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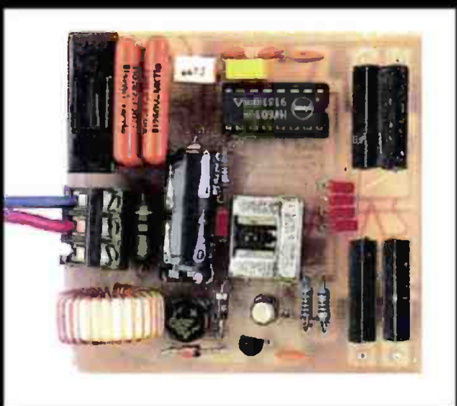
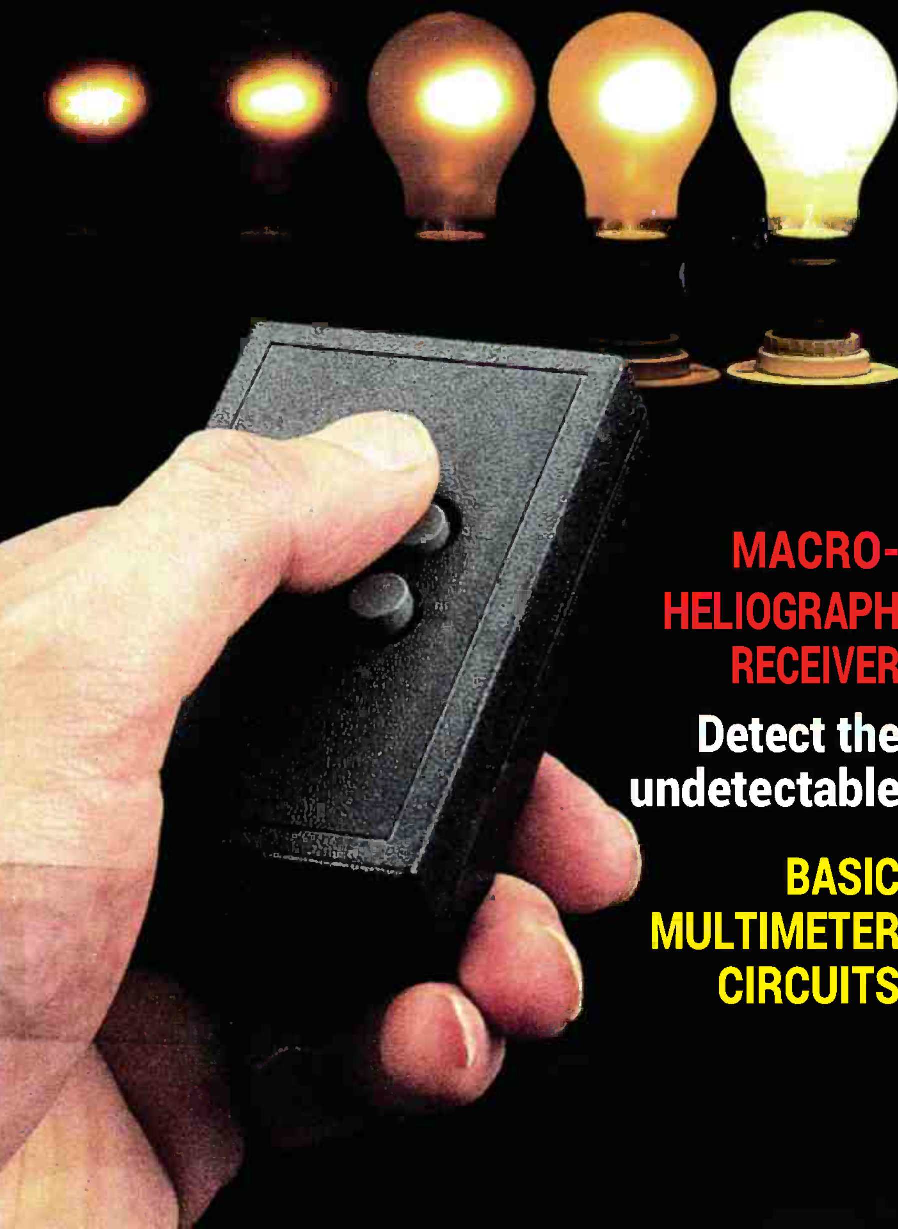


using our cover PCB



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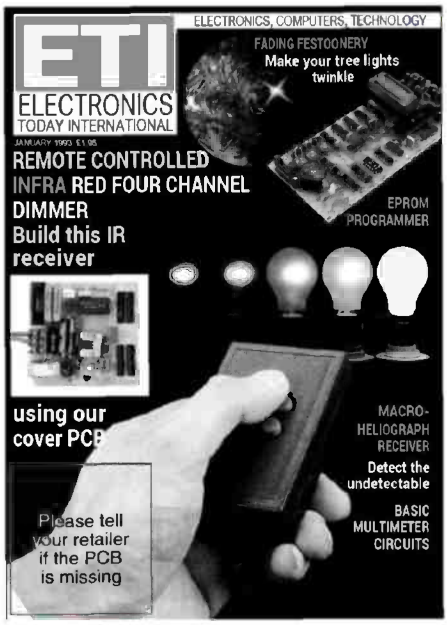

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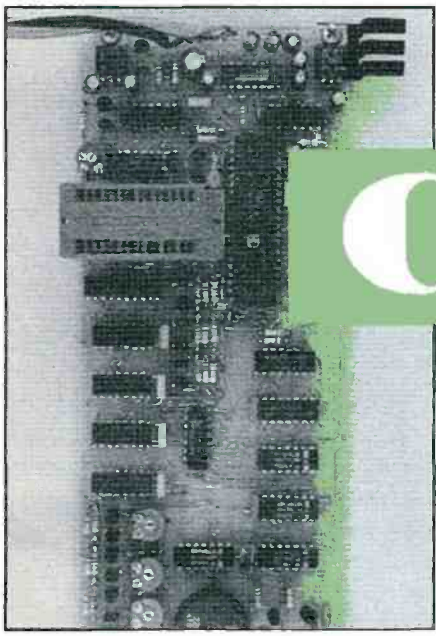
Features & Projects



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Regulars

Editorial

by Paul Freeman

The 'Smart age'

Just recently the term smart has taken on a whole new meaning. The term as-cribed to the neat, well-dressed individual could fall into insignificance compared with the 'intelligent' use of the term. Soon, you will not be the 'smart Alec' for using the latest technology to be one step ahead, rather it's use will be required by you.

Although smart-cards have been in use in France mainly for bank transactions and cash flow, they are not in general use in the UK yet. Their ultimate introduction could be from a different angle your CV-ID card. information stored on. your plastic friend could be your medical, educational and criminal history, financial liability, insurance risk factor, to name but a few - in fact your passport (or not) to the many activities in life.

Enter The Smart Book

About to appear is a single 3.5" disk called a SMART book. Most of us with computers know how much text can be crammed onto a disk, but the cramming, stacking or compres-sion on these magnetic floppies bas got the stage where 100 colour images accompanying 100 pages of text is possible.

The tools are now there for anyone in educational, medical and publishing environments to create your own books. One simple advantage to this electronic book as opposed to the CD-ROM is the simple application of updating, adding and correcting your latest publication. Here comes the revolution!

OPEN CHANNEL

Every once in a while on a consumer magazine the likes of ETI, something takes the fancy of readers. Indeed, something I wrote in this column a few months back has generated more mail than anything else I've ever written. My original comment was quite flippant (as many of my comments are!) and was regarding dogs, and an electronic dog collar which vets in the States are currently (pun intended) using to train noisy dogs to keep quiet. Every time the dog barks it gets an electric shock. Eventually the dog learns to keep its big mouth shut.

First letter I received was from a dog collared human who was fed up getting attacked and bitten, as he made his way around his parish visiting his security-dog-guarded flock. He was most interested in whether ETI could publish a design for a dog repellent. He'd built one which had been published earlier in a rival magazine. Apparently it did work, but parts had been difficult to come by, and he wanted a new version.

As part of what has turned out to be quite an on-running saga, I asked other readers if they knew of, or could design, a suitable dog repellent which could be presented in project form in ETI. Although no such dog repellent has yet come my way I've had a significant number of letters from readers to suggest that such a project would be extremely popular.

Indeed, I've even had a letter from a British Amateur Electronics Club member who even seems to deny the existence of the original dog repellent reported to me. Apparently, the BAEC has conducted a forum over the last two years or so regarding pet/pest repellents and none of the contributing members could suggest an electronic circuit. The member even went on to suggest it couldn't be done. Well I've news for the member - the Post Office issues electronic dog repellents to its postal delivery staff who feel threatened by dogs on their delivery rounds. So an electronic dog repellent is viable, and maybe a more positive attitude should be adopted by BAEC members.

What's needed, is a hobbyist's version. Unfortunately, I've filed the original letter in that great filing cabinet called our local tip, and can't reply directly to the author to ask him for more information about the dog repellent first published in an electronics magazine. So, if he's reading ETI this month, could I ask him to get back to me regarding the first dog repellent. I'd like to see the design myself. Meanwhile, perhaps other readers could put their designing hats on, and suggest a new circuit.

Balancing Act

Other mail arrived on my desk recently, regarding one of the terrestrial television broadcasters' last main arguments against satellite television - NICAM. Now, NICAM is a clever way of adapting the old PAL television format, to give high-quality digital audio alongside the vision signal. It's, in fact, an ingenious method of upgrading sound, and suitably equipped television receivers can be used to take the PAL signal received from terrestrial transmitters and give excellent stereo sound.

Satellite television channels all come with stereo sound, so terrestrial television channels has more-or-less had to upgrade simply to compete. In the past, another of terrestrial television's arguments against the need for viewers to go to a satellite reception system was that the standard of program-ming on satellite channels was not as good as that from terrestrial channels. Well, some think that's changing now -there are currently thirteen English-speaking satellite chan-nels from Astra, and while these channels tend to be quite specialised in what they transmit, they give a wide variety of quality programming (some of it indeed excellent). So, terrestrial television is about to be given a run for its money.

Considering this, it disappoints me to bear from unsatis-fied viewers who want NICAM. stereo sound - and have gone out and bought a NICAM equipped television receiver - yet still have to wait for the terrestrial broadcasters to upgrade their transmitters to be NICAM-capable. Worse, some view-ers have now been told no upgrade of their transmitter to NICAM is planned. I sympathise with ET! readers and others in this position because I suffered similarly myself until recently. Even now I can only receive the independent channels with NICAM. BBC channels aren't yet available.

The BBC proudly boasts - on its own teletext service - that it currently serves over 90% of the population with NICAM. I only have one thing to say -only 90%? Where does thatleave the other poor 5.4 million suckers?

Frankly, it is an appalling situation. The broadcasters have us believe reasonable national NICAM coverage is available, yet the situation is far from this. Worse still, there appears to be little or no effort - particularly by the BBC - to expand towards a proper national coverage at a rate which could be even construed reasonable. The reader who wrote to me to express his disquiet against the situation lives in Hereford. I live in the East Midlands. We're not talking about being in the back ofbeyond here, although the BBC appears to think it.

NICAM is one of the terrestrial broadcasters' last argu-ments against satellite television. Are they going to waste it? Remember that satellite television has 100% coverage.

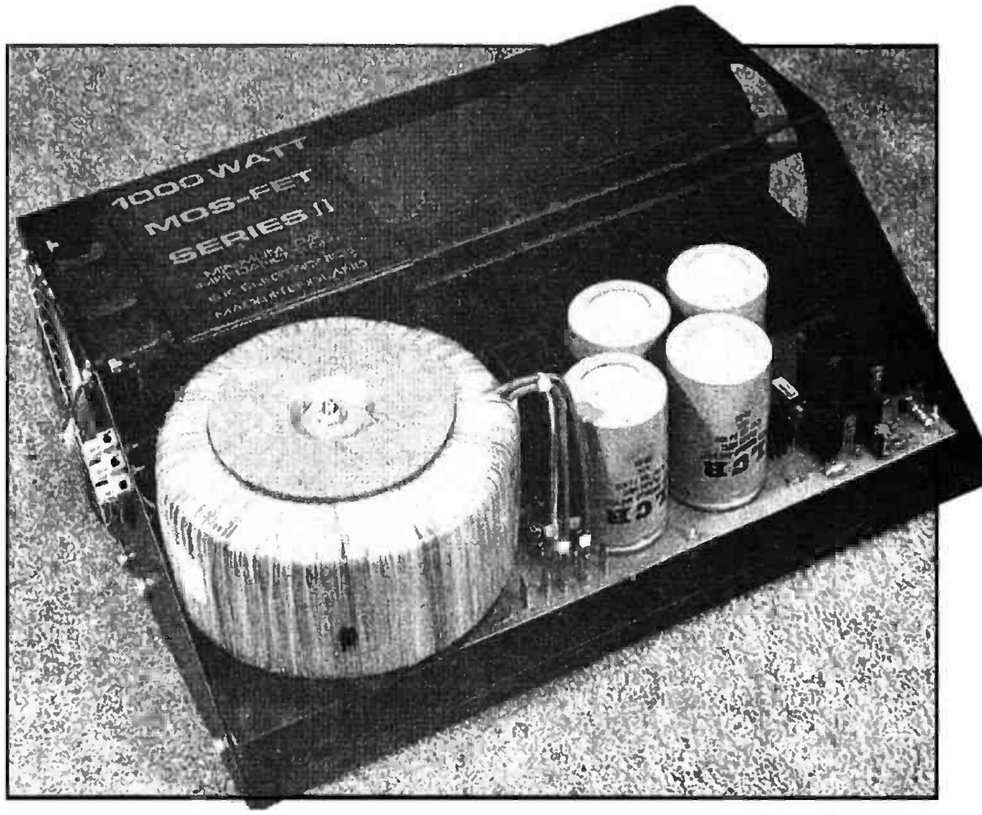
Ringing the changes

Every now and again it becomes necessary to fine tune telephone numbers. Sometimes this is to incorporate changes in the telephone system brought about by combinations of small local exchanges, into a single and much larger district exchange. Typically, this entails only those users originally on the local exchanges having an extra digit applied to their user number. Sometimes, this is undertaken on a larger level where a single dialing code changes to incorporate expan-sion - consider the change a year or so ago when the London code of 01 was changed to either 071 or 081.

Rarely, is a change undertaken like the one which is planned for April 1995, in which all dial codes in the system will have an extra digit I after the initial 0. So, as examples, Birmingham will become 0121, London will be either 0171 or 0181 and Bristol becomes 01272. At the same time the international dialing code (currently 010) will change to 00.

Although still well over two years away, April 1995 is the chosen date to allow manufacturers and service providers in the telecommunications industry time to modify equipment.

Keith Brindley



THEY'VE GOT THE POWER

BK Electronics have doubled the power with the release of their new 1000 watt MOS-FET amplifier module. The OMP/ MF 1000 has taken over from the popular OMP450 as the flagship of the OMP module range.

Delivering 1000 watts RMS into a 2 Ohm load, the OMP/ MF 1000 provides a no compromise price/power/ performance ratio and, as with all of the OMP range, its advanced MOSFET circuitry achieves sonic clarity and reliability.

