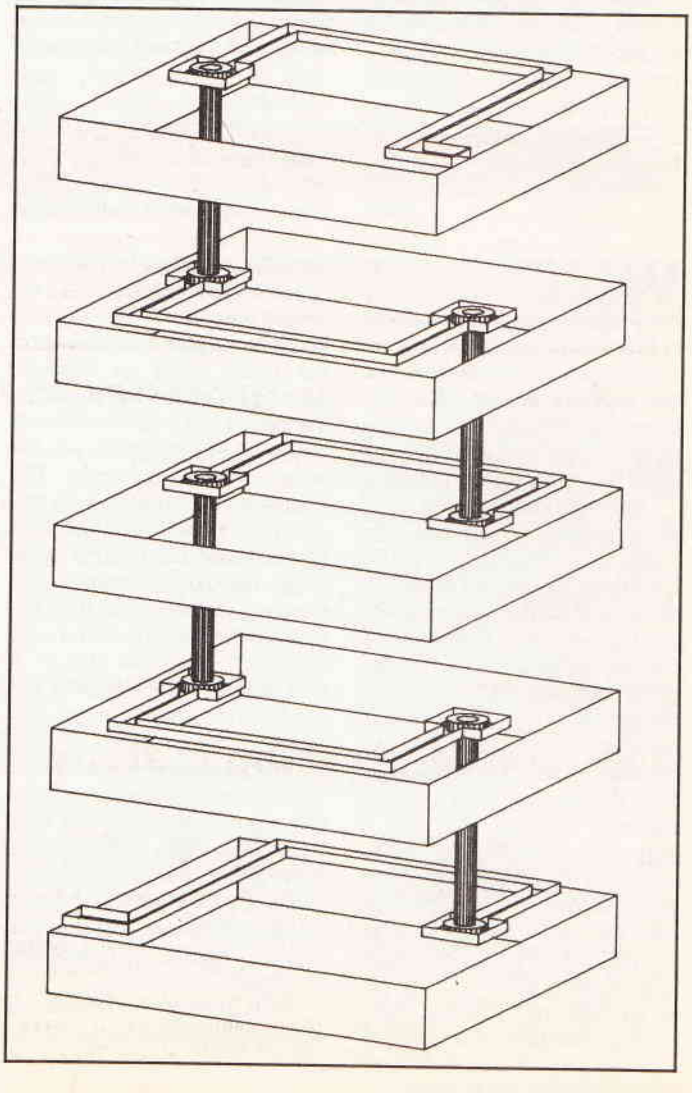
Enquiries to British Telecom's Corporate Newsroom on 071-356 5369.

SURFACE MOUNT INDUCTORS

Hampshire based Electroustic Limited have made available a series of surface mount inductors. The idea of an inductor as a lump of iron with some wire wound round it is an old view. Difficulty in manufacturing such components on a small scale has meant the inductor has been left trailing behind the widely available capacitor for surface mount technology.

The inductor has caught up with the capacitor in the surface mount world by using techniques borrowed from the manufacture of the capacitor. An inductor can be constructed in a similar way to a multilayer chip capacitor by using ferrite instead of ceramic — the difference is that each plate has to be connected in series by means of plated through holes instead of in parallel.

The range of values is currently limited from $0.22\mu H$ to $22\mu H$ but is being extended all the time as the product is developed. This product has many applications in the electronic and telecommunication industries where surface mount is now extensively used.



ETI NEWS stateside

New gate array technologies

Semiconductor manufacturers see a large market for field-programmable gate arrays. These arrays are proliferating in both numbers and new architectures, opening up possibilities not available to custom or semi-custom chips. The tools used to develop applications for them are in many cases the same as those used for gate arrays.

Xilinx and Actel both described the latest generations of their very different technologies. These are the RAM-configured logic-cell array of Xilinx and the antifuse-configured array from Actel. These two technologies will face competition from a range of ideas with little in common except a generally finer granularity than has been the norm.

Apple Computer's array, called Labyrinth, have cells with four input and four output links, allowing unlimited two-dimensional cascading. There are only two outputs in a cell, but they each go to two neighbouring cells. At the edges of the chip, the leftover I/O lines are brought out, so the array can continue on another chip.

A 4-bit configuration makes the cell a half adder or a 1-bit register. This configuration also determines which inputs go to which outputs. The register contents are undisturbed when the configuration is changed. This allows registers to be loaded before the array is reconfigured to operate on the data.

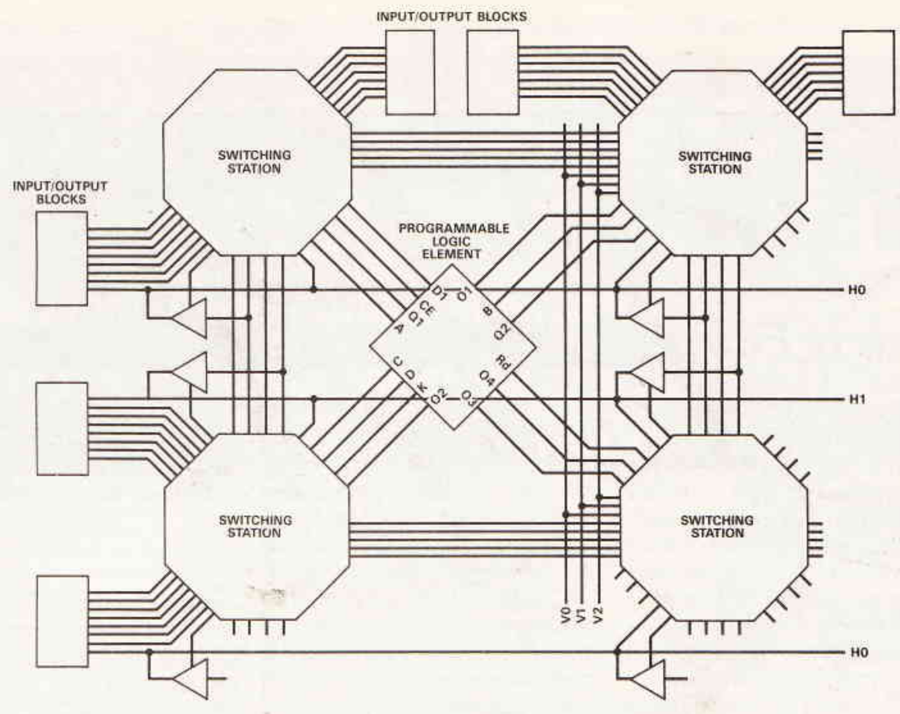


Fig. 2 The switching stations route all long connections between programmable logic elements and I/O blocks in the Kawasaki Steel array. Neighbouring PLEs have direct connections.

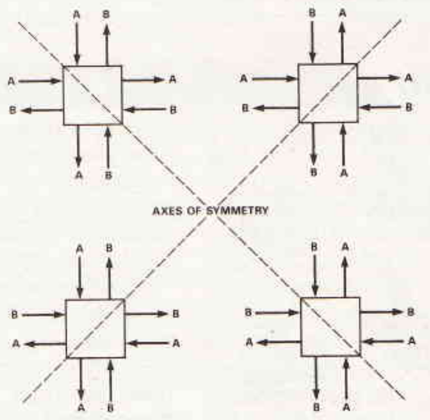


Fig. 1 The cells in the Labyrinth array are connected permanently in four orientations. The A outputs are connected, as are the B.

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.

New vehicle tracking system

A new system for tracking a stolen vehicle uses the car's cellular phone to transmit its longtitude and latitude to a monitoring station which locates the car on a map and calls the police station closest to the car. A loran-C receiver hidden in the car allows the tracking system to determine car longitude and latitude. Monitors track the car's direction and speed from the loran-C data.

The vehicle-tracking system works with a vehicle-security system, which automatically calls the monitoring station if the car is started without its security system being disarmed. Electronics sense if the car is being towed or if the security system is disconnected from the tracking system.

The system, called Intercept, from Code-Alarm Inc., Madison Heights, Michigan, is being used in the Detroit metropolitan area. By the end of 1991 the system will operate in other cities. Other tracking systems require that the police cars carry the tracking equipment and owners activate these systems after a car is stolen. Because Intercept includes a loran-C receiver, police departments do not have to install any equipment in their cars.

READ\WRITE

ETI LETTERS

Safety First

Since the publication of my article on Electrical Safety in mains equipment (Dec 89), I have paid special attention to any mains related designs published to see if any lessons had been learned by your contributors. Allowing for the natural lead time before publication, the noticeable improvements have virtually zero. Oh-well, I thought I had had my say so I will have to live with it.

Then came the January issue which I bought before Christmas, which has made me put pen to paper in the form of a complaint letter for the first time in my life.

On opening up to page 50, I could not believe what I was seeing such a blatent death trap within these pages. Whilst many of your readers will have the common sense not to duplicate this construction, you must agree that to present this an example of an 'experimental unit' to the younger and less experienced constructor is downright irresponsible. I urge you to publish a suitably prominent warning at the earliest possible moment, stating that in no way should such an arrangement be copied. I also urge you to exercise more caution when publishing projects which have any mains content, carefully vetting them for adherance to basic safety considerations.

A Gayne, Worcestershire

I take your point Mr Gayne. We should always be aware of the dangers associated with mains electricity in our projects or otherwise and for that we should not have published a picture showing open construction. The power supply for the ETI SBC09 in the January issue should have some form of protection around it. Having said that we expect this project will only be attempted by an experienced constructor who knows what they are doing in the computing and electronics world.

As a footnote to this, I can never recall reading in magazines about the dangers of mains when constructing valve radios and amplifiers in my early years (I started when I was eleven in the early sixties). I hate to admit it, but shocks were a regular occurence when trying to get a steam radio to work. Still, I did learn the hard way. Ed.

40-30

After reading Launcelot Dow's letter in your December issue of ETI, I feel I must rise to the defence of Mr Linsley Hood.

This man is not just a great man and respected engineer but a highly respected designer who has had articles published in Wireless World longer than Mr Dow has been building amplifiers.

There seems to be two types of hi-fi enthusiasts one like myself who builds amplifiers to designs of people like Mr Linsley Hood and have been brought up on electronic magazines and those who read a certain Hi-Fi magazines to which the 'golden-ears" write articles on exotic hi-fi.

I feel sorry for those taken in by them, you only have to read various editions stretching back over several years to realise that what was 'flavour of the month' in 1985 was not in favour in 1990 including American exotics costing thousands of pounds.

Readers are told to buy very expensive items which could at a pinch buy a flat in Scotland.

Not a hint of an apology when those expensive items are later shrugged off as being inferior in sound quality to their latest 'million dollar' item.

No wonder the back of the magazine is filled with poor souls trying to sell their now out-of-date gold plated items. I wonder how many divorces have taken place over frustrated hi-fi perfectionism.

Mr Dow must have misread the letter in November when changes to the circuit are mentioned. These are circuit design changes and just changing components will make no difference to the stability of the amplifier.

D Lucas, Glasgow.

I have been following the debate between Mr Nalty and Mr Linsley-Hood in your Read-Write column with interest.

Having built the 80-Watt amplifier designed by John Linsley-Hood and marketed by Hart electronics, I can testify to the excellence of this amplifier. I have compared it with several top make amplifiers which it equals, and in most cases surpasses in perceived sound quality. I had to make one for a friend after he heard it and became dissatisfied with his expensive commercial amplifier. The quality of the kit in respect of the PCB's and the clear instructions are first class.

I have also purchased the PCB's and components for the Virtuoso pre-amp from Mr Nalty. I have to say that I was dissapointed with the quality of the PCB's and the muddled instructions particularly with regard to upgrades of upgrades. Surely any product that purports to rank with the best shouldn't need upgrading?

D. Jackson, Bluntisham, Cambs.

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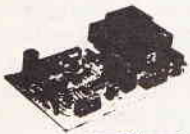

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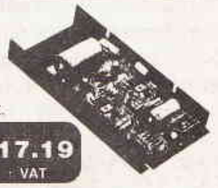

Provides sound reproduction of the highest quality with distortion levels below 0.02%, this module offers superlative performance in all types of audio equipment. Full over-load protection is incorporated ensuring reliability of the highest order. Supplied with its own heat sink, it opertes from a 40V-65V supply rail into loads of 8-16 ohms.

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This low cost unit provides a powerful 10W output making it ideal for all medium power applications requiring quality reproduction with rugged performance. Representing excellent value for money it operates from a supply of 18V-30V into loads of 8-16 ohms.

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With a host of features including 3 individual level controls, a master volume and separate bass and treble control, it provides for inputs for microphone, magnetic pick-up and tape, or second pick-up (selectable), and yet costs considerably less than competitive units. This module is ideal for discos and public address units and operates from 45V-70V.

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As MM 100 with two guitar + 1 microphone input intended for guitar amplifier applications.

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The IR1470 consists of a separate transmitter and receiver providing a beam of up to 50ft which, when interrupted, operates a relay in the receiver which in turn may be used to control external equipment. The system requires only 65mA from a 12V supply. Size: (each unit) 82 x 52 x 57mm

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The DP3570 consists of an adjustable timer switch and 12V stabilised power supply designed to provide switching of loads up to 4A at 240V A.C. for a preset time between 10 secs and 6 mins, the timed period being initiated by the normally open or normally closed inputs.

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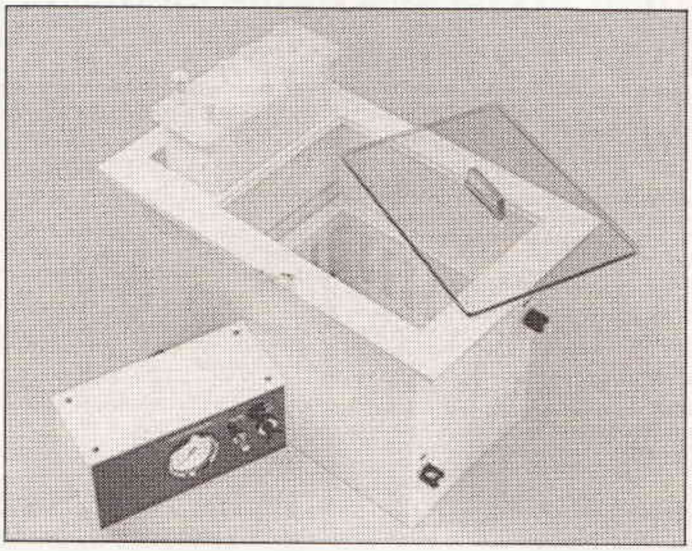
FIGHTING COMPETITION BY CUTTING PRODUCTION COSTS

A corporate view by Production Techniques Ltd.



Everyone involved in semiconductor manufacture in Europe is only too well aware of the intensive competitive pressures they are already facing and will continue to face at an even higher level, not only to maintain market share in post-1992 Europe but to hold their own against competition from the rest of the world, and particularly from Japan.

It is true that the European chip market has been enjoying a boom. According to the Dataquest Consultancy growth in 1989 was 22%, higher than the performance of either the United States or Japan.

Even so, it is considered doubtful that chip manufacturers, whether European-owned or overseas companies with a European presence, are generating sufficient profit to fund the research and development needed to produce the advanced chip technology which alone will ensure long term success in what is an increasingly international market

One example of the type of research demanded, from many which could be given, is the development of the 64-bit D-Rams (dynamic random access memories) which are expected to be available around the mid-1990's.

To compound these problems still further, purchasers of electronic components of all types, including the increasingly complex products for which they are seeking, are demanding ever higher quality standards, at realistic cost and delivered on time, in accordance with just-intime production schedules.

Chip manufacturers envisage various ways of meeting the situation. At the corporate level, managements look to policies of acquisition to achieve greater economies of scale in order to support a stronger research and development capability.

Politically, some look to action, by their own governments or on a wider pan-European or even international scale, ranging from expansion in such directions as the Joint European Submicron Silicon (Jessi) initiative to more controversial issues like retreating within an electronics "fortress Europe."

Less dramatic and yet perhaps more likely to achieve positive results in the relatively short term is to turn to the search for and introduction of economies in the production process itself. These can be aimed at cutting production time, improving efficiency, reducing maintenance costs, eliminating idle time, saving energy, reclaiming materials for re-use and similar policies.

Though individually, each such improvement may have only a modest effect on the bottom line, collectively a number of measures of this type can have a considerable impact.

One area in which improvements of this nature can be achieved is in the choice of cost-effective methods for handling the many fluids used in chip production, from special etchants and acids to various solvents and different grades of purified water.

Production Techniques Ltd. specialise in the design and manufacture of pipeline fittings, components and accessories, together with complete systems, for handling the highly reactive and high purity fluids widely used in the electronics industry.

Their 'Chemcon' range of PTFE products have been used by chip manufacturers in the UK and overseas for many years in etching baths and wash tanks as well as in the form of complete pipework and control systems for the transfer, dispensing and recirculation of these liquids.

They claim that major cost savings can be obtained from their combined pump and filter unit, used in wafer etch baths to deliver, filter and recirculate the etchant.

In addition to the savings in labour costs, significant economies are gained by the recirculation and re-use of costly materials and by the elimination of the considerable costs of disposal of effluent which cannot be discharged through the public sewers, without treatment.

A leading UK semi-conductor manufacturer has carried out a comparative cost analysis of acid usage before and after installing a 'PFU 20000' combined pump and filter unit. Using a conventional etch bath, 20 litres of HF were used, over a 24-hour period, costing £49.80 per day.

After installing the combined pump and filter unit, with recirculation and reclamation of acid, it was only necessary to provide a 'top-up' of 0.87 litres in the 24-hour period, at a daily cost of £2.16. This represents a reduction in acid usage of 19.13 litres per day, giving a daily cost saving of £47.64. At that time, the cost of a new 'PFU' system was £4,500.00, which, on the saving of acid costs alone, represented a payback of approximately three months.

Since then, a new version of the 'PFU' has been introduced, designated 'PFU 30000'. Its principal new feature is the incorporation of the valves in a separate control box, instead of being installed within the unit itself.

This new arrangement will have no effects either way on acid usage, but reduces maintenance and servicing costs.

The latest version of the 'Chemcon' pump also has a remote valve with similar benefits to those obtained from the pump and filter unit.

Designed for continuous operation over long periods, the 'Chemcon CBP 500' is used both for process and laboratory work, and is available for bench mounting or in a wallmounted cabinet.

Economies in production can be built-in at the design stage of a new fluid handling system or in the course of a major rearrangement of the plant, when a specialist can advise on plant layout, component selection and the integration of the various elements into a space-saving system which is easy to operate and maintain.

Production Techniques have many years experience in the design of such fluid handling systems in the electronics industry as well as supplying the components required. Their product range includes all types of pipe fittings, tubes and hoses, solenoid, non-return and pressure relief valves. pumps. aspirators. pressure regulators and flowmeters, all fully compatible.

Although it is never easy to quantify the savings from a fluid handling system, or to establish a reliable pay back period, suppliers and installers of such systems are convinced that there must be a significant, if indefinable, benefit to the bottom line.

In today's increasingly competitive semiconductor marketplace, any cost reduction using more cost-efficient production equipment will help to ensure a stronger position in the difficult years ahead.

BACK TO BASICS

2

This month Paul Coxwell looks at the magnetic associations with electricity.

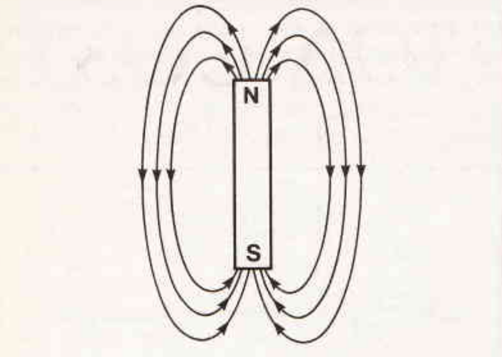


Fig.1 Lines of force surrounding a magnet

Last month it was shown that the chemical action in a cell causes electrons to be moved from one electrode to the other, thereby creating a potential difference between the two terminals. There is another important way in which electricity can be generated — by using magnetism.

Some materials, such as magnetite, are naturally occurring magnets. Certain other materials can be made magnetic by subjecting them to the field from another magnet. Iron, for example, can be easily magnetized, but it can also lose its magnetism fairly easily and is therefore called a temporary magnet. Other materials can retain their magnetic properties for much longer periods and are therefore known as permanent magnets. An alloy of steel is often used to produce such magnets.

The magnetic effects are concentrated at the poles of a magnet, which in a bar magnet are the two ends. The poles are referred to as the north pole and south pole, the former being the end that would point north if the magnet was suspended so that it is free to turn. Lines of magnetic force, or flux lines, leave the magnet at its north pole and re-enter it at the south pole. Within the magnetic materials the lines travel from the south pole to the north pole, and a complete magnetic circuit is formed. (Figure 1 shows how these lines are usually represented in diagrams.)

Just as unlike charges attract and like charges repel, so it is with magnetism: Unlike poles attract and like poles repel (Figure. 2).

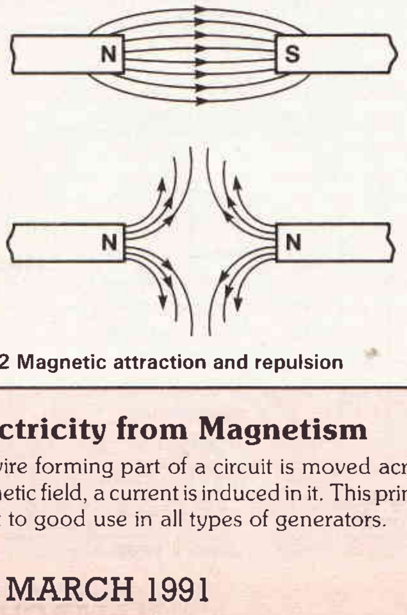
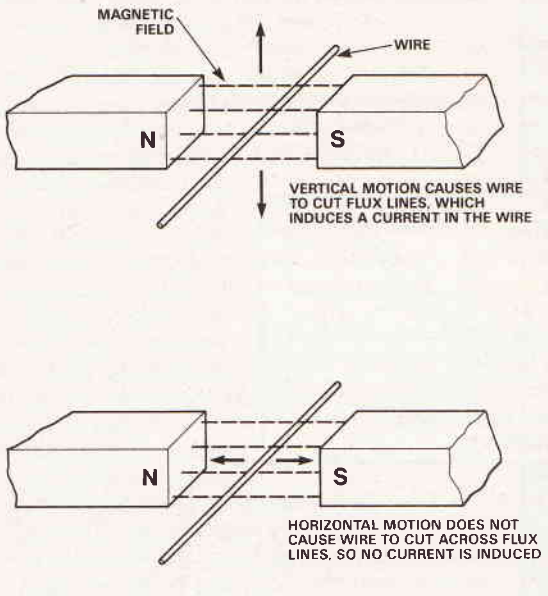


Fig.2 Magnetic attraction and repulsion

Electricity from Magnetism

If a wire forming part of a circuit is moved across a magnetic field, a current is induced in it. This principle is put to good use in all types of generators.

The magnitude of the induced current is directly proportional to three factors: the speed at which the wire cuts through the magnetic lines of flux, the strength of the magnetic field, and the amount of wire which passes through the field. The amount of wire cutting the magnetic field is usually increased by forming the conductor into a coil of many turns. It is not important whether the magnetic field remains stationary and the conductor moves or vice versa; all that is necessary is relative movement between the two, and both methods are employed in practical generators. It should be noted that for a current to flow the conductor must cut the lines of flux; movement parallel to them causes no induced current (Figure 3). The right-hand rule can be used to determine the direction in which current will flow. The right hand should be held so that the thumb, first finger, and second finger are all at right-angles to each other. (With the palm facing down and the thumb pointing to the left, for example, the first finger points forward and the second finger points down.) If the hand is oriented such that the thumb points in the direction in which the conductor is moved, and the first finger points in the direction of the magnetic field (from north to south), then the second finger shows the direction of the induced current (Figure. 4).



VERTICAL MOTION CAUSES WIRE TO CUT FLUX LINES, WHICH INDUCES A CURRENT IN THE WIRE

HORIZONTAL MOTION DOES NOT CAUSE WIRE TO CUT ACROSS FLUX LINES, SO NO CURRENT IS INDUCED

Fig.3 Inducing a current in a conductor

There is a very important distinction which must be made at this point. In the first part of this series it was seen that electrons flow from negative to positive in a circuit. Electricity was being put to good use long before electron flow was discovered, however, and it was assumed by convention that electricity flowed from positive to negative. The right-hand rule assumes the conventional current flow theory, and the second finger will therefore point in the direction of conventional current flow. It does not really matter whether the electron flow theory or the conventional current flow theory is used, so long as it is clear which is in use. The remainder of this series will assume conventional current flow when looking at magnetism.

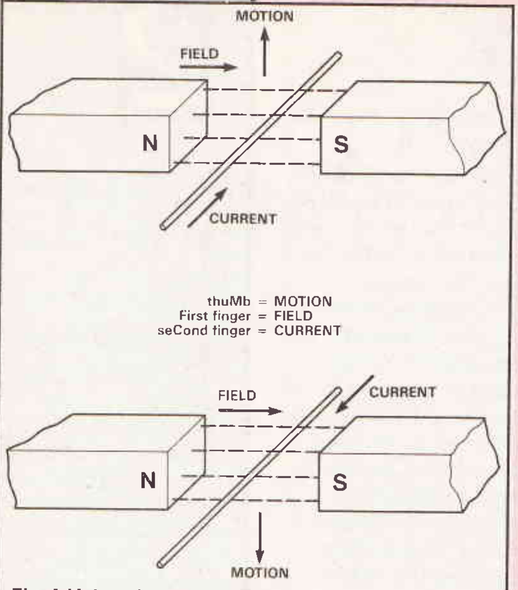


Fig.4 Using the Right-hand Rule

Magnetism From Electricity

Moving a conductor across a magnetic field causes a current to be induced, and the converse is true: Passing a current through a wire causes a magnetic field to be generated around that wire. The direction of the field depends upon the direction of the current, and another rule using the right hand can be employed. If a wire carrying a current is grasped in the right hand, with the thumb pointing in the direction of conventional current flow, then the fingers wrapped around the wire show the direction of the generated magnetic field (Figure.5). The strength of the field is proportional to the amount of current flowing through the wire.

A magnetic field suitable for practical uses can be made by winding the wire into the form of a coil (Figure.6). The magnetic field around each turn of the coil adds to the others to produce a much stronger overall field. The direction of the field can be determined using the right-hand rule: If the fingers are wrapped around the coil in the direction of current flow, then the thumb will point to the end of the coil which will be the north magnetic pole.

Different materials possess a different capacity for holding magnetic lines of force. Iron, for example, can hold many more flux lines than air, and is said to have a lower reluctance. An iron core is often inserted in a coil to increase the flux density and provide a much stronger magnetic field. When a coil is used in this way to produce a magnetic field, it is called an electromagnet. The electromagnetic effect is very important to many aspects of electronics, and will be examined again with the subject of inductance.

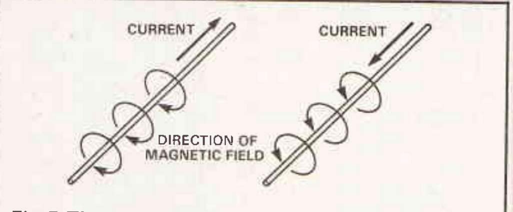


Fig.5 The magnetic field surrounding a current-carrying wire

It has been seen that a current flowing through a conductor sets up a magnetic field. This field can be used to produce motion if it is made to interact with another magnetic field, due to the attraction and repulsion of unlike and like magnetic poles (Figure 7). This time the left hand may be used to determine the direction of motion. The thumb, first finger, and second finger are held at right-angles as before, with the first finger pointing in the direction of the magnetic field and the second finger pointing in the direction of current flow. The thumb then indicates the direction in which the wire will move.

Remember the two rules: The left-hand rule determines direction of motion when a current is supplied (the motor effect) and the right-hand rule determines the direction of induced current when a wire cuts a magnetic field (the generator effect). Both rules assume conventional current flow.

The Moving Coil Meter

The interaction between electricity and magnetism is not only used for generators and motors. One very common use in electronics is the moving-coil meter, which measures current flow.

If a bar magnet is pivoted between the poles of a horseshoe-shaped magnet, it will turn until north and south poles are aligned at each side (Figure 8). A spring may be added to try to keep the bar magnet positioned so that like poles are together. The spring is therefore acting in direct opposition to the magnetic field, and the magnet will turn so that the force acting in one direction by the magnetic field is equal to the force acting in the other direction by the spring. If the strength of the bar magnet could be increased, it would turn further against the pressure exerted by the spring.

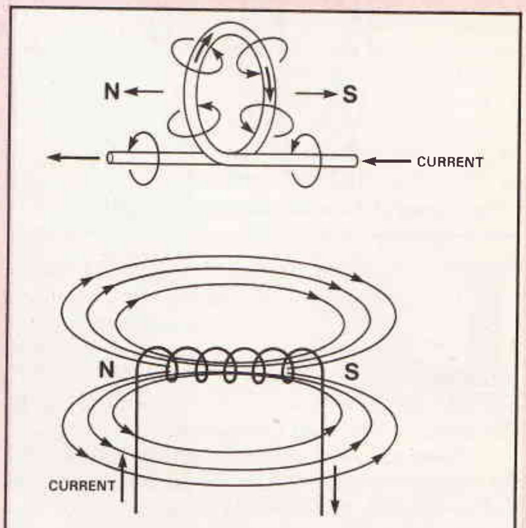


Fig.6 The electromagnet

The moving-coil meter replaces the bar magnet with a core upon which is wound a coil of wire (Figure 9). The strength of this electromagnet is then determined by the current flowing through the coil. As the current increases, so does the strength of the electromagnet formed by the coil. This causes the whole coil assembly to turn further against the opposing pressure of the spring. By attaching a pointer and providing a calibrated scale, the unit can be used to measure the amount of current flowing in any circuit. The moving-coil meter is also known as the D'Arsonval movement.