The OMP/MF1000 is priced at £259.00, including V.A.T., plus £12.50 delivery, and is available from BK Electronics, Units 1 & 5 Comet way, Southend-on-Sea, Essex. SS2 6TR Tel: 0702 527572

NEW PORTABLE TRAFFIC INFORMATION SERVICE

The UK's first portable traffic information service that de-livers live national and regional traffic information has been launched by Air Call Communications. The service will be of benefit to businesses and individuals who rely on the road system such as salesmen and distribution, fleet and retail companies.

Air Call's AARoad-watchservice sends live traffic information direct from the Automobile Association (AA), via Air Cali's national radio paging network, to be displayed on pocket-sized four line message pagers. The service operates day and night, 365 days a year. Subscribers receive traffic information relevant to the re-gional zone they are traveling in. As they travel through regions the traffic information received on Pagers will automatically change accordingly. There are a total of 10 regional zones. With access to live traffic information, drivers can plan routes in advance and avoid traffic congestion. To help with long distance journey plan-ning, major national traffic inci-dents are sent to all subscribers.

Information received on AA Road-watch Pagers warns drivers of traffic congestion and details its cause such as burst water mains or traffic lights out of order. Where available, alternative routes are suggested.

Information is transmitted within 60 seconds of it being received by the AA and updates are sent until the congestion clears. Users are notified of incoming information by a flashing red light or by an audible tone.

The British Road Federation estimates the cost of idle vehicles to be £16 per hour including man hours. The CBI estimates that traffic congestion costs British business £15 billion per year in higher fuel and vehicle mainte-nance costs and in lost man hours. Air Call believes that these costs can be reduced by using its AA Road-watch service.

Subscribers can opt for either a fixed cost monthly rental package of £19.95 or they can purchase the AA Road-watch Pagers at £ 160 and pay a fixed monthly subscription of £7.50 for the information service.

SONY ANNOUNCE SMALLEST CAMCORDER YET

Sony has released details of the new CCD-TR8 camcorder. This is the smallest camcorder produced by the company to date and weighs 690grams.

Set to transform the camcorder market, Sony have developed a Lithium Ion battery for camcorder use. The NP-500 powers the CCD-TR8 and becomes an integral part of the camcorder.

Lithium Ion batteries do not suffer from the 'memory effect' as do conventional camcorder batteriesanddo nottherefore have to be fully discharged before recharging. The battery can now be 'topped-up' at any time, without having to discharge it first.

The CCD-TR8 is a stereo Hi8 camcorder, which utilizes a high precision 113" CCD imager with 440,000 effective pixels, this provides the highest picture quality.

Full range auto focus is main-tained by way of the Sony Inner Focus system, manual control is possible with a dial at the front of the camera. Manual control over exposure and gain is also pro-vided in 24 steps, while program auto exposure features portrait, sports and HSS modes.

The CCD-TR8 has an 8x power zoom with a variable speed of 1.5-16 seconds while the lens is protected with an automatic lens cover, controlled by the power switch.

Supplied with the CCD-TR8 is a Sony camcorder station. The station can be left permanently connected to the television, while the CCD-TR8 is clipped and unclipped from its base. Also, when connected to the camcorder station, automatic charging of the battery takes place. For longer periods away from home the AC adaptor unclips from the camcorder station and can be used elsewhere.

The CCD-TR8 supplied with accessories, including remote control is available in the UK from December.

TV ON YOUR PC!

magine Graphics Ltd has launched a television and video adaptor for use with all VGA based PCs. Now one monitor can be used to display the two different sources of information.

The Videomate, model JV-819PT, is a real time video standards converter using the latest in microprocessor technology to change a low resolution, interlaced, composite PAL signal to a high quality, non-interlaced, VGA RGB signal.

The VIDEOMATE provides PC users with the ability to display TV and video signals on any standard VGA, SuperVGA or autosync colour monitor. Sound is also provided by an audio amplifier and built-in speaker. The user simply switches between TV/video and a standard VGA PC display allowing the PC to carry on processing data or compiling a program while the user watches TV or video.

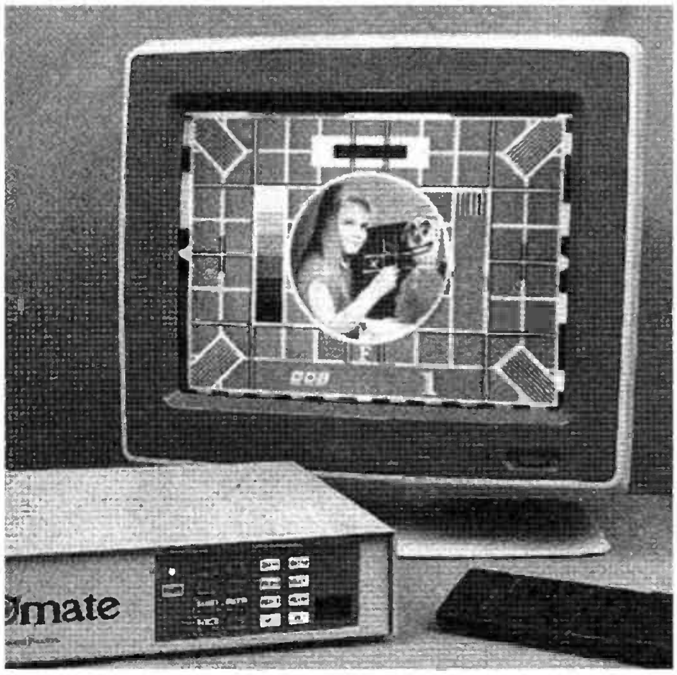
Application areas include: education, training, corporate presentations, security, financial dealing rooms, factory floor automation and leisure.

An infra-red remote control is provided allowing users to automatically or manually tune and store up to 41 UHF and VHF/cable TV channels, switch to a video source such as a VCR or camera, adjust colour, contrast, brightness and volume - just like a modern, sophisticated TV set. An on-screen display shows all these functions plus time of day and on-off timer.

The VIDEOMATE is priced at £269+VAT.

For further details contact:

Norman Garland - Imagine Graphics Ltd, Tel: 0727 830638



THREE NEW ELECTRONIC BOOK PLAYERS ON SALE FROM OCTOBER

utumn 1992 sees the launch of three models of Data Discman, the electronic book player, from Sony.

The first of these models, the DD-DR1 is an electronic book drive unit, without an LCD screen, for use with a personal computer. An RS232C interface to link with an IBM PC (or IBM compatible) is included, with emulator software providing audio, text and graphics playback.

This unit, which will also playback 8cm CD audio singles, may be powered by a dry cell battery, in-car, with a car adaptor, or from an AC power supply. Continuous playback of six hours is possible with six AA batteries.

Supplied with an AC power adaptor, EBIF lead and software for IBM and IBM compatible PC, the DD-DR 1 will retail for £299.99 and will be available from November.

The DD-8 is a portable electronic book player with a fixed 4" LCD screen display and a front-loading mechanism for electronic book insertion. The screen can display ten lines of 30 characters, and graphics with a resolution of 256(horizontal) x 200(vertical) pixels.

A truly portable machine weighing only 450g, the DD-8 will playback speech, music translations, or any other audio that is included in the text of the electronic books.

The DD-8 incorporates a bookmark facility that will resume play where it left off. An auto scroll facility is also included, with variable speed control. The machine can be powered by dry cell AA batteries, in-car with a car adaptor, or from an AC power supply.

Supplied with headphones, a video lead for connection to a television, an AC power adaptor and carrying case, the DD-8 is priced at £279.99.

The DD-10EX, a portable machine which features all the facilities of the above model, also has a backlit 3.5" LCD screen which flips up and is adjustable for angle.

The DD-10EX also operates from a supplied rechargeable battery, or dry cell batteries, as well as from the supplied AC power adaptor. Complete with headphones and video connecting lead, the DD-10EX will retail for £379.99.

WORLD'S FIRST ROBOTIC EATING AND DRINKING MACHINE

The world's first robotic eating and drinking machine which will give a measure of independence to severely disabled people, was unveiled at Keele University in September.

A machine with a robotic facility to aid eating has already been commercially developed by Keele University's rehabilitation robotics department, and the drinking facility is another major breakthrough.

Now, with the help of a £5,000.00CareGrantfromUnited Norwest Co-operatives, the inventor, Mike Topping, plans further development of the machine which has already astonished scientists and medical engineers.

"We believe that with a little further development the machine will clean teeth, shave, apply cosmetics and give a facial massage. The machine already has the capacity to add seven other functions" he said.

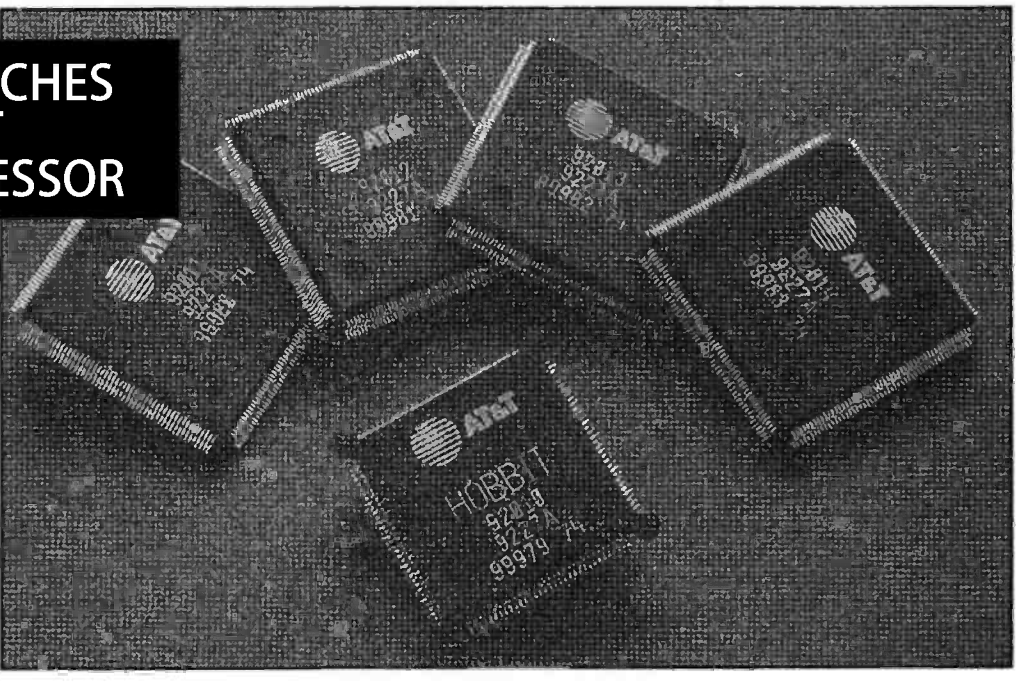
Mr Topping, who has a computer background, has had to pick up engineering skills as he has progressed, and his department has had to rely heavily on public donations to develop his project. Mike got the idea for the machine after seeing how some children at a special school were so depend-ent on others to feed them.

Be developed the machine during a research period at Keele University following a spell of unemployment. His. assistant on the project is a teenage electronics. technician, Robert Finney.

Mr John Thomson, chief executive of United Norwest co-operatives, said the £5,000 grant was one ofthe largest grants made nationally as part of the Coop's community care scheme, and the feeding and drinking machine was one of the most exciting and rewarding projects with which they had been involved.

"It will prove a boon to severely disabled people all over the world and will be of particular· help to people with cerebral palsy" he said.

AT & T LAUNCHES HOBBIT MICROPROCESSOR



AT&T Microelectronics has launched the Hobbit microprocessor, a device which will form the basis for future generations of personal communicators.

AT&T estimates that, by the year 2000, there will be around I billion potential users ofpersonal communicators, devices which will combine voice messaging, electronic mail and portable fax and modern functions, but which could eventually incorporate advanced features such as graphics and full-motion video communications.

"The technology to build superior mobile communications devices is here today," said William Warwick, AT&T Microelectronics president. "You'll see the first Hobbit-based per-sonal communicators before the end of this year," he added.

The ATT92010 Hobbit processor, which was developed at AT & T Bell Laboratories, combines high performance, low power consumption, and a full range of communications facilities. To support the processor itself, AT & T Microelectronics has introduced four highly integrated peripheral support chips, which provide a complete solution for building a personal communicator. These include handling of external storage devices, power management, and display handling.

"Personal communicators represent the next step in giving mobile users access to global communications services," said, Dan Lankford, head of AT&T ME's. operations in Europe. "Europe has traditionally been at the forefront of communications technol-ogy, a lead which continues today. We see vast potential for these new devices, and we are proud to be the first to offer a complete silicon solution to personal communicator manufacturers."

The Hobbit microprocessor will be supported by Go's Pen Point operating system, which is tailored for the needs of both pen-based input, and communications devices in general. Pen Point provides task handling facilities, to guarantee that a personal communicator will simultaneously handle communications functions such as call (exception, and user functionssuchas writing a memo a memo. The software also provides a consistent user interface, which will make communicators as easy to use as a standard telephone.

The processor is optimise for communications and portable applications. The 20MHz, 32-bit Hobbit chip delivers 37 VAX MIPS per watt, nearly five times the figure for Intel's i486DX, and nearly 30 times that for Intel's 386SL. It is designed for fast context switching and interrupt response, so that the chip can quickly switch between various tasks, for instance editing a document, receiving incoming email, and sending a fax.

Because the ATT92000 Hobbit chip set has been designed with communications in mind, and without having to retain backward compatibility with existing devices, it represents a very efficient silicon implentation of the required functions. The CPU, for instance, consists of just 400,000 transistors: processors with similar performance com-monly exceed l million transistors.

To achieve the low power consumption necessary for battery powered mobile operation, the entire Hobbit chipset runs at 3.3V, rather than the older standard 5V. System software can stop the processor clock, putting the chip in a low-power standby mode which consumes just 50μW (50 mil-lionths ofaWatt) of power.

AT&T will supply a complete set of development tools for the Hobbit processor and its associated support chips, allowing designers to quickly realise real-world personal communicator solutions.

LOW COST DATALOGGER

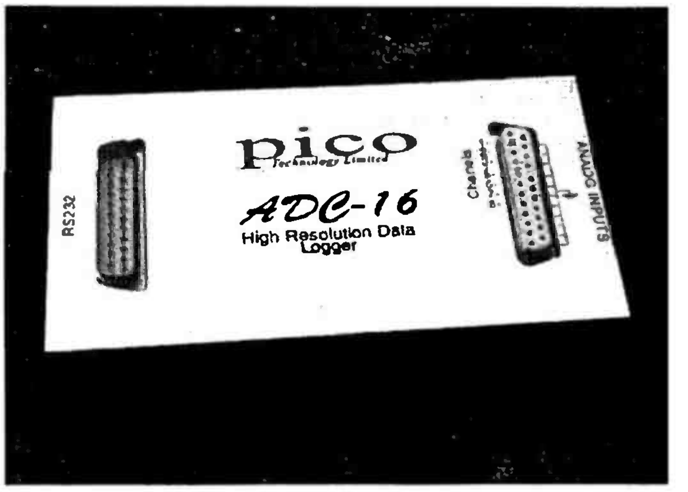
Pico Technology Limited announce a new addition to their range of PC based data acquisition products. The ADC-16 is a high resolution data logger that plugs directly into the serial port, requiring no external power. It features 8 channels of analogue input at 16 bit resolution.

Unlike plug-in cards it uses no expansion slots making it easy to install and use with portable PC's. The use of a serial connection cable means the unit can be positioned near the experiment to minimise noise pick up.

It is supplied with PicoLog data logging software which allows full use of the ADC-16's features: involving selection of resolution for each channel from 8 to 16 bits and either single ended or differential inputs. Each recorded sample can be the maximum, minimum or average of a number of readings, collected over a period of a few milliseconds to a day. The software also includes a comprehensive range of graphical and text reporting tools.

The ADC-16 costs £99 (plus VAT) which includes software drivers and a manual.

Further details contact Pico Technology Ltd, Telephone 0954 211716.



UK FAILING TO EXPLOIT ITS TECHNICAL 'KNOW-HOW' SAYS IEE PRESIDENT

Although it has long regarded itself as a nation of inventors, the UK is significantly failing to exploit its own technical 'know-how' and expertise. It is also failing to recognise the importance of buying in the best know-how technology from elsewhere, and as a result is lagging behind its overseas competitors.

This was the message given by Professor Peter Lawrenson in his Inaugural Address as President of the Institution of Electrical Engineers (IEE), Europe's largest professional engineering society.

World trade in technical 'know-how', or disembodied technology as it is sometimes called, now amounts to $34 billion a year - more than the total of all international passenger fares - and is set to increase. However, Professor Lawrenson warned, this trade is increasingly been exploited by the USA, Japan and Germany.

"Although the UK" he said "has always given rather 'mystical' prestige to inventions and patents, it has failed to award similar prestige to innovative success following from patents and the exploitation of knowledge through design rights, copyrights, trademarks and licensing".

"For too long we have suffered from a belief that cleverness in technology, and particularly science, is the key to success. Rather it is the exploitation of technical know-how and innovation that leads to the creation of benefit and wealth".

"The emphasis being placed internationally on knowledge and innovation, technology property and technology licensing has increased significantly within the last decade. Furthermore there is a close correlation between those countries with high and increasing patent activity and those achieving industrial success. Against this background the performance of the UK is disappointing, at the very least".

"The percentage of patents granted in the USA to UK inventors shows a steady decline whereas those of our main competitors, Germany and Japan, show a significant increase, reflecting the importance being attached in those countries to new technical knowledge".

The new IEE President went on to comment on the current UK situation.

"Some companies" he said "do have a positive attitude to patenting and to know-how transactions, including buying-in from outside, and are aware of the need to stay continuously abreast of worldwide best practice. Unfortunately, far too many companies seem to have no policy whatever in relation to patenting or licensing strategy".

Professor Lawrenson ended his Address with a call for a change in UK attitudes and for a new framework for positive action.

"There is a clear need for the implementation of vigorous policies to encourage the exploitation of know-how and technology, both by purchase and sale, to ensure that our manufactured products are truly of world class design and quality and that every possible compensation is made for high labour and production costs and for restricted R & D budgets".

ELECTRONIC CAR IMMOBILISER

UK Electronics have designed and manufactured a new car immobiliser in conjunction with Acorn Auto Electrical Specialists. Using the latest technology, the two Oldham based companies have produced and launched this new security product in response to repeated customer demand.

Designed to stop vehicles going missing, 'Active 8' is inexpensive and easy to fit. It works by cutting out two electrical circuits, normally starter motor and ignition, to make it doubly safe and secure. Another major benefit is that it is fully automatic: once the ignition key is removed it is activated in 8 seconds, hence the name Active 8. Simple and convenient to use, with no remote controls to be carried, it works whenever the car is left - even when paying for petrol.

The system is de-activated by turning on the ignition and pressing a virtually invisible micro thin pad, positioned for the driver's convenience. A new company, Active 8 Ltd has been established to market and distribute the immobiliser via car security specialists and other automotive outlets.

ETI

NEWS

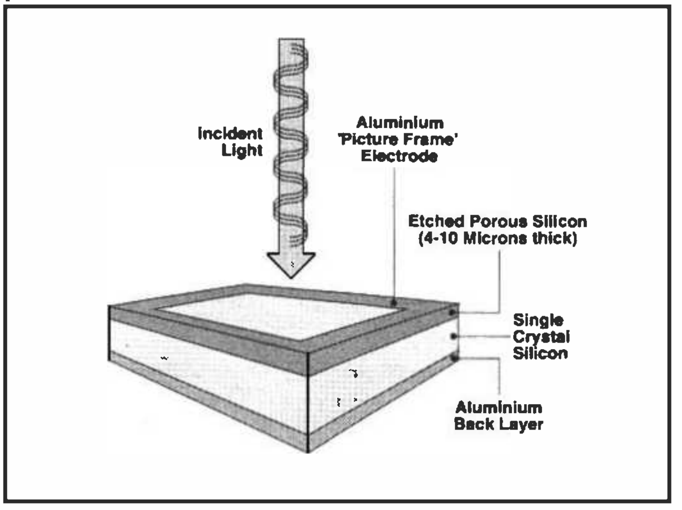
...Stateside...

Advances in photo-detectors

The recent discovery that porous silicon emits light has been followed by a number of breakthroughs, including an all silicon light-emitting diode. Researchers are now discovering that porous-silicon layers make supe-rior photo-detectors and high efficiency solar cells, and could tum out to be a superior optical recording medium. While the underlying physics that produces the unusual photonic effects is still a mystery, the new material is prov-ing to be highly cooperative in application-oriented research.

The ability of porous silicon to absorb photons surprised a search group at the State University of New York at Buffalo, which has produced a metal/ porous silicon/silicon photo detector.

It was found that the MRS photo diode is comparable in performance to



commercially available silicon photo diodes, but without needing an anti-reflection coating.

Standard silicon photo diodes need additional surface treatment to keep photons from bouncing off before they are captured in the silicon lattice. Experiments suggest that a porous-silicon layer is able to trap 100% of the photons striking it, eliminating the additional anti-reflection processing step.

The MRS device is formed by depositing a square frame of aluminium over a porous-silicon layer etched into s standard single-crystal silicon substrate. The frame acts as one electrode for the detector, and a second electrode is formed by depositing aluminium on the backside of the wafer. Measurements of the detector response showed that it bad a very high conversion efficiency - 97%. Since about 2% of the light falling on the 3mm-square area was reflected, it was concluded that the porous-silicon layer converts virtually all the light that is trapped. This would make porous silicon an ideal candidate for high-efficiency solar cells.

Since this is only the first pro-totype, it is reasonable to expect better performance can be obtained by varying process parameters. The only caveat with this new process is the question of long-term stability.

Since research on porous silicon is moving so fast, there is no data on the long-term variation of parameters. If the material turns out to be as stable as normal silicon, porous-silicon devices could easily be incorporated into VLSI designs with only a few additional processing steps.

Reducing cost of fibre optics

What it calls a circular-grating surface-emitting laser, which emits a circular column of light from its surface has been produced by Bell-Northern Research. The company said this improves the efficiency of coupling laser light to optical fibres. In contrast, conventional lasers generate a divergent light beam that requires precise positioning of the fibre to capture light efficiently.

Packaging that will hold lasers and wires in precise alignment still makes up more than 70% of the final cost of fibre-optic wiring. The Bell-Northern development makes it possible to relax these tolerances, and to substantially cut costs.

Sub-micron contaminants research

A recent $62 million Co-operative Research and Development Agreement package announced by the US Department of Energy includes an initial $6 million nine-month funding for a joint centre to be created by Sandia National Labs and Sematech.

The research centre will study the feasibility of 0.1 micron manufacturing methods, by looking at new ways to remove clean-room contaminants as small as 0.01 micron. Also being explored are ways to isolate particulate sources.

Turning compost automatically

A US company has introduced a machine that turns compost automatically. Key to its operation is a solar panel that charges a 12V battery, which in turn powers a drive mechanism. The heavy duty battery is sealed and will run up to 28 days without sunlight.

Called The Swisher Solar Composter, from Swisher Mower and Machine Co, Inc., Warrensburgh, Missouri, it is made in various sizes, the largest of which is 184 gallons. A dual compartment model allows simultaneous composting and storing. the compost container is recycled galvanized steel and is square for mixing and folding. A patent is pending.

Wireless communicator

Service workers - including quality-control inspectors, warehouse clerks, nurses, couriers, and waiters - do not need a portable computer, but rather a simple and fast way to communicate information.

Granite Communications Inc.; Amherst, New Hampshire, has recently introduced a hand-held, wireless, data-communications tool. The Videopad contains a microprocessor with 1 M-byte memory and uses a menu-driven touch screen that displays alphanumerics, icons, and graphics. Videopad is custom designed for the application and can be easily re-programmed. Models are differentiated by their communications interface, either spread-spectrum radio or modem. In operation, a user enters data on the touch screen, then sends data to a receiver, which is connected to a host computer or network. Up to 100 Videopads equipped with spread-spectrum radio can communicate simultaneously with the receiver at distances of up to 1,000ft. The modem is particularly useful for store and forward applications, but can also operate in real time. Videopad is about one-third the price of notebook and pen computers and, at 18-oz, one-quarter the weight. The batteries that power the unit are rechargeable.

Throwing some light on the subject of LEDs

Having read the letter from I. Field in the September issue of ETI, I have researched the problem of comparing the light output of LEDs and lamps. The light output of lamps is usually stated in lumens, which is the luminous power or flux, while the brightness of LEDs is stated in candela, the unit of luminous intensity.

It is possible to find the output of an LED in lumen's if the view angle is given. It must be assumed that the luminous intensity given is the average over this solid angle. Candela (cd) is another name for the units lumen's per steradian (lm/sr). The view angle must therefore be converted into a number of steradians. If 'v' is the view angle, then the number of steradians is:

$$2\pi[1-\cos(v/2)]$$

This number of steradians can now be multiplied by the number of candela to give the luminous power of the LED. This calculation can produce interesting results, for instance, it can show that an LED with a much greater brightness in candela than another LED, may actually have a lower luminous power.

All the units used so far have been photometric, that is they are adjusted to the response of the eye. The eye is at its most sensitive at 555nm and at that wavelength one watt of radiant energy is equal to 680 lumen's. On either side of this wavelength the number of lumen's per watt reduces according to the sensitivity of the eye. It is interesting to work out the radiant power of LEDs (in watts) as their efficiency can then be found.

I think the readership of ETI would find this an interesting topic for an article. I'd like to take this opportunity to thank you for producing the best electronics magazine in this country.

Robert Johnstone.
Worcester Park, Surrey.

Induction Loop Systems

In response to Mr Trayers request for information regarding Induction Loop systems for the hard of hearing on the letters page of the December issue of ETI.

We have been manufacturing loop systems for the hard of hearing since 1989 and have many units installed at various sites including concert halls, Hospitals, Churches and Conference centres.

Mr Trayers might be interested in our equipment.. The PDA100 is designed specifically for applications such as his.

Grants are often available from the local authority to help with the purchase of loop products and VAT is not normally charged for personal purchases by disabled persons.

Steve Mehew, A VX Systems, Washington, Tyne & Wear.

Audio response measuring system - Buylines

Somehow the Buylines section on of our two part project Automatic audio response measuring system in the November/ December issues was missed out.
We produce it here.

Buylines

The address for all orders is:
Ralph Mantel,
Pipinstr.23
W-4790 Paderborn,
Germany.
The prices for the UK in pound sterling are:
Compensated measuring microphone with cable and plug £39 Software £29
PCB with printed overlay £19.
All three items together for the favorable price of £79 (saving £8)
Complete kit or ready built PCB please enquire.

Automate Requirements

Firstly I would like to congratulate you on the improvement of the magazine.

The main point of this letter is to deal with the Automate Mixer Project. I must say it is quite an impressive project - one that a few of us here are especially interested in. There is one thing that worries me about the project and that is the number of magazines it is going to take to see it through to the end. At this rate I would suggest that by the time it is completed the technology will be out of date that one would be better off by buying one off the shelf

Why not give your readers the option of buying a manual containing the complete documentation for the project. I know that I would be willing to pay in the region £25 - £30 for such a document. I myself are in need of a decent mixer for my MIDI based system, I know of a band here that is in need of a decent mixer for their events, and there was inter-est expressed by the campus radio station here who could use the mixer as part of an automatic music request system.

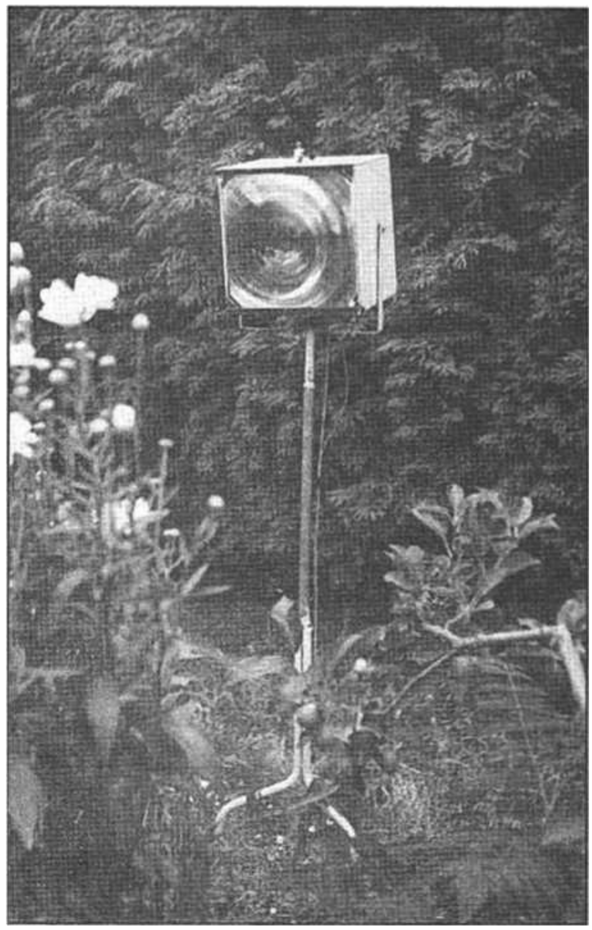
David Ingles
Lancaster University

Points noted Ed

Macro Heliograph Receiver

PROJECT

Investigate sub-sonic low intensity frequencies with this receiver. I P Wilkinson provides the details.



Plop, whine, click, growl, buzz, (deep and high) and other such sounds are the sort of signals that can he heard on the headphones plugged into a Macro Heliography receiver. These signals are the result of sunlight being reflected from the shiny membrane, com-prising the wing or wings, of a flying insect, much like the heliography used at sea.

This tiny amount of reflected sunlight is observable, after amplification, and can lead to many hours of fascinating study in wing beat frequencies, and thus the 'signature' of particular species of insect. Since there arc more than 400 varieties in our countryside, this adds up to a lot of sound effects.

The essential ingredient required is of course sunlight. This has to be of sufficient strength to at least, cast a shadow. I have devised a simple table, for reference see Table 1.