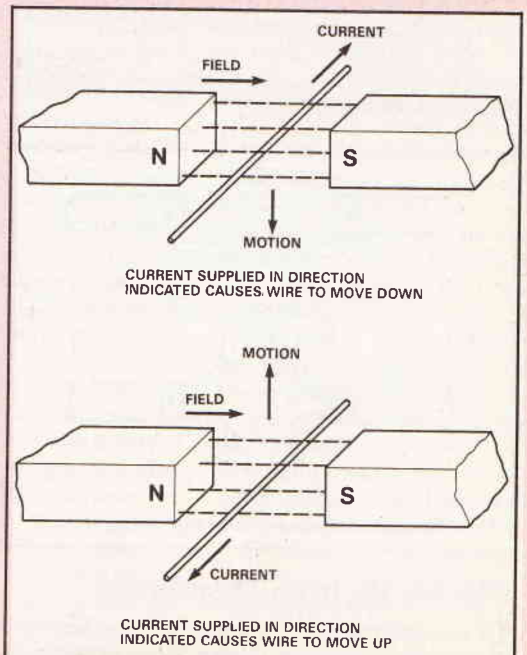


Fig.7 The motor effect and Left-hand Rule

Moving-coil meters are made to measure greatly varying currents. The exact current that a meter will measure depends upon the number of turns in the coil and the strength of the horseshoe magnet, among other things. The sensitivity of a meter is usually quoted as the current which will move the pointer to the far side of the scale. This is called full-scale deflection, or FSD, and may vary from a few microamperes to several amperes, depending upon the intended use of the particular meter. The basic current-measuring meter is known as an ammeter, and meters designed to measure currents only in the milliamps or microamps ranges are called milliammeters and microammeters respectively.

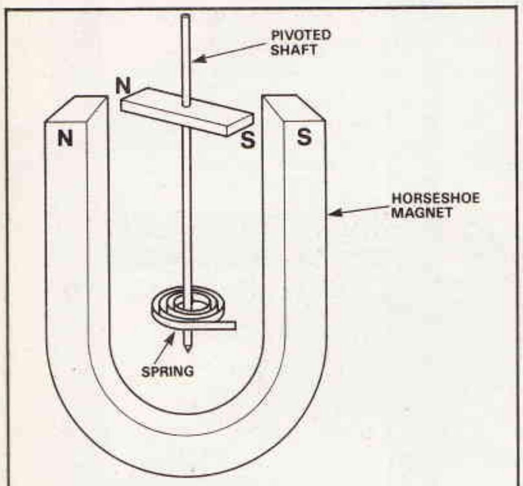


Fig.8 Basic principle of the moving-coil meter

Ammeters are connected in a circuit by breaking the wiring at some point and connecting the meter across the break. The current flowing through the circuit then also flows through the meter, which will indicate the current flowing (Figure 10). It is important to connect the meter the right way round, and the terminals are always marked with a positive and negative indication. If current flows through the meter the wrong way, the magnetic field generated by the moving-coil is reversed and the pointer will try to move backward, possibly causing damage to the instrument. Similarly, the meter must be capable of handling the maximum current one would expect to find in the circuit, for if the full-scale value is exceeded the pointer will travel past the end of the scale. If there is any doubt about the correct meter to use, the test should first be made with the highest-rated instrument available.

Meters designed for test purposes, as opposed to meters dedicated to measuring current in a specific circuit in a piece of equipment, often provide several switched ranges. A typical meter found on a service bench may offer current ranges of 1mA, 10mA, 100mA, 1A, and 10A FSD. The lowest range suitable for the current being measured should be chosen — the 100mA range for a current of 35mA, for example. If the approximate current flow is not known, the highest range should be selected first to avoid damaging the meter. If the meter shows less than 1A when on the 10amp range, it is safe to switch down to the 1A range, and so on. The actual moving-coil meter only has one range, but resistances are connected across the meter by the range switch to extend its measuring capability.

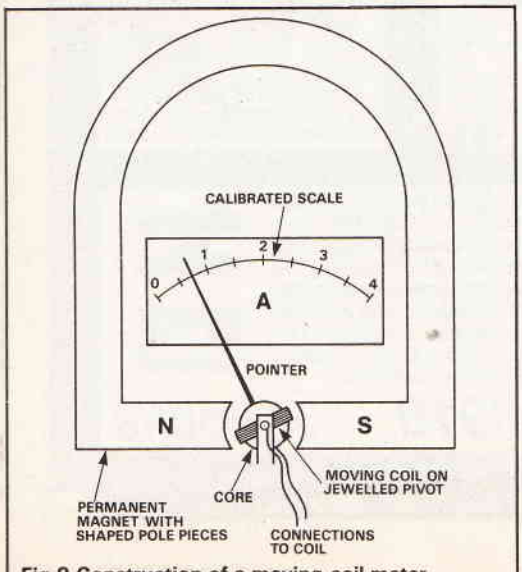


Fig.9 Construction of a moving-coil meter

Measuring Voltage

The moving-coil meter has a pointer which moves in proportion to the current flowing in a circuit, but can also be used to measure voltage.

Recall that Ohm's Law shows that voltage, current, and resistance are dependent upon one another. One version of the Ohm's Law formula shows that current is equal to voltage divided by resistance; if the resistance is kept constant then current will vary in direct proportion to voltage. With a fixed resistance of 1000R, for example, a potential difference of 1V will produce a current of 1mA, 2V will produce a current of 2mA, and so on.

If the resistance of a moving-coil meter is known, it can be used to measure voltage (Figure 11). The example shows a milliammeter with a full-scale deflection of 1mA and a resistance of 2000R. This internal meter resistance is caused by the resistance of the coil, through which the current to be measured must pass. By applying Ohm's Law, it can be calculated that the milliammeter will require 0.2V to register full scale.

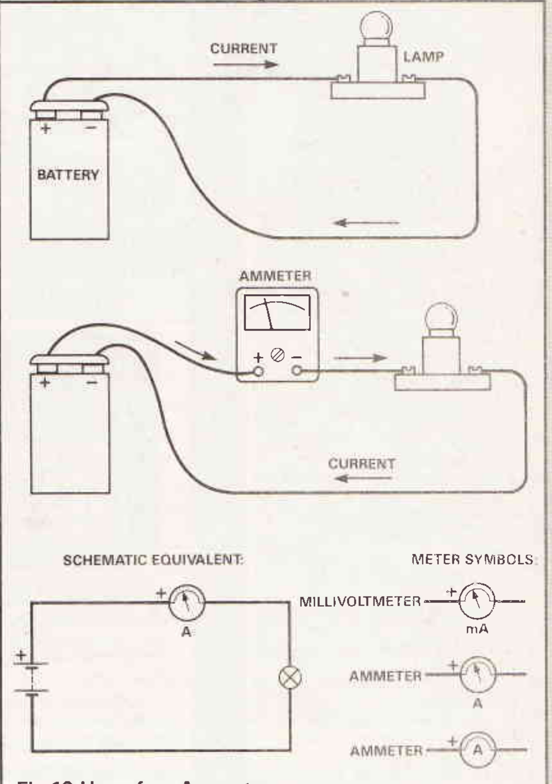


Fig.10 Use of an Ammeter

Voltmeters usually employ resistors so that they may be used to measure higher voltages, and a multi-range voltmeter uses a switch to select different ranges. Service type meters may offer 3, 10, 30, 100, 300 and 1000V ranges or something similar.

Next month's installment looks at basic DC circuits and how resistances combine.

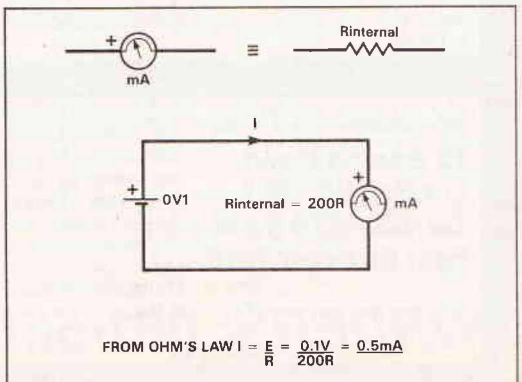


Fig.11 Using a meter to measure voltage

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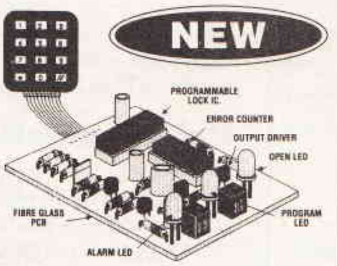

Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4–digit sequence will operate the lock while incorrect entries will sound an alarm. The number of incorrect entries allowed before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and code on the supplied keyboard. Kit includes; keyboard, alarm buzzer, high quality PCB and all electronic components. Supply 5–15V DC. Will drive our Latch Mechanism (701 150 @ £16.50) or relay directly.

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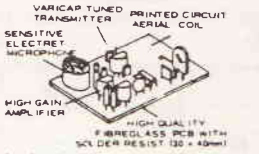

Only 45x25x15mm, including built–in mic. 88–100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **£6.35**

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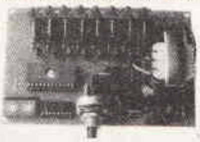

DL8000K 8–way sequencer kit with built–in opto–isolated sound to light input. Only requires a box and control knob to complete **£39.95**

DL1000K 4–way chaser features bi–directional sequence and dimming 1kW per channel ...**£23.95**

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DL3000K 3–channel sound to light kit, zero voltage switching, automatic level control and built–in mic. 1kW per channel **£19.55**

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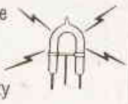


Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.

XK124 STROBOSCOPE KIT. **£17.25**

ARE YOU HEATING YOUR HOUSE EVERY SUNDAY MORNING

when you're nicely tucked up in bed? Why waste money with your old timeswitch when you could programme the CT6000 to switch your heating on and off at precise times (including different times at weekends) and even allow for your regular outings to walk the dog!

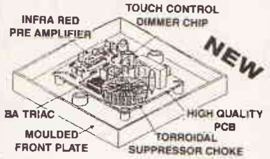
The CT6000 Clock/Timer Kit which is easy to assemble and programme is ideal for controlling any electrical appliances which need to be switched on and off at set times of a daily or weekly basis. The clock is mains powered (with battery backup) and has a 24Hr LED display (so you can read it in the understairs cupboard) with days of the week and status indicator, four outputs which can drive relays or triacs or a special kit (XK114) which fits inside the box and contains a PCB, terminal blocks and one relay with 3A/240V changeover contacts. Up to 3 extra relays can be accommodated on the XK114 if required.

The kit which comes complete with box, pre-drilled and printed front panel, circuit board, components and full assembly instructions measures 16×10×5.5cms.

CT6000K Clock/Timer Kit £59.95

Optional Parts XX114 Relay Kit £6.90, 701 312 Relay £1.38, 303 104 9V Rechargeable Battery £5.20

REMOTE CONTROL DIMMER KIT



Imagine controlling the brightness of your lights or switching them on or off from the comfort of your armchair! This kit contains all the components from front panel to the last screw to enable you to do just that and fit the shallowest wall boxes. Max power 300W (not fluorescents).

XK132..**£19.95**

IR TRANSMITTER KIT

Designed for use with the XK132 and comes complete with a pre-drilled box. A PP3 9 volt battery is required.

Mk 6 .... **£4.95**

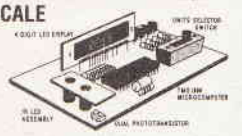
XK136 TOUCH DIMMER KIT.............**£12.96**

VERSATILE REMOTE CONTROL SYSTEM

These kits can switch up to 16 pieces of equipment on and off or control 16 functions depending on the keyboard selected for the MK18 transmitter. MK12 receiver has 16 logic outputs and operates from 12 to 24V dc, or 240V ac. via the transformer supplied. The MK18 requires a 9V battery and keyboard. Great for controlling lights, TVs, garage doors etc.

MK12 IR Receiver..............................**£19.55**
MK18 Transmitter...............................**£8.95**
MK9 4-Way Keyboard........................**£2.75**
MK10 16-Way Keyboard....................**£7.95**
601 133 Box for transmitter.............**£2.95**

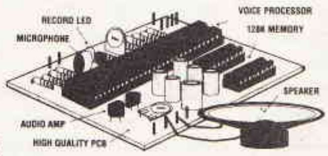
ELECTRONIC WEIGHING SCALE



Kit contains a single chip microprocessor. PCB, displays and all electronics to produce a digfital LED readout of weight in Kgs or Sts/Lbs. A PCB link selects the scale-bathroom/two types of kitchen scales. A low cost digital ruler could also be made.

ES1 **£8.25**

VOICE RECORD/ PLAYBACK KIT

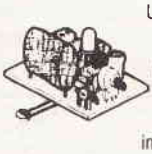


This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or light reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places. In fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daughter's £8 doll to an £80 taking doll!!

Size .... 76 x 60 x 15mm
Message time .... 1–5 secs normal speed, 2–10 secs slow speed

XK129 **£25.95**

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Maximum load 3kW (240V AC). Temperature range up to 60°C. Size: 7x4x2.5cms. **XK140** **£8.95**

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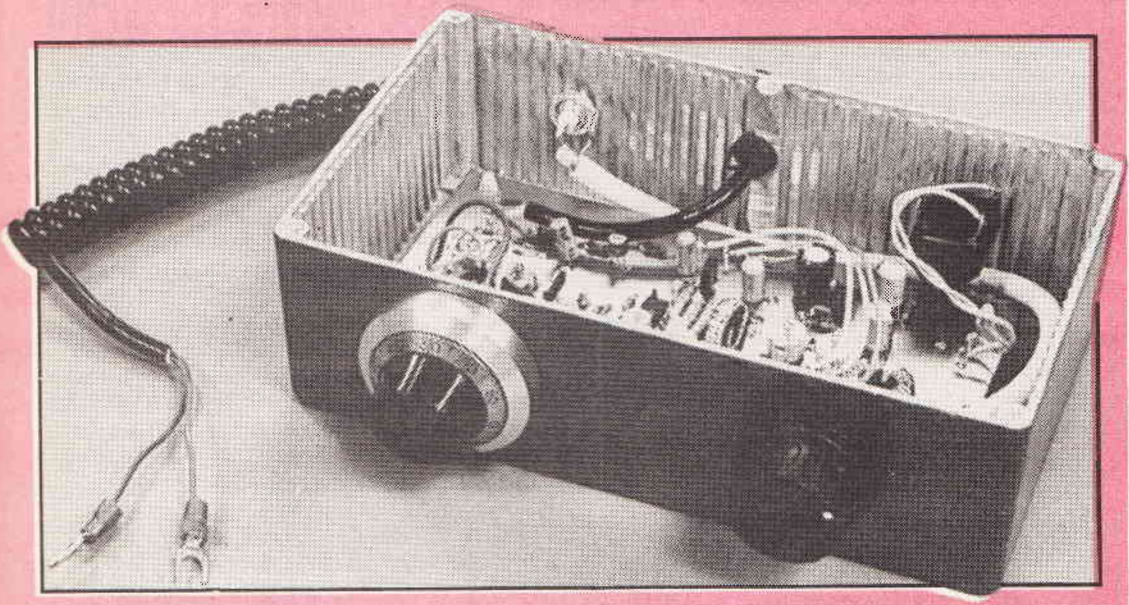
A SIMPLE SSB RECEIVER



David Silvester constructs this handy little receiver for the amateur bands.

A communications receiver is not the only way that a newcomer to short wave listening has of breaking into the amateur bands. It is reasonably easy to construct a direct conversion receiver for the 20 metre amateur band with three FETs and two integrated circuits that produces less noise than that received as background noise from a long wire or dipole antenna. With such simple equipment it is possible to receive transmissions from Australia and New Zealand without difficulty.

However what about the lower frequency bands? In this instance the background noise is higher so the sensitivity required from the simple receiver is much less than that for the 20 metre band. Thus with a lower gain requirement the receiver can be made simpler still, in fact consisting of one discreet transistor and two ICs along with three coils and 44 other components. The circuit is not an original but based on an old design in Solid State Design for the Radio amateur that can no longer be reproduced as many components are no longer available.

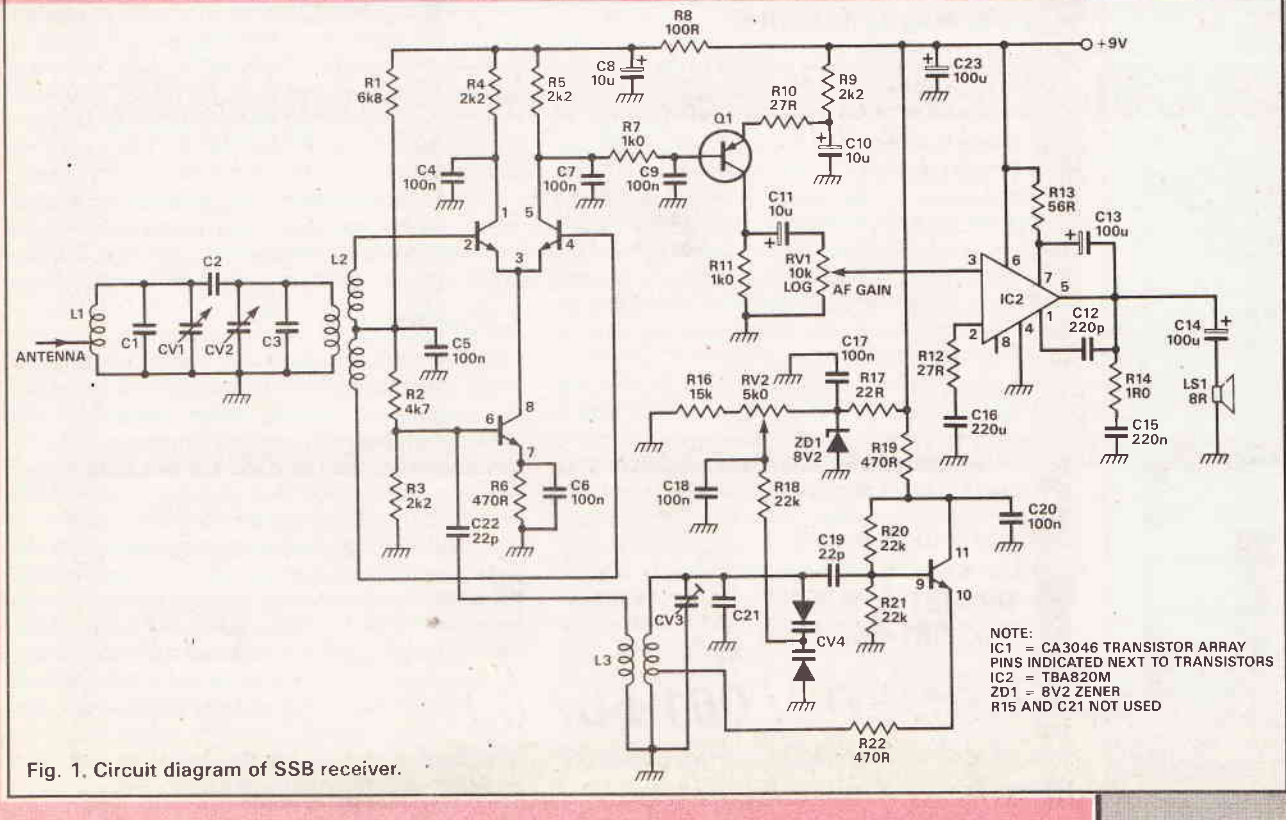


Fig. 1. Circuit diagram of SSB receiver.

HOW IT WORKS

The full circuit diagram is shown in Figure 1. The inductor L1 resonates with the parallel capacitance of C1 and VC1 at 3.6MHz. A tap on this inductor transforms the input impedance of the antenna to a level such that the tuned circuit retains a reasonable Q. L2 with the parallel capacitance of VC2 and C3 form a second resonant circuit at the same frequency. These two are coupled by a small capacitor C2 to form a bandpass filter to select the 80 metre band from the full frequency band that the antenna presents. The output side of L2 has two windings that produce antiphase outputs for the first active stage that forms the mixer/amplifier. The inductor design details are covered later in the text.

All of the transistors except for the PNP transistor Q1 are part of a CA3046 transistor array within a 14 pin dual in line IC package. The CA3046 consists of a differential pair and three other separate NPN transistors of which one is unused and has all of it's terminals connected to ground. In Fig 1 these transistors have their IC pin numbers next to the terminal.

The resistor chain R1 to R3 provides a set of voltages to set up the DC conditions for the mixer/amplifier stage. About 1.45 volts is presented to the base of the bottom transistor (pin6) and if we ignore the RF signal that comes through C22 for the moment, this fixed voltage causes a constant current to flow in the transistor. This current is set by the value of R6. At the junction of R1 and R2 another fixed voltage of 4.5V biases the bases of the differential pair via the output windings of L2. Due to the use of the CA3046 array the differential pair will be made from two very similar transistors, much more alike than two separate transistors could ever be made. Because of this balance the current from the lower transistor's collector (pin8) will split equally between the transistors in the differential pair, giving a voltage at the two collectors of about 7.5V. Now let us add the RF signals to this circuit. With the antenna connected, two antiphase signals at 3.6MHz pass to the differential pair and by the nature of this circuit the differential signal is amplified whilst any signals common to both inputs will be ignored.

If this sounds rather like the characteristics of an op-amp then you will not be surprised to hear that all op-amps have differential pairs for their input stages.

In the case of the radio receiver mixer, the current that is supplied by the lower transistor is varied at a rate controlled by an oscillator based around L3. Thus the differential pair transistor has two RF signals presented to it, one at the base from the antenna and another from the emitter from the oscillator. The differential pair mixes the two signals and of the possible outputs the audio signal is selected out by the low pass filter of C7, R7 and C9. This AF signal is amplified by Q2, passes through the volume control and to the TBA820M audio power amplifier IC2 that powers the loudspeaker or headphones.

It should be obvious that in a direct conversion receiver both the antenna, the band pass filter and the oscillator are designed for the same frequency, and thus it is possible for feedback within the input transistors to allow some of the oscillator signal to leak out of the antenna. The most important advantage of using the differential amplifier/mixer is that the oscillator voltage is presented equally to both emitters and any feedback will give equal voltages at the bases of the two transistors. But the inductor L2 is wound in a differential mode with a central RF ground and any signal fed across the full winding will tend to cancel out preventing the oscillator signal getting out of the antenna.

The oscillator is a fairly standard Electron Coupled Hartley design with feedback to a tap on the coil. R20 and R21 bias the base of the transistor at about half supply voltage whilst R19 and C20 form a filter to prevent any voltage variations in main supply potential affecting the oscillator frequency. The oscillator frequency is set by the tuned circuit of VC3 and VC4. You will note that a C21 is also included as part of the capacitance but in practice it was not found necessary to add any additional capacitance at 3.6MHz. The circuit can however easily be retuned for other frequencies and then C21 will be needed. With such possibilities in mind it was decided to leave C21 on the schematic drawing. VC4 is a dual variable capacitance diode, the capacitance of which is controlled by the voltage supplied by RV2. Variations of voltage by affecting the diode's capacitance vary the frequency the oscillator produces. ZD1 and R17 provide a stabilised voltage at the upper end of RV2. The value of R16 is chosen so that when turning the potentiometer RV2 over it's full range the oscillator will tune over the 80 metre band. R18 and C18 isolate RV2 from RF signals whilst passing the DC signal. C19 couples the base of the oscillator transistor to the tuned circuit and R22 couples the feedback. R22 also sets up the standing current in the transistor and helps to reduce the level of feedback so the the oscillator signal is a clean sine wave. The output of the oscillator is taken from a second winding on the coil, through an isolating capacitor to the mixer's lower stage.

Coil Winding Details

The input coupling from the antenna to the first active stage is through two inductors that have to be wound on Micrometals T68-6 torroids. The advantage of using these torroids is that the inductance produced is directly proportional to the square of the number of turns used on the coil. In the literature the inductance for a 100 turn winding is given from which it is easy to calculate the number of turns needed for the coil to be made. As a result of the torroidal form it is difficult for signals to couple inductively to the coil and this helps prevent interferences.

The first stage is L1 in parallel with C1 and VC1. A tap on L1 gives a transformation of the low impedance that the antenna presents to a level that will give a reasonable Q to the filter circuit. To wind this coil take a 2ft piece of 26SWG enamelled copper wire and at a point about 8 inches from one end bend the wires together and twist them together for about 2 inches. Take the twisted section and with the shorter of the two wires downwards bring the shorter end up through the torroid, and the longer end downwards locking the wire onto the torroid. Continue the winding so that the shorter end forms 5 turns passing through the torroid. The longer end is wound through 25 times to form the whole of L1. In the radio the short end goes to ground, the twisted wire is the antenna connection and the remaining end connects to the capacitors.

L2 also consists of 30 turns on a T68-6 torroid but the input impedance of the differential amplifier is such that the amplifier input will not load the tuned section. L2 is made from three 2 ft. pieces of 30SWG enamelled copper wire twisted together and wound simultaneously on the torroid. In this case it is important to identify the start and end of the three windings after completing the inductor. The easiest way to do this is with a multimeter on ohms range. The circuit board is arranged so that the starts all come to one side of the torroid and the ends to the other.

Construction

On the circuit board the upper surface of the board forms the groundplane and the remainder of the connections are on the lower surface. If the constructor decides to make his own board then a double sided board is used but only one side is etched and there is no need for the registration of two masks. The photoresist is left intact on the upper surface or the board is coated so that the copper layer will not be removed during etching. After etching, all of the holes are drilled and the through track pins are inserted into the four holes that need them. These holes are at the end of the short tracks from the battery, the loudspeaker, the volume control and the coil L3.

After making these four connections the groundplane is removed from around the rest of the holes to prevent the pins shorting to ground. The author uses a small drill for this.

All of the other ground connections are made by soldering to the upper groundplane. If we look at IC1 then pins 12, 13 and 14 are bent outwards so that when the IC is inserted these pins rest on the groundplane whilst the rest pass through the board to the lower tracks. These pins are shown as lines on the component layer of Figure 2 and you will notice that there is no corresponding pad on the track layer. Similar lines mark the groundplane connections of many of the other components.

Because many components are soldered to this groundplane it is necessary to start construction from the centre of the board and work outwards as this prevents the possibility of damaging one component whilst trying to solder another. A good starting point may be in the area of C22.

Contrary to normal amateur practice it will be necessary for the semiconductors to be soldered to the board in the middle of construction rather than as the final stage. There is no problem in this providing care is taken and the constructor ensures that the soldering iron has it's bit earthed via the mains lead. All of the components can be placed using Figure 2 and the components list. Where the component is to be soldered to the upper surface then the wires will need to be bent so that one passes through the board to the lower tracks whilst the other has about 3-4mm of wire on the top surface. Soldering is tricky as the component needs to be held still whilst the groundplane end is soldered but it tends to twist around the hole for the other wire. The large surface of the upper groundplane also acts as a magnigicant heatsink and if the soldering iron is too small or of a low power the solder will not attach correctly to the groundplane leaving a dry joint which has a disastrous effect on the circuit operation. All that is necessary is to wait until the solder is seen to flow out over the groundplane rather than forming a ball on the surface.

After fixing the components, attach wires for the battery supply, the loudspeaker, the volume control and the ten turn frequency control pot. Ensure the wires to the pots are connected the correct way round or they will not work in the way expected. The ground connection of the volume control is to the anticlockwise end and the ten turn pot is connected with the anticlockwise end connected to R16. The antenna connection is made by removing the outer insulation of a piece of coax cable and winding the outer screen into two tags. The centre conductor is bared and soldered to the pad on the lower surface. The outer screen tags are both soldered to the upper groundplane.

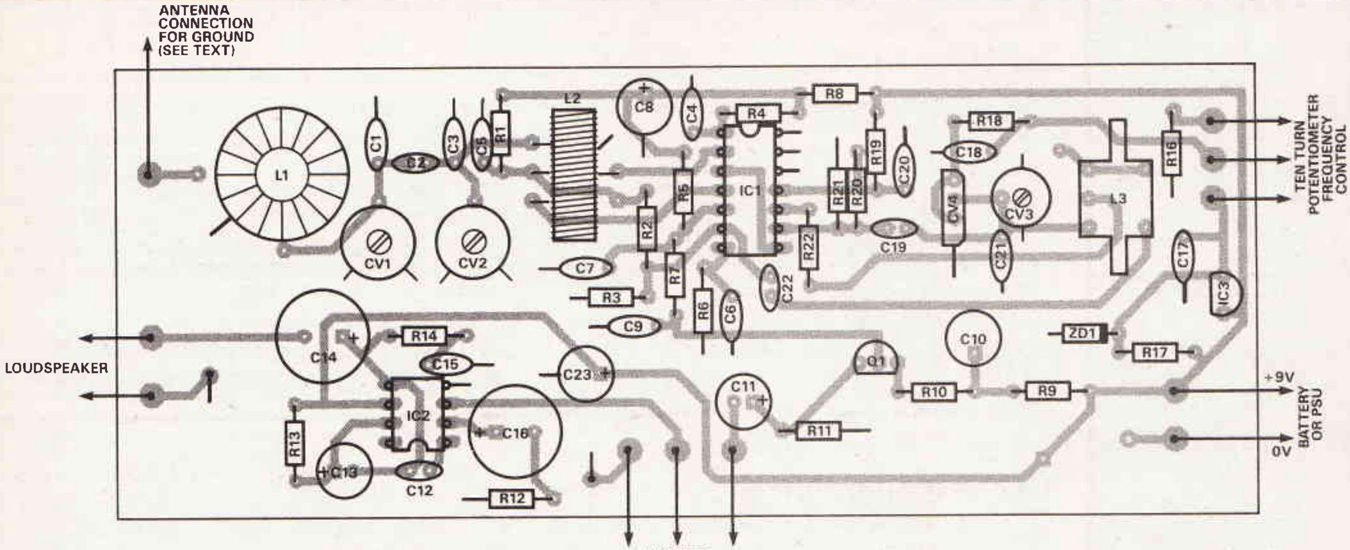


Fig. 2. Component overlay for the receiver.
Note — Groundplane connection indicated by line from component

It will be easy to test the radio on a benchtop prior to installing in a case as it is easier to make alterations and correct errors with the unit out of it's case. Of course after the unit is boxed,the radio frequency range will change slightly due to capacitive coupling to the case and the radio will need to be retuned although the adjustments will be slight.

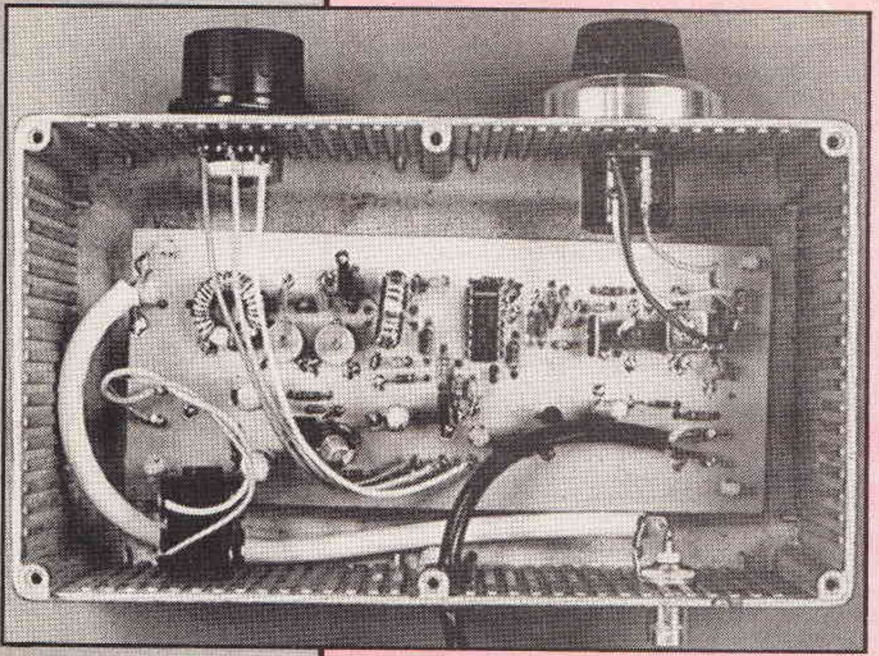
The prototype was mounted in a diecast box. Plastic PCB stand-offs fit into holes in the board and the other ends are stuck into the box after drilling of the holes for the potentiometers and the power, loudspeaker and antenna sockets. The author tends to use the box upside down with the lid at the bottom and having a set of rubber feet fitted to prevent the box moving whilst tuning is in progress. Layout is not too important providing the leads are kept as short as possible.

Testing

With only three variable items other than the main controls it is easy to adjust the radio. Firstly set RV3 to a position where the vanes are half meshed and turn the ten turn potentiometer fully clockwise. There is an adjustable core for the inductor L3 but this should not be altered. With these settings we need to check the oscillator frequency. The aim is to set the frequency to 3.8MHz. The way of doing this depends on the equipment available. The easiest of course is a frequency counter or an oscilloscope. A lower cost alternative is a reference frequency source which produces signals at fixed frequencies. With such a source set the output on megahertz steps and tune VC3 until a signal is heard. This will correspond to a received signal of 4MHz. Switch to 100kHz steps and the signal should remain. Now turn VC3 so that the vanes become more meshed and count back three signals. The high end of the radio will now be set on 3.8MHz. The low reception frequency can now be found by turning RV2 slowly anticlockwise and counting the 100kHz steps. The radio should reach and go slightly below 3.5MHz.

The Antenna

The final stages of tuning requires that an antenna is connected to the receiver, it being assumed that the



constructor does not have an RF signal source. In the simplest case all that is required is an inverted L antenna. A 2-3 ft. section of copper water pipe is drilled at the end to take a screw, solder tag and nut to form the earth connection and is hammered into the ground. A length of coax cable is bared and the outer screen connected to the solder tag whilst the central conductor is attached to a long length of enamelled copper wire. The enamelled copper wire is then taken upwards to a convenient point, in the authors case a string from an upstairs window, and then along the garden to another piece of string that forms the end of the antenna. Such a simple wire antenna will receive a large number of stations around Europe although if the wire length is tuned for the 80 metre band then reception will be better due to input matching. However if your garden like the authors is too small for a full 80 meter dipole then the simple wire will do. Once the antenna is up and connected the final part of tuning the receiver is to tune the input filter by turning CV1 and CV2 to get the loudest signal from a station.

For such a simple receiver it is surprising how well it works, better than the author had expected. Due to the simple design with only three tuned circuits it is not too difficult to modify the rig to work on other amateur bands although as frequency increases the problem of oscillator drift become more acute and the maximum should be limited to the 20 metre band. Whatever band the radio is built for it will provide hours of enjoyment.

PARTS LIST

RESISTORS (all 0.25W metal film)	
R1	6k8
R2	4k7
R3,4,5,9	2k2
R6,19,22	470R
R7,11	1k0
R8	100R
R10, 12	27R
R13	56R
R14	1R0
R15	Not Used
R16	15k
R17	22R
R18,20,21	22k
RV1	10k log volume control
RV2	5k ten turn potentiometer
CAPACITORS	
C1,3	330p ceramic
C2	47p ceramic
C20,4,5,6,7,9,17 ,18	0.1µ ceramic
C8,10,11	10µ electrolytic
C12	220p ceramic
C13,14	100µ electrolytic
C15	220n ceramic
C16	220µ electrolytic
C19,22	22p ceramic
C21	Not Used
23	100µ electrolytic
CV1,2	6 to 60p trimmer
CV3	3 to 30p trimmer
CV4	KV1236 dual variable capacitance diode BB212 suitable with board modification
SEMICONDUCTORS	
IC1	CA3046 transistor array
IC2	TBA820M
ZD1	8.2V 400mW zenner diode

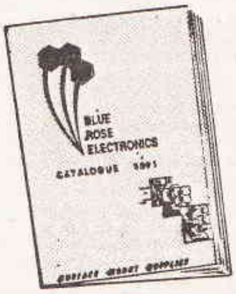
MISCELLANEOUS

LI and L2 wound on Micrometals ferrite cores T68-6. See text for details

L3 TOKO 154AN7A6440EK coil

LS 1 8R loudspeaker or low impedance headphones

10 turn potentiometer knob with indicator



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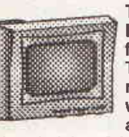

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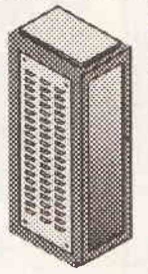

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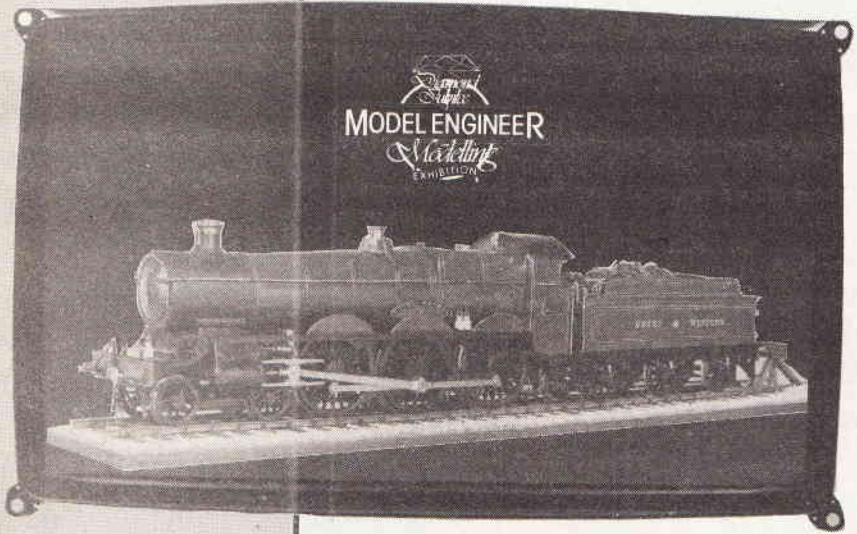


James Archer continues his look at the American approach to higher TV standards

In the previous section it was mentioned that ACTV-I is an enhanced definition system rather than a full quality HDTV, but benefits from being fitted into a single 6MHz NTSC channel. Further developments has led to the creation of ACTV-II a full HDTV system, which uses an extra 6MHz channel for augmentation signals which improve the pictures carried by the ACTV-I system. So ACTV-II is an ACTV-I picture plus extra information on another channel, and fully compatible with both NTSC and ACTV-I receivers. Figure 6 shows the basic principles of how the ACTV-II system operates.

The ACTV-II source picture is a 1050-line, 60 frames per second, 2:1 interlaced HDTV picture. Firstly, the source picture is compared with the ACTV-I picture derived from it.To reconstructed the ACTV-I picture it is necessary for the ACTV-II encoder to contain an ACTV-I decoder. This takes the ACTV-I component signals and reconstructs them into the form that they would have in a widescreen 525-line progressively scanned EDTV receiver. These components are known as Y, I and Q (Figure 6).

These reconstructed signals are then subtracted from the component signals of the original HDTV source picture, Y, I, and Q on the diagram, and the result represents the difference between the original picture and the ACTV-I EDTV picture. These difference signals will include the lost resolution from the conversion process and any spurious signals created in the conversion process. If this information could be sent to the receiver, it could enable the receiver to reconstruct a full quality 1050 line HDTV picture, but unfortunately the difference signals require a bandwidth of about 20MHz, and are too wide to be carried along even a 6MHz augmentation channel. Some means must therefore be found of compressing the difference signals to fit into a 6MHz channel.

When the the Y′I′ and Q′ signals are subtracted from the Y I and Q signals, the resulting difference signals, shown as δY, δI and δQ on the diagram, have bandwidths of 20, 10 and 10MHz respectively. These are called 'augmentation signals', and they must be compressed and multiplexed to fit into the 6MHz baseband channel. Figure 7 shows how the compression of the δY signal is acheived.

The 20MHz δY signal is filtered and split into three separate bands of frequencies (figure 7). Frequencies above 18MHz do not pass through the filters, and are effectively discarded. The lowest frequency band is from 0 to 6MHz, and is called the δY_L, signal. The next two bands, from 6-12MHz and from 12-18MHz are frequency shifted down to DC by beating them with signals at 6MHz and 12MHz respectively, and then they are passed through low-pass filters so that we end up with two signals, each

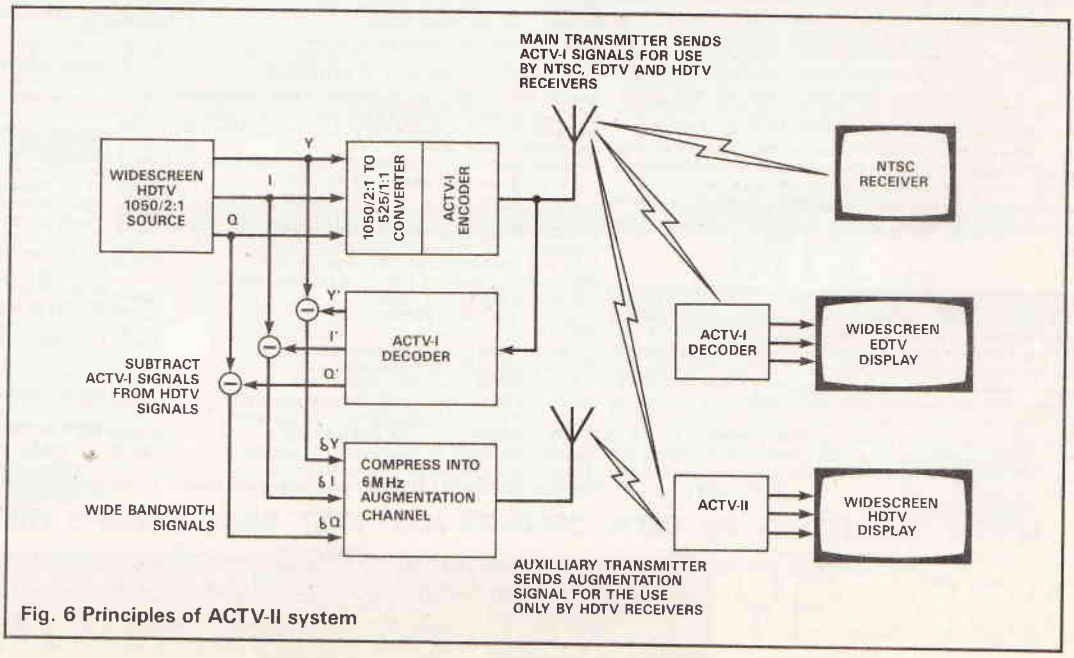
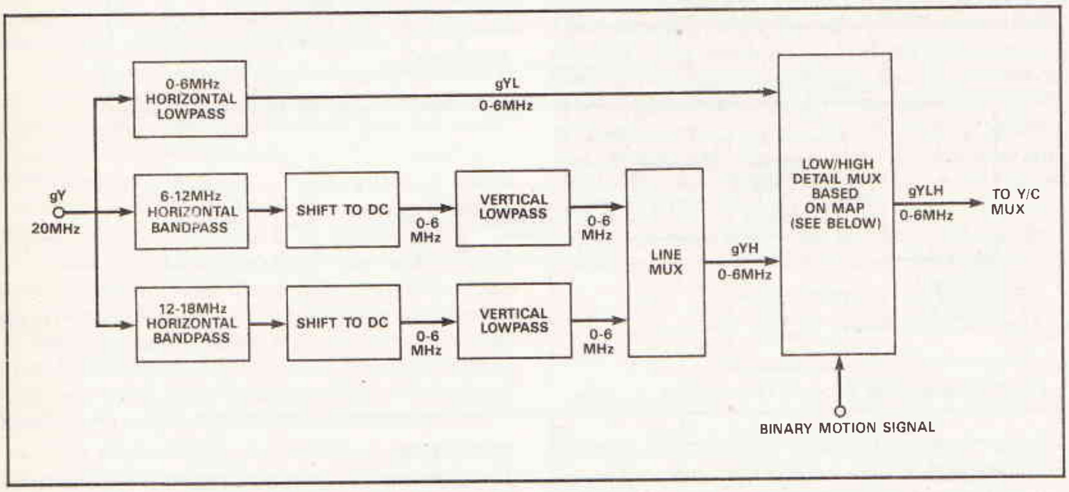


Fig. 6 Principles of ACTV-II system

taking up from 0-6MHz. The two signals are then multiplexed line by line, to give a 6MHz wide signal called δY_H. The resulting two signals δY_H and δY_L are then multiplexed together into another 6MHz wide signal, δY_{LH}LH. The two signals δY_L and δY_H are then treated differently according to whether still or moving parts of the picture are being transmitted. When still areas of the picture are being transmitted the two signals δY_L and δY_H are multiplexed frame by frame, but on moving pictures only the δY_L signal is transmitted. To switch between the two cases, i.e., stationary or moving parts of the picture, a signal called a 'binary motion signal' is used this is derived from the vertical-temporal luminance 'helper' signal or by examining the differences between frames in the ACTV-I signal. The output signal is then further multiplexed with the compressed δI and δQ signals, which are derived in a similar way, the resultant being a single 6MHz signal which is split into alternating lines and expanded in time to produce two 3MHz wide signals. These two signals quadrature modulate a radio frequency carrier signal which is placed at the centre of the 6MHz wide augmentation channel.



The ACTV-II receiver.

The ACTV-II receiver is tuned to the main signal and a separate tuner section automatically receives the signals coming along the augmentation channel; information about the frequency of the auxiliary radio frequency signal can be carried in the ACTV-I signal. For the augmentation signal the odd and even lines are quadrature demodulated, and the δY, δI and δQ signals are processed differently according to whether they carry information about still or moving areas of the picture. After appropriate time expansion and demultiplexing the augmentation information components are added to the components of the ACTV-I picture that has been received on the main channel, and the result is a picture which can have some l8MHz of horizontal luminance resolution in still areas, and about 6MHz in moving areas, the corresponding chrominance figures being 2.4MHz and 1.2MHz.

Progress with ACTV-II

The description of ACTV-II is intended only to explain the principles of the system; the final format of this signal has not yet been confirmed, and other techniques for constructing the augmentation signals could be developed. Figure 6 shows,the ACTV-I signal will be transmitted by the main transmitter which provides signals for NTSC,EDTV and HDTV receivers, whereas the augmentation signals are transmitted by an auxiliary transmitter on a different frequency, and these are only of use to HDTV receivers.

Other possible augmentation signal techniques

The engineers at the David Sarnoff Research Centre are currently considering other types of augmentation signal. Although we have so far shown how the ACTV-I signal has been packed with extra information and the ACTV-II augmentation signal has been compressed from 20MHz to make it fit into a 6MHz channel, and we have implied these processes can be carried out without any corresponding disadvantages, in reality the processed signals will have less redundancy and be less robust than the originals. If the augmentation signal could be digital instead of the compressed analogue signal, it should be more rugged, and studies are under way on this. One idea would be to digitise the analogue augmentation signal. This requires a great deal of data compression to fit the signal into a 6MHz channel, and might then be just as susceptible to errors as the analogue signal.

Another, more futuristic idea from the research centre, is that the 6MHz channel should be used not as an augmentation channel, but as a channel carrying all the information necessary to create high-definition pictures at the receiver. There is obviously not enough bandwidth available in a 6MHz channel to carry an HDTV picture, but the idea is that the channel could be used to carry a digital signal that represents a complete high-definition still image. A series of such images would be sent at a reduced temporal sampling rate, together with some extra digital information describing the 'motion vectors' corresponding to moving parts of the image. In the receiver a series of still images would be received at a frequency considerably less than the normal frame rate, and the receiver would use the motion vector information to calculate the positions of the moving parts of the picture, and would then synthesise a complete series of moving images. Although such a technique might work, it seems that much more research effort will have to be put into it before it leaves the drawing board, and if the other techniques are considered to be 'putting a quart into a pint pot', then this idea would be squeezing in a whole gallon!

Entry — Level ACTV

The introductory system, ACTV-I, which has been described, provides Enhanced definition television in a compatible manner, within the normal NTSC 6MHz radio frequency channel; a full HDTV system can only be achieved using ACTV-II. Although it is expected that ACTV-I will be the transmission standard that is used initially, the David Sarnoff research engineers realised that some studios may find it expensive to change to ACTV-I straight away, and they have therefore suggested a simpler, entry-level form of the system, called ACTV-E . Very few details have yet been published, but the major difference seems to be that the ACTV-E signals do not contain the 'helper' signal that is an essential part of ACTV-I.

Progress with ACTV.

The Advanced Compatible Television techniques that have been described allow for the development of an evolutionary system that can initially be introduced compatibly within a standard NTSC channel and which can provide widescreen pictures with enhanced vertical and horizontal resolutions. The later addition of a second 6MHz channel enables full quality HDTV signals to be transmitted.

Extended field trials of the ACTV system have not yet been carried out; only tests in practical conditions will confirm whether the signals will be able to stand up to problems that occur due to attenuation over long signal paths, and due to reflections in areas where reception is difficult. Critics of the system have suggested that the presence of a second subcarrier might create difficulties if stereo sound signals are also carried in the same television channel. There are still unanswered questions as to whether remodulation of the ACTV signal onto a different frequency channel by a video recorder would lead to the second subcarrier becoming visible as a patterning effect. Tests are currently taking place, and it is predicted that ACTV receivers could reach the marketplace by 1993.

The future success of ACTV could stem from an important development which began in 1990; four companies with strong interests in the American HDTV market have joined together in a development consortium to push for the development and adoption of American-designed HDTV technology. Sarnoff Laboratories, RCA (Thomson), NBC, and Philips have agreed to concentrate their research and development, and they also welcome other companies who might wish to take part. This could be the turning point for the Americans as they finally agree to 'get their act together'.

SuperNTSC – Faroudja Laboratories

Many broadcasting engineers have been impressed by the demonstrations which has come out of the Faroudja Laboratories, a major supplier of high-tech circuits for broadcasting. The Faroudja system is called, without undue modesty, SuperNTSC. It is a 525-line NTSC compatible EDTV system which can be carried in just a standard 6MHz channel, without any augmentation channel, and it also has the claimed advantages of using no extra subcarriers or hidden channels, and of using existing technology. As expected from the name SuperNTSC, Faroudja laboratories have based their system very closely on NTSC, making great efforts to overcome cross-colour, cross-luminance, and a limited chrominance bandwidth NTSC decoders, have been improved by incorporating complex filters into sets but even the most complex decoder is not going to completely separate luminance and colour signals superimposed during the frequency-division multiplexing process, and so Faroudja engineers decided the solution to these cross-colour and cross-luminance problems must lie in making modifications to the original coding process.

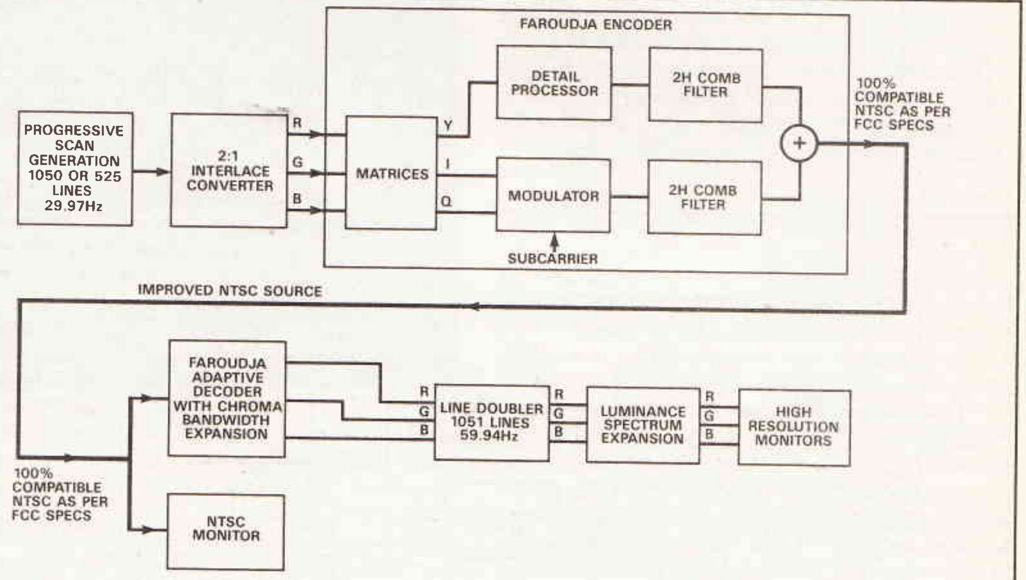


Fig. 8 Operation of Super NTSC system

Precoding

The main idea used in the improved encoder is to prevent luminance and chrominance spectra components from overlapping, even before the multiplexing process takes place.

This is done by prefiltering the individual components through comb filters. Luminance information is comb filtered between 2.3 and 4.2MHz, this being the frequency range that is most likely to suffer from overlap with the chrominance signals. The chrominance is comb filtered too, and the net result is that the area where the two signals overlap is appreciably reduced, and reducing the possibility of intermodulation effects that cause cross-colour and cross-luminance. The two signals are then frequency division multiplexed to produce an NTSC signal, but this time the actual cross effects on the transmitted signal are much less than usual,and when the signals are again filtered by comb filters in the receiver, the results are very much better than standard NTSC,with manufacturers claiming the pictures come close to the original RGB source pictures. In addition, the amount of chrominance noise, usually seen as black 'sparkles' in areas of highly-saturated colour, is much reduced. Much of the so-called chroma noise that is seen in conventional receivers is in fact due to a combination of high frequency luminance noise which gets into the chrominance channel and the chrominance noise proper. The effect of this luminance noise is especially noticeable at around the colour-subcarrier frequency, and so the effect of the comb filtering that takes place in the improved NTSC system is to reduce the amount of luminance noise in the area of the subcarrier, the net effect being an apparent improvement in the signal to noise ratio of the chrominance signals.

SuperNTSC builds upon these improvements in the NTSC system, and the principles of operation of the SuperNTSC system are shown in Figure 8.

The source picture is progressively scanned at either 1050 lines or 525 lines, at a 29.97Hz frame rate. This progressively scanned source image is then converted to an interlaced signal fed, in either RGB or YIQ component form, to the so-called SuperNTSC encoder. The luminance signal is split into two, with the complementary filters shown in Figure 8, the signals between 2.3 and 4.2MHz being comb filtered, and then combined with the remaining parts of the luminance signal in an adder. The I and Q colour difference components are fed to a quadrature modulator, together with the subcarrier, and the resultant signals are comb filtered before being combined with the treated luminance signals to form a SuperNTSC composite television signal in which the potential for cross-colour and cross-luminance artifacts has been very much reduced. The SuperNTSC signal is, 100% compatible with a standard NTSC signal, and can be transmitted over all the existing terrestrial transmitter networks, but this signal has the potential to provide better pictures in the home if special receivers are used.

The incoming signal received could be fed to a standard NTSC receiver without any problems, and the same signal used to feed a special decoder, which gives better results than standard NTSC, especially when coupled to a display which has line doubling circuitry in order to produce a continuously scanned picture.

The chrominance signals are comb filtered and then subtracted from the delayd incoming video signal,the resultant being the luminance component Y. The chrominance signals are then demodulated to provide I and Q signals, and these, together with the Y signals, are fed into a resistive matrix from which the R, G, and B components are derived.

The chrominance processing is, rather more complex than the filtering shown in figure 9 would imply. The comb filtering is carried out in an 'adaptive' manner; whenever a sharp chrominance transition is detected the coefficient of the comb filter circuitry is changed so that its action is optimised, and this is done continuously in response to changes in the pictures.

Also included in the decoder is a second processor which improves the pictures considerably because of its ability to adaptively vary the bandwidth of the chrominance processing circuitry. In determining the optimum bandwidth of the decoder there are two main criteria to be satisfied; rather paradoxically, the bandwidth should be large in order that the receiver will be able to display sharp chrominance transitions, but for minimum chrominance noise and cross-colour the requirement is for a narrow bandwidth. The adaptive decoder of the SuperNTSC system allows both requirements. When large chrominance transitions occur the filters are adjusted for maximum bandwidth, but when the chrominance signals are low in level and there are no sharp transitions the filtering is adjusted so that the effective bandwidth is narrowed, thus keeping noise to a minimum.

Another technique used in the SuperNTSC decoder is called 'chrominance bandwidth expansion'. This increases the positional accuracy and sharpness of colour transitions, for any change in colour will occur at the same point as a luminance transition, but in ordinary receivers the chrominance information is blurred or smeared due to limited bandwidth of the chrominance channel. In the SuperNTSC decoder, the coincident luminance and chrominance transition is examined, and the colour transition is effectively regenerated in a form which gives a much wider bandwidth, so that sharp colour transitions can now be displayed.

SuperNTSC improved display techniques

As Figure 8 shows, signals from the adaptive decoder are fed into an advanced line doubler which has been designed to provide RGB picture signals with either 1050 lines, 2:1 interlaced, at 59.94 f.p.s., or alternatively signals with 525-lines, continuously scanned.

This line doubler uses motion compensation techniques to avoid motion artifacts, and a technique known as 'horizontal multiplicative enhancement' to increase the sharpness on luminance edges. To improve the vertical resolution a form of detail processing is used, and aperture correction is adopted to compensate for the reduction in definition caused by the finite size of the scanning spot, thus providing a sharper image.

Faroudja claims that a picture signal with a basic 8MHz bandwidth can provide pictures with the appearance of an image that might have originated from a signal of 15 to 20MHz bandwidth.

Other Applications Of SuperNTSC

The techniques used in the SuperNTSC system have a much wider application than might at first be thought. Researchers working on the ACTV systems have experimented with the use of SuperNTSC pictures instead of standard NTSC pictures as their basic signals, and with the SuperNTSC decoder and display; the use of SuperNTSC should result in better pictures, since the original NTSC cross-colour and cross-luminance effects will be much reduced. In a similar manner the techniques developed by Faroudja could be applied to PAL systems throughout the world with appropriate modifications to the filtering circuitry. Somewhat surprisingly, the one significant ATV feature the SuperNTSC system does not yet provide is a widescreen display, but the Faroudja paper submitted to the FCC advisory committee on advanced television systems says that an aspect ratio of 4:3 is the first step. An eventual second step will be to move towards an aspect ratio of 1.61:1 (i.e. 4.83:3) whilst remaining fully compatible with 4:3 receivers, although there may be the need for a black strip to be displayed at the top and bottom of the picture, the so-called letter box display. Various techniques could be used to provide the widescreen feature, however, and a few minutes thought about the application of SuperNTSC to the ACTV system, as mentioned at the start of this paragraph, will show just one method by which widescreen SuperNTSC could eventually become practicable.

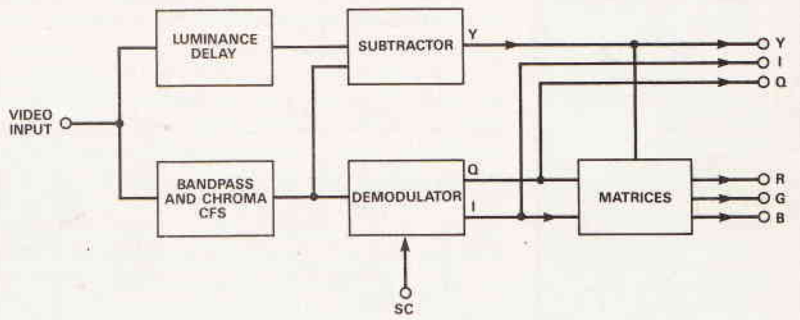
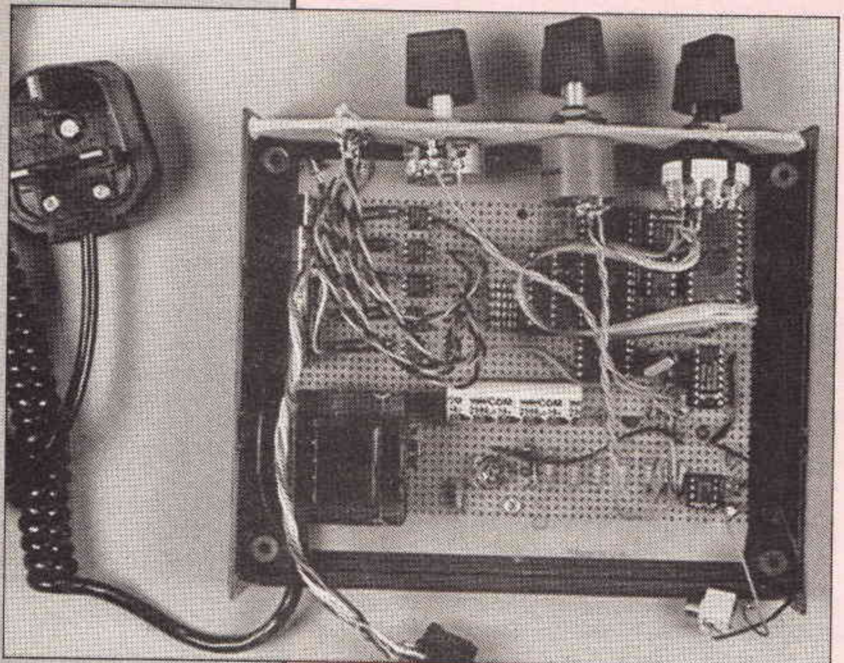


Fig. 9 Principles of Super NTSC decoder

In the next article in this series we will look at some fascinating ideas which have been put forward as possible contenders for the potentially huge American ATV market, and see how they could also have implications for existing European terrestrial systems.