Sun factor 1 is the PSD (Photo Synthetic Datum) defined as the, minimum light level required for photo synthesis

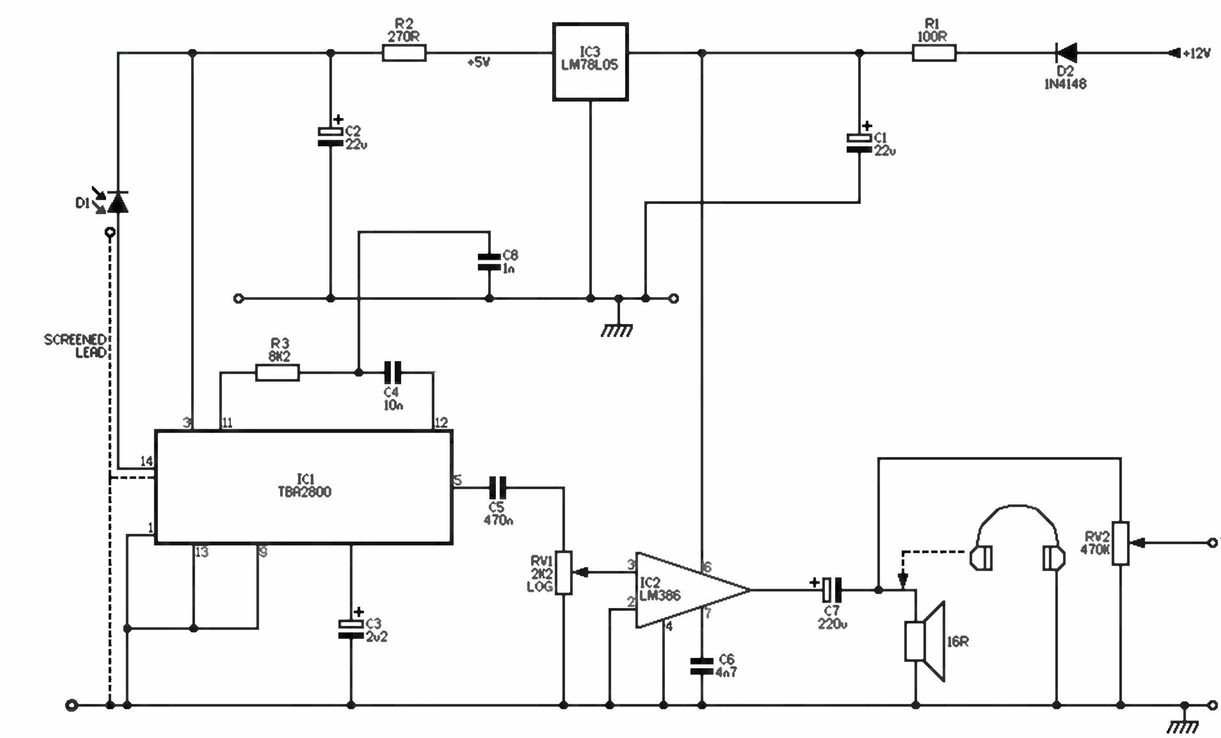


Fig.1 Circuit diagram of receiver

activity in plants. Safe sunbathing for sensitive skins of no more than 20 minutes a day, a SF of 2.5 is reasonable.

Looking at a shadow, estimation becomes quite easy with practice, and is born out by the signal results. For example at SF3 a hover fly, species Episyrphus balteatus, is detectable at a distance from the receiver of about 15 feet.

Butterflies are not easily detectable mainly because the wings are less reflective and show moving. At best at SF5 you might hear the odd Plop! sort of sound a small butterfly signature makes a few feet away.

Given the high resolution and sensitivity of the MH Rx other 'things' are detectable. A dew laden cobweb vibrating in the wind or under the movement of the spider or the spiders lunch can register. No doubt other things will come to mind, ripples on water etc.

Construction of the receiver is simplicity itself. Just two ICs and a few components mounted on strip board, a plastic lens a photo detector and a box to stick it all in. Mount the box a frame much like a camera on a tripod, connect phones and battery, 'aim' at the local flower patch or pond, sit back in the deck chair relax and listen to an aphid winging its way to wherever aphids wing their way to on a balmy sunny day.

Sun factor	Amount of Light	Signal strength.
0	No shadow	Nil
1	Very faint shadow	Poor
2	Shadow	Weak but usable
3	Good shadow	Fairly good
4	Strong shadow	Good
5	High contrast shadow	Very good

The detection corridor is determined by the cross - sectional area of the lens and the overall gain of the system. So the aphid winging its way at say, 10 mph, is not going to impress you for long. A hover fly is more entertaining as it generally stays in one place.

If you imagine you are looking down a tube 20 feet long and some few inches in diameter, and an insect can fly from from one side, and out of the other, you might get a better impression of what I mean. Aiming this invisible tube at say a cluster of flowers where the insects are flying in circles then signals are going to be better maintained.

So now we come to the lens, and bearing in mind the comments in the last paragraph, it needs to be a little larger in cross section than your average camera lens. It has also, in photographic optical parlance, got to be a 'fast' lens. Able in other words, to be usable at low light levels.

Now this might sound like a tall order in terms of expense, weight, etc. The lens happily for us, is a cheap plastic one, and low in the weight stakes, and 'fast'. A Fresnel lens, commonly used on overhead projection lamps, varying around 8 to 14 inches square, with a short focus satisfies all the criteria I have outlined. For those of you with a photographic bent, I am talking of an f stop faster than a 1.2 probably less than a ONE, with some of these types of lenses.

A perfect optical focus is not required, a pin photo diode not being so demanding as the human eyeball. Thus saving in cost compared with high resolution glass lenses is achieved.

Deciding on the cross-sectional area of the lens, will determine the size of the housing for it, and the overall bulk of the finished project. I started off with a 13" lens, which I still use, but one can get by quite well with a 5" lens, a considerable saving in the enclosure materials.

Reference to Figure 3 gives you some idea as to the general fabrication of the enclosure, using thin ply, dowel and glue. Build the unit around the lens, after determining the focal length. Focus the sun on a bit of card and measure the distance from the back of the lens to the card, and make a note. Adding roughly a quarter of an inch to this focal length, will give the position for the photo diode.

Fine focus for best results is achieved by adjusting the position of the Veroboard, when mounting inside the enclosure. A target comprising a model electric motor with a 1" tin plate propeller set some 15 feet away (in sunlight SF3 or greater) will provide an ideal focusing and test rig.

Some method of sighting is required, and reference to Figure 2 shows a crude but workable method using basic hardware. Adjust the rear sight using the motor simulator as the target. Once the focusing and sighting arrangements

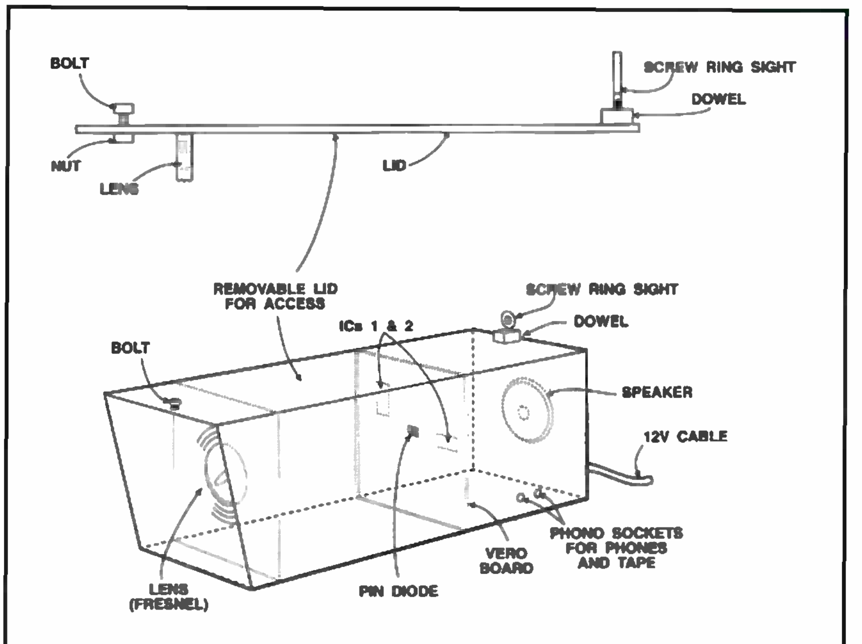


Fig.2 Case details and sighting arrangements

have been made secure with glue and pins to prevent disturbance to these settings.

Build the MH Receiver on an area of Veroboard to fit snugly inside the enclosure vertically as shown, with the photo diode centrally placed on the lens axis. (Figure 2). Recess the lens well back inside the enclosure approximately 2 inches on the base. It is wise to use the MH Receiver in a sheltered place, from inside an open window, under a tree to avoid accidental direct exposure to the sun.

Assembly of the electronics is simple enough, start off with the pin diode mounted in the centre of the strip board and check alignment in the enclosure with the lens axis, the actual mounting of the board on two blocks of dowel for support is the method I used. Commence with mounting the IC socket for IC1 orientated in such a way, that pin 14 is closest to the anode of the pin diode photo detector. Cut away any excess track to avoid stray pick up. If for some reason you want to mount the diode on a pillar, then ensure the lead from the anode is kept short and well screened.

IC2 you can solder straight in to the board, screening the lead if a long run, to pin 3. RV1 can be a preset mounted on the board, adjust for minimum volume consistent with a

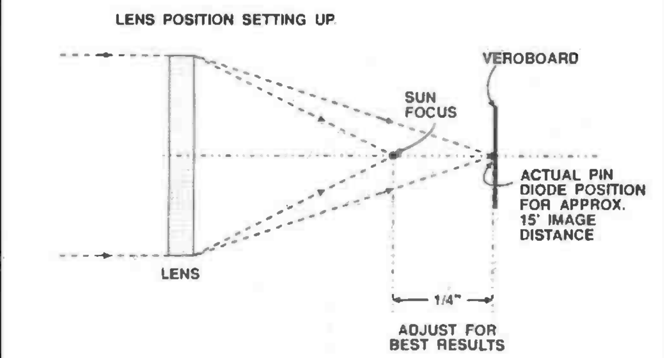


Fig.3 Lens position set up

reasonable level of output.

D1 is for reverse polarity protection for when running this receiver from a battery out in the field or garden etc. The gain of the receiver is around 70db, and like most high gain systems, noise starts to rear its ugly head, especially when we are amplifying what after all is a change of leakage current in a reversed biased diode, a notorious source of noise, which in this application increases with the light level on the diode.

The RC network between pins 11 and 12 of ICI reduce this noise factor somewhat, at expense of bandwidth, C1 being the most critical value, should you wish to experiment. C2 is a decoupling capacitor and is located as near to the IC pins as possible. All resistors are 1/4 watt, all capacitors polyester or min layer types. Headphones are better for this sort of activity, and can be directly connected across the loudspeaker of 16 ohms. RV2 is set to about 80k on the wiper. This provides about the right level for tape recording the various sounds detected. A supporting frame to allow hands free operation is recommended, much along the lines of a camera tripod. I utilised part of an old bar stool with an extended centre column, and mounted a bracket at the top of this to, give azimuth, and tilt capability.

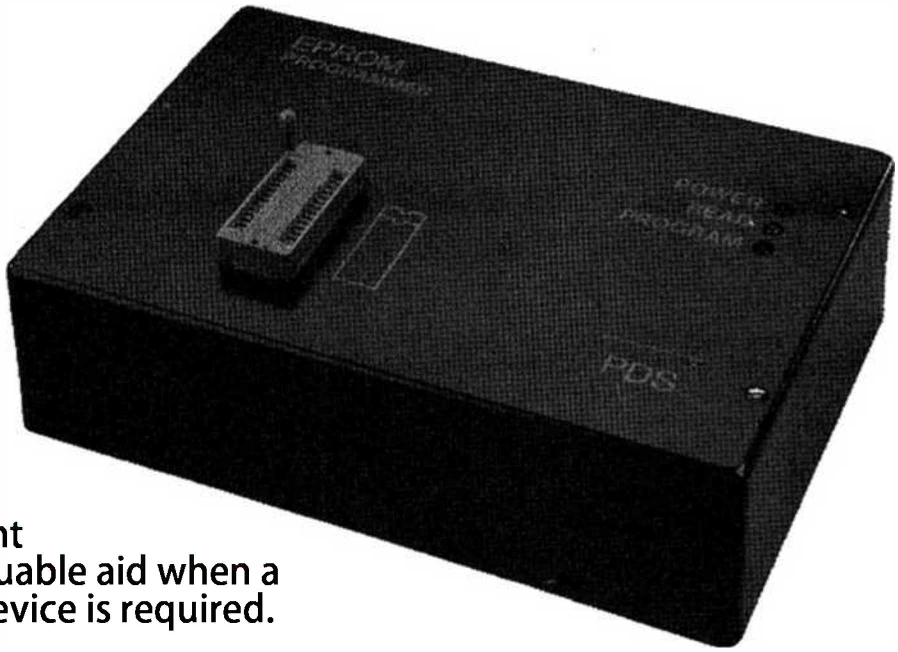
This project would provide a challenge in building over the winter months ready for the forthcoming summer. Take care with cutting the lens down to size, especially if it is the two layer Fresnel type, to avoid getting chaff between the two slices. Clamp together when sawing, then glue round the edge.

Source for lenses: Anchor Supplies, Nottingham. Large (worn round the neck) plastic reading lenses, are an alternative.

Good luck and good hunting.

PARTS LIST

RESISTORS		CAPACITORS		SEMICONDUCTORS		MISCELLANEOUS
R1	100R	C1,2	22u	IC1	TBA2800	LS1 loudspeaker 16R or headphones
R2	270R	C3	2u2	IC2	LM386	
R3	8k2	C4	10n	IC3	LM78L05	
RV1	2k2 log	C5	470n	D1	Photo Diode	
RV2	470k	C6	4n7	D2	1N4148	
		C7	220u			
		C8	1n			



A project as an aid to other projects. Paul Stenning provides an excellent design and an invaluable aid when a pre-programmed device is required.

EPROM Programmer

There has long been a requirement for a cheap straight-forward EPROM Programmer, suitable for occasional home use, without the extra features found on many commercial units. The EPROM Programmer presented here will program the standard 27 family of devices, from 2716 to 27512, and can be used with any computer which has an RS232 serial port. I have avoided the usual "Catch 22" situation of requiring a programmed EPROM to make the EPROM programmer work! This design uses readily available components to reduce the likelihood of obsolescence.

The unit is powered from an external PSU, since this is cheaper than buying the individual parts! One of the low cost unregulated types with an integral mains plug is suitable, providing it is capable of supplying between 10 and 18 Volts. DC at 500mA without too much ripple, the voltage regulator IC21 will run cooler if the voltage is nearer the lower end of this range. The types sold for powering electronic keyboards appear to be the most suitable. The prototype is powered by an old Sinclair ZX81 PSU (type UK.1200).

The programmer itself is dumb and is fully controlled by the host computer via the serial port. Control software can be written in BASIC, and a suitable listing for IBM PC compatible computers is given later. Additional software listings are given for initial testing, and to convert to and from standard Intel-HEX files. A disk is available from the author, containing these programs, as well as comprehensive menu driven control software and a selection of useful utilities, see Buylines for details.