ARIENNE'S LIGHTS



A micro-controlled lightshow by Kevin Kirk

The tenth birthday party is a milestone in a girl's life, one that must be celebrated in a style that she would like to become accustomed to. My girl's party had to feature a disco in one of our outhouses. This disco must have flashing lights as well as the obligitary loud music.

The music was no problem, but the lights must be a little bit special, none of the tired old sound to lights for this young technocrat. So it must have at least six different light sequences, some of which must be in time to the music some set by manual control. To stop interference with the music the actual switching must be silent and the circuit must be isolated from both the amplifier output and the mains for safety.

It was decided to make the unit five channel, as it gave a more pronounced sequence, especially if used with a rope or mini lights.

To give a good range of sequences, a microprocessor was used instead of a board full of logic. The reasons are:
The unit becomes a lot easier to wire up, the sequences may be changed at a later date, extra sequences can be added, it is a lot cheaper and the processor may be removed to make a simple but effective bar light show (more of this later).

To enhance the options available, two different types of input were chosen as the audio input. The first was a simple frequency dependent input and the other was an amplitude level.

Using the micro gave a lot of flexibility, so the choice of sequences was fairly wide. The initial choice of sequences was made by Arienne herself and consisted of the following:

- Straight sequence, this is the simple 'light chaser' or 'walking light' it's speed can be set via the manual speed control.
- Sound sequence, similar to the above but it moves on in time to the music. One light will stay on when the music stops. This sequence is very effective with music which has a lot of sound bursts.
- Bar Graph, the number of lamps lit depends on the level of the music.
- Sound to light, the lights flash in time to the music, the lights will all go off when the music stops.
- Strobe/sound light, the first lamp flashes at a rate set by manual control and the others build up according to the level and duration of the beat.
- Starburst, a nice sequence that consists of all of the lights coming on one after the other then all going out (5 Times), then all the lights come on and go off one at a time (5 times).

This is followed by a 'walking hole' where all the lights are on except for one which moves along (5 times) and finally the lights come on in a 'sunburst' starting from the middle, then the next 2 lights and finally the last 2 lights this then reverses (5 times). The sequence then repeats.

This sequence is recommended for a static display where something needs highlighting.

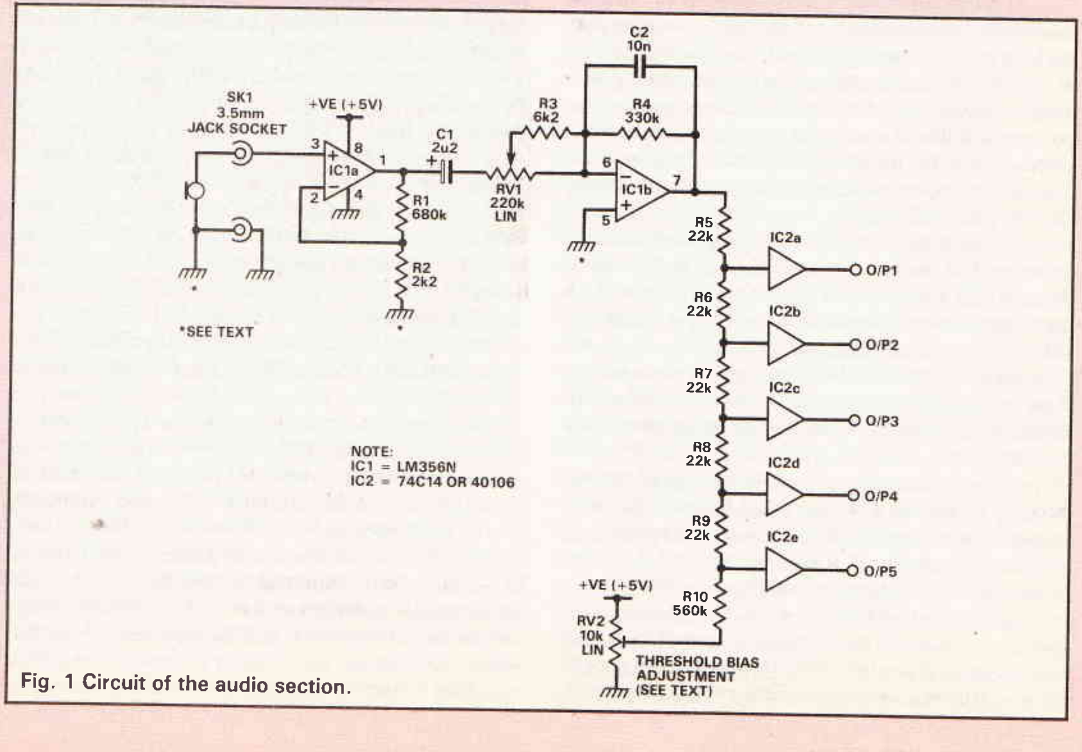


Fig. 1 Circuit of the audio section.

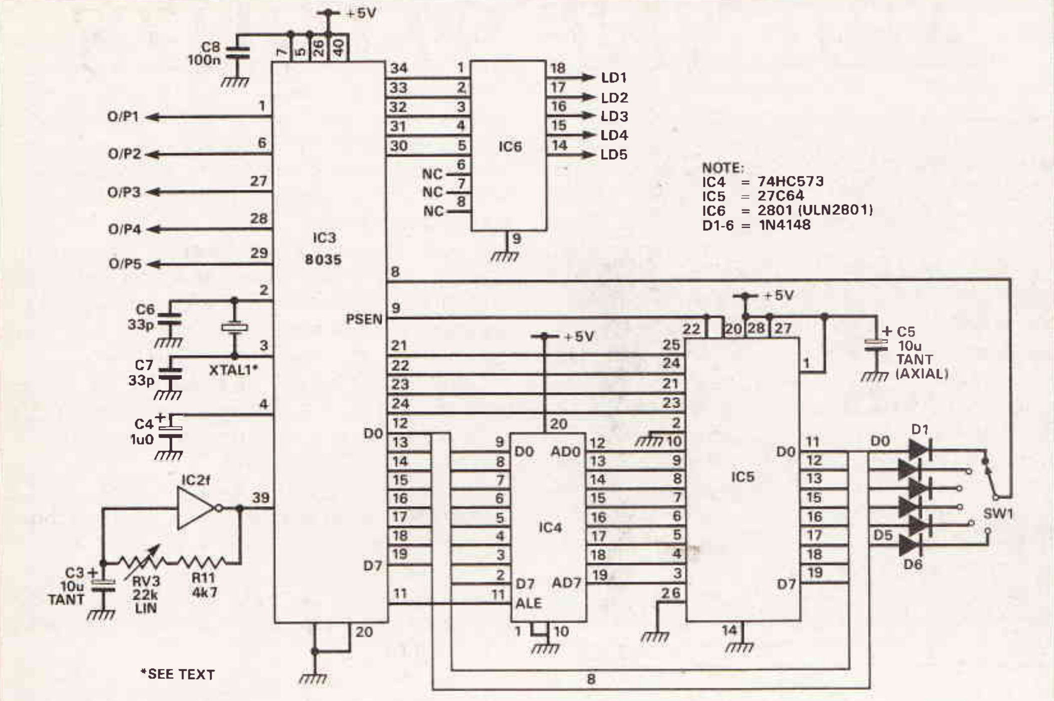


Fig. 2 Circuit of the processor section.

Circuit Operation

As I mentioned in the pre-amble this project may be built in two ways, either as a full blown processor controlled multi sequence light show or for those with a smaller budget as a very effective bar graph display. To this end the circuit diagrams are drawn in three parts, the simpler version uses the audio and output sections only, neat huh?

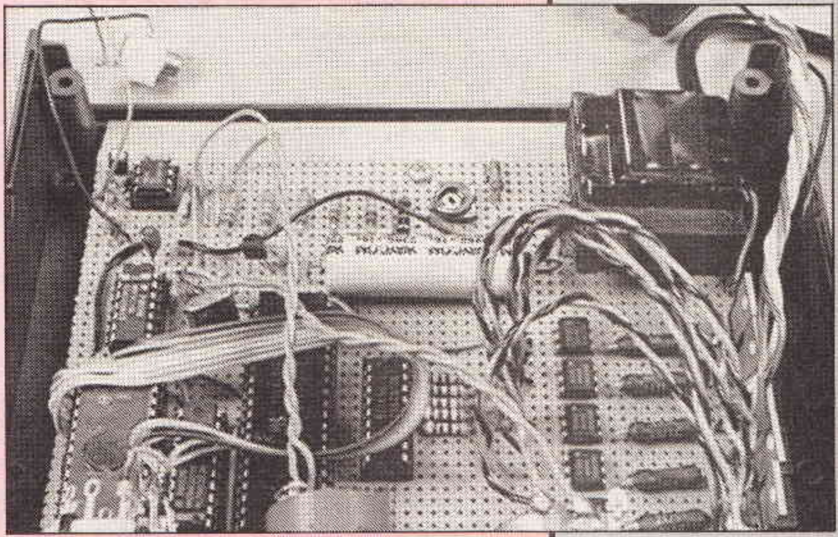
The audio input is from any standard microphone, the prototype used a cheap and cheerful stick mic from a cassette recorder, but virtually any will do as long as it is not too insensitive. The first op amp acts as a simple high gain amplifier (>250). It's output has a DC offset so C1 sees this off. VR1 sets the gain of the next stage, with C2 giving a high frequency roll-off so the high notes don't effect the sequence (much!).

This output is fed into a divider chain so the lower amplitudes just trigger IC2a, the next higher triggers IC2a and b and so on. The preset is to overcome the 2.2V (approx) threshold on the schmitt triggers so each one triggers smoothly. The more astute readers will have noticed that the chain is linear and sound as we all know is logarithmic, so for the very best effect you should change the values to give a logarithmic progression with R5 as the smallest, try R5 = 47R, R6 = 470R, R7 = 4K7, R8 = 47K, R9 = 470K and R10 = 1M.

The output from IC2a-e (marked O/P 1-5) can either go into the relevant processor connections or directly into the output stage, for those building the processor version, I will describe the operation of this part.

For those of you who read my Telephone combination lock (an improved version of which I am working on, watch this space!!) you will notice that I am using another version of the ubiquitous 48 series single chip micro-controllers. This is based on the 8080 and, although it has more bugs in it than a Libyan coffee shop, it has a couple of really neat features both of which are that it is CHEAP. It does have full I/O and data/address multiplexing and a wonky timer. In this instance I'm driving it with an 11MHz clock, although virtually any old clock speed down to 5 or 6MHz will do (I happen to have a lot of 11MHz crystals) because it divides it down by 15 before it starts so it then lumbers along at a fairly sedate 733kHz.

For all it's little faults it is a well used little beast (most Computer Keyboards have one in) and can be capable of reasonably good performance if the programmer is prepared to take some time and effort with it (I once designed a fully fledged Hayes compatable Soft Modem using one of these, complete with 2 soft UARTs, three speeds etc all in 2K Bytes. Never again though!).



For this application neither great speed nor great performance is required as it basically just looks at the inputs and after a bit of jiggery-pokery shoves them out again.

The software is written in sequences so that it performs a complete sequence before it changes to the next sequence. So for example if sequence 6 is chosen then it will go right to the end before changing even if the switch is changed just after it has started. The switch is simply used to pull one data line down to signal which sequence is required. If the 6th sequence is required for a static display then the switch can be removed and it will always default to this sequence.

IC2f is used as a simple oscillator to determine the sequence speed. IC6 is an octal driver of which only 5 outputs are used.

The rest of the circuit is the address/data latch and Program EPROM. The processor sends out the lower 8 bits of the address on the data bus together with a signal called ALE (Address Latch Enable) which is used to store them in a latch which in turn drives the EPROM when the data is being sought, which if you know your 8080/8085 should sound familiar to you.

The output section uses an opto isolator with a crossing zero detector and output triac. The crossing zero detector is used to trigger the triac only as the mains voltage crosses the zero point in the cycle. This means that the current through the device and subsequently the load is very low (in practise it is not exactly zero as the triac wouldn't actually latch) which in turn means that RFI is not produced, what that means to you is that it doesn't cause clicks on the music, like some light shows. The output of the Opto triac is capable of driving a diddly little bulb of about 10 watts or so and so could be used to directly drive a light rope or 5 sets of christmas tree lights (try it it looks pretty good arranged in a wheel).

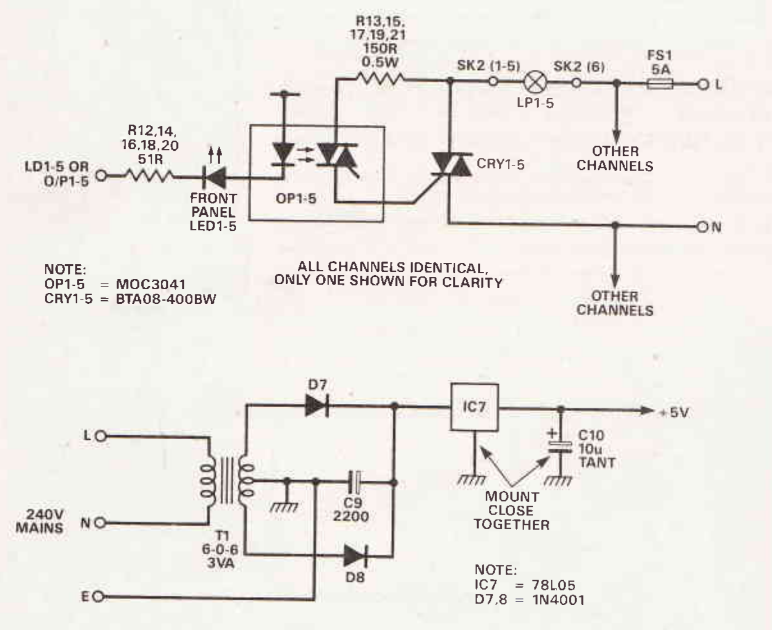


Fig. 3 Power supply and output section.

However to do serious justice to the circuit then decent triacs should be used. I chose the BTA08-400BW (snappy little name eh?) because it has isolated tabs so they could all be bolted to a common heatsink, if required. On the prototype I drove 200 Watt floods with no heatsink and they got barely warm as they are already hard on when the main current passes through their dissipation is fairly low, another plus for zero crossing. If you are going to use fairly large lamps then fit heatsinks and in any event don't go above 1Kw per channel as incadescent lamps have a positive temperature coefficient so they have a large inrush current (most die at this point) on start up which is about twice their normal operating current.

Note that the front panel LED is mounted in series with the opto triac LED so you can see exactly what it is doing on the front panel. This is a very useful feature if the unit is mounted on a disco console with the lights facing the crowd so you can't see them properly.

On the simple version simply connect the outputs marked OP1-5 from IC2 directly to the end of R12 (and it's brothers on the other channels). To stop over dissipation on IC2 it may be a good idea to change the value of R12 to 82R. In this instance IC2f oscillator output can be used to drive another opto (via a 330R resistor) and triac to provide a simple strobe light, if it is not used then tie the input to 0V.

Construction

There is nothing in the circuit that should cause any problems if the circuit board is used. However, is it isn't used then great care is required on the mains wiring, remember it is lethal. When testing the circuit I would recommend using an Earth Leakage Circuit Breaker.

If the simple unit is required then connect the links shown on the PCB close to C10, you will not need to put anything inside the thick line.

If you want to build the unit on your own PCB or into a system, note that the 0 Volt lines are starred to reduce interference from the switching currents of the LEDs on the Audio Input.

I would recommend that the unit is tested without the Mains power supply or triacs fitted, using a separate DC supply (greater than +8V) connected across C9 (observing polarity). When you are happy everything works, then connect the triacs and transformer. Note that all the tests mentioned below may be done using the front panel LEDs instead of the lamps and I would recommend this as the best course of action initially as the system will be easier to fault find on with no mains floating around it!

Then switch to the sound to light, put the microphone close to a sound source preferably some music with a good beat. Adjust the preset to about mid travel now adjust the volume control RV1 until all the lights flash consistently with the music.

Now turn to the music controlled sequence, the sequence should be reasonably smooth with each beat, if not adjust RV1.

Finally turn to the Bar Graph display, turn the music volume up to the level you will likely be using it at and adjust the preset until all of the lamps light up on each beat. Reducing the volume should reduce the number of lamps lit.

As with many systems like this the above settings will eventually be made by experience, different settings produce different effects so don't be afraid to experiment.

Final setting up is straight forward after connecting the lights then start the simple sequence and ensure that all of the lamps light in turn. If not switch off before rewiring.

The Use

Over the years I've put together quite a few disco systems and have had quite a bit of experience with light shows. Some of my early ones were horrible they clicked and whirred rivalling the music in volume.

The only thing that I've learned is that the layout of the lighting is nearly as important as the light show itself. In many instances a very dramatic effect can be made using simple small white bulbs, say 12 volt wired 40 in sequence (yes that's right running dim) on each channel, wired as spokes in a wheel or in a fan shape on a wall. Another dramatic effect was to use small pigmy bulbs in waterproof fittings along a fence.

So don't be afraid to experiment, but always check your wiring with a meter before you connect up because triacs can blow very fast.

The party was a great success with Arienne playing Queen Bee on the light show controls, now they all want one!

A copy of the Hex Dump for the EPROM is available by sending an SAE to ETI.

PARTS LIST

RESISTORS (all ¼W 5%)

R1	620k
R2	2k2
R3	6k2
R4	330k
R5,6,7,8,9	22k
R10	560k
R11	4k7
R12,14,16,18,20	51R
R13,15,17,19,21	150R
RV1	220k lin
RV2	10k preset lin
RV3	22k lin

CAPACITORS

C1	2µ2
C2	10n
C3,5,10	10µ tantalum
C4	1µ
C6,7	33p
C8	100n
C9	2200µ/16v

SEMICONDUCTORS

IC1	LM358N
IC2	74C14 or 40106
IC3	8035
IC4	74HC573
IC5	27C64
IC6	2801
IC7	78L05
OP1,2,3,4,5	MOC3041
CRY1,2,3,4,5	BTA08-400BW
LED1,2,3,4,5	Red LED's
D1,2,3,4,5,6	1N4148
D7,8	1N4001

MISCELLANEOUS

XTAL 1	See text
SW1	6 way 1 pole wafer
SK1	3.5mm jack socket
SK2	6 pin socket (mains)
TR1	6-0-6v 3VA PCB transformer Farnell Cat No 141-471

Microphone, PCB, case, knobs

BUYLINES

The Software is available by sending 2 new blank 27C64 or 27C128 EPROMS and a stamped addressed envelope to Kevin Kirk c/o the Post Office, Cwmystwyth, Dyfed. I will blow one and keep the other. EPROMS with stuff in will be sent back I'm afraid, as will old ones as they aren't worth the hassle.

Other parts are fairly straight forward to obtain, I got the original components from Farnell (0532 636311) who take Access and Visa, the box came from Maplin and PCB from ETI.

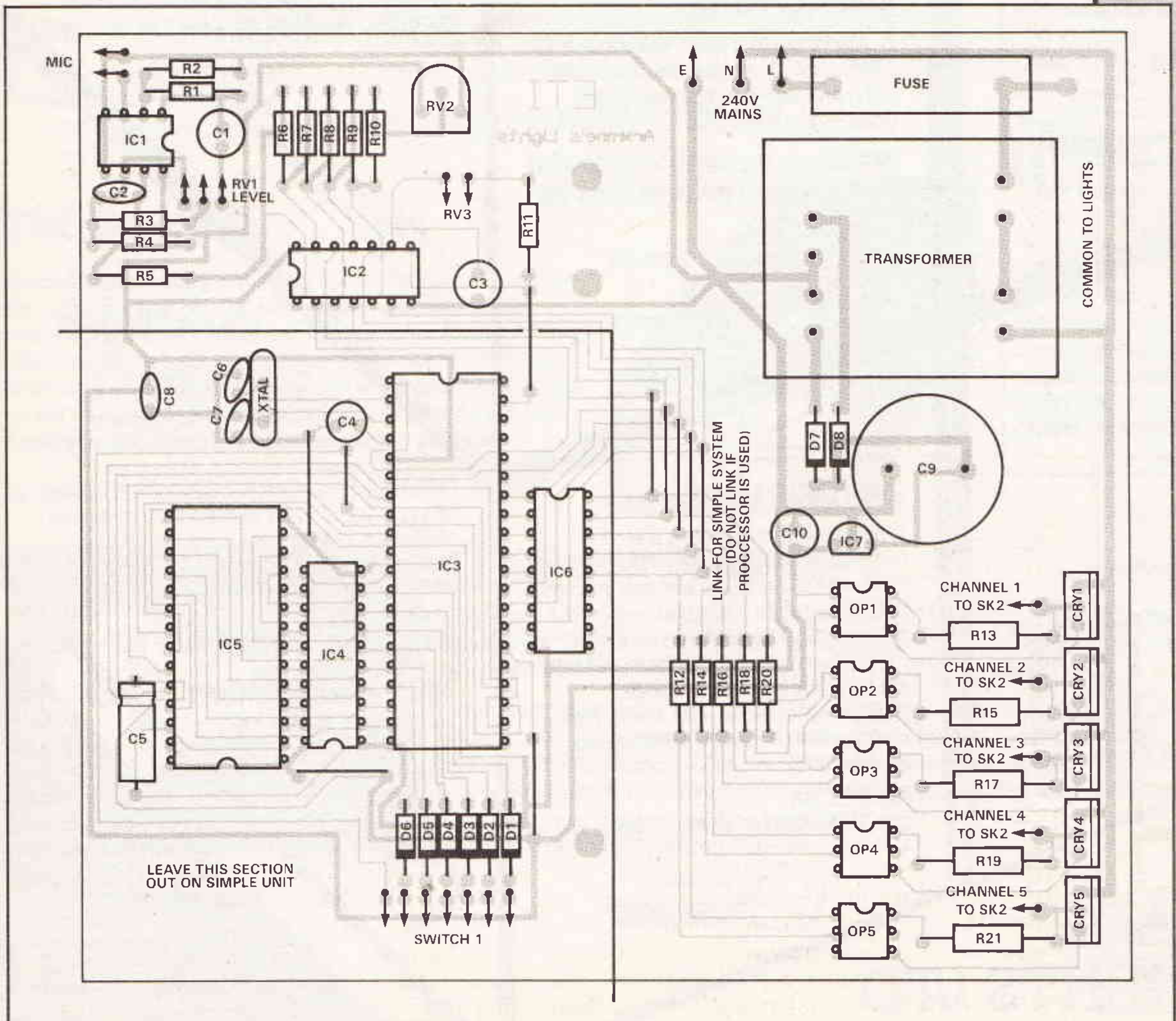


Fig. 4 Component overlay for Arienne's Lights.

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(Value £100+)
PARCEL 2B: 5000+ top grade components for £49! + VAT
(Value £500+)

INTEGRATED CIRCUITS

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PARCEL 3B: 500 ICs for £49! + VAT

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PARCEL 7A: 100 LEDs for £5.90 + VAT
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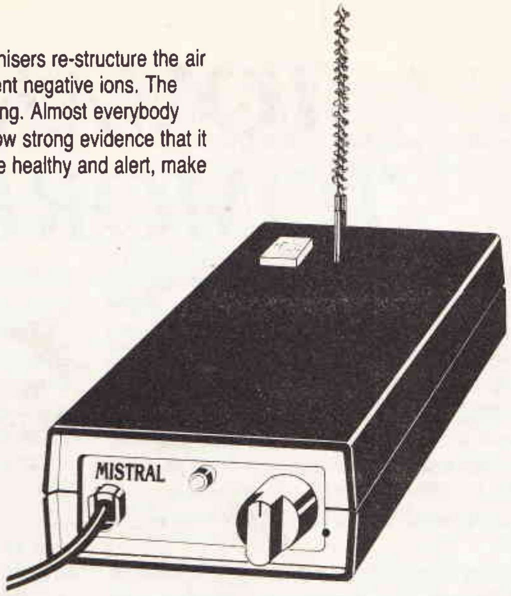
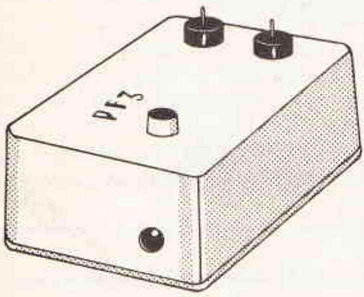


MISTRAL IONISER PARTS SET **£32.66** ☐

INTERNAL EMITTER PARTS SET (optional) **£3.22** ☐

ION FAN (optional) **£11.27** ☐



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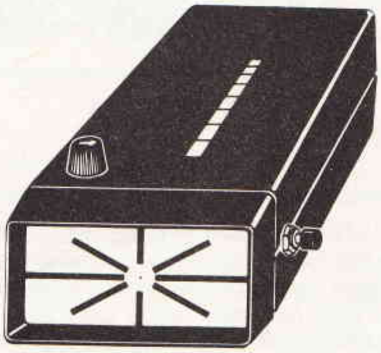

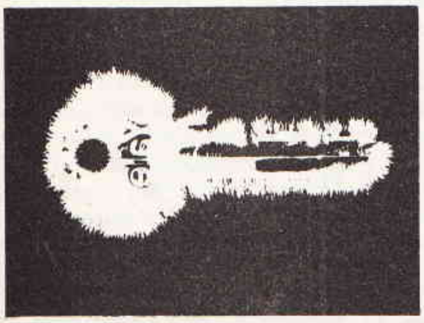

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KIRLIAN CAMERA SET **£19.78** ☐

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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1

TOWARDS TOMORROW

Andrew Armstrong looks at tomorrows technology today.

This is the first of a new series of occasional columns in which I will write about whatever I find most interesting in technology and related fields. Often I will be touching the edge of science fiction, discussing things which cannot yet quite be achieved, and may never actually be done even when possible. I hope that what I find interesting will also interest other people — please write in with your comments so that we can decide whether and if so how to continue the series.

Fiction has dealt with interstellar travel, though at present few people would believe this to be practical in the forseeable future. Equally, almost nobody thought that men would walk on the moon until a few years before it actuallly happened. The reality was different from the fiction in this case, as so often happens. Early technological achievements usually seem to be less spectacular, more costly, and subject to more problems than fictional accounts would have us believe, but eventually the reality becomes commonplace and surpasses the fiction.

So it will be with interstellar travel. Nobody will zoom to the stars on a rocket, but a limited form of exploration using unmanned probes may be possible.

The non-intuitive fact that radiation exerts a pressure can be used to propel spacecraft, and indeed practical lightsails (using sunlight for propulsion) are under development. Other electromagnetic radiation can also be used, and in 1985 Dr Robert Forward (consultant to the US Air Force) proposed a microwave powered interstellar probe.

The minimal version of the "Starwisp" probe would consist of a mesh of micron wire, with an integrated circuit chip at each intersection. It would use 16 grammes of wire and 4 grammes of semiconductors to make up a 1km area sail. When irradiated by a 10GW microwave beam (the source of which we will address later) for about a week, it would reach 1/5 the speed of light. 91 years later, when passing through the Alpha Centauri system, a further period of microwave irradiation would provide power to transmit high definition colour television pictures back along the direction of the beam, with enough power for reception by a suitable radiotelescope.

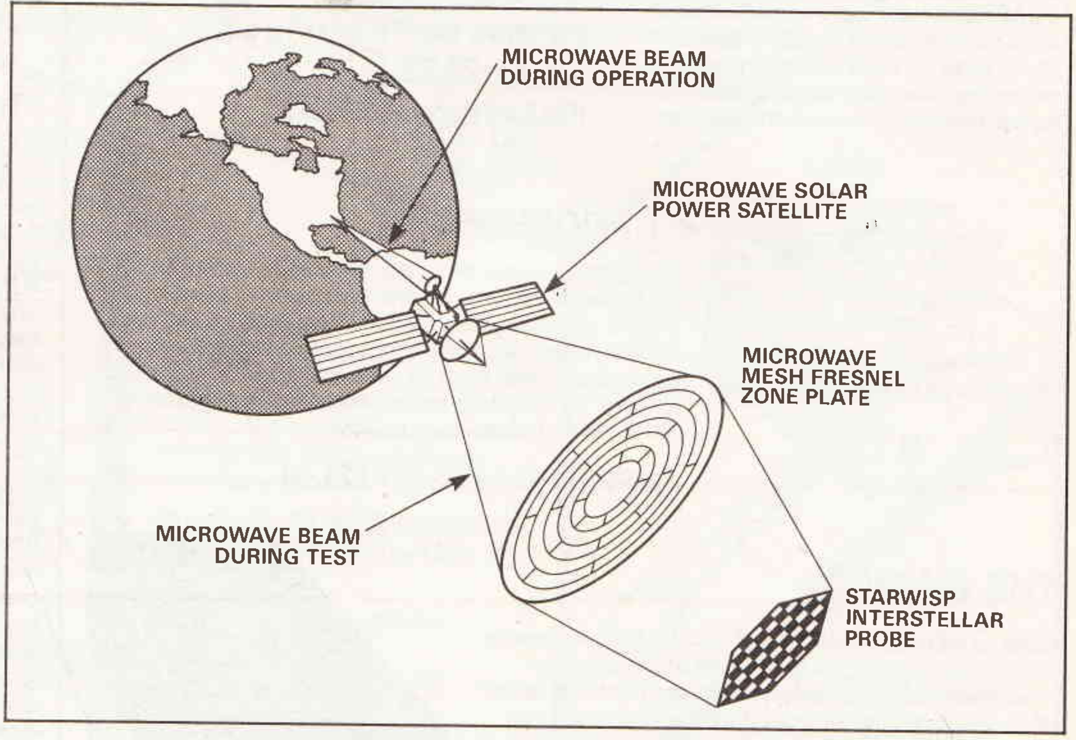
Clearly such a probe cannot be made at present, but extrapolation of recent technological advance into the future suggests that it will be possible between ten and twenty years from now. Let us take the main requirements in order:

Micron wire can be made now, but not in significant quantities. It is not clear how adequate quantities could be made practically, but who, twenty years ago, would have thought that kilometres of single mode optical fibre (optical waveguide) could be made and considered cheap enough for ordinary telecommunications use.

The integrated circuit at the junction of each set of wires is rather speculative at the moment. It seems unlikely that silicon would be sufficiently radiation resistant to last, and the best candidate at present looks like indium phosphide. Of course, there is a long way to go between the present state of tile art and VLSI chips using indium phosphide, but the general techniques of IC manufacture are known, so it is not so large a step as that from the first silicon transistor to the transputer.

Consider what the microcircuit at each junction would have to do. First of all, it would have to work as part of a distributed array processor, in conjunction with the other circuits in the array. To enable propulsion, junctions would have to switch to short circuit or open circuit condition as appropriate. Yet others would have to configure themselves to rectify microwave power to provide DC to run the system.

On arrival at the destination the real fun would



begin. The probe, having travelled all the way at 20% light speed, would probably have suffered damage, and would have to configure its processing array to work around large holes or tears. Again, some junctions would configure themselves as rectifiers to provide power, while others would serve as parts of a phases array transmitter.

In order to send a beam of microwaves back to Earth, the probe would measure the relative phase and strength of the signal received, and transmit a reciprocal signal from that part of the array. This technique can produce a tightly directional signal, despite major irregularities in the transmitting array.

The same principle is applied to the design of the now obsolete 'squarial', in which a flat plate array of receiving aerials is made to perform as a directional aerial. The same effect could be achieved with a non-flat array, for example moulded into the roof of a vehicle, if appropriate phase and gain compensation were applied to each element. This principle will no doubt be applied to military satellite communications, with active gain and phase compensation steering the beam, if indeed it has not already been done.

Back to Starwisp. The really difficult part is to build up a picture without any optics! The way to do this is to make each element of the array sensitive to just one frequency of light, and to the phase as well. The phase and gain information from a number of elements will give directional information about incident light, even if each element has for example 180° solid angle sensitivity. Thus shape can be determined without lenses and focussing. Colour, and even false colour infra red images could be built up from the different frequency detectors in the array. Of course, single frequency phase sensitive detection of light is a task the doing of which is not yet known. There may never be an electronic means of such detection, but it is more likely that a means will be found, perhaps using quantum devices built using nanotechnology. (I intend to cover this in a future column.)

Propulsion

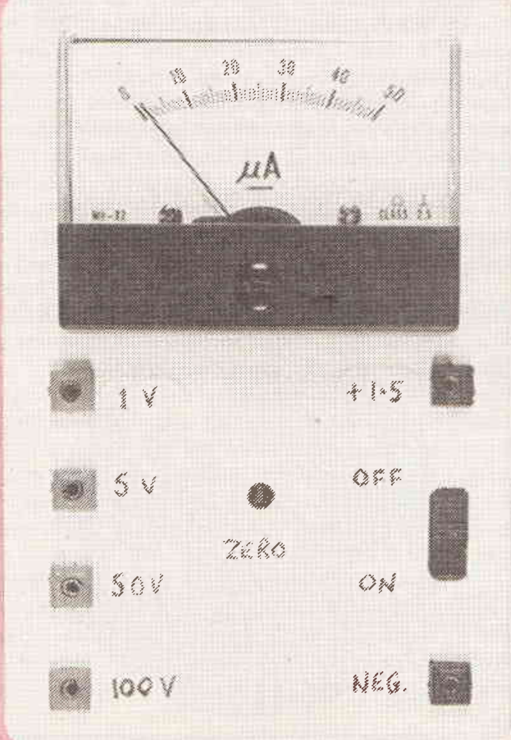
Earlier on I referred to a 10GW microwave beam providing acceleration for Starwisp. If the launching of Starwisp could be coordinated with the commissioning of a solar power satellite (SPS), the SPS could be used for about a week to launch Starwisp before being beamed at Earth to provide enough electricity to allow several large power stations to close. Hopefully, the production of another SPS could be timed to permit the transmission of a beam to illuminate Starwisp for about a week at its destination, so that it can gather data and transmit it back to Earth.

For the few readers who may not have encountered the idea of an SPS before, it is a satellite in geosynchronous orbit. It generates electricity using photovoltaic panels, and converts the DC to microwaves which it beams at a collector array in an unpopulated area. Environmental damage resulting from this is thought to be smaller than for fossil fuel or nuclear power generation, and perhaps less than for tidal power generation by flooding the habitat of rare flora and fauna. The debate looks set to run and run.

There are a number of technological problems to solve before Starwisp or any similar space probe can be launched, but the largest obstacle will be in finding the political will to forward this area of scientific research.

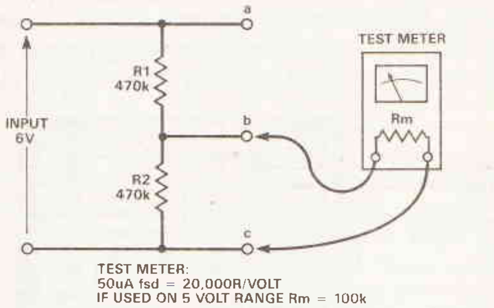
DESIGNING AN ELECTRONIC TESTMETER

1



John Smith develops a circuit idea into a working proto-type test meter

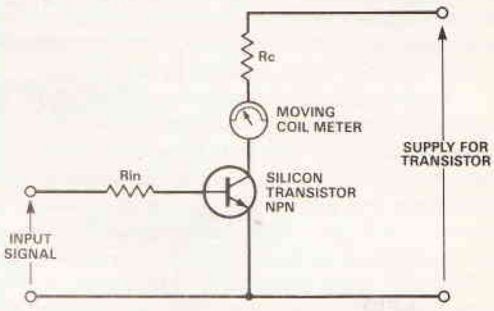
Moving coil multimeters, even good ones, can take a significant current from the circuit under test, and this may give rise to inaccurate readings. Referring to Figure 1; if a 50µA — 20,000 R/volt-meter, on a 5 volt range, is used to measure V_{bc}, then, due to the shunting effect of R_m, a reading of about 0.905 volts will be obtained, an error of over 2 volts. If a meter taking 1µA full scale (1M/volt) again on a 5 volt range, is used then the error will be less than 1/5 volt. Not exact, but quite near enough for one to be satisfied that the circuit is working correctly.



TEST METER:
50uA fsd = 20,000R/VOLT
IF USED ON 5 VOLT RANGE Rm = 100k

Fig. 1 Standard Testmeter applied to potential divider

To get such a high input resistance an electronic testmeter is needed. Commercial instruments are usually expensive, so this project is intended to provide a fairly simple unit at a reasonable cost. This cost may be reduced if the constructor can provide some of the main items from stock! A moving coil meter may be made more sensitive by the use of a transistor amplifier, as shown in Figure 2. This basic circuit suffers from a number of defects; one of which is that the transistor I_c is affected by temperature, and another is that the input signal has to exceed the V_{be} of the transistor — some 600-700 mV, before any readings are obtained. The latter difficulty can be overcome to some extent, by the use of a Germanium transistor, but only at the expense of greater temperature instability.



Rin PROTECTS TRANSISTOR BASE FROM OVERLOAD
& ALLOWS FOR CALIBRATION OF CIRCUIT
Rc PROTECTS MOVING COIL METER FROM OVERLOAD

Fig. 2 Greater sensitivity is provided by a transistor amplifier

A better circuit is shown in Figure 3. Here the transistor is supplied with a permanent bias current through R_b and the resultant quiescent I_c is balanced out of the meter circuit by the combination of R_c and the resistor network including RV1. The diode is also supplied with a permanent current via R_d, and as it is a silicon device, it should present a similar potential difference from anode to cathode as the V_{be} of the transistor. Thus, by returning the negative input lead to the diode anode, rather than the supply negative, V_{be} is virtually eliminated from the input circuit. RV2 allows the system to be calibrated.

A further improvement can be made by using a second transistor instead of the diode, and forming a balanced amplifier configuration, known as a 'long tailed pair' (see Figure 4). It is now possible to set the meter zero by altering the bias to one of the transistors, using RV1.

The gain of the circuit in Figure 4 may be increased by adding two further transistors, and we now have an amplifier consisting of two balanced Darlington Pairs (Figure 5). This arrangement will perform quite well, and variations of it are often given as meter amplifiers. It can be constructed from four separate transistors, but an attractive alternative is to use the five-transistor array, the CA 3046, as all the

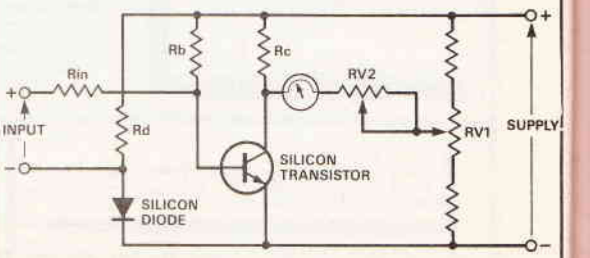


Fig. 3 Improved transistor amplifier circuit

semiconductors will then be in thermal equilibrium, and there is a convenient 'on chip' link which we can use for the connection between the emitters of Q2 and Q3. Musing on the possibility of utilising the fifth transistor somewhere, results in the circuit of Figure 6. The last transistor, which must be the one including the substrate connection, supplies a constant current to be balanced amplifier tail; and this transistor's bias is, in turn, stabilised by D1 and D2. The two diodes also provide a degree of temperature compensation.

There are two major drawbacks in this last arrangement; the first is that a relatively large number of components are needed, and secondly a fairly high supply voltage is required. This latter point is also a problem if an Op-Amp IC is used as a meter amplifier.

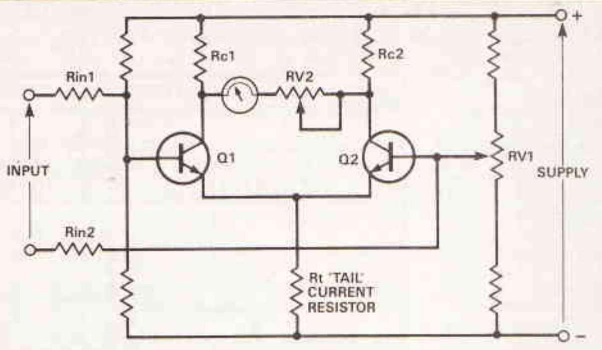
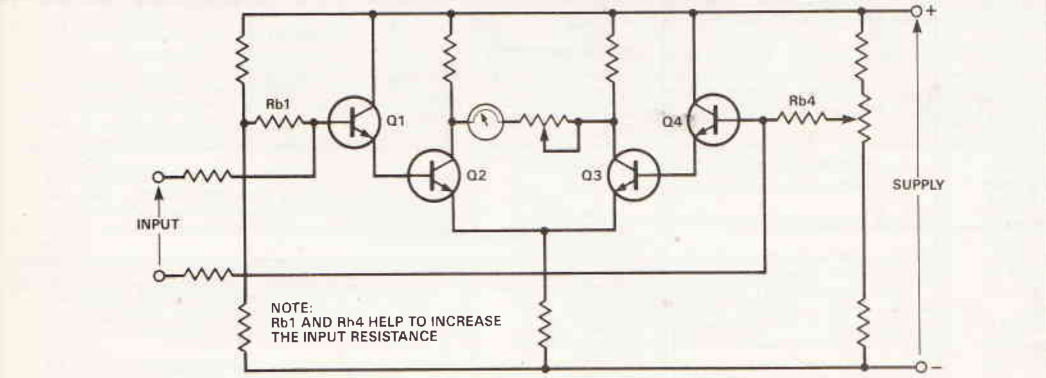


Fig. 4 A two transistor long-tailed pair amplifier



NOTE:
Rb1 AND Rb4 HELP TO INCREASE THE INPUT RESISTANCE

Fig. 5 Increased gain using Darlington Pairs

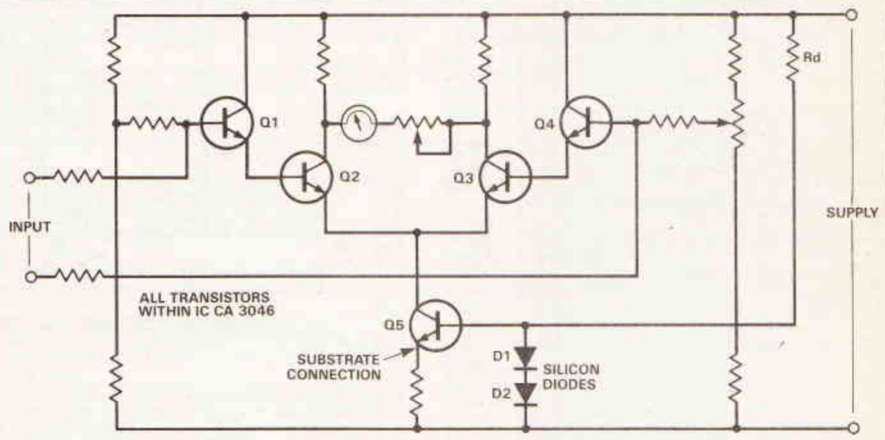


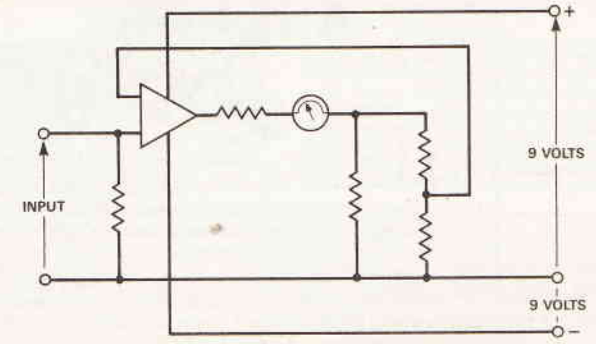
Fig. 6 Transistor array amplifier

An outline circuit is shown in Figure 7, and needs some ±9 volts for satisfactory operation.

To keep the amount of components down, and the supply requirements low, a different approach is required, so the basic DC amplifier shown in Figure 8 was examined. This idea looked promising, but the P N P output transistor was a bit of a problem. We were still keen to use a CA 3046, but there are no P N P transistors in a 3046!

We were looking for operation from supplies of ±1.5 volts, and the normal V_{be} of a silicon transistor is, as has been mentioned before, about half of this value, so the circuit shown in Figure 9 was suggested. The P N P transistor has been replaced with two N P N devices, the first operating as a common emitter, and the second as a common collector (also known as an emitter follower). Q5 is used to supply the 'tail' current as in Figures 6 & 8, although in the final version this arrangement is not utilized, and a simple resistor chain has been substituted. The important operating potentials are shown in Figure 9.

The gain of this amplifier is defined by the ratio of R_{in} to R_{fb} and has been found to be extremely accurate. Gains of over 1,000 times have been achieved, and this allows a 1 mA meter movement to operate with an imput current of only 1A. No special temperature compensation provisions have been made, other than the use of a single I C for all the semiconductors, and no noticable drift has been experienced. The gain is so precise that no calibration



OPERATIONAL AMPLIFIER: TOTAL SUPPLY NEEDS ARE 18 VOLTS

Fig. 7 An op-amp meter amplifier

is necessary, and all the ranges are obtained solely by the use 1% tolerance resistors, which are easily, and cheaply purchased. The final circuit is shown in Figure 10.

Next month we will turn this final development into a practical construction giving five voltage ranges.

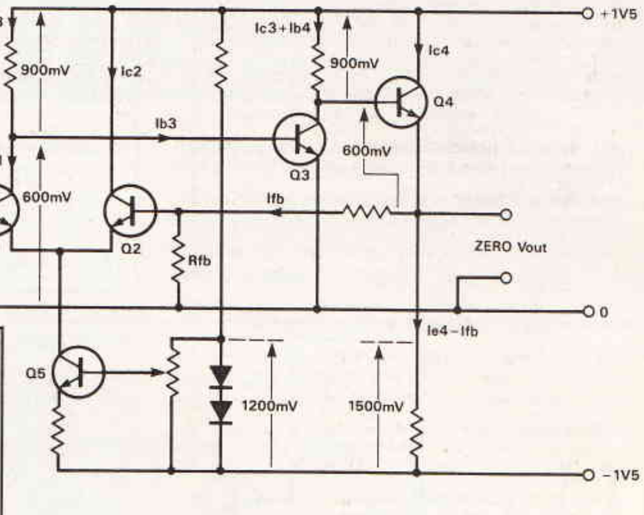


Fig. 9 Low voltage amplifier

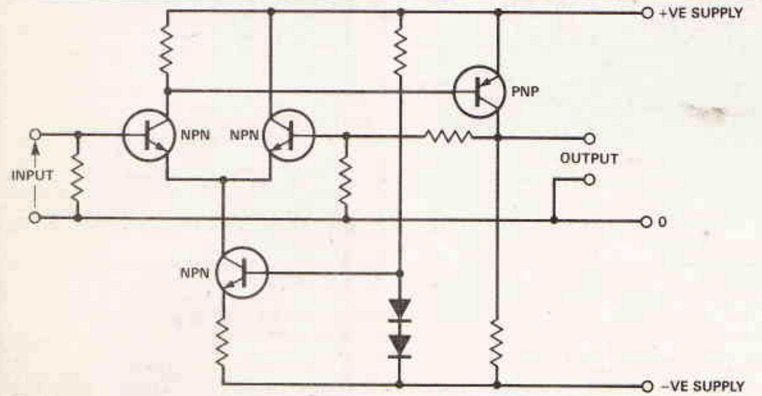
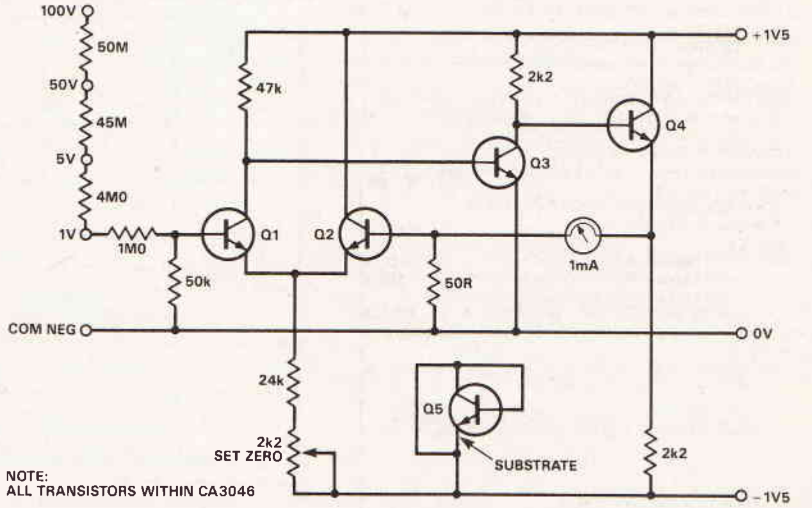


Fig. 8 Basic DC amp approach



NOTE:
ALL TRANSISTORS WITHIN CA3046

Fig. 10 Final developed design for testmeter

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minimum system consisting of mother board, 1 meg of memory case, power supply, 1.44 meg floppy, interfaces, and monitor i

£525.00 inc VAT (single drive mono 286) pc12

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TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.

TOROIDAL TRANSFORMER. 24v 5A encapsulated 4" dia £5.00 ref 5P34.

TESTING TESTING

Mike Barwise delivers the last in the series of Testing Testing.

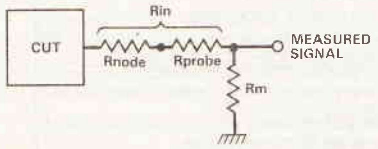

Fig. 1 Potential divider network at input

In this, the final part of Testing Testing, we will examine the characteristics of measurement probes in detail, and discuss the implications of these characteristics on the results you get from your measurements.

The Pure Resistance

We already saw, when we discussed multimeters, that the probe and instrument input resistance form a potential divider with the circuit under test (CUT) measured node at its input and the instrument input at its output (Figure 1). Assuming the effect is purely resistive as in Figure 1, it is clear the measured signal will always be a little bit smaller than the actual signal. The result is defined by $R_m/(R_m + R_{1n})$ where:

R_m is the meter resistance
R_{1n} is the input resistance.

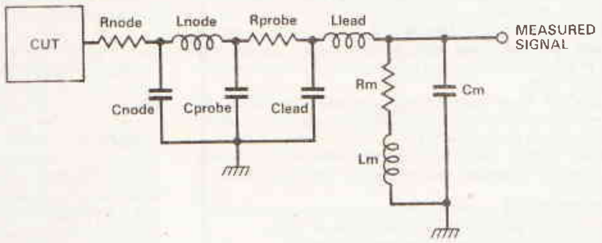

Fig. 2 Effective capacitances and inductances

In the case of the meters, the input 'probe' (a piece of thick wire) had negligible resistance, and the meter resistance varies from about 30K to 10M, so the attenuation of the signal would seem small. The input resistance is not solely the probe resistance. The ouput resistance of the CUT node also contibutes: the input resistance is the sun of the probe and the CUT node ouput resistance. If either is significant compared to the meter resistance, the signal will be attenuated, and the meter will read low. The saving grace is, if you know the meter, the probe and the CUT node output resistance, you can correct your reading by applying the potential divider formula in reverse:

$V_{real} = V_{measured}.\,(R_{node} + R_{probe} + R_{meter})/R_{meter}$

The Impure Resistance

All this is fine for purely resistive systems, but in the real world there is no such thing. Even the humble quarter watt resistor also has some capacitance and some inductance, each of which will contribute a reactive component (frequency-dependent parallel or series resistance) to the value of the resistor. Similarly, a capacitor has some inductance and resistance, a diode has some capacitance, and so on. These are generally referred to as stray effects, and their values are mostly small: 10pF and 1nH are typical orders of magnitude. At DC, these have no effect on our results, as at zero Hz, inductive reactance (series) (X_L) is zero, and capacitive reactance (parallel) (X_c) is infinite. The moment we start to vary the signal in the presence of AC), these series and parallel equivalent resistances (Figure 2) combine with the purely resistive elements to create an impedance, but at low frequencies the effect will be negligibly small. The really critical question is at what point measurement starts to get unreliable, and to answer this, you need to be able to calculate the effects contributed by the stray C and L.

The Formulae

The formulae for calculating the reactance of the stray effects are as follows:

$X_C = 1/2\pi fC$ for capacitive reactance
$X_L = 2\pi fL$ for inductive reactance

where f is in Hertz, C is in Farads, and L is in Henries. To derive the impedance we must somehow combine the effects of the resistance, inductance and capacitance. As the reactance is a dynamic effect, it is not valid to just add the reactance to the resistive component. The correct formula for arriving at impedance in series circuits takes account of the phase of each effect as well as its magnitude:

$Z = \sqrt{R^2 + X^2}$

Where:
Z = impedance (in ohms)
R = resistance
$X = X_L - X_C$
X_L = inductive reactance
X_C = capacitance reactance

This formula has a curious similarity to Pythagoras' Theorem, and indeed, if you plot the vector diagram of the 'forces' involved, they form a right-angled triangle.

For resistive and ractive components in parallel, we use the formula:

$$Z = \frac{1}{\sqrt{\frac{1}{R^2} + \frac{1}{X^2}}}$$

which looks very like the conventional resistors in parallel formula.

It is generally possible to ignore the effects of stray inductance here, as for moderate frequencies, a straight piece of wire like the 'scope probe lead will have a very small stray inductance in proportion to its stray capacitance. The 1nH stray inductance typical of bits of wire like probe leads up to about 1 metre long will exhibit at most a few ohms series reactance at frequencies below 20MHz or so. This allows us to use the approximation:

$X = X_C$

In other words, capacitive reactance and resistance are the only terms we need to consider. Just for comparison, ECL III high speed logic working at 500MHz, only allows simple wire connections of 0.4" or less! Any connections longer than this must be specially conditioned with resistive loads to minimise both the capactive and inductive effects of the connection (impedance matching).

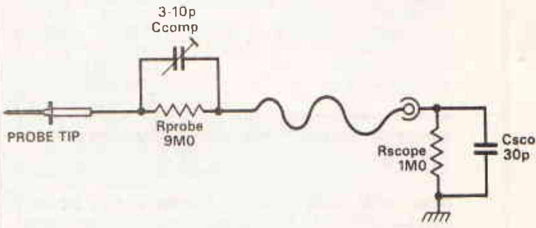

Fig. 3 Matching resistance and capacitance effects

Do Not Disturb

So far we have only considered the potential divider effect: the apparent loss of signal amplitude resulting from probe CUT and node impedance being significant in proportion to meter impedance. The less immediately visible but potentially more disruptive and occasionally destructive effect we must allow for is the loading effect of the measuring equipment (including any probes) on the circuit node being monitored. This loading effect will result in an actual loss of signal amplitude, due to the extra current being drawn by the measuring instrument. The results can occasionally be catastrophic, or at best highly misleading (see ETI April '90).

X10 'SCOPE PROBE R_{in} = 10M, nominal C_{in} = 15p 'scope R_{in} = 1M, C_{in} 30p, total C = 15p

Hz	X_{Cin}	Z_{in}
1K	10M6	7M27
10K	1M06	1M05
100K	106K	106K
1M	10K6	10K6
10M	1K06	1K06
20M	532R	532R
50M	212R	212R

Fig. 4 Table of Reactances and Impedances for X10 probe

As we found our right back in part one of this series, you cannot make a measurement in electronics without stealing a bit of current. This amounts to adding an extra parallel load to the CUT node. The value of this load is equal to the total of the probe and instrument impedances in series.

The effects we are discussing are frequency dependent, and most significant at the high end which suggests the best example is the 'scope and its probes. When we looked at these on a basic level in an earlier part of this series (ETI Dec. '89) we saw how it is possible to maintain the division ratio of the CUT+probe/instrument potential divider across all relevant frequencies by matching the resistive divider with a capacitance in the same ratio (figure 3). Although the division ratio is maintained constant, this system does not stop the overall input impedance from falling as the frequency rises at the measurement node.

X1 'SCOPE PROBE R_{IN} = 1M, nominal C_{in} = 40p 'scope R_{in} = 1M, C_{in} = 30p, total C = 70p

Hz	X_{Cin}	Z_{in}
1K	2M27	915K
10K	227K	221K
100K	22K7	22K7
1M	2K27	2K27
10M	227R	227R

X1 probe not characterised above 10MHz

Fig. 5 Table of Reactances and Impedances for X1 probe

If we calculate Zin for the typical X10 'scope probe of figure 3 over a range of frequencies (Figure 4), we see a pretty dramatic increase in loading of the CUT as the frequency of our signal exceeds the audio band. The precise calculation is quite complex, as the impedance of the basic series/parallel network is also modified by the distributed capacitance and inductance of the probe lead. To simplify the calculation, a figure is normally quoted by the probe manufacturer for input capacitance when used with a standard 'scope input (1M, 30p). This quoted figure is the basis for the table of Figure 4.

For a X1 probe, (Figure 5) the figures are even worse, as the lack of a potential divider and compensation capacitor produces R_{in} of 1M and C_{in} of about 70p once plugged into the 'scope.

The X1 probe will also exhibit a variable attenuation with frequency, due to the mismatch between the probe capacitance and the 'scope input capacitance (C_{probe}/C_{scope} not equal to R_{probe}/R_{scope}). This will lead to distortion of complex waveforms, as the attenuation of upper components will depend on their frequency: the probe will exhibit significant rolloff at high frequencies.

It will be seen from these figures that, capacitance takes over from the resistance as the major contributor to CUT loading in frequencies in the order of 10kHz for both probes. This is really quite surprising (you thought you'd bought a 1M or a 10M 'scope probe!), but, for the X10 probe, the impedance is still in the 10^5R range up to 100kHz, which is well out of the audio band. It is in the megahertz region that things start to get a bit problematic.

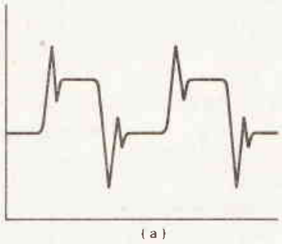

Fig. 6a Effect of Undershoot and Overshoot

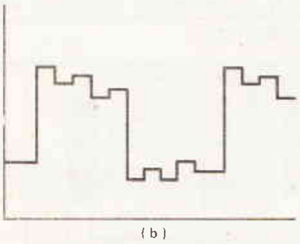

Fig. 6b Effect of adding reflected signals

The Real Problem

The cause of the trouble is really the relatively high capacitance of the probe assembly (including any capacitance at the measuring instrument). A very interesting difference between the two probes is the contribution of 'scope input capacitance to the total capacitance used to derive the impedance. For the X1 probe, C_{scope} and C_{probe} have to be added, whereas for the X10 probe, C_{scope} can be ignored. The provision of the potential divider in the probe circuit has isolated the measurement node from the effects of C_{scope}. The penalty for this is that our signal has been divided by 10 in amplitude.

Even a X100 passive probe, which has an input resistance (including the 'scope) of 100M, has an input capacitance of 6-7p, and the penalty for this comparatively low capacitance figure is a basic signal attenuation of 99%!

Get And Keep It Matched

I have heavily stressed this point about impedance matching, because it is one of the most commonly ignored sources of measurement problems of all kinds: bad readings and blown-up circuits.