Please note that the programming algorithms used may not be exactly as specified in some EPROM manufacturer's data sheets. Because of this the unit cannot be guaranteed to program every device successfully, however no problems have been experienced to date.

HOW IT WORKS
HARDWARE

The circuit may appear complicated initially, however a comprises of several relatively straight-forward sections. It is not necessary to understand the operation of the circuit to build and operate the unit with the software given, however a good understanding is most useful if you wish to write your own control software.

Note that when a number is followed by an 'h' in the following description, for example 27h, is a hexadecimal number, and when a number is followed by a 'b' it is binary, other numbers are decimal. Any signal name which is followed by a "-", for example STROBE-, is active low, on the circuit diagram this will be shown with a bar over the name.

Useful information on EPROM pin-outs and programming requirements can be found on pages 498-499 of the 1993 Maplin catalogue, the project was designed around this data (note that the Maplin programming information for the 2732 is incorrect).

IC2 and surrounding components generate the Baud Rate dock signal (CLOCK1) for IC3, with the rate selectable by LK1. The CLOCK2 signal is used to produce the programming timing pulses, see later. IC3 is a 6402 "Universal Asynchronous Receiver/Transmitter" (UART). In this application it is configured for 8 data bits, 1 stop bit, no parity checking. Note that unused pin 2 is taken low, this pin is used on the RCA CDP1854 to select standard operation mode, this device is otherwise pin compatible can therefore be used in place of the 6402. IC3 is reset by IC4:A and associated components.

When serial data is received on pin 20 of IC3, is converted to a parallel output on pins 5-12 (R0-R7), and pin 19 goes high. A short time later (set by R4 and C8) pin 18 is taken low, which clears the high on pin 19. The pulse so generated on pin 19 is referred to as the STROBE signal, and indicates to other parts of the circuit that data has been received and is valid.

If pin 23 of IC3 (SEND) is pulsed low, data on pins 26-33 (D0-D7) is transmitted in serial form on pin 25.

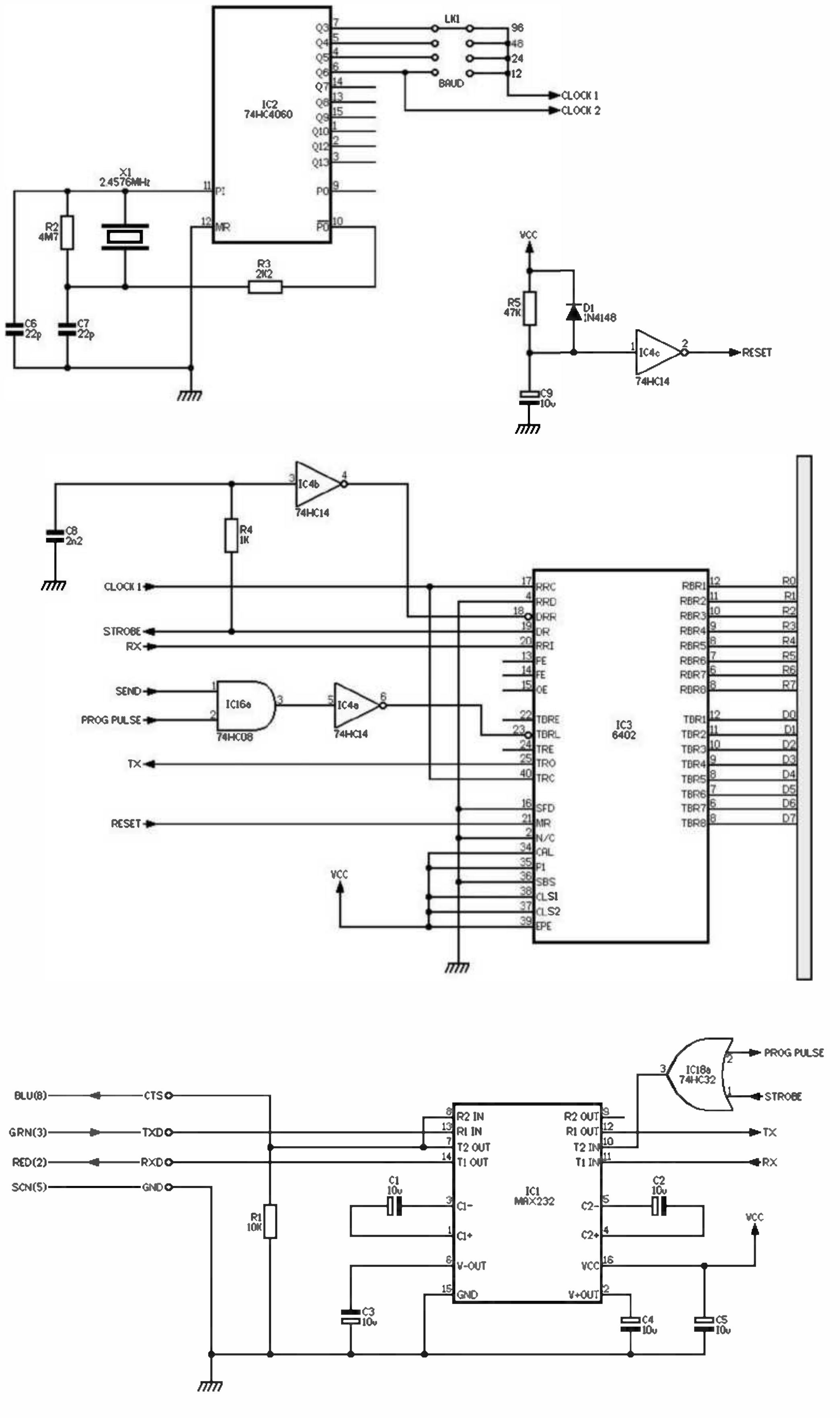


Fig. 1 Serial Interface Circuits

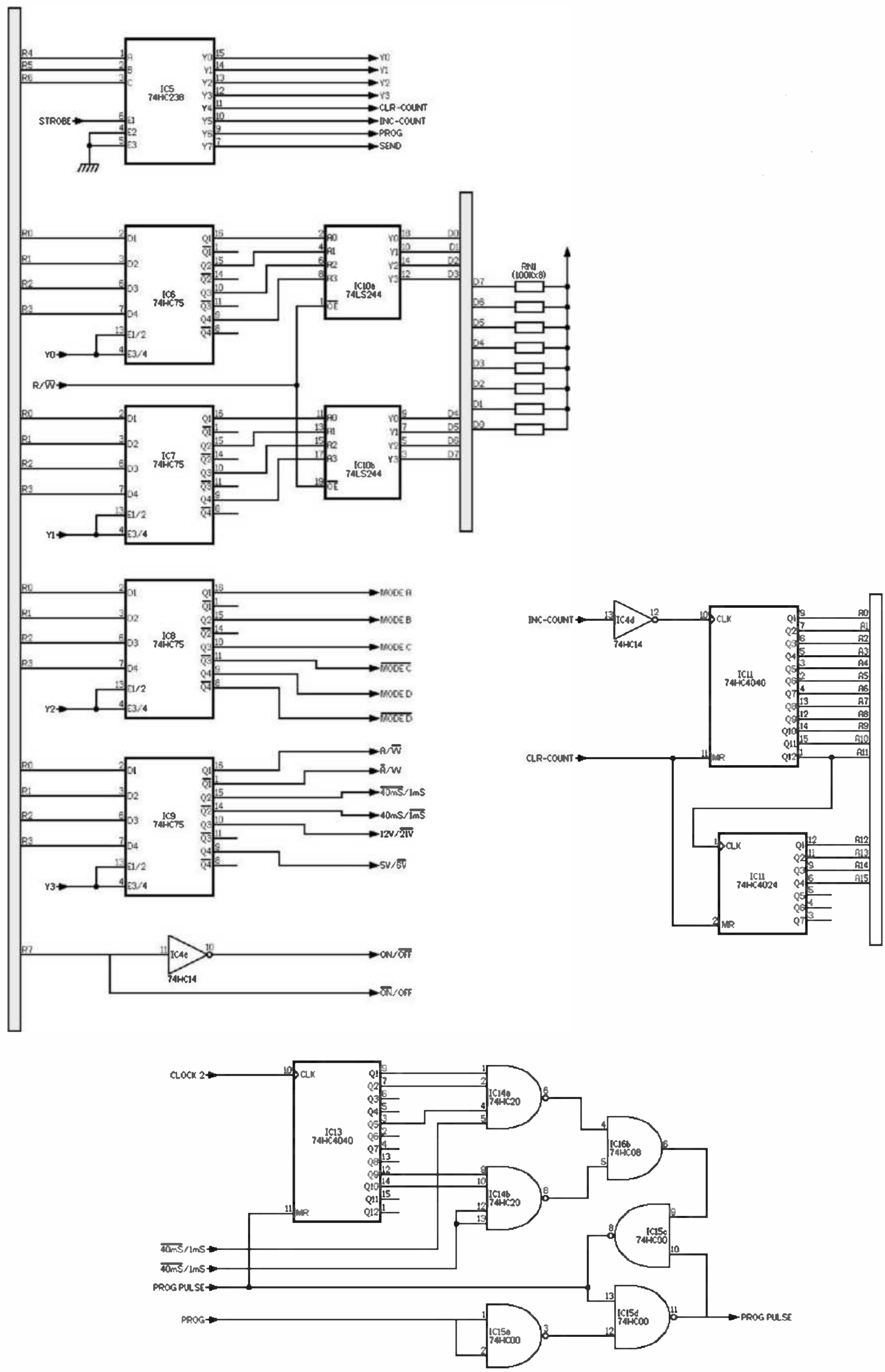


Fig. 2 EPROM Programmer Logic

IC1 is the serial line driver/receiver, which converts RS232 standard serial signals to from standard 5V TTL levels. This IC contains voltage converters to produce the required transmission voltages (9V) from a single +5V supply.

In this application the 8 bit received data is used as 4 data bits on RO-R3 and 4 control bits on R4-R7. 3 of these control lines (R4-R6) are taken to a 3 To 8 Line Decoder, IC5. The STROBE signal is taken to one of the Enable lines on IC5, thereby causing the outputs from this IC to be short pulses. For example, If OOh is received, lines R4-R6 will be low, STROBE will pulse high and consequently pin 15 of IC5 will pulse high and the remaining outputs will stay low.

The remaining control bit (R7) controls the power to the EPROM, when it is high all power is removed from the EPROM socket so the device can be inserted or removed. When the device is being read or programmed this line is taken low.

The 4 data lines are taken to the inputs of 4 Quad D-Type Latch, IC6-IC9. The Latch Enable lines on these IC's are connected to 4 of the outputs of IC5 (Y0-Y3). Data can therefore be stored in these latches by seooing the required data on lines R0-R3 and the latch number (0-3) on lines R4-R6. The data will be continuously available on the latch output lines. Referring back to the previous example, if OOh is received, lines R0-R3 will all be low, and line Y0 will pulse high, storing Oh (0000b) in IC6. Similarly seooing 35h will store 5h (0101b) in IC9.

Latch IC6 is used to hold the least significant nibble (4 bits half a byte) of the data which will ultimately be programmed into the EPROM, whilst JC7 holds the most significant nibble. IC5 holds the EPROM type information (see later), and IC9 holds 4 setup bits. Bit 1 of IC9 controls whether the unit is in Read or Write (Program) mode, bit 2 sets the programming pulse length to either 1 or 40 milliseconds, bit 3 sets the programming voltage to either 12 or 21 volts, and bit 4 sets the supply voltage whilst programming to either 5 or 6 volts. Note that the latches have active-high and active-low outputs, and one or both may be used.

The data outputs from IC6 and IC7 are taken to a tri-state buffer (IC10), which in turn drives the EPROM data lines. IC1 O is controlled by the RN-line, such that it's outputs are enabled in Program mode and tri-state in Read mode.

The EPROM data tines are also connected to the data input lines on the UART (IC3), and the Y7 output from IC5 is connected to pin 23 of IC3 (SEND). Therefore if 70h is received, the data currently on the EPROM Data Lines is transmitted back along the serial interface to the computer.

The EPROM Address lines are controlled by counters IC11 and IC12. These are connected to lines Y4 and Y5 from IC5, and are therefore cleared to 0000h by sending 40h and the count is incremented by sending 50h. This approach is quicker than having to set the actual address each time since it only requires one byte to be sent along the serial link.

Line Y6 from IC5 (PROO) is used to start a programming pulse. The programming pulse (either 1ms or 40ms) is produced by dividing down the CLOCK2 signal. This signal has a frequency of 19.2kHz (24576MHz divided by 128), which equates to a period of 52.1us. This is fed to counter IC13, which is normally held reset by the Set Reset flip-flop built from IC15c and IC15d. When the PROG line pulses high the flip-flop changes state and the counter starts counting the CLOCK 2 pulses. If a 1ms pulse is required, pin 5 of IC14a will be high and pins 12 and 13 of IC14b will be low. When the count reaches 19 (52.1us x 19 = 989.9us), all the inputs of IC14a will be high, it's output wit therefore go low, changing the state of the flip-flop again via IC16d, and resetting the counter. A 0.99ms pulse will therefore be present on the output of the flip-flop, 0.99ms being well within the 1ms +/5% specification. If a 40ms pulse is required IC13 counts 768 CLOCK2 pulses (52.1us x 768 = 40.01ms).

The PROO PULSE and STROBE signals are coupled via IC18a and IC1 to the RS232 CTS (Clear To Send) line. This prevents the host computer from sending further data whilst a program pulse is programming while STROBE is still high. This means that data can be sent as fast as possible and no delays are needed in the software.

PROG PULSE- ls coupled with the SEND signal to IC3 by IC16a. This prevents the SEND signal getting through whilst PROG PULSE· Is low. This situation will never occur in normal use, however during initializations the software requests a 40ms program pulse immediately followed by a SEND. If the RS232 CTS line is present and working then data will be sent, since the CTS line win stop the computer sending the SEND request until after the program pulse has finished. If CTS Is not working the SEND request will be sent immediately but no data will be returned due to JC16a stopping the SEND pulse reaching IC3. The software notes the lack of received data, prints a warning and then adds delays to allow for the program pulse. You should by to get CTS working properly as there will be a significant speed penalty otherwise.

We now come to the connection switching required for the different EPROM types. The table below shows the pin-outs for the 6 types of EPROM this unit will program. 2716 and 2732 are 24 pin devices and fit Into pairs 3 to 26 of the EPROM socket, the pin-outs shown below relate to the socket not the device.