The matching problem is, in fact, even more complex than I have suggested in this outline: quite

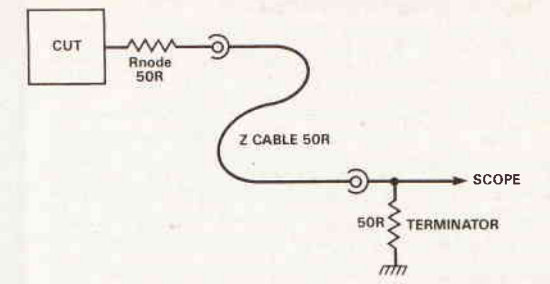

Fig. 7 Adding a terminator

apart from loading and attenuation problems, high frequency signals can actually be reflected back and forth along a test lead even interconnections in the circuit if the source and target impedances are mismatched. This behaviour is analogous to a resonant circuit. Let's view this for a square wave. If the signal transition time is long compared with the time it takes for the signal to propagate down the lead and back again, the reflection will add to the transition, causing overshoot or undershoot (Figure 6a). This is the most common scenario, and I'm sure most of you who have used even TTL logic will have seen these effects on the 'scope at one time or another. A common place where they can be observed is at the ends of ribbon cables 1 metre long. The more problematic effect of reflection occurs, when the signal transition is shorter than the round-trip time of the reflection. The reflected portion of the signal will then be added to the nominally level portion of the waveform, creating steps (Figure 6b). These are potentially capable of taking the signal across its logic threshold with the possible result of either false triggering or glitches.

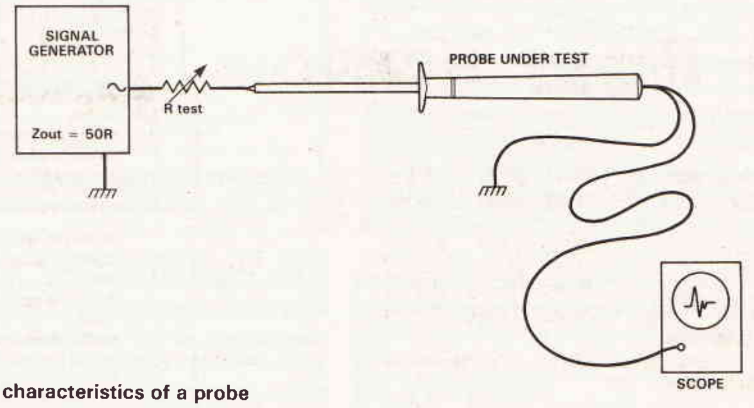

Fig. 8 Finding the characteristics of a probe

The same effects can occur for fast analogue (linear) signals, but the results are more difficult to disslocate from normal operational signals. Fortunately, the average co-axial signal lead or 'scope probe has been designed to have a very low propagation delay, in the order of 2ns, so signals with rise times less than about 5ns while they may exhibit under — or overshoot, are unlikely to be grossly distorted. A 5ns risetime realises a maximum frequency of 50MHz, so your ordinary 20MHz 'scope just won't notice. A 60MHz 'scope may start to show reflection problems toward its top end, which is why one uses a terminator (figure 7). If I have a nominal 50 signal source (circuit node) connected to my 'scope by a 50 BNC lead, I must fit a 50R terminator at the 'scope socket, so the signal does not suddenly run into the 'brick wall' of the 'scope input impedance and bounce back down the lead. The simple 50R terminator is ust a 50R resistor to ground, but a perfect one should take into account the parallel impedance of the 'scope at the frequency of interest. This would be difficult to arrange, and the resistor does quite well for most purposes. The commercially available X10 'scope probe does not suffer from reflection problems for practical purposes, but you may find them if you push a X1 probe beyond its quoted frequency limit (normally about 10MHz).

Why bother with the 50R lead? It will give you better reproduction of fast signals than the X1 probe (nearly as good as the X10 probe), and its basic attenuation factor, when properly terminated, is only 2, which is less of a penalty than the 10 of the 10M probe.

There is as usual, a compensation, which lets you off the hook to some extent when trying to match source and target impedances across frequency. Just as all our test gear has parallel stray C and series stray L, so do all the components in the circuit you are investigating. It is therefore very unlikely that the CUT node impedance will remain constant as the signal frequency rises. If you are lucky (in simple circuits) the CUT node will drop in impedance at about the same rate as the probe impedance with increased frequency. This will leave you all square, with about the same effective loading at all frequencies, and about the same match as well. More complicated circuits do present impedance matching problems, and they can be very difficult to pin down, particularly now, when we are returning to overall high impedance circuits using FETs and CMOS. In my younger days (!) we used valve (High Z) circuits and analogue meters, so these considerations were constantly in the background. Some basic examples of the deleterious effects of resistance mismatch were given in Testing Testing April '90, and it is possible to find many examples of similar effects in dynamic circuits. Anywhere small currents are changing at high frequency, in CMOS oscillators, phase-locked loops, short cycle RC timing circuits using small capacitors with high value resistors, the 'scope probe impedance may well alter working conditions, although frequently not enough to disrupt circuit function. You may never know what changes occur in the signal you are examining when you apply your probe. When the probe is off, you can't see the signal, and when the probe is attached, the change has already been made. The only way for critical work is to assess the node and instrument impedances and calculate the probable effect of the probe.

Impedance Vs Attenuation

For general work, while the X10 probe presents quite sufficient impedance, its attenuation is too great for small signals to be easily observed, and for high impedance measurements, the X100 probe limits you to very large signals indeed.

The average good 'scope has a maximum Y gain range of 5mV/cm. About 1cm of trace is normally required for stable triggering, so the smallest signal you can lock to is about 5mV p/p. To examine the signal, it should ideally be about four times this size, or around 20mV p/p (4cm). The X10 probe delivers 10% of the input signal to the 'scope, so the signal minima at the probe tip are 50mV and 200mV, which are really quite large signals. The X100 probe would require 0.5V and 2.0V for the same display.

The answer is some kind of active probe. Commercial active probes are excessively expensive for the amateur, but a satisfactory one may be built at home. The use of a small signal FET can bring inherent probe capacitance down to around 10p (or less with extreme care), and DC resistance to ground can be in the order of 100M. A suitable signal amplifier can boost rather than attenuate the signal, and once past the amplifier, there is enough signal to allow matching of cable characteristics without loss of amplitude.

The biggest problem I have encountered working on such a probe is external stray C. The probe may have a capacitance in the order of 10p, but as soon as it is picked up, or put near a piece of metal like the case of the quipment you are testing, its capacitance can be quite drastically modified. My experiments so far have shown that picking up such a probe can increase its capacitance to ground by about 60p!

I hope to deliver my finalised probe as a project fairly soon, in the meantime, you might as well check the characteristics of your existing 'scope probes. This is all the more important if you have bought cheap ones such as those available in the hobbyist shops.

Check Your Probes!

An easy way to check the characteristics of unspecified probes is to rig the test circuit shown in Figure 8. The signal generator must be known to have a low output impedance compared with everything else in the test setup. The amplitude of the signal is measured on the 'scope with the variable resistor at minimum value (0R), and the variable resistor is then adjusted until the 'scope shows a reduction of 50% in peak-to-peak amplitude. The value of the variable resistor is then nominally equal to the probe impedance at that frequency. This does not take account of stray effects in the test rig: most multi-turn miniature trimpots have quite a lot of capacitance to ground, and the big precision wirewound ones are quite inductive. It will, give you an adequate guide to your probe performance. As the effect is a continuous function, you should be able to plot a satisfactory graph, and then use this to assess the intrusiveness of your measuring system. If you are being really particular, you would use a set of non-inductive fixed resistors instead of the variable resistor. A resistance substitution box would do the trick at lower frequencies, but a specially designed one would be needed to minimise the C and L of the switches and wiring.

Conclusion

That's it for TESTING TESTING, though there are still a couple of basic test gear projects in the pipeline, which will refer back to this series. I hope I have passed on some of the tricks of the trade, and that bright ideas will be triggered by them.

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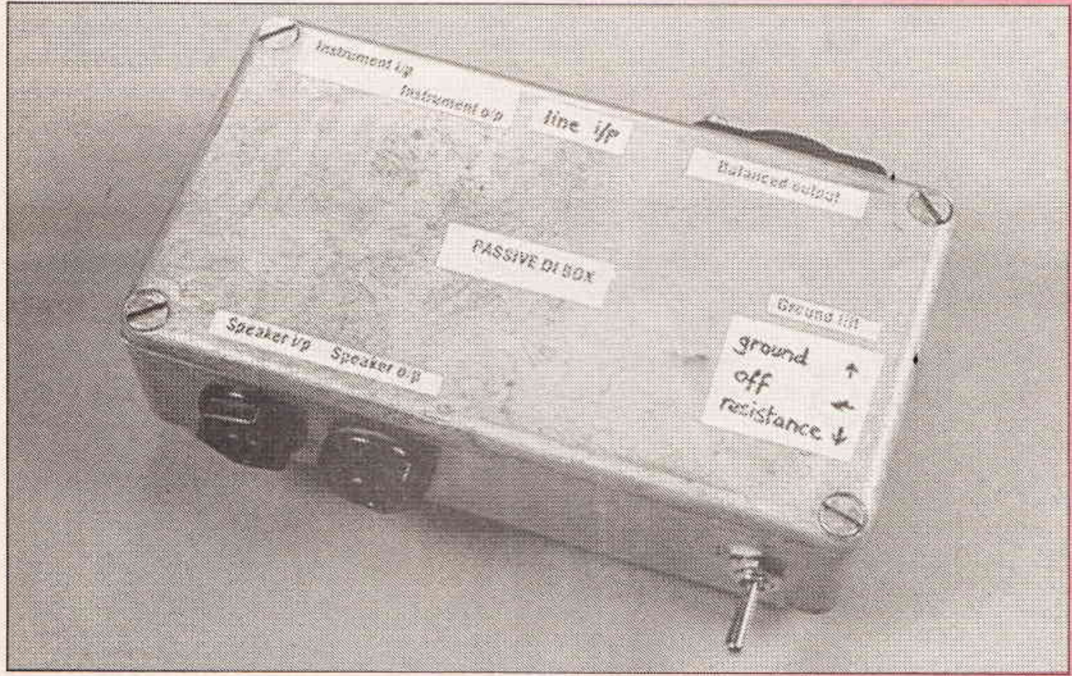
DIRECT INJECTION BOXES

A useful tool in the recording studio and on stage by Peter Kunzler.



Sometimes a sound engineer wants to make recordings of a live band on stage, without interfering with the stage layout. The flat dweller wants to record electric guitar without annoying the neighbours. A recording enthusiast might prefer to change the standard high impedence musical instrument output to the typical low impedance mixer input. To many mixer inputs, high impedance is the least desirable signal, since microphone amps are usually designed to take 600R balanced lines.

The balanced line system is used by recording studios to reduce interference. Audio signals are passed down two wires, with a screen around them to shield against magnetic effects. If a current is induced down the cable by a stray magnetic field, both audio wires will carry the current. At the mixer input, only differential signals are amplified, hence any induced currents that appear simultaneously on both wires are ignored. However, most electric guitars and synthesisers have high impedance, unbalanced outputs.

A direct injection (DI) box is a simple remedy for the mismatching of different systems. Several types of circuits are commonly seen in audio installations. The first type is called a passive DI box because it contains no active components! Open it up and you'll find a microphone transformer at the heart of the circuit. The microphone transformer does several jobs at once: isolation, commion mode rejection and impedance matching. Isolation is important. It means that one piece of badly connected equipment in the studio is less likely to blow up another! Common mode rejection is a convenient feature of a transformer in this design, as any idientical phase signal appearing at both ends of a transformer primary winding will produce no current in the winding, and therefore no signal in the secondary winding. Impedence matching is provided by the transformer design.

A practical circuit for a passive DI box is given in Figure 1. It uses a die-cast box and conventional jack socket and microphone transformer. A loop circuit is provided for insertion into the loudspeaker circuit of a guitar combo. You just hook the DI box in the speaker circuit (make sure the loudspeaker is connected properly when using a valve amp) and Bob's your uncle!

The box also has an instrument loop, which is handy for signal splitting of microphones, keyboards and other gear such as samplers, that have direct outputs. The DI box can be inserted into the cable between the instrument and the stage amplifier. On top of this all, you're given a line input suitable for high line level signals, such as tape machine outputs. The DI box has no balanced input, but this is not a problem. If you have a balanced signal, you probably won't need a DI box. The mechanical layout of a Passive DI box depends on the amount of space available. A 30 x 60 x 110mm die-cast box will just enable you to squeeze the jack sockets and a miniature screened microphone transformer into the inside space.

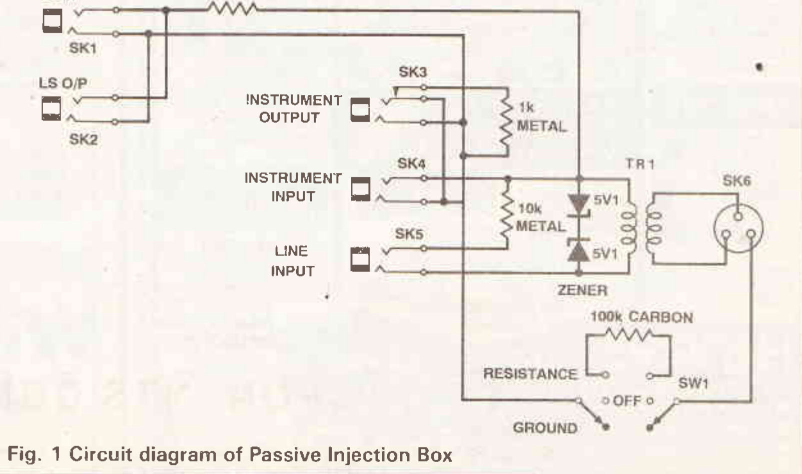


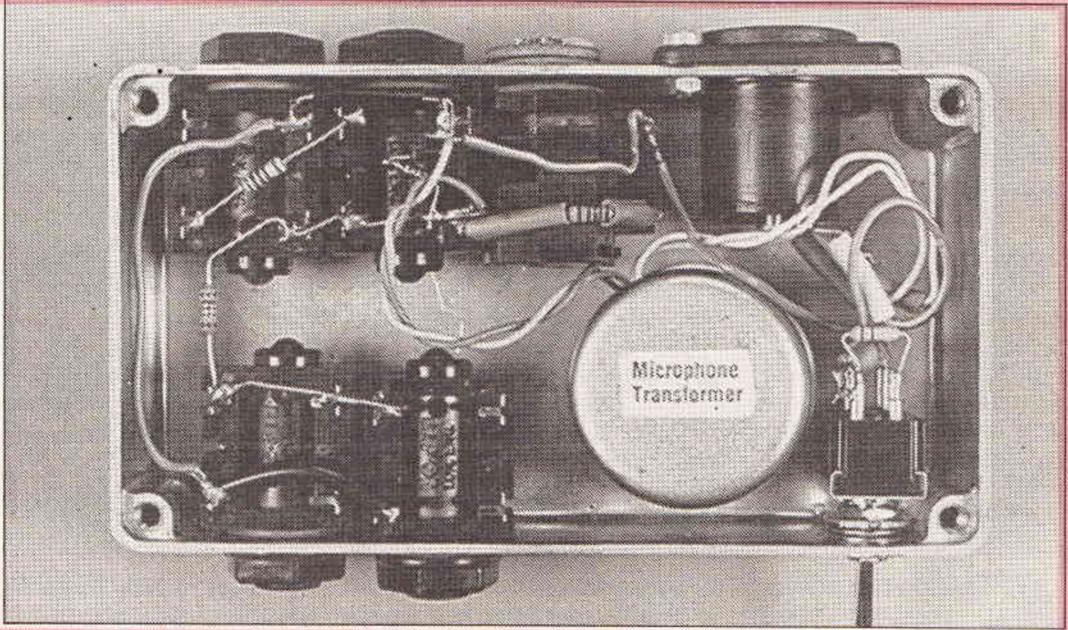
Fig. 1 Circuit diagram of Passive Injection Box

PARTS LIST

RESISTORS (all ¼W 5%)	
R1	100K metal oxide
R2	1K metal oxide
R3	10K metal oxide
R4	100K carbon oxide

SEMICONDUCTORS	
ZD1,2	5V1 400mW zener

MISCELLANEOUS	
TR1	Microphone transformer Impedance 2k primary, 600R balanced secondary
SK1,2,3,4	¼" mono jack sockets
SK5	¼" stereo jack socket
SK6	Canon or XLR three pin socket
SW1	2 pole change over toggle switch



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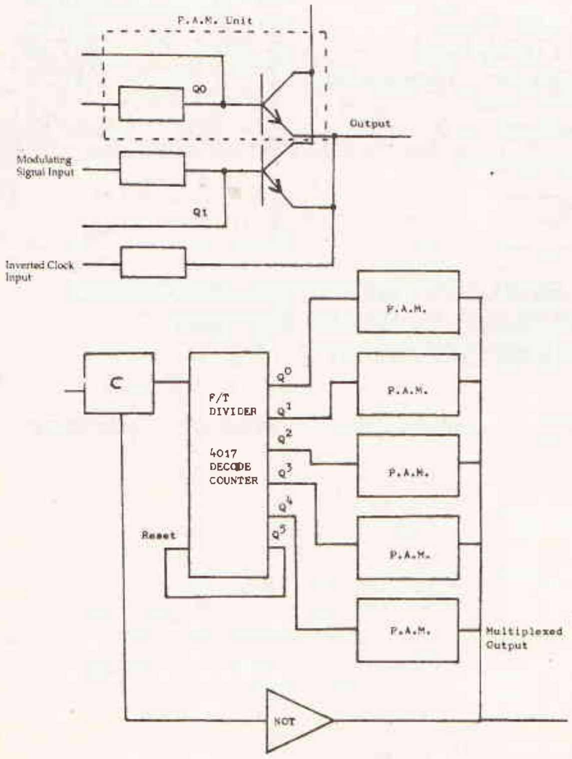
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UNDERSTANDING RIAA EQUALISATION

RIAA

An assessment of some hi-fi characteristics by David Silvester.

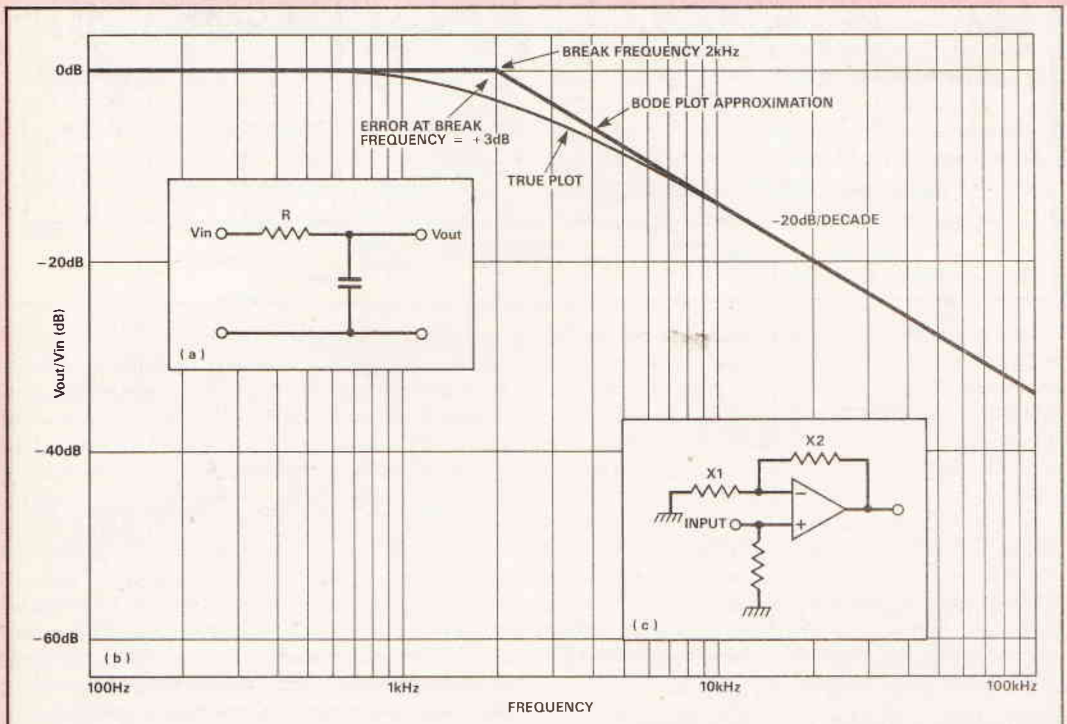

Fig. 1a Simple RC Filter
Fig. 1b Frequency plot of filter
Fig. 1c Standard non-inverting amplifer

This article was prompted by a letter by Mr. Baker in the July 90 issue of ETI in which he asked for RIAA compensation to be explained. I hope here to explain the basics of the RIAA equalisation, why we need it and how to achieve it. To understand the following I have to assume that the reader will be familiar with a number of terms that will be used frequently but will cover them briefly as a reminder.

Gain and Decibels

The gain of a circuit is simply the ratio of the output to the input voltages:-

Voltage Gain = Voltage out (Vo)/Voltage in (Vi)

Now for any circuit the gain can be any positive number from the smallest to the largest that can be imagined but can never be negative.

When we wish to talk about high or low gains then the number of zeros that have to be remembered becomes inconvenient and electronic engineers resort to a logarithmic scale. For this we use the base that:-

Power Gain in Bels = log (power out/power in)

If we assume that the input and output impedances are the same then this equates to:-

Voltage Gain in Bels = 2 log (voltage out /voltage in) since the power is proportional to voltage squared. But the Bel is still a rather inconvenient unit so the decibel is used where there are 10 decibels (dB) to one Bel. This gives the well known relation:-

Gain in dB = 20 log (Voltage out/Voltage in)

A few of the important figures to remember are that
0dB = times1
3db = x 1/$\sqrt{2}$
20dB = x10 and 40dB = x100.

Bode Plots

Bode plots are a standard approximation technique where the curve that forms the response graph of an amplifier or filter can be represented as a set of straight line approximations. Consider the simple RC filter in Figure 1a, and it's corresponding response graph in Figure 1b. Now at DC the capacitor will present a virtual open circuit to the filter and the gain will be equal to 1. As the frequency increases the impedance of the capacitor drops. At a particular frequency, in this case at 2kHz the reactance of the capacitor is exactly the same as the value of resistance, but because the voltage across the capacitor is 90 degrees

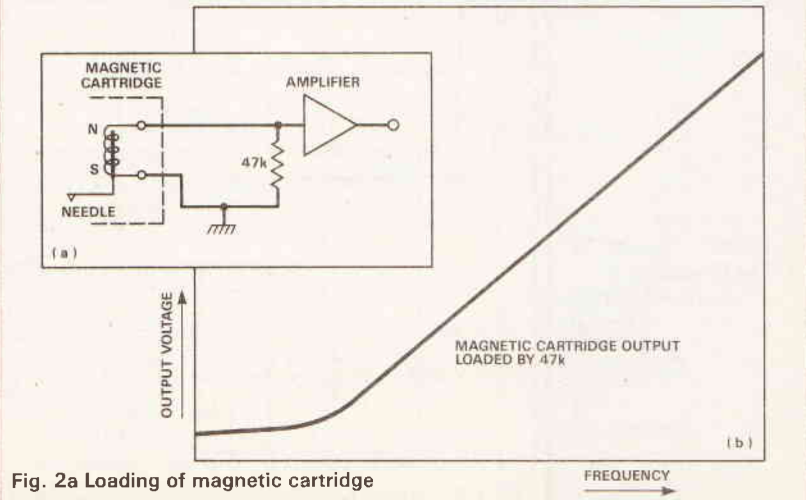

Fig. 2a Loading of magnetic cartridge
Fig. 2b Magnetic cartridge output loaded by 47k

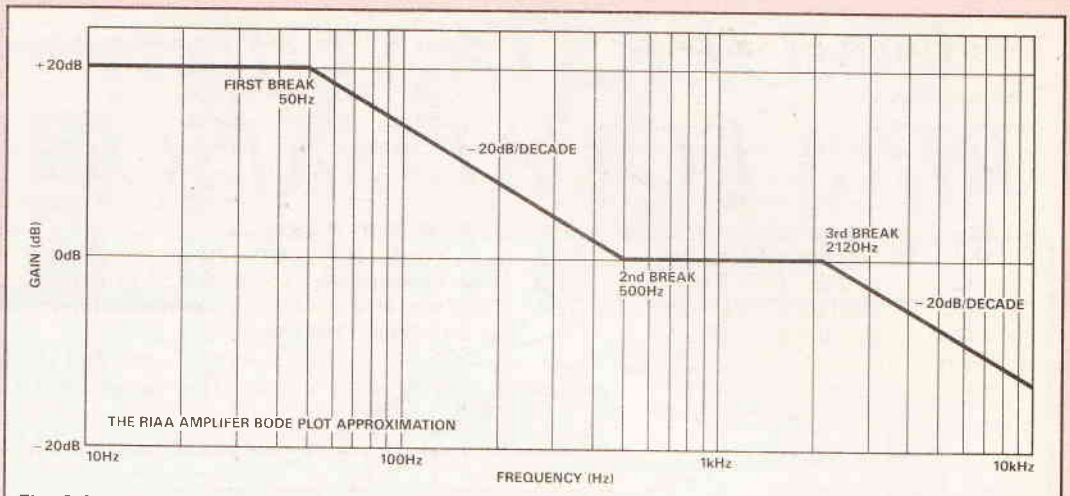

Fig. 3 Bode plot approximation

out of phase with the voltage across the resistor the output voltage is $1/\sqrt{2}$ or 3dB not one half. With an extra increase in frequency we reach a point where the gain of the filter falls at a rate of 6dB per octave (or 10dB per decade, it's the same thing) If we look at the Bode plot then this filter is represented by two straight lines one horizontal at 0dB and the other falling at 6dB per octave. These two lines cross at 2kHz. The maximum error in the Bode plot is 3dB at the break frequency when Xc = R but this is of little importance compared to the ease of understanding that the Bode plot allows about the circuit characteristics. For further information refer to The Art of Electronics by Horowitz and Hill.

Amplifier Gain Calculation

We will be using the standard non-inverting amplifier configuration for our later calculations as shown in Figure 1c.

The amplifier gain for this design is $1+(X_2/X_1)$ where X can represent resistance (a simple resistor), reactance (a capacitor or inductor) or combinations of them say a capacitor and resistor in series.

The Magnetic Cartridge

The magnetic cartridge to which RIAA compensation is applied consists basically of a coil with a moving magnet in it. The coil is loaded with a 47k ohm resistor and an amplifier that is assumed to have no affect on the loading, Figure 2a. The problem is that the output voltage of the cartridge depends on the rate at which the magnet moves in the coil. If the frequency of the mechanical motion that activates the needle doubles, although the amplitude remains the same, then the magnet has to move twice as fast. The output voltage from the coil will double in frequency together with the output voltage. This gives the curve in Figure 2b of rising frequency against rising output. However we expect that our hi-fi amplifier will have a constant output with frequency. Thus we need to compensate for the cartridges output/frequency response. Luckily for us the hard work of calculating the compensating amplifiers required response and it's Bode plot has been carried out for us and the RIAA characteristic is an international standard to which all magnetic cartridge manufacturers and therefore compensating amplifier designers have to work. Please remember that in Figure 3 the Bode plot is presented and the actual required response is a smoothed curve. The RIAA curve has break points at 50, 500 and 2120Hz as shown, the curve being based relative to the gain needed at 1kHz although the compensating amplifier will have extra gain to lift the output voltage to a level usable by the following power amplifier.

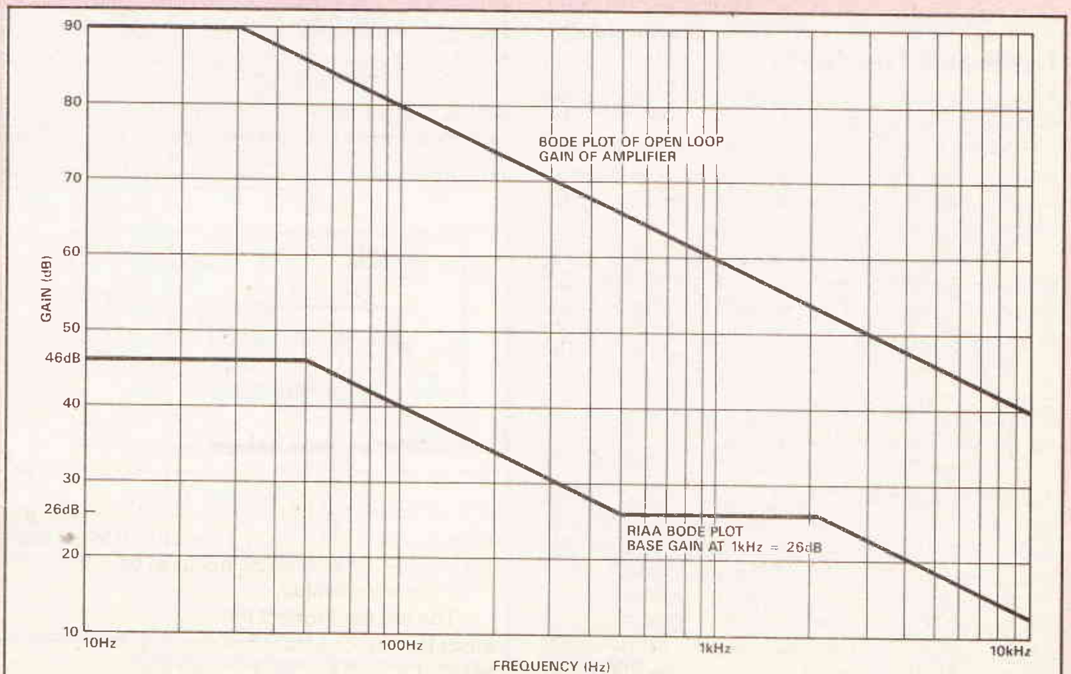

Fig. 4 Bode plot of open-loop gain and RIAA Bode plot

The Equalisation Amplifier

The Basic Needs

The gain needed from the equalisation amplifier depends upon the input voltage from the cartridge and the output voltage that must be passed to the following stage, the power amplifier. To correctly load the cartridge the input impedance must be 47R to 100k shunted by less than 50p and have an output impedance of less than 100R. The compensating amplifier design must try to limit output offsets and have sufficient gain so that the feedback components that tailor the basic amplifier response to that required can operate as expected. Low noise goes without saying as the magnetic cartridges output is low.