PIN	2716	2732	2764	27128	27256	27512
#1	**	**	VPP	VPP	VPP	A15
2	**	**	A12	A12	A12	A12
3	A7	A7	A7	A7	A7	A7
4	A6	A6	A6	A6	A6	A6
5	A5	A5	A5	A5	A5	A5
6	A4	A4	A4	A4	A4	A4
7	A3	A3	A3	A3	A3	A3
8	A2	A2	A2	A2	A2	A2
9	A1	A1	A1	A1	A1	A1
10	A0	A0	A0	A0	A0	A0
11	D0	D0	D0	D0	D0	D0
12	D1	D1	D1	D1	D1	D1
13	D2	D2	D2	D2	D2	D2
14	GND	GND	GND	GND	GND	GND
15	D3	D3	D3	D3	D3	D3
16	D4	D4	D4	D4	D4	D4
17	D5	D5	D5	D5	D5	D5
18	D6	D6	D6	D6	D6	D6
19	D7	D7	D7	D7	D7	D7
#20	CE/PP+	CE/PP-	CE	CE	CE/PP-	CE/PP-
21	A10	A10	A10	A10	A10	A10
#22	OE	OE/VPP	OE	OE	OE	OE/VPP
#23	VPP	A11	A11	A11	A11	A11
24	A9	A9	A9	A9	A9	A9
25	A8	A8	A8	A8	A8	A8
#26	VCC	VCC	NC	A13	A13	A13
#27	**	**	PP-	PP-	A14	A14
28	**	**	VCC	VCC	VCC	VCC

** = No Pin
NC = No Connection
PP+ = Program Pulse, Positive Going
PP- = Program Pulse, Negative Going
OE = Output Enable (Active Low)
CE = Chip Enable (Active Low)
VPP = Programming Voltage
VCC = Supply Voltage
GND = Ground (0V)

It can be seen from the above that most of the pins are the same for all devices. Only 6 pins require special attention, these are 1, 20, 22, 23, 26 and 27, and are marked with a '#' next to the pin number.

The four MODE lines from IC9 control the function of these six pins and are set up by the software to suit the EPROM type required. Note that two of the active-low levels are also used. The table below shows the logic levels on each of these lines, for each of the 6 types of EPROM, together with the code that needs to be sent to select that type.

EPROM TYPE	A	B	C	C-	D	D-	SETUP CODE
2716	1	1	1	0	1	0	2Fh
2732	1	0	1	0	0	1	25h
2764	1	1	0	1	0	1	23h
27128	1	1	0	1	0	1	23h
27256	1	0	0	1	0	1	21h
27512	0	0	0	1	0	1	20h

(MODE LINE spans columns A to D-.)

I will now describe what this means for each type of EPROM

2716:
PIN 1: not used.
PIN 20: MODE B and MODE D are both high, so IC17b pin 6 remains high, IC16c pin 8 follows PROG PULSE, as does IC17c pin 8 which is coupled via 06 to PIN 20. PIN 20 is only pulled up in Program mode, so in Read mode it is permanently low.
PIN 22: MODE A and MODE D are both high, so IC15b pin 6 is low and 01 and 02 remain off. R-/W is coupled to the pin via 02.
PIN23: MODE D is high, so Q5 and Q6 are on, coupling VPP to PIN 23.
PIN 26: MODE C is high, so Q7 and Q8 are on, coupling V+ to PIN 26.
PIN 27: not used.

2732:
PIN 1: not used.
PIN 20: MODE B and MODE D are both low. IC16c pin 8 will remain low and U17:B pin 6 will follow PROG PULS. IC17c pin 8 will therefore be PROG PULSE inverted, and is coupled via 06 to PIN 20. PIN 20 is only pulled up in Program mode, so in Read mode it is permanently low.
PIN 22: MODE D and MODE A is high, so IC15b pin 6 is high. This switches on 01 and 02, coupling VPP to PIN 22
PIN 23: MODE D is low, so Q5 and Q6 remain off. A 11 is coupled to PIN 23 via 04.
PIN 26: as 2716.
PIN 27: not used.

2764 and 27128:
PIN 1: MODE A is high. This switches on 03 and 04, coupling VPP to PIN 1.
PIN 20: MODE B is high and MODE C is low. IC16c pin 8 remains low and U17:B pin 6 remains high, therefore IC17c pin 8 remains low.
PIN 22: MODE A and MODE C are both high, so IC15b pin 6 is low and 01 and 02 remain off. R-/W is coupled to PIN 22 by 02.
PIN 23 : as 2732.
PIN 26: MODE C is low so 07 and QB remain off. A13 is coupled to PIN 26 by 05. Note that in a 2764 EPROM there is no conection to PIN 26.
PIN 27: MODE B is high and A14 will remain low since it is outside the addressing range. IC17d pin 11 will therefore follow PROG PULSE.

27256:
PIN 1: as 2764.
PIN 20: as 2732.
PIN 22: as 2764
PIN 23: as 2732
PIN 26: as 2764
PIN 27 - MODE B is low so IC16 pin 11 will remain low. IC17d pin 11 will follow A14.

27512:
PIN 1: MODE A is low so Q3 and Q4 will remain off. A15 is coupled to PIN 1 by 03.
PIN 20: as 2732.
PIN 22: MODE A is low so IC15b pin 6 will be high, switching on Q1 and Q2, coupling VPP to PIN 22.
PIN 23: as 2732.
PIN 26: as 2764.
PIN 27: as 27256.

Note that D6 and D7 are germanium types, since silicon types would cause the logic 0 inputs to the EPROM to be at the limit of the specifications.
The two logic gates which would otherwise be unused, are used to control Read and Program LED's. IC18b pin 6 goes low when R-/W and ON-/OFF are both low, lighting 09 (Read) via 010, whilst IC18c pin 8 goes low when R/W and ON-/OFF are low, lighting 08 (Program) via 09. When both LED's are off it is safe to fit or remove the EPROM, the other lines would have been set low by the software before taking ON-/OFF high.
IC21 is the main 5 Volt regulator and powers all the logic IC's. D11 protects the whole circuit against reverse polarity, since it is easily possible to reverse the polarity on the sort of PSU used. LED D10 indicates that the unit is powered up.
IC20 supplies the power to the EPROM, and is enabled by the ON/OFF- line via Q17 and Q18. Q19 raises the GND pin of IC20 by 1 Volt, giving 6 Volts. When 5 Volts is required Q19 is shorted out by Q20 controlled by IC18d, this happens when 5V/6V or R/W- is low.
IC19 is a step-up switching regulator which produces the programming voltage required. The voltage is set by shorting out sections of the resistor chain with transistors. 2716 EPROMs require 25 Volts, not 21 Volts, so the MODE D- line is used to set this. The R-/W line controls Q15 and Q16 which connect the power to the EPROM when the unit is in Program mode.

PARTS LIST

RESISTORS (all 1/4W 5% or better)

R1,6-19,27-33,36-38,41,42	10k
R2	4M7
R3	2k2
R4	1k0
R5	47k
R20,21	22k
R22,23,40	330R
R24	0R47 (or 2 x 1R0 in parallel)
R25	1k2
R26	8k2
R34	5k6
R35	1k5
R39	470R
RN1	100k x 8 SIL resistor network
RV1	470R or 500R horizontal preset
RV2-4	4k7 or 5k0 horizontal preset

CAPACITORS

C1-5,9,15,16	10µ 16V radial
C6,7	22p 0.2" pitch ceramic
C8	2n2 0.2" pitch ceramic
C10	220p 0.2" pitch ceramic
C11	470n 0.2" pitch
C12	47µ 35V radial
C13	47µ 16V radial
C14,17	1µ0 16V radial
C18-20,22-27	100n 0.2" pitch
C21	220µ 25V radial

INDUCTORS

L1	470µH 2.3A bobbin type

SEMICONDUCTORS

IC1	MAX232
IC2	74HC4060
IC3	6402
IC4	74HC14
IC5	74HC238
IC6-9	74HC75
IC10	74LS 244
IC11,13	74HC4040
IC12	74HC4024
IC14	74HC20
IC15	74HC00
IC16	74HC08
IC17,18	74HC32
IC19	TL497
IC20,21	7805
Q1,3,5,7,15,17	ZTX750/751/752
Q2,4,6,8,13,14,16,18-20	BC547/548/549
Q9-12	BC557/558/559

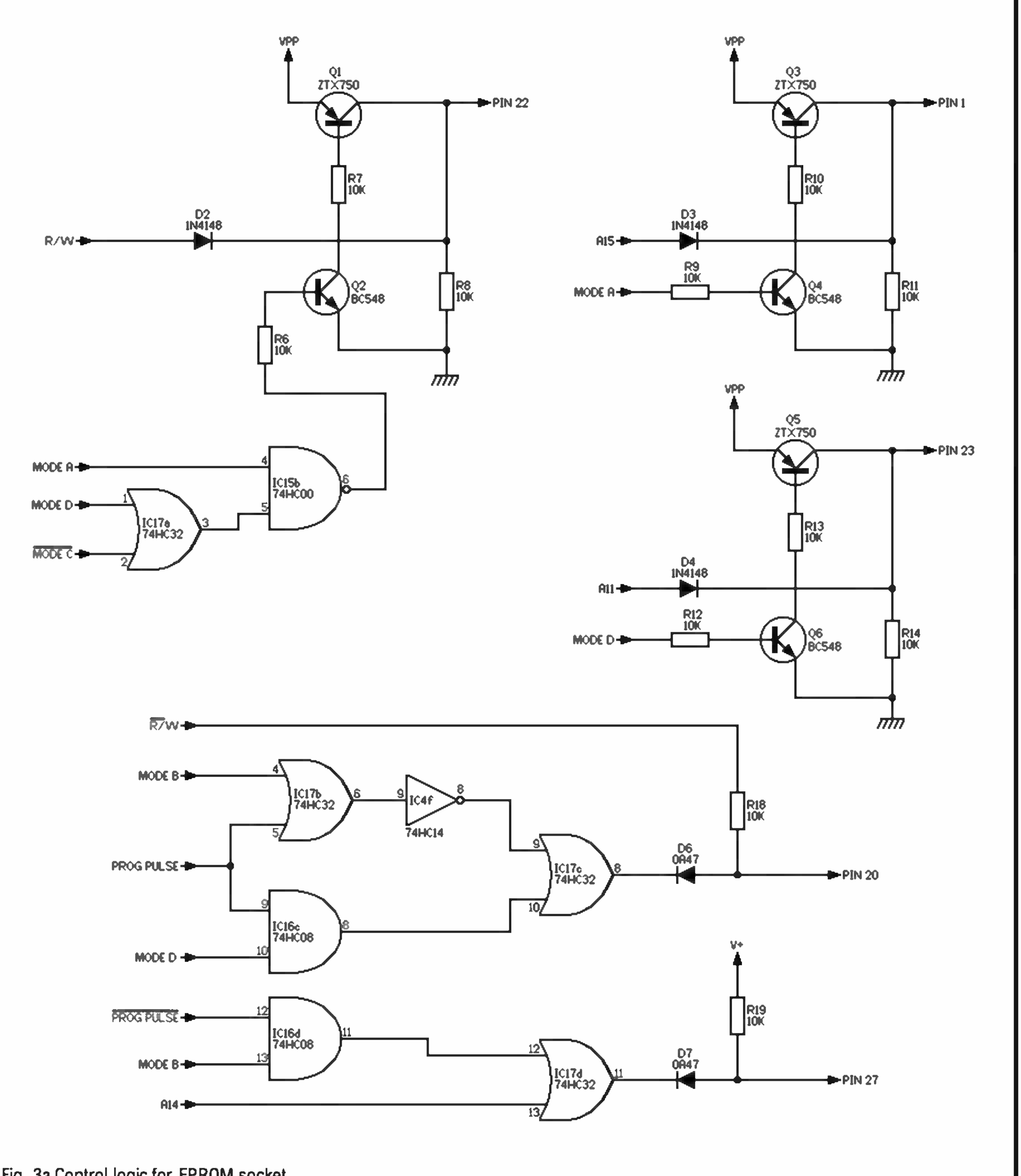


Fig. 3a Control logic for EPROM socket.

D1-5 1N4148 silicon signal diode
D6, 7 0A47 germanium signal diode
D8 Red LED
D9 Yellow LED
D10 Green LED
D11 1N4001

MISCELLANEOUS

SK1 28-way ZIF Socket
XT1 2.4576MHz crystal

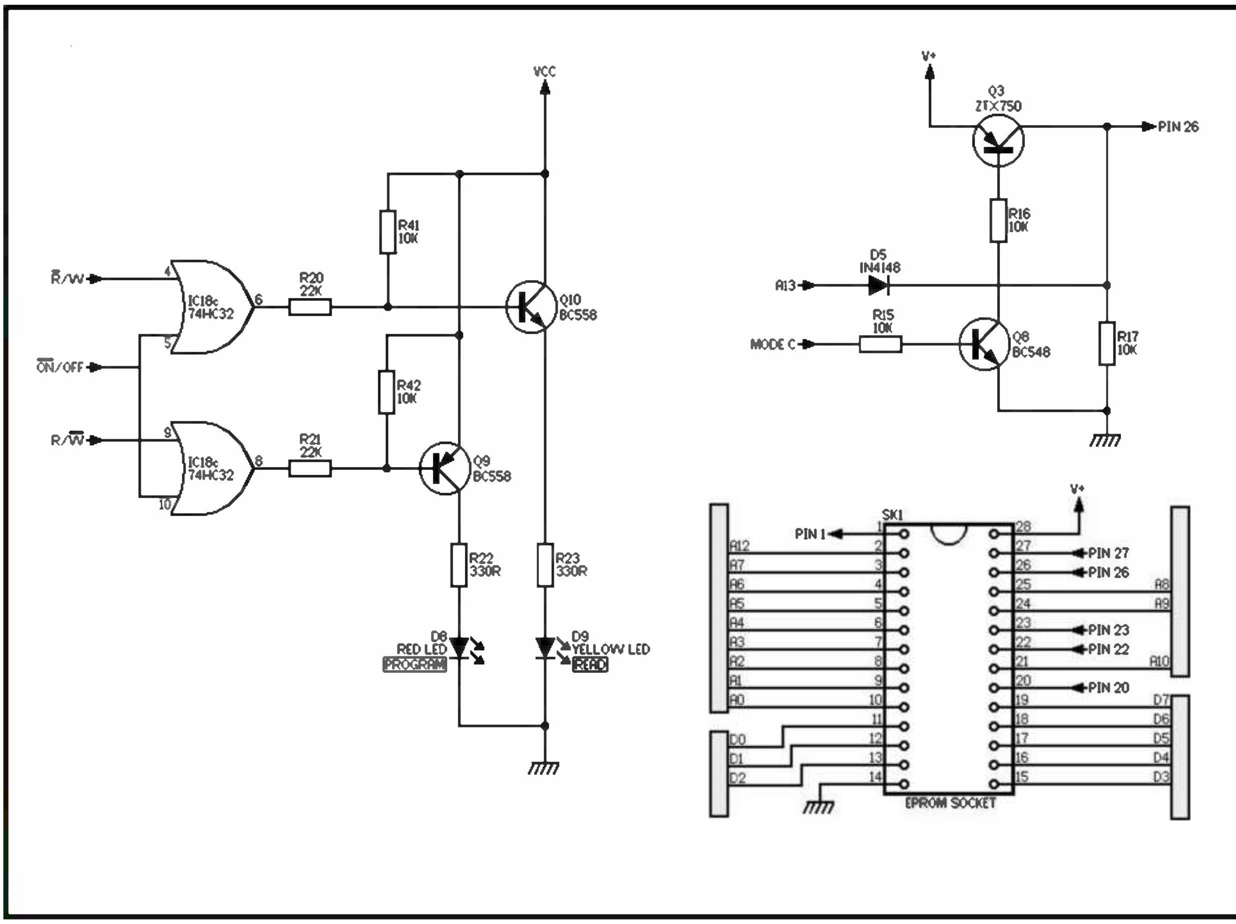
Power Supply (10-18V DC@ 500mA), DIL IC sockets (1 x 40 way, 1 x 14 way and 3 x 28 way), Heat sink for IC21, PCB, Case type MB6, M3 hardware, Connectors for power and RS232, Veropins, Tinned copper wire (24SWG) or through-PCB pins.