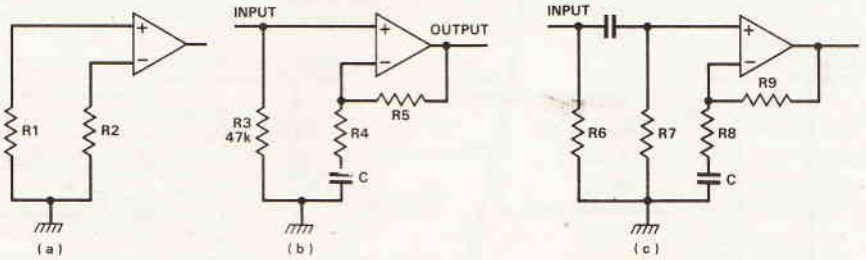

Fig. 5 Operational Amplifier circuit options

In Figure 4 I have assumed that the compensating amplifier will be required to give an extra 26dB of gain at 1kHz and the RIAA response has been plotted with this offset. The amplifier whose response we will modify to the RIAA characteristic must at all frequencies have a gain above the response needed so that the feedback that controls it's response will be able to work. In this case I have plotted the response of a simple 741C device in Figure 4 although in practice a lower noise audio chip would be selected. As can be seen the 741's gain is always well above the required response curve.

Output Offset Limiting

Consider the op-amp in Figure 5a. If the internal offset errors in the amplifier are ignored, then the output voltage will depend on the difference in the input voltage times the gain. Now if the two resistors R1 and R2 are of different values whilst the input current drawn by the amplifier input transistors are the same, the output will be offset due to the different voltages induced at the input due to the input current flowing in the input resistors. Now if R1= R2 then only the internal transistor errors control the output offset and these will be small compared to the error introduced by differing resistors.

One way round having to have different values of input resistor is to arrange that the gain of the amplifier falls to unity at DC. This is achieved in Figure 5b where capacitor C gives 100% feedback at DC and has no effect at operating frequencies. For the perfectionist R7 can equal R9 in Figure 5c but the value of R6 must be increased so that the parallel equivalent of R6 and R7 equals 47R to 100k ohms.

The Amplifier Design

Let us now design the full equalisation amplifier from scratch using the required response in Figure 4. We start from the point where the gain at low frequencies must be 46dB or times 200. Consider Figue 6a. Please note that in Figure 6 only the feedback components have been shown but the real world amplifier will need power and input resistors to work. Figure 6a shows the base amplifier that must give the gain of 200 times. Now it was decided that Ra would be set at 1k ohms and thus Rb must be 200 times larger or 200k. There is no reason why any other value of Ra cannot be chosen, and if you wish to calculate all of the possible combinations and tell which gives the nearest calculated results to available component values then I should be most interested in the results. However remember that components have tolerances and these will throw out the calculations very easily. Resistors having 1% tolerance are no problem, it is the tolerance of the capacitors that may be troublesome.

On now to Figure 6b, the values of Ra and Rb have been included. For the first break frequency of 50Hz we know that at this frequency the impedance of Ca will be 200k, and from:-

Xc = $1/2\pi$ x Frequency x Capacitance we can calculate the value of Ca. The calculated value is 15.9n and the closest obtainable component is 15n. This value is added to Figure 6c.

However the response levels off at 26dB at 500Hz and we need to stop the feedback impedance falling above this frequency. Thus we add Rc to Figue 6c. The value of Rc arises from the gain needed in the middle of the 500Hz to 2120Hz band, this being 20 times. Thus Rc is simply 20 times the value of Ra or 20k. This resistor is in series with Ca. There is an approxomation in this calculation but I shall ignore the error at present other than to note that the gain acheived is actually times 21 not 20 and to get a gain of exactly 20 times then Rc needs to be 19k but that is not a prefered value.

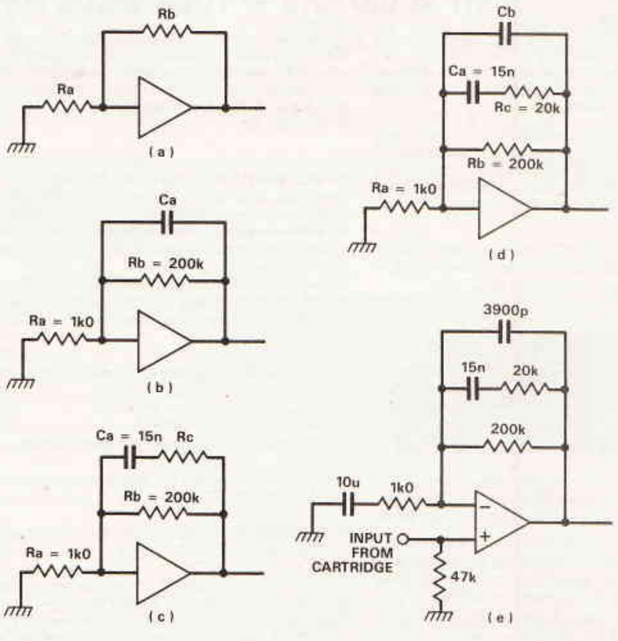

Fig. 6 RIAA amplifier designs

The last component to add is the capacitor that causes the response to fall above 2120Hz. Similar to the situation in Figure 6b but with a feedback resistor of 20k we can in a similar way calculate the value of another feedback capacitor Cb. This calculates to

3750p and component values give us the preferred value of 3900p.

The last bit to add is the capacitor that causes the gain to roll off to unity at DC. To prevent distortion the rolloff starts at 16Hz and since we know the frequency, 16Hz, and the resistance of 1k, we can calculate the capacitor value and select the nearest available standard value. Thus we arrive at Figure 6e in which I have added the single input resistor that would be needed if the amplifier were an op-amp operated from a balanced power supply. If the input has a voltage offset with respect to ground then a capacitor will be needed to isolate the offset from the magnetic cartridge. Remember this capacitor must not affect the frequency response of the amplifier but because of the 47k input impedance the value will be about 47n.

Alternatives

The design outlined is not the only way of achieving the RIAA response characteristic, nor does the design we have just completed have to have the values we have calculated. Figure 7 shows two alternative ways of acheiving RIAA equalisation. Providing the RIAA response is achieved along with the required gain then you will have achieved the result you need.

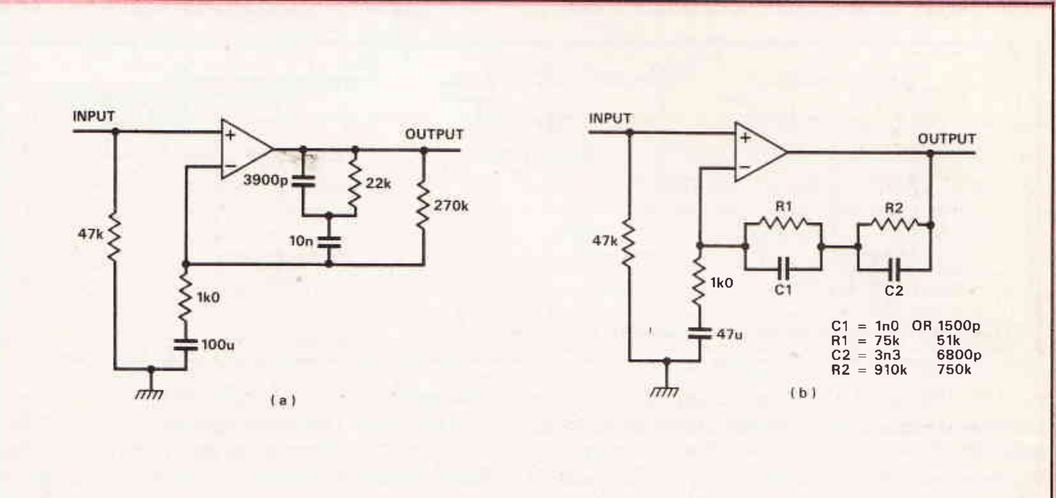

Fig. 7 Alternative amplifier designs for RIAA

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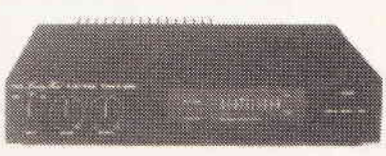

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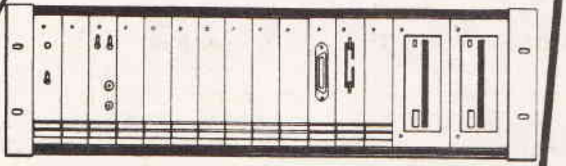

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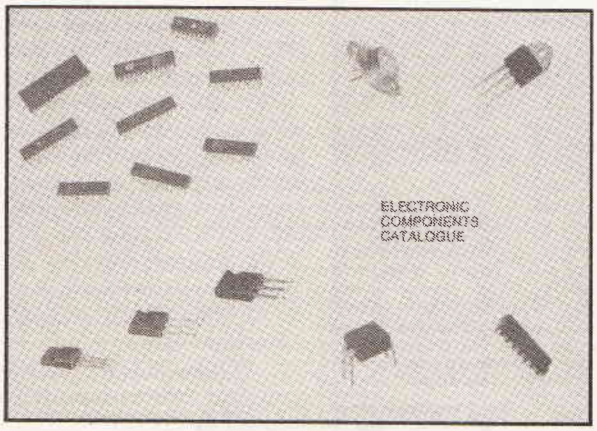

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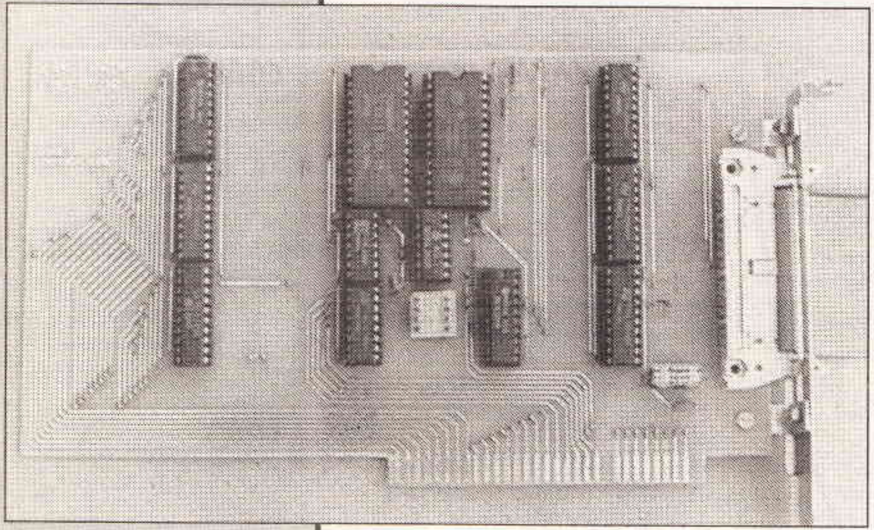


A tool for simplifying firmware development on IBM PC compatibles by Mike Bedford.

Over the last two months we have published the hardware design of the SBC-09 control computer and guided the reader in the art of firmware development and 6809 programming. In particular we concentrated on the IBM PC (or compatible) as a development system and gave some advice on suitable hardware and software tools. The one such tool for the PC which is not too readily available commercially is the EPROM emulator and as a result we now present this piece of equipment as a constructional project. Of course, this emulator is by no means dedicated to use with the SBC-09 and has, in fact, been designed to emulate a very much larger range of EPROMs than just the 27128 used on the SBC-09.

Specification

As already hinted, the emulator presented here is designed around the IBM I/O Channel specification. It utilises an 8-bit wide data bus and may therefore be used in compatibles of either the basic PC or the PC/AT. DependIng on certain component choices, it has an access time of as little as 105.6ns (host port) which means that it may be used with PCs up to l0MHz and very fast ATs or 386-based machines. It should be stressed, however, that the author does not have access to a wide variety of different PCs and as a result the unit has only been tested on a 12MHz AT, the maximum figures being a result of calculations. In the unlikely event of needing to use this emulator in a machine with too high a clock speed, a solution is provided in the section entitled Access Time Considerations.

Turning to the other end of the emulator, the target port, can emulate EPROMs up to 64kbytes. In practice this means the 2758 (if there are still any out there), 2716,2732, 2764,27128,27256 and 27512 including the A and B suffix variants (lower programming voltage) and the 27C variants (CMOS). Also in the 25-series we have the 2516 (identical to the 2716), 2532 and 2564. Paged EPROMs are not supported and so the 27513 cannot be emulated. Turning to the access time, things are less stringent from the target port and an access time of 272ns is achieved with cheap components whereas by selecting a few different components, the emulator may easily be used in place of even the fastest available EPROMs (150ns).

HOW IT WORKS

There really isn't a lot of difference between the circuitry of one EPROM emulator and another and it has to be admitted that the circuit presented here does follow that of the author's previous emulator (32k EPROM Emulator for the ETI Stand Alone EPROM Programmer) rather closely. On these grounds, this section will be brief. An EPROM emulator is really a memory expansion card but differs from normal memory boards in that it may be accessed either from the host computer (ie the PC) or the target system via a pod plugged into an EPROM socket. This is referred to as dual ported memory and the busses of the two systems are kept isolated from each other by use a two banks of buffers, only one of which may be enabled at once. Now depending on whether a signal is an input or an output to the RAM, the buffers have either their outputs or inputs respecitevely connected to the RAMs. This can be seen from the circuit diagram. The one exception to this is the data bus on the PC port which needs to be able to read or write and therefore a bi-directional buffer is used, the direction of which is controlled by the -SMEMR signal. It could be argued that only write access is required but for the sake of using a 245 instead of a 244 we get read access too. The data bus on the EPROM port only needs to be uni-directional since we are emulating a read only device. The rule for enabling of the buffers is that the PC gets priority and the EPROM port gets access whenever $\overline{CE}$ is low, so long as the PC doesn't want access – this is controlled by IC6 gates b and c. Attempting to read from or write to the emulator whilst emulating will cause the target to crash. An apparent anomoly on the EPROM port is that the $\overline{CE}$ signal is not routed through the buffers to the RAM but 0V is used instead. This is merely to keep the loading down to one load on any EPROM pin and of course, the result is the same since the buffer can only be enabled if $\overline{CE}$ is low. The $\overline{CE}$ signal on the PC port is simply a decode of address bits SA16, SA17, SA18 and SA19. SA19 is connected to the G1 enable input of the 138 and so the board can only be located at addresses where this bit is high, ie above 512k, all modern machines having RAM at least to this address. The other 3 address bits would allow the card to be located at any 64K boundary in the top 512k but since only $\overline{Y0}$, $\overline{Y1}$, $\overline{Y5}$ and $\overline{Y6}$ are routed through to LK1 then only addresses 512K ($800000), 576k ($90000), 832k ($D0000) and 896k ($E0000) may be selected, all other slots having conflicting designations. Really the only other bit of active circuitry to mention is IC6a and IC9. These gates simply use the most significant address bit (SA15) to split the $\overline{CS}$ signal into a pair, one for each of the RAMS. lastly, one or two passive bits: R1, R2 and R3 prevent $\overline{OE}$, $\overline{WE}$ and $\overline{CS}$ on the RAMS from floating when neither set of buffers are enabled, holding these signals in their inactive state to prevent false writes. C1-C4 and C5 are decoupling and reservoir capacitors respectively and ensure a good clean power supply.

Construction

Construction of the board is my no means difficult. However the board is double sided without plated through holes, and there is the time consuming task of fitting a number of through pins. The positions of these are marked on the component overlay and these should be fitted first. None of these are located under ICs so all may be inspected on the completed card. In just a couple of places, connection of top and bottom tracks is achieved by a component leads (not

IC pins as this would prevent use of sockets) so if a component lead passes through a pad on both sides of the board it should be soldered to both. As always, we reccommend use of IC sockets and especially for the RAMs. If it is only intended to emulated EPROMs up to 32k (ie the 27256) then IC8 may be omitted. One decision needs to be made during construction, namely what its base address should be. On a 512k machine, $80000 is suggested as the card will then also serve to expand base memory (but not to the magic 640k). On a 640k PC then the only options are $D0000 and $E0000 and the choice could depend on what else is fitted. $80000, $90000, $D0000 and $E0000 are selected by linking 1 to 8,2 to 7,3 to 6 or 4 to 5 respectively on LK1 which is physically an 8-way solder DIL header plugged into an 8-pin socket. The only other bit of advice concerns the inspection and testing of the finished board. This is particularly important as PCs do not come cheap and a mistake could prove to be an expensive one. Firstly, before plugging in the ICs, the board should be well inspected for blobs of solder or other shorts between tracks or IC pins. This should be carried out under a bright light and ideally using a magnifying glass. Using a multi-meter, infinite resistance should present itself between + 5V and 0V on the I/0 connector and that no two adjacent pins on this connector indicate a measurable conductance. Actually you may get a 'kick' on testing between + 5V and 0V due to C5 but this should die away. Once the card has passed these tests, it should be safe to add the ICs and plug it into a PC. Debug should be used to prove the correctused to prove correct operation of this card (at least from the PC port) — if this is something new then the MS-DOS manual gives full details.

The back panel could be left off but should really be added. The buylines section suggests it will be less expensive to use the discarded blanking plate for this purpose, adding a couple of metal brackets. If this approach is adopted, Figure 4 should be consulted for the exact positioning as this is quite critical.

Now to the pods. A solder type header must be used, it is more robust for frequent pluggings and unpluggings than an IDC type and these are available with high profile covers which means the resistors and DIP switches can be neatly housed. Also, we have more conductors than will go into a 28-pin IDC header due to the fact that all the spare conductors on the cable carry earth to improve noise immunity. The fitting of the DIP switch and resistors in the header can be quite tricky so, if there is a requirement for emulating only a single device type (eg the 27128 used on the SBC-09), a considerable amount of effort could be saved by building up a dedicated pod. These are made, based on the appropriate multi-device pod, by missing out the resistors and switches and hard wiring those contacts made by the switch for the required EPROM. As a final point, we urge the reader to label the pods so that after a few months of disuse, the user won't have to dig out this article to determine which EPROMs a particular pod supports and what the DIP switch settings should be.

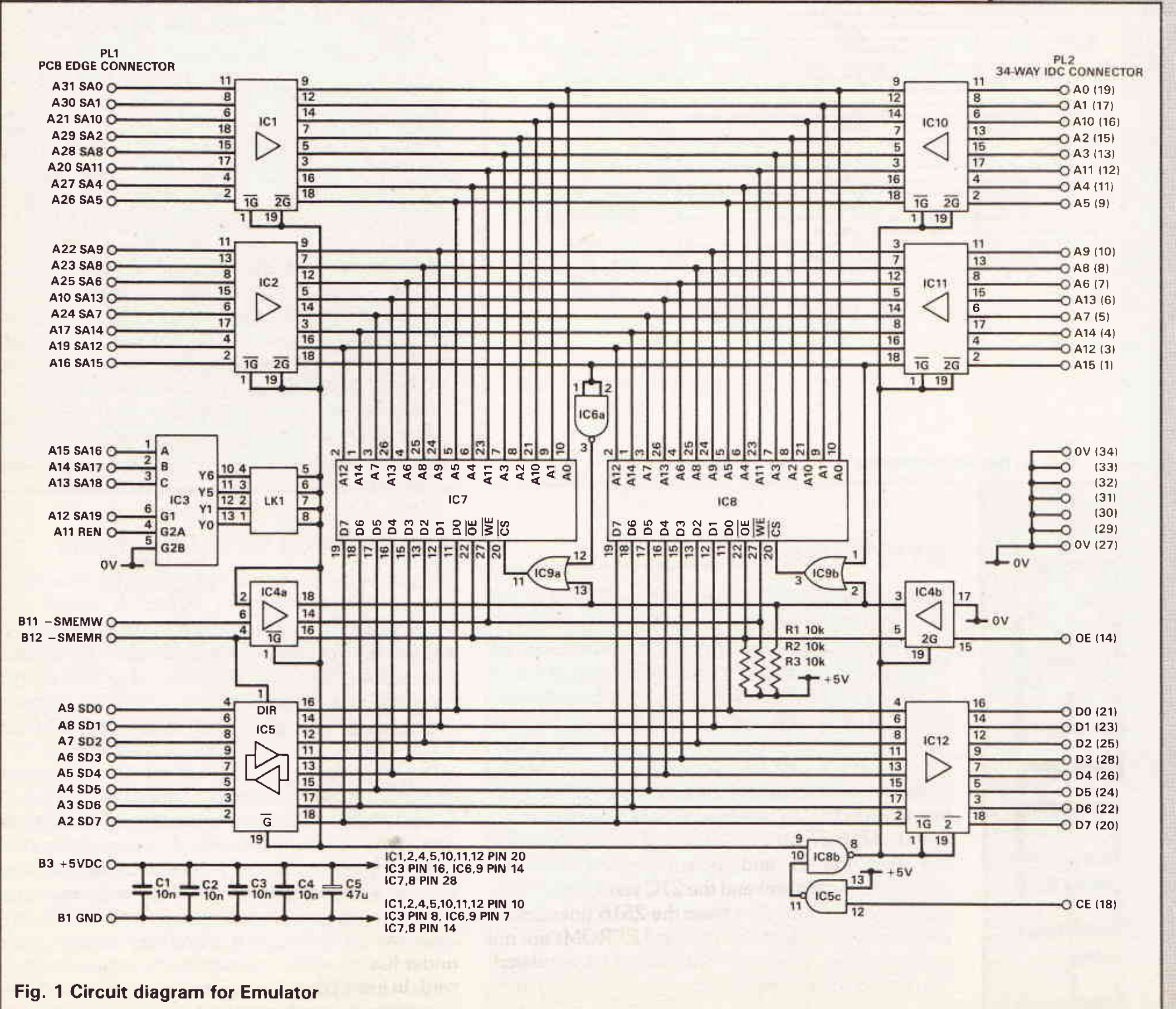


Fig. 1 Circuit diagram for Emulator

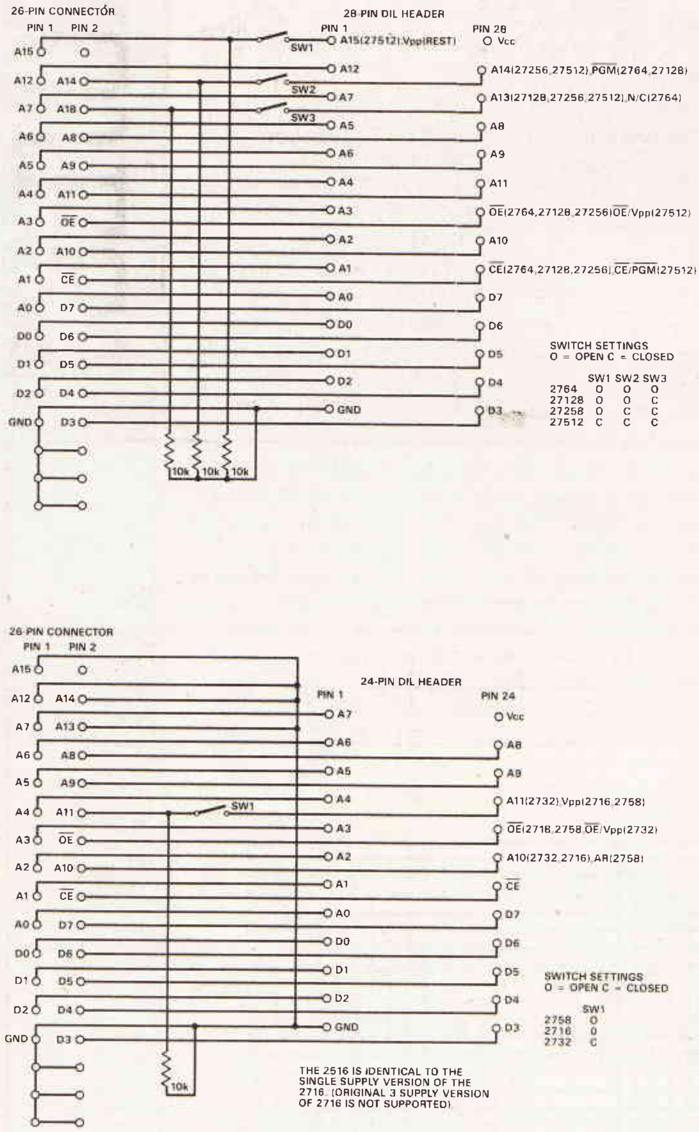


Fig. 2 Various header connections

PARTS LIST (Main Board).

RESISTORS (all ¼W 5%)

R1-R3	10k

CAPACITORS

C1-C4	10n, Ceramic
C5	47µ, 16V Axial Electrolytic

INTEGRATED CIRCUITS

IC1,IC2,IC4,IC10, IC11,IC12	74LS244 or 74F variants
IC3	74LS138 – see text on Access Time Considerations
IC5	74LS245
IC6	74LS00
IC9	74LS32
IC7,IC8	62256-15, 62256-10, 43256-10 or 43256-70 (See Access Time Considerations)

MISCELLANEOUS

PL2	34-way male IDC connector with latches and 90° solder pins
PCB	
Through Pins	
IC Sockets	1×8-way, 2×14-way, 1×16-way, 7×20-way, 2×28-way
LK1	8-way DIL header in socket (listed above)

PARTS LIST (2758,2716,2732 Pod)

34-way IDC cable connector (female)
24-pin solder type DIL header with high profile cover
34-way 0.5" pitch IDC ribbon cable
switch – ordinary miniature toggle or use 1 gang of 2-way DIP
1×10K, ¼W resistor

PARTS LIST (2764,27128,27256,27512 Pod)

34-way IDC cable connector (female)
28-pin solder type DIL header with high profile cover
34-way 0.5" pitch IDC ribbon cable
3-way DIP switch
3×10K, ¼W resistors

PARTS LIST (2532 Pod)

34-way IDC cable connector (female)
24-pin solder type DIL header with high profile cover
34-way 0.5" pitch IDC ribbon cable

PARTS LIST (2564 Pod)

34-way IDC cable connector (female)
28-pin solder type DIL header with high profile cover
34-way 0.5" pitch IDC ribbon cable

BUYLINES

If the standard access time version is being built then all the electronic components will be available from just about any supplier. If the intention is to speed things up then a bit of shopping around will be required to keep the cost down. Farnell (0532 631111 or via Trilogic on 0274 691115 for 25% more if you don't have an account) stock a 100nS RAM chip for not much more than the 150nS types from most other suppliers. A 70nS part, on the other hand is both expensive and difficult to find. They are stocked by Farnell. The 74F logic family is not stocked by as many suppliers as the 74LS types but may be obtained from Verospeed (0703 644555), Farnell or RS Components/Electromail (0536 204555). The PCB is available from ETI's print service and a PC type metal rear panel may be obtained from RS Components/Electromail as part no. 435-844. Alternatively, you may wish to add a couple of brackets to a spare PC blanking plate and use this as the back panel. The software is available from the author on a 5.25" diskette for £10. The address is: 4, Holme House, Oakworth, Keighley, W. Yorkshire BD22 0QY.

Access Time Considerations

The parts list give a number of options for some of the components, differences being in speed and accordingly in the access time of the finished unit. For a 4.77MHz PC or a 12MHz AT (or slower) if it is intended to emulate a 300ns EPROM (or slower) then the first component in each list (which also happens to be the least expensive) may be used and the remainder of this section can be ignored.

The access time required on the target port clearly depends on the target hardware and may be determined by reading the access time off the EPROM (assuming it hasn't been fitted with a faster than necessary device). In many cases it is expected that the access time requirements will be met by use of just the basic component options.

The development system access time requirements will be more difficult to meet, especially for 8 or 10MHz PCs (the ATs having 4 wait states). The 4.77MHz PC requires an access time (address valid to data ready) of 445ns which is no problem, even with the slowest of devices. Similarly, even a 12MHz AT has an access time requirement of in excess of 334ns which can easily be met. This time is an estimate since the timing information such as is found in IBM's Technical Reference Manual for the PC does not appear in the equivalent AT publication. This time is therefore the length of just the waitstates which we can say with confidence is less than the overall access time requirement. The 8MHz and 10MHz turbo variants of the PC, on the other hand, requires access times of 240ns and 180ns respectively. Access times quoted for turbo PCs are conservative estimates based on IBMs information for the PC (ie the original 4.77MHz) and Intel's data sheets for the faster processors. The reason I say they are conservative is that they don't take into account any possible increase in speed of the glue logic on the main board — something which will vary from one manufacturer to another and on which we have no information. For a 16MHz AT the time will be in excess of 248ns which as we shall shortly see is only just less than the access time achieved with the basic components. This being so, it may be worthwhile trying these first before going to the expense of faster versions since as already pointed out these AT timings are conservative estimates.

The access times for the emulator are as follows:

PC Access= Time (Address to Data)	RAM Access Time (CS to Data)	+	138 Delay (Binary Select to O/P H to L)	+	244 Delay (Output Enable to Low)	+	00 Delay (High to low)
	+ 32 Delay (High to low)	+	245 Propogation Delay				
EPROM= Access Time (CS to Data)	RAM Access Time (CS to Data)	+	00 Delay (Low to High)	+2*	00 Delay (High to Low)	+	244 Delay (Output Enable to Low)
	+ 32 Delay (High to low)	+	244 Propogation Delay				

Table 1: shows the delays of the various TTL chips in both their LS and their F flavours.

Device	Timing Parameter	LS	F
138	Binary Select to O/P (H-L)	41ns	9.0ns
244	Output Enable to low	30ns	8.0ns
32	High to low	22ns	6.3ns
245	Propagation Delay	12ns	7.0ns
00	low to High	22ns	6.0ns
00	High to low	15ns	5.3ns
244	Propagation Delay	18ns	6.5ns

Table 1: TTL Timing Parameters

It is now clear that the PC port access time with a 150ns RAM and LS TTL devices is 270ns and the EPROM port access time is 272ns. We can now see why the PC port timing is OK for a 4.77MHz PC or a 12MHz (and possibly a 16MHz) AT but will not fit the bill for 8/10MHz PCs, 20MHz ATs and most types of 386 based machines. We shall now determine the necessary changes for turbo PCs and if anyone does have some sort of mega machine then the same principles can be applied to determine the changes necessary (assuming that the timing requirements can be found out).

150ns RAMs will be the standard part available from most suppliers but a bit of shopping around (see Buylines) could well reveal the 100ns part at virtually no extra cost. This being so, the RAM is the first line of attack in improving the emulator's access time and this change alone will give PC port and EPROM port times of 220ns and 222ns respectively. We are now OK for the 8MHz PC but need to shave another 40ns off for the 10MHz turbo PC. Now going to a 70ns RAM certainly will push the price up a lot so the sensible approach for further improvement is to substitute some of thee chips. It can be seen from Table 1 that changing IC3 to a 74F138 and IC9 to a 74F32 will give a PC port access time of 172.3ns and so we are now within limits for the 10MHz PC. This change will also reduce the EPROM port access time to 206.3ns but to achieve compatibility with the currently fastest available EPROMs (150ns) it would also be necessary to change the 244s on the EPROM port and the 00 to 74F parts. It should be noted that a result of substituting 74LS parts for their 74F equivalents is that the power consumption of the board will rise.