BUYLINES

All components are available from Maplin, the majority can probably also from your usual supplier. Small 0.47R resistors do not appear to be readily available. use two 1R0 components in parallel. The PCB will be available from the ETI PCB service, next month. Before purchasing a power supply, check the latest bargain list from Greenweld (0703 236363), they often list suitable units for about £3.

The software listed in this article, together with a comprehensive menu driven control program and some useful bits and pieces (IBM PC or compatible only) is available from the author at the following address: Paul Stenning, 1 Chisel Close, Hereford, HR4 9XF. Please send a blank PC formatted disk (3.5" or 5.25'), together with a cheque or postal order for £10, a return address label and adequate return postage (overseas 2 International Reply Coupons). If you do not have a disk send £12 and I will supply one (please specify size). BAE.C. members see newsletter for a special offer!

The author would also be interested to hear from users of other computers who have either written suitable control software or who are looking for some - he will attempt to put one in touch with the other! Please write with an SAE.



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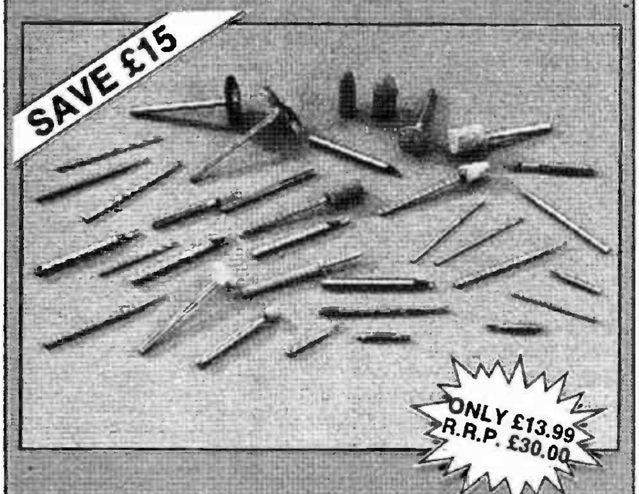

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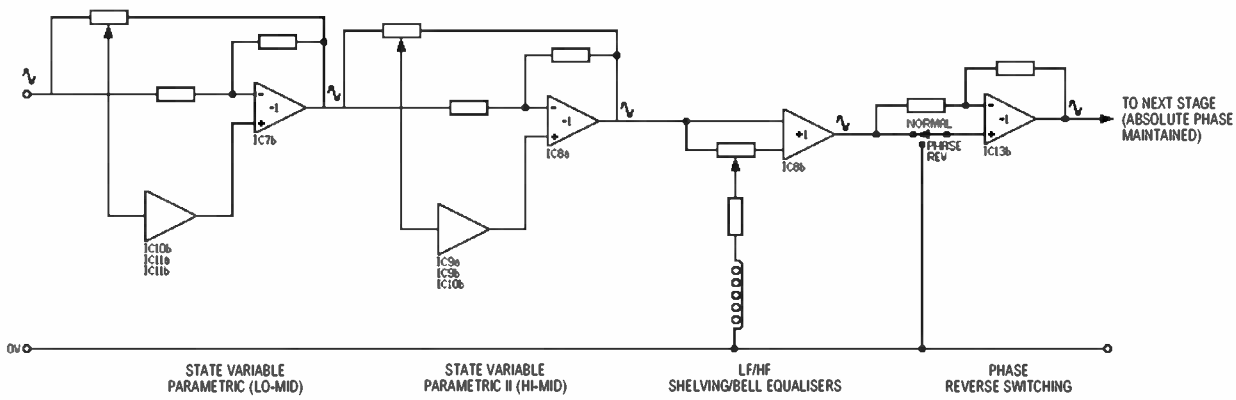


Fig.6 Block schematic of EQ phase manipulation through equalisation.

Automate Anniversary Mixer

PROJECT

This month, we weigh up the pros and cons of the different designs used in the Equaliser.

HPF BREAK FREQ. (Hz)	R(freq.) (R56,R57)	Rpreferred
20	22.1k	22k,100R
30	16.1k	16K,100R
40	12.05k	12k,56R
50	9.64k	9k1,560R
60	8.0k	7k5,560R
80	6.03k	6k,27R
100	4.82k	4k7,120R
120	4.02k	3k,10R
140	3.44k	3k,430R
160	3.01k	3k,10R
180	2.68k	2k4,270R
200	2.41k	2k4,10R
220	2.19k	2k2
240	2.1	2k0

LF BREAK FREQ. (Hz)	R91 (calculated)	R91,R106 (preferred)
30	780k	750k,30k
35	670k	620k,50k
40	585k	560k,24k
45	520k	510k,10k
50	470k	470k,link
55	425k	390k,33k
60	390k	390k,link
65	360k	360k,link
70	330k	330k,link
75	310k	300k,10k
80	290k	270k,22k
85	270k	270k,link
90	260k	240k,22k
95	245k	240k,5k1

Fig.7 (Table 2) Discrete resistor values for active filter sections (LF).

You've probably been wondering what happened to some of the diagrams mentioned in part 8. I think that the very mention in the opening paragraphs of Steven Spielberg brought every Gremlin in the vicinity out of the woodwork to bear upon last month's installment! Space restrictions meant that we had to undertake some open-heart surgery on that particular episode (so that it would fit into the magazine) and regrettably, the missing diagrams were part of this surgery. The gremlins (aside from those already mentioned) seem to have been on piece rate because the How It Works of the HF equaliser section was omitted. Quell barbe! All of the aforementioned means that any interested parties - there are still some of you left out there, I hope will have to constantly refer to last months issue. (You have still got last month's ETI ...). I went on at some length in last month's issue about the importance of retaining absolute phase throughout the system and the text mentioned an absolute phase restorer pre-EQ. The original design was implemented as described but combining both parametric sections in one Baxandall summing stage did give some headaches especially when both stages were set to similar frequencies.

With a bit of lateral thinking (and some nifty redesign work), the summing section for the low-mid parametric was , transferred as per the circuit diagram to the op-amp IC9b previously-described as the 'absolute phase restorer'. In this way, the inverting action of this stage was used 'construc-tively' as it were to separate the two parametric sections and so prevent interaction (though the EQ overall still retained the necessary in-phase response).

Volunteering an Op-Amp for the Job

Okay, so much for the error round-up. This month, we'll be looking at some of the problems which had to be surmounted during the design of the EQ.

The choice of op-amp was a difficult one. With so much written in previous issues about the subjects of both op-amps and equalization, all should have some idea of the attributes necessary of such a device in this application. Key requirements are, of course, high gain/bandwidth product, fast slew rate, low noise and a reasonable current sourcing output stage. Absolute noise internally generated by the semiconductor is a lesser consideration because the noise floor has been determined by the choice of circuitry in earlier stages, but the final choice of op-amp shouldn't worsen unduly the noise performance of the equalization stages.

At first, the TLO series of FET op-amps looked attractive in many ways. This would have seemed to have been particularly true of the TL074 type this four op-amps in a single package IC would have allowed one whole stage of EQ within a single IC. Noise performance is reasonable for such an application because, as previously shown, the noise floor has already been determined by the previous input stage. FET architecture means that bias currents are usually very low and so DC offsets are minimized.

This is important because an obvious requirement is for the EQ to be switched in or out of circuit for purposes of comparison etc and any DC present as we switch between the 'wet' and 'dry' signal paths will impinge itself upon the audio as a click. Output stage current sourcing capability - necessary for the integrators - is also reasonable with this family of chip.

The only down-point is that the device has a rather disappointing gain/bandwidth product - 3MHz - which is somewhat limiting to good high level, high frequency performance, a major pre-requisite for any high quality EQ. I have therefore used dual op-amp packages which make for a less tidy layout than the quad package but can yield better flexibility.

This is the case because the specification calls ostensibly for the fitting of the NE5532 dual bipolar op-amp in the key areas of the EQ. The TL072 is used as a summer where performance is less critical and DC offset reduction is of greater importance. Using dual package op-amps - as opposed to the quad type of the TL074 means that we can interchange between the two types, fitting all of one family - bipolar - or all of the other - FET - if so desired or the application demands greater performance in one aspect. To the best of the author's knowledge, there are as yet no good quality quad bi-polar op-amp packages available at reasonable cost although I stand to be corrected on that one.

In simple terms, this means the user fitting FET op-amps where click elimination is of paramount importance and fitting bipolar types where the requisite is for good performance up to and beyond HF. Good performance is a relative term and it should not be thought that overall performance in any aspect is compromised by the fitting of a particular type - with both types, it is excellent in all aspects and the difference is basically a paper one- ie visible on a spec. sheet but not audible.

Options, Options, Options!

Various options have also been included for your delec-tation. Whether or not they are to be included on your version depends upon the importance-versus-cost-considerations that you place upon such items. Without wishing to sound like an out-of-work advertising copywriter or a frustrated estate agent, these include a switchable high pass filter with fixed or sweepable centre frequency, an LF equalizer with switchable bell or shelving characteristics and variable turno-ver frequency and an HF equalizer also with variable turnover frequency and bell or shelving response, all available with easy-payment plans! I saw no good reason for *not* including them and to configure them out of circuit, whether permanently or until such times as money permits their inclusion, is but a trivial operation with a soldering iron and a few wire links or resistors. Both of these sections (LF and HF) are extremely flexible and as such, extremely useful, too. They are both sufficiently innovative to be called 'original' which is no mean feat in an audio environment plagued by copies and modifications of existing, proven designs. This is not to say that I have not done the same thing myself but an 'own-design', especially in the world of mixing desks, helps to avoid any impending accusa-tions of AUDIO piracy in the courts! As far as the question of whether any or all of the options should be fitted, cost is not the only consideration here. A basic two band shelving and two band full parametric, able to be switched in and out as required, needs a minimum of eight knobs and one switch. Making the LF frequency variable, with switchable bell or shelving responses, and the HF control with variable slope adds another two rotary controls and a switch to our already-swollen ensemble of controls. (It would have been nice to have had the HPF In/Out switch back-stop operated as an integral part of the frequency pot but dual-gang pots with switches proved impossible to find).

FREQ.	CALCULATED C	PARALLEL C(preferred)
2k	36n	33n,3n3
2k5	29n	27n,2n2
3k	24n1	22n,2n2
3k5	20n67	18n,2n7
4k	18n1	18n,100p
4k5	16n1	15n,1n2
5k	14n5	12n,2n7
5k5	13n1	12n,1n2
6k	12n1	12n,100p
6k5	11n1	10n,1n2
7k	10n3	10n,330p
7k5	9n6	8n2,1n5
8k	9n0	8n2,820p
8k5	8n5	8n2,330p
9k	8n	6n8,1n2
9k5	7n6	7n5,100p
10k	7n2	6n8,390p
12k	6n0	5n6,390p
14k	5n2	4n7,470p
16k	4n5	3n9,560p
18k	4n0	3n9,100p
20k	3n6	3n6

Fig.8 Table of values for HF equaliser.

Space - The Final Frontier?

Fitting all of the different controls physically onto the panel without ending up with a channel strip which requires the arms of a gorilla to operate the furthermost control - is a conspicuously difficult task. Commercial designers can specify to the pot suppliers that they need x amount of dual concentric triple-gang 50k anti-log pots with integral push-on/push-off

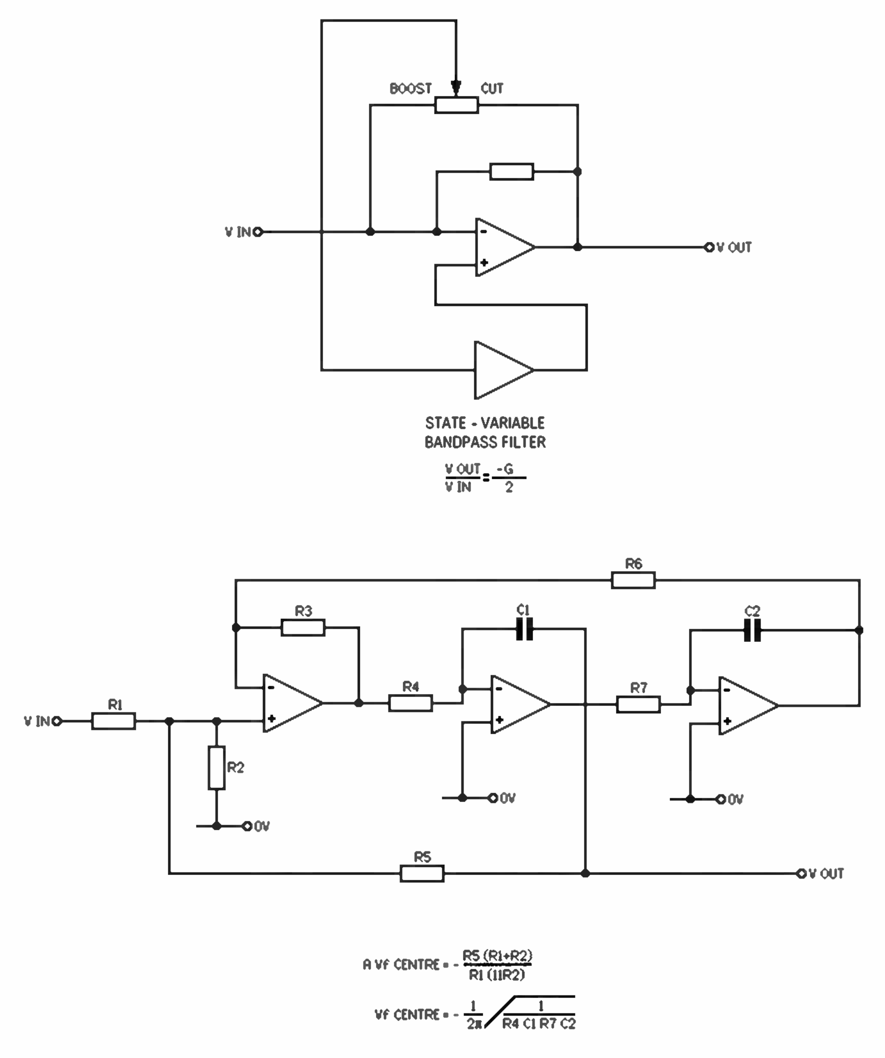


Fig.9 Parametric EQ sections on schematic form.

switch and an auxiliary switch - you know the type, they prevail on car radio cassette players. These are able to be moved simultaneously in about four different axes of movement, and can control volume, balance, fader, on/off and space and time functions all from one rotary shaft! In this way, two controls can be piggy-backed one on top of the other (normally Q and centre frequency in the case of equalisers), with a corresponding saving in valuable physical panel space. The plebeian DIY designer, on the other hand, doesn't, have this avenue of escape open to him/her and so must struggle with what he/she's got, fitting all separate pots and discrete switches in as tight a squeeze as possible. Anyway, that was MY problem!