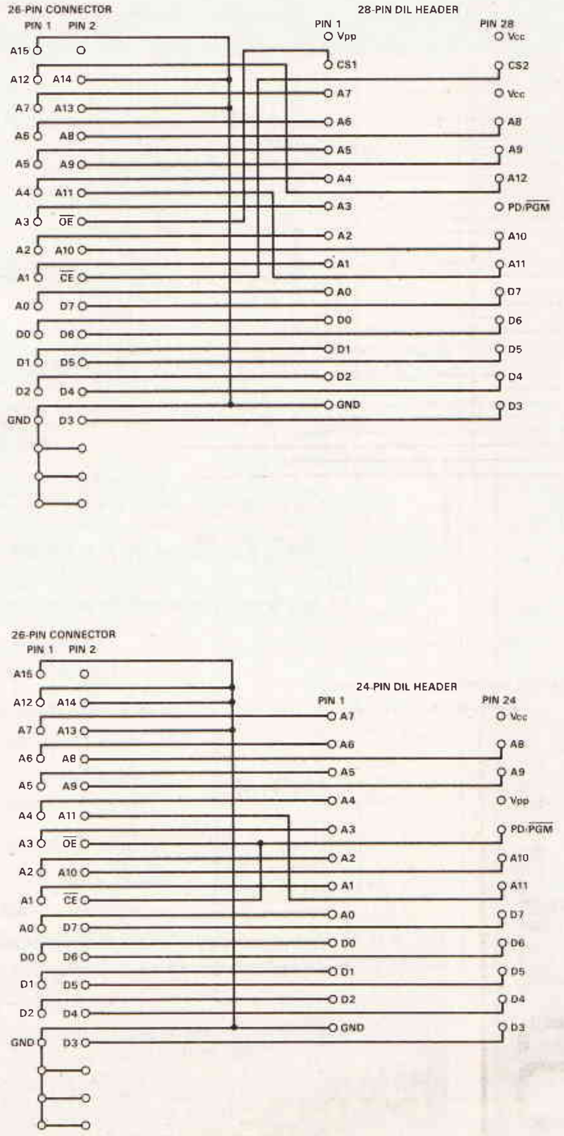


Fig. 2d More header connections

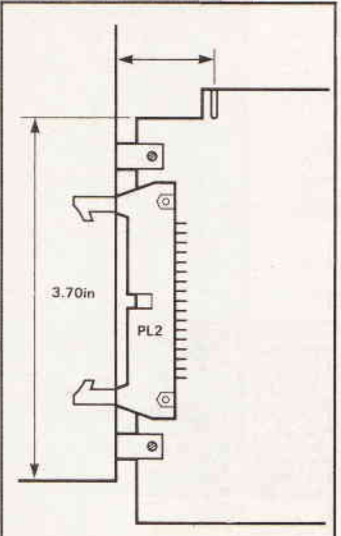


Fig. 4 Back panel positioning

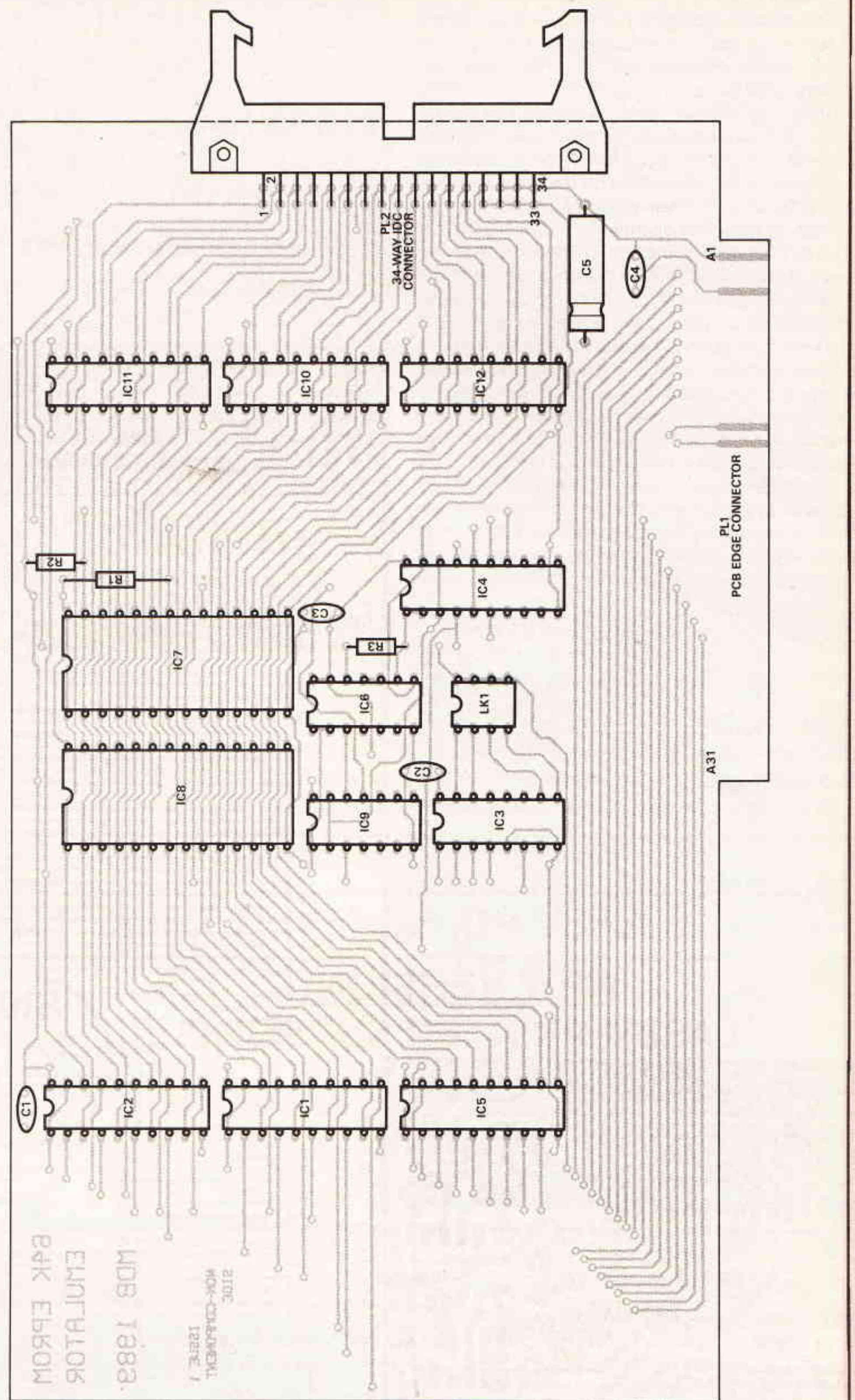


Fig. 3 Component overlay for 64k Emulator showing non component side track work only

In the unlikely event of someone intending to use this card in a machine of such mind blowing proportions that none of the substitutions mentioned will achieve the necessary access time or if such changes are considered not economical, all is not lost. Nearly all such machines have non-turbo modes intended for use with software or hardware which will work on an AT but not at high clock speeds. The solution, clearly, is to switch to a slower clock speed whilst loading code to the emulator.

This could be done manually from the front panel or a key combination (usually Ctrl Alt -) but it would be more convenient to do automatically. A batch file should be produced which will call the system utility to select a low clock speed, then execute the load program and finally execute the previously mentioned utility, this time to put the speed back to its normal high value. This assumes that the machine has a speed command (or similar) — many, but not all turbo machines do.

Software

A software package is available to allow object code in either Intel or Motorola (5-records) format to be downloaded to the EPROM emulator. The file containing this code is called EMU64K.EXE and it is therefore executed by typing EMU64K at the DOS prompt. All the functions of this software are accessed from a single menu (Figure 5). In view of the simplicity, there is no on-line help although the software does prompt the user at certain places. The following is a brief description of its operation.

The bottom left hand box is a menu of available actions, these being selected by moving the highlighted block using the arrow keys and then pressing Return. The bottom right hand box shows the current Filename, Format, Offset and Hardware Address, all these parameters being stored at the end of a session in order that they may be recalled when the package is next run. Each function is now described:

Download On selecting this function the data in the selected file is written to the EPROM emulator. Any offset specified will be subtracted from all addresses in the file. In the event of the file not existing, being of the wrong format, having an invalid checksum or having addresses lower than the offset, an appropriate error message will be written to the screen.

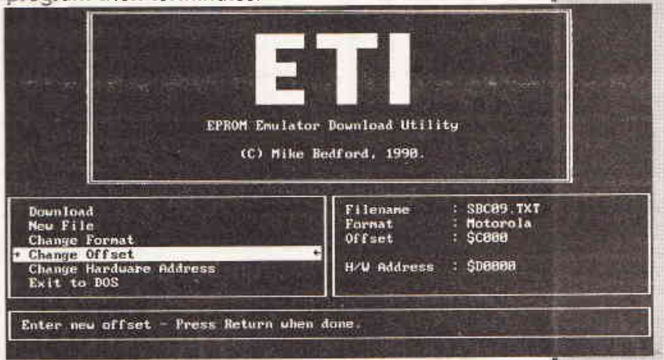
New Filename On selecting this function a cursor will appear below the first character in the filename, thereby allowing the user to edit this. All normal editing functions are available. Return terminates this function.

Change Format On selecting this function, the file format will toggle between Intel and Motorola.

Change Offset On selecting this function a cursor will appear below the first digit of the offset address thereby allowing the user to edit this. Valid keys are the hex digits 0-9, A-F and the arrow keys which move the cursor. Return terminates this function. Use of an offset allows a block of code assembled at a non-zero address on the target system to be loaded into the emulator at address 0000.

Change H/W Address On selecting this function, the address at which the software expects to find the hardware of the emulator is changed. This changes cyclically in the sequence $80000, $90000, $D0000, $E0000 each time this function is selected. Clearly this must be set to match the address selected by LK1 on the emulator board.

Exit to DOS Any changes of filename, format, offset or hardware address is written to the save file and the program then terminates.



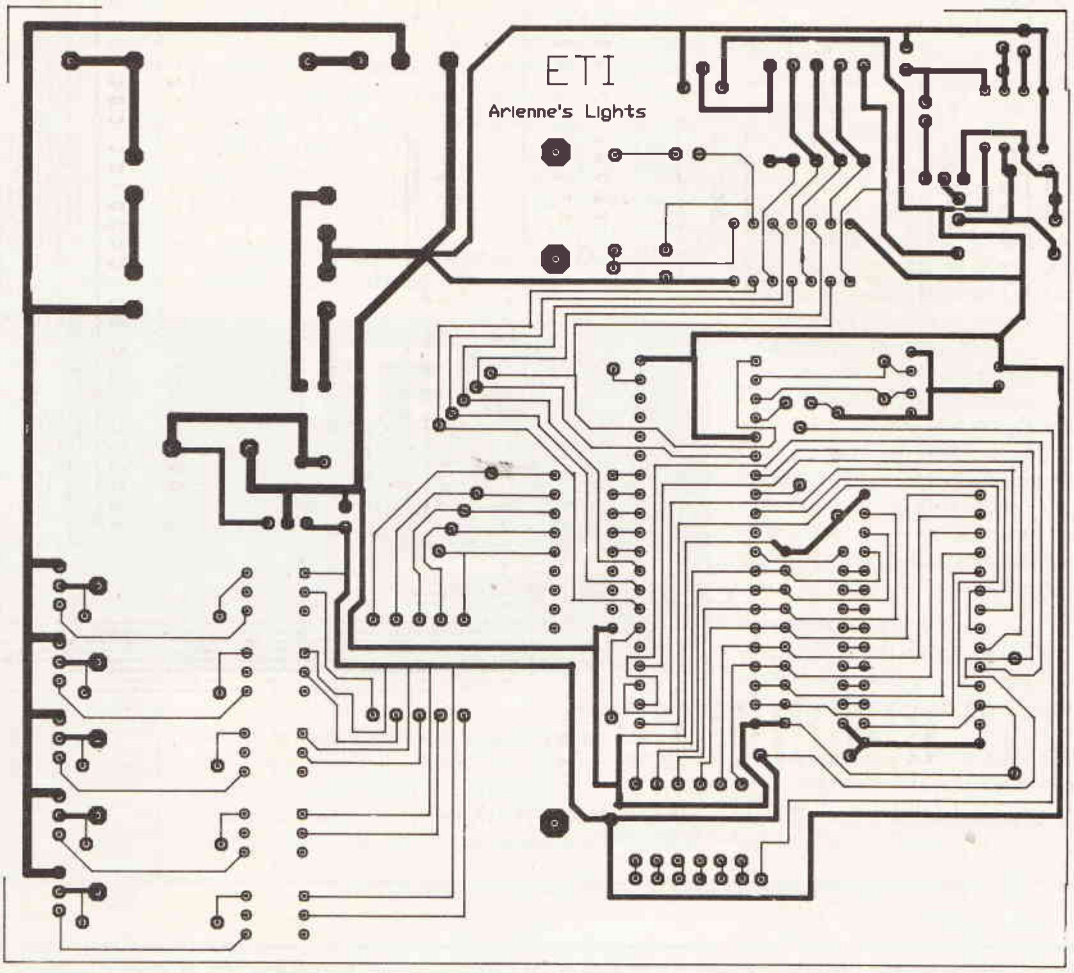
```
                      ETI

          EPROM Emulator Download Utility

            (C) Mike Bedford, 1990.

  Download                        Filename      : SBC09.TXT
  New File                        Format        : Motorola
  Change Format                   Offset        : $C000
* Change Offset                *
  Change Hardware Address         H/W Address   : $D0000
  Exit to DOS

 Enter new offset - Press Return when done.
```

Fig. 5

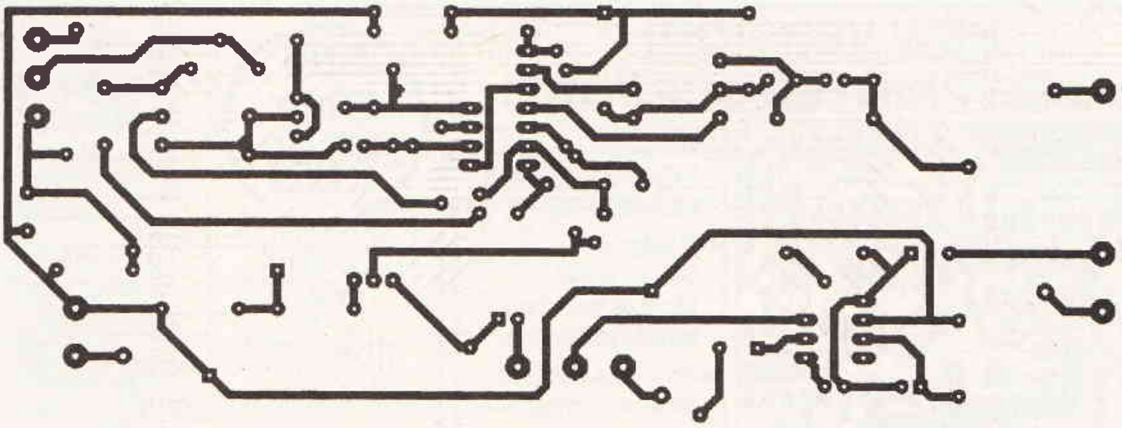
Last Month

A book reference should have been given at the end in the second part of SBC09. It is: Programming the 6809 by Rodnay Zaks and William Labiak (Available from Maplin price £17.95). And the corrected ETI SBC09 Test program will be reprinted next month.

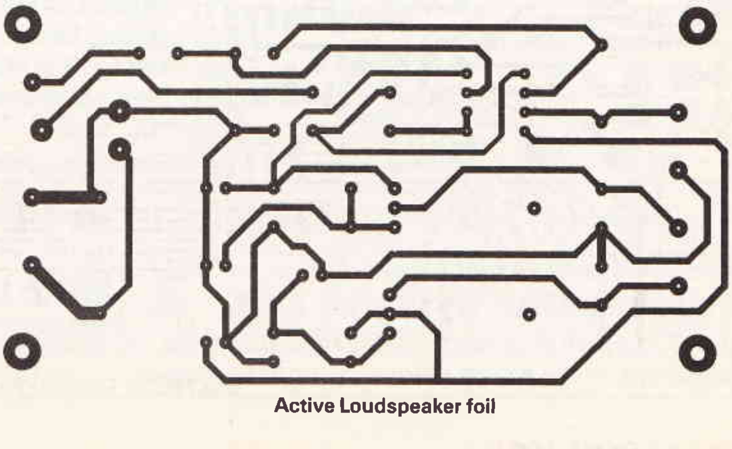
PCB FOILS



Arienne's Lights



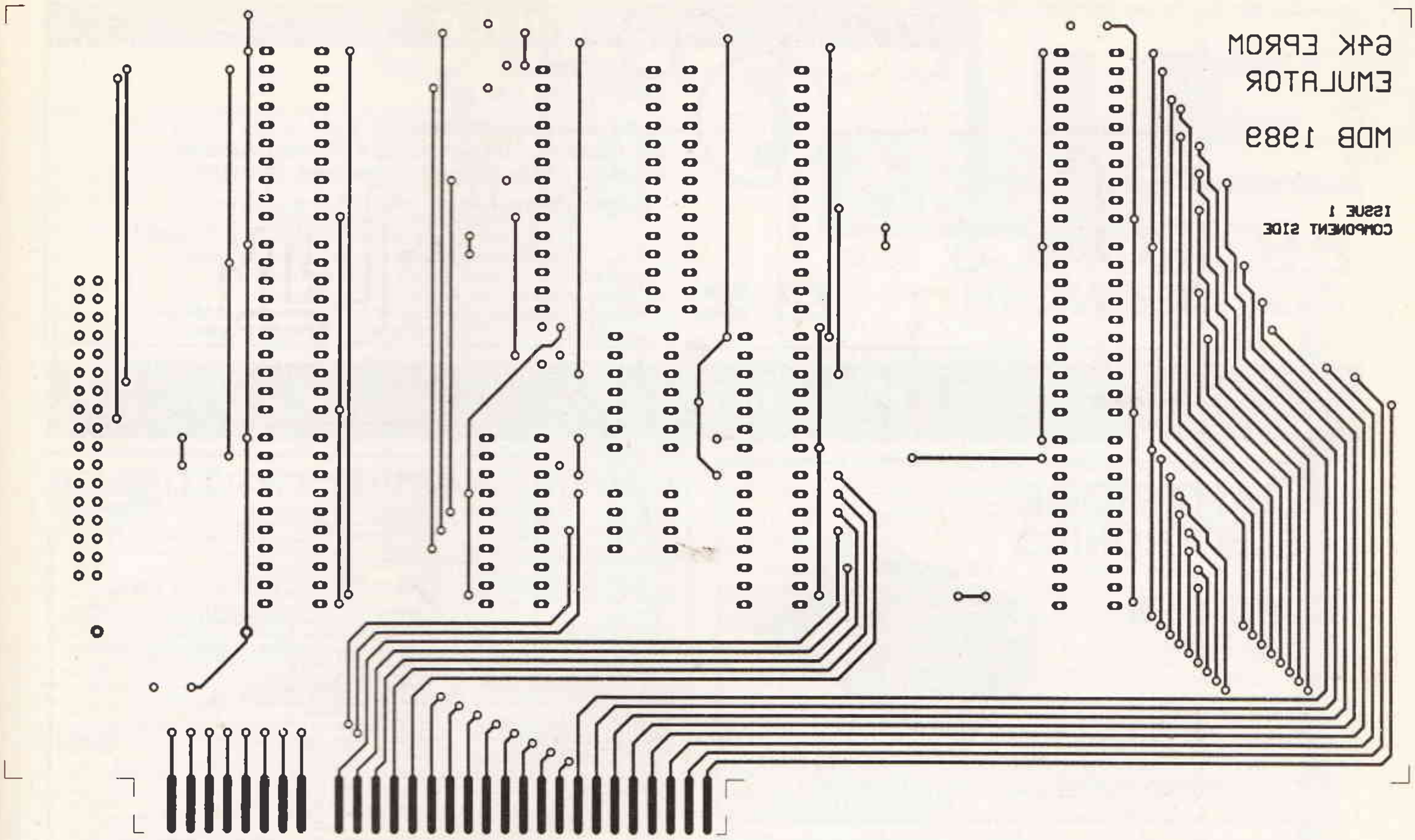
Simple SSB Receiver



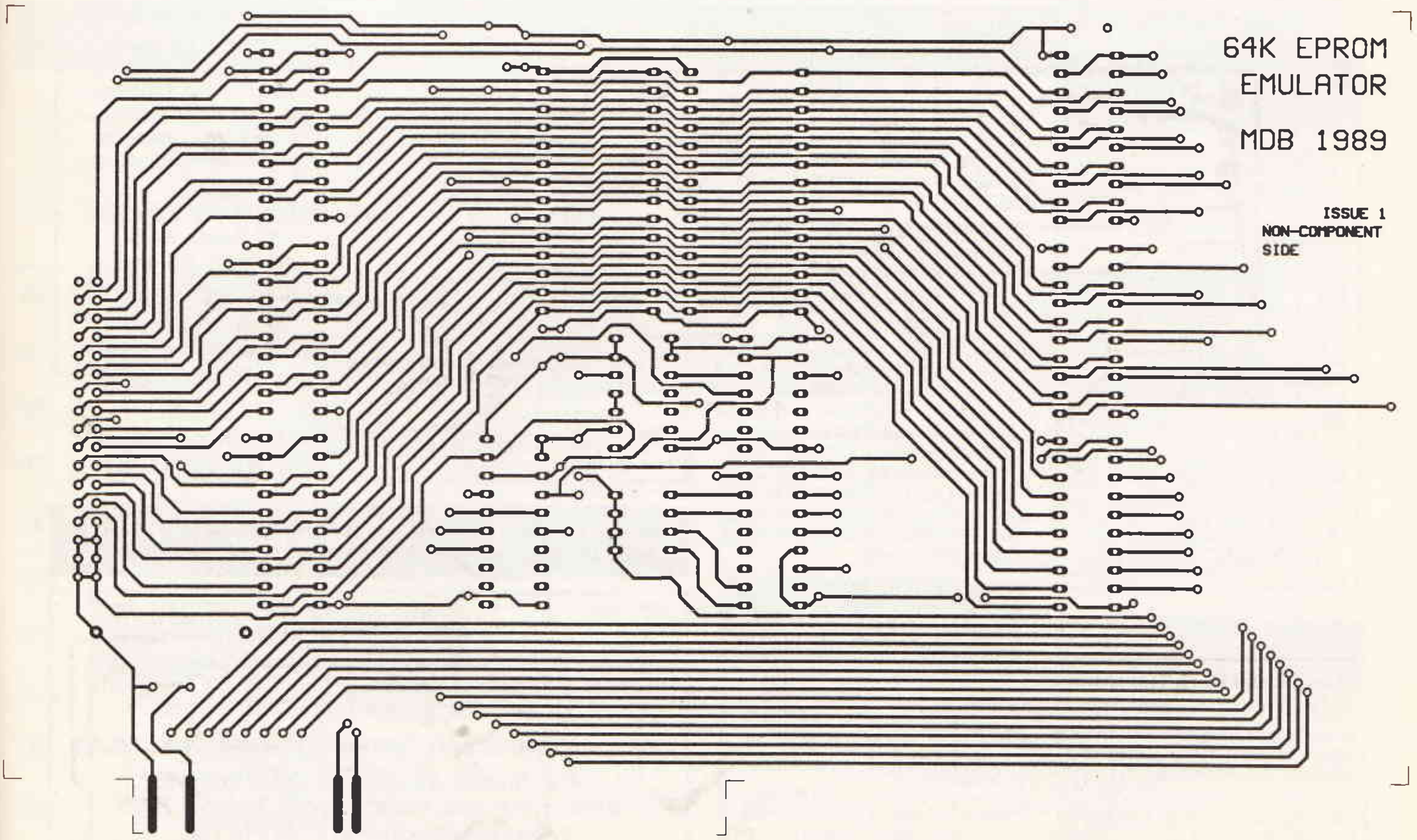
Active Loudspeaker foil

Meter Tester (Tech Tip) (January 1991)
In the diagram, R20 should be wired in parallel with R21 and the position marked 'I' on the toggle switch SW3 should be left open.

Slide Projector Controller (September 1990)
It is suggested that IC5 should be an MC3021, a non-zero crossing opto-isolator to work efficiently.



64K EPROM Emulator Topside



64K EPROM Emulator Bottom side

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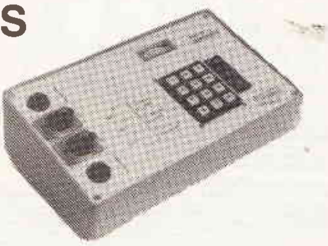

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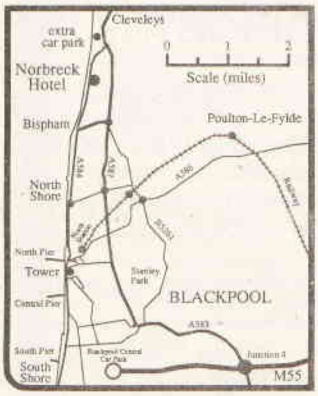

NEXT MONTH

Next month we really do start the series on LASERs giving both a theoretical and practical insight into this developing technology. The first feature looks at how they work and where they find an everyday use. Ray Marston, the celebrated circuits man starts a new mini circuit file series and Back to Basics looks at DC resistive networks.

Having finalised the design of our electronic voltmeter in this issue, we take to the work bench to put it together in April.

Also on the project front, if you are interested in measuring anything that moves or rotates and that could be in the highly mechanical confines or a car engine, then the ETI Tachometer could be just the instrument you are looking for. Alternatively instead of constructing the passive Direct Injection Box within these pages, you might want to knock-up the active version next month. And finally we present a practical design in EPROM Erasers where you can wipe out the chip and not your eyesight.

All this valuable information can be obtained in the April issue from your newsagent on March 1st.

The above articles are in preparation but circumstances may prevent publication

LAST MONTH

The February edition featured an Anti-theft alarm to protect electrical goods, the third part of the Remote controlled timer, the electrical house manager and a twin-driver speaker kit construction.

On the features side we presented articles on extracting energy from waste, a basic course in electricity, the first on the American idea for HDTV and the second part of the micro-controller dealing with firmware development.

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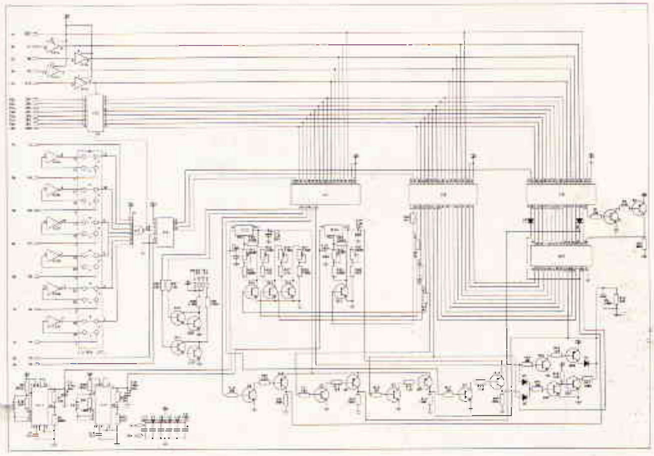

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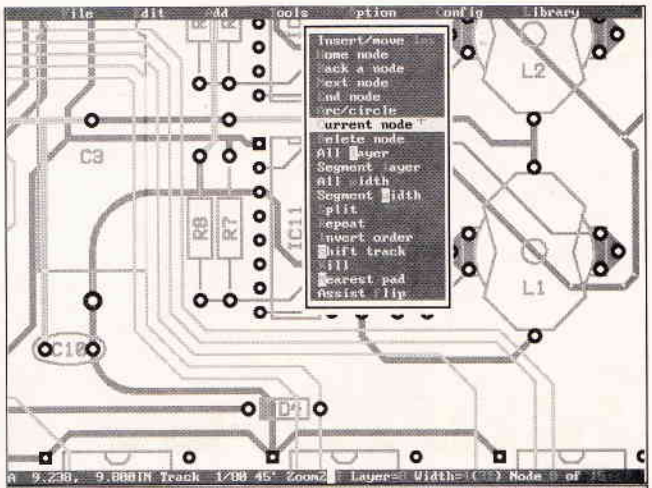

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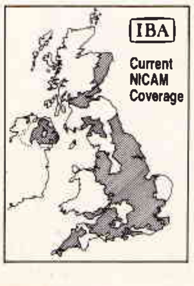
The complete kit contains all the components required to build the unit. However you will also need: a power supply, 12V at 600mA regulated e.g. YZ21X at £8.95; a co-ax Y adaptor e.g. FS23A at £1.20; a co-ax lead to connect to your TV or video; RW36P 2m long at £1.28, JW39N 5m long at £1.98, or JW40T 10m long at £2.95; a phono lead to connect to your hi-fi e.g. RW50E at 98p or a SCART/Peritel lead JW36P at £4.95. An infra-red remote control kit is also available LP20W at £29.95.

Complete kit LP19V only £139.95 incl. VAT + £1 mail-order handling charge.



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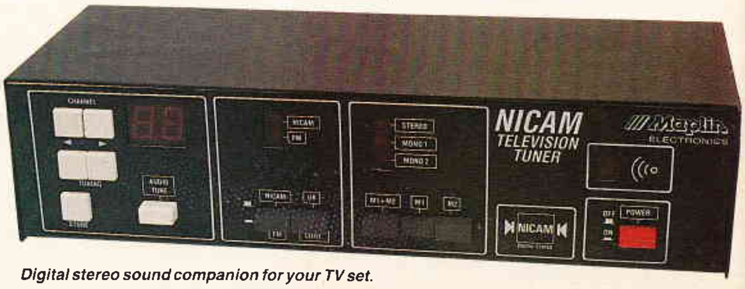

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