The inclusion of TWO insert points (nothing to do with an acupuncturist's map) - both pre and post EQ - might be intriguing to some of our slightly more au-fait readers perhaps used to seeing just one insert point - the pre-EQ one in the channel strip.

The whole subject of dynamics will be covered at a later date. As far as we are presently concerned, however, it relates t the channel as a completely entity in that we have to decide where in the audio pathway we may wish to externally process the signal. Again, from a commercial point of view, wishing and having are two completely viewpoints. Next month, we'll show diagrams of the points in the signal pathway where we may wish to access audio and conversely the points where normally we actually CAN in many commercial products. The money which was saved by not including any internal dynamics control bas been put to good use - for a cost of about £0.80 per channel, it has been used to provide another insert point at a post EQ stage. This is a definite rarity but it is a most useful facility to have. For this to be so, we only have to cast our minds back a few months to what I said about over-zealous use of the EQ and the fact that this very quickly robs the whole channel of headroom. Being able to access the channel Post EQ means that equalization produced transients can be controlled with an external gain control of good pedigree. In this way, the gain of the whole channel can. in effect, be controlled. For the sake of a couple of drive amps - a luxury, really - and a jack socket, I cannot see why it is not. included on more desks hovering around the mid price range. The pre-EQ insert point 1s the more usual one to have. To think of it more as a POST FRONT-END or POST INPUT ST AGE gives a better clue to the kind of use to which it's normally put A dynamics processor, for example, can be inserted here and used to control signals which are periodically unruly and may cause the channel to clip at a later stage - the channel gain control has been set for the average signal level (so that signal-to-noise ratio is good) but it can't cope with transient extremes. Any close mic'd drum kit or other percussive section is bound to output signals which are strongly transient in nature and a bass guitar, especially if it has been Direct Injected has a very wide dynamic range. Sibilance or plosive from vocalists' microphones can also cause annoying momentary overloads and these, too, can be controlled.

Gain control can also be used for creative (rather than corrective) measures, enabling a voice which is perhaps lacking in certain registers to maintain a reasonably constant loudness level out of the recorder or it may be used to 'tighten up' up' a bass guitar or bass drum. Bass guitar is a good example to quote, as it transpires. Although many (or most) bass guitarists will want their sound directly injected, some engineers prefer to mike the guitar, too. Direct injection bass will be clear and pure but will lack forcefulness (known in the trade, somewhat vulgarly, as 'balls') while miked bass is usually too boomy and lacks clarity. It is therefore necessary to input the dynamic range of the bass guitar on two channels.

Other FX processors such as noise gates or expanders may be used. As the insert point is almost invariably post High Pass Filter -as in the Automate - any high level LF such as rumble or air conditioning burble can be effectively removed before it can cause spurious triggering of the processor.

HOW IT WORKS
LF AND HF EQUALISER

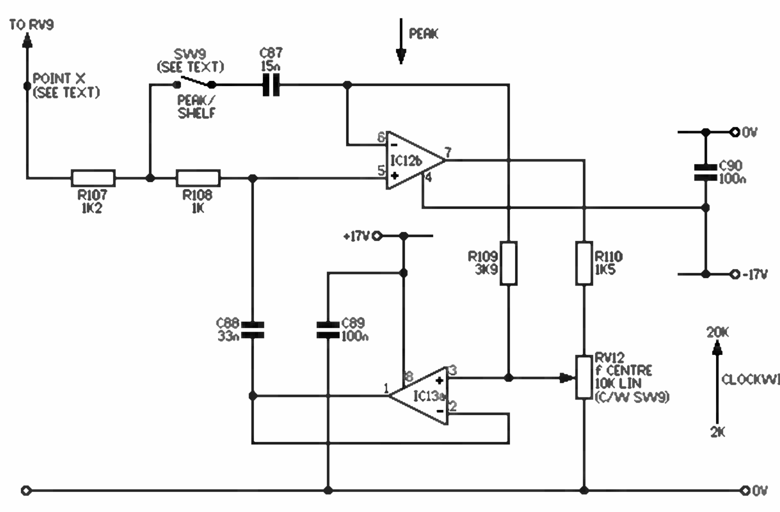
It is useful to have a bell type equaliser at the low end of the spectrum since It means that boost to bass frequencies, can be given without increasing lower frequency intrusions or disturbances such as air-conditioning burble, mic handling noise or platter rumble. I have included also graphs of the boost/cut responses with an ideal control law as well as those from the 10k pots used. (Figs. 11d,13b). It can be seen that the control has slightly more effect at the extremes of rotation. This is caused by the loading effect of the (relatively) low value pot -which has been used to minimise Johnson noise as much as possible but in practice, the effect is barely noticeable. Larger value pots - 10k say-would minimise this to a certain extent, at the expense of slightly worse noise performance. If the individual wishes to fit this larger value, It will mean wading through a horrendous amount of maths to re-jig identical responses. C'est la vie!

The HF equaliser is another unusual and rather unconventional type. It uses a circuit arrangement which in shelving mode, is, in essence, the reciprocal of the LF control although such a function cannot be yielded simply by transposing the positions of the resistors and capacitors. It incorporates an unusual modification to the shaping of the curve through the addition of the capacitor to the network which can be switched IN or Out as required using SW9 {which will normally be part of RV12 when this is fitted). The turnover frequency can be changed by varying the effective capacitance to ground using a variable bootstrapping technique centered around IC13a. This arrangement, by virtue of the way that current magnitudes are altered around the loop, changes the effective value of the capacitor from 3n3 at the most clockwise setting (max frequency) of RV12 to 33n at its minimum setting. The break frequencies can be determined as follows:

$$F_{corner\ low} = \frac{1}{2\pi(R107+R108)C88_{effective}}$$

$$F_{corner\ high} = \frac{1}{2\pi(RV9+RV107+R108)C88_{effective}}$$

The value of C88 has been chosen to give a noticeable change in subjective character of the sound without excessive colouration. It allows the generation of more steeply rising 'boost' curves than is usual with this type of control since it sharpens the corner of the curve. While It cannot be described as a true 'bell' type response, nonetheless, It has the potential to produce greater subjective. brightness enhancement than a conventional shelving equaliser.



Section of Automate 4 band equaliser (HP Shelf/Peak).

Phew! The response curves shown in Figure 11 show far more elegantly what all of this means.

There is available the option to fit an inductor into the network in the arrangement shown in Figure 14a. This does achieve the desired bell response at the expense of using an inductor {with some of its associated problems). In some ways, this is a better arrangement than the previous switched capacitor type. Switching the capacitor into circuit achieves the bell resonant type response, again with C88 arranged effectively as a variable capacitance to ground. The diagram in Figure 14a shows just what all this means while Figure 11a gives the response curves. It is left to the individual's discretion as to which of the two is the more preferable as regards desired response. Should the frequency determining pot RV12, be omitted from the finished board, the break frequency is determined using C88 tied to ground directly (avoiding the use of IC13a), with a value chosen from the table in Figure 8. A typical arrangement is shown in Figure 14b. Each of these two equalisers are then arranged as variable admittances to ground in the so-called swinging input style cut and boost arrangement of IC8b. C77 and R94 minimise clicks on the output as SW6 is operated. Again LED 5, 6 and associated components provide an optional indication of EQ IN and PHASE REVERSE respectively.

PARTS LIST

HIGH PASS FILTER/PHASE REVERSING SWITCHING

Resistors (all 1/4W unless otherwise stated)

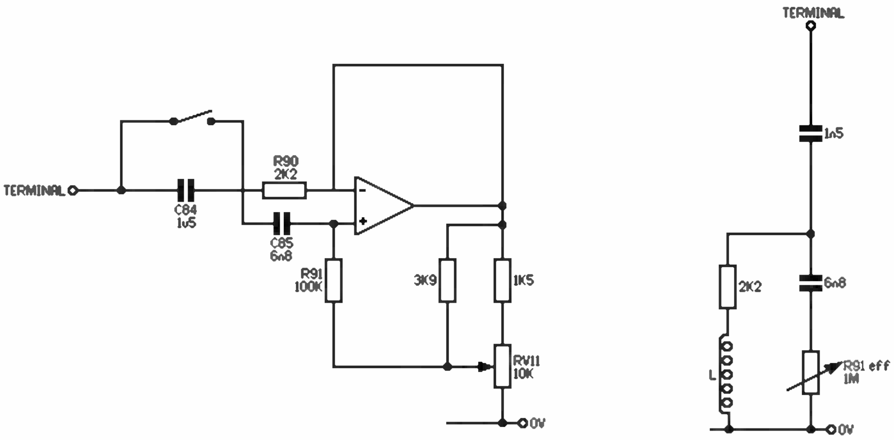
R53,67	1M
R54,55	2k (or see Table 1)
R56,65,66	10k
R57	6k2
R58	1k
R59,60,63	22R
R61,66	1k
R62,64	100k
R111	1k5 (optional - see text)
R112	47k (optional - see text)
RV2 (optional)	20k dual miniature PC mounting (with switch)

CAPACITORS

C46,55,57	4u7 non polarised
C47,54,56,58	100n polyester
C48,49	330n polyester
C50,51	100n disc ceramic
C52	47p polystyrene
C53	100u 40V miniature radial non polarised
C59	22p polystyrene
C91	4u7 25V radial electrolytic (optional)

SEMICONDUCTORS

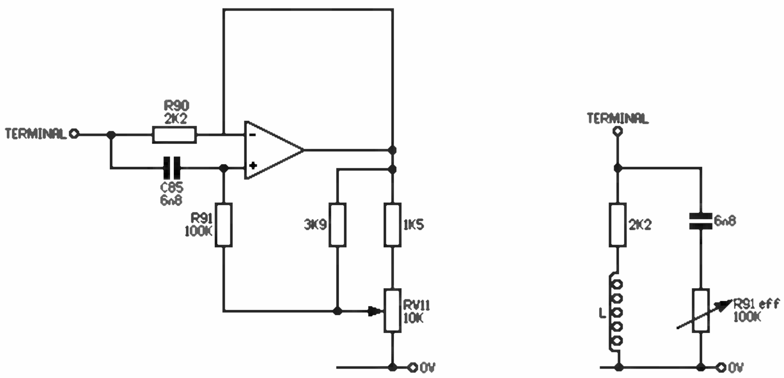
IC7	NE5532
Q3,5	BC559C
Q5,9	BC549 (Q9 optional - see text)
D1,2,3,7	1N4148



LF SHELF/BELL EQUALISER SHOWN WITH SHELF RESPONSE SELECTED, RV2 FREQUENCY CONTROL SET FOR MAX (30hZ)

RESONANT

$$f\ \text{CENTRE} = \frac{1}{2\pi}\sqrt{\frac{1}{C84\ C85\ R90\ R91\ \text{effective}}}$$



LF SHELF/BELL EQUALISER SHOWN WITH SHELF RESPONSE SELECTED, RV2 FREQUENCY CONTROL SET FOR MAX (100hZ)

SHELVING

$$f\ \text{CENTRE} = \frac{1}{2\pi\ C85\ R91\ \text{eff}}$$

OR

$$X_L = 2\pi f L \quad \text{WHERE } X_L = 2K2 \text{ AND } L = C85\ R90\ R91\ \text{eff}$$

$$f\ \text{CENTRE} = \frac{X_L}{2\pi L}$$

Fig. 10 LF equaliser in schematic form.

LED1	0.1'Green LED
LED4	0.1' Red LED (optional· see text)

MISCELLANEOUS

SW5 PC mounting DPDT push switch (which may be combined with RV2)

JK2 PC mounting 1/4' stereo jack socket with switched contacts 8 pin DIL Sockets to suit, PCB, Veropins, M3 mounting hardware, knobs and buttons to suit

4 BAND EQUALISER

RESISTORS (all 1/4W 1% unless otherwise stated)

R68,69,88,89	10k
R95,96,97	47k
R70,76	33k
R71,72,77,78	12k
R73,79	15k
R74,75,80,81	750R
R84,85	750R
R82,83,86,87	2k
R90	2k2
R91,102,105	100k
R92,109	3k9
R93,110,113, 115	1k5 (R113,115 optional - see text)
R94	1M
R98,108	1k
R99,100,103	22R
R101,104	4k7
R106	(see Table 2)
R107	1k2 (see text)
R114,116	47k (optional - see text)
R117,118	(see Table 3)
RV3,4,9,10	PC mounting miniature 10k LIN
RV5,7	PC mounting miniature 20k LOG
RV6,8	PC mounting miniature 10k dual LIN
RV11 (optional)	PC mounting miniature 10k LIN c/w integral push DPDT switch
RV12 (optional)	PC mounting miniature 10k LIN c/w integral push switch

CAPACITORS

C60,83	100u 40V non polar radial electrolytic
C61,63,65,79,81	22p polystyrene
C62,64,66,68,71, 73,76,78,82	100p disc ceramic
C67	820p polystyrene
C69	6n8 polystyrene
C70	10n polystyrene
C72	18n polystyrene
C74	47n polystyrene
C75	330n polyester
C77	1u polycarbonate
C80	10p polystyrene
C84	1u5 polycarbonate
C85	6n8 polystyrene
C87	15n polystyrene
C88	33n polystyrene
C92,93	4u7 (optional - see text)

SEMICONDUCTORS

IC8	TL072
IC9,13	NE5532
Q6,8	BC559C
Q7,10,11	BC549C (Q10,11 optional - see text)
LED2	0.1" green LED
LED5,6	0.1" red LED (both optional - see text)
D4,5,6	1N4148

MISCELLANEOUS

L1	27mH inductor
SW6,7	PC mounting push on DPDT switch
SW8	PC mounting push on DPDT switch (or may be integral to RV11 if fitted)
SW9	PC mounting push on DPDT switch (or may be integral to RV12 if fitted)
JK2	PC mounting 1/4' stereo jack socket with switched contacts

8-pin IC sockets to suit, Veropins, PCB, Control knobs, switch caps to suit, M3 mounting hardware

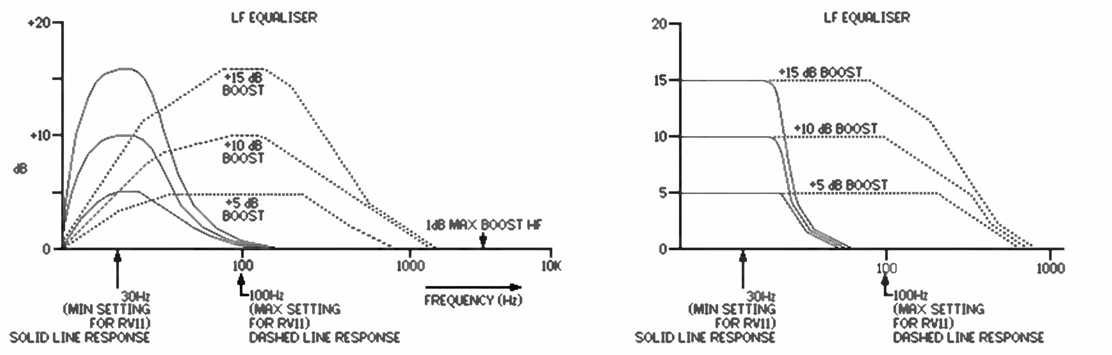


Fig.11 Responses to LF equaliser section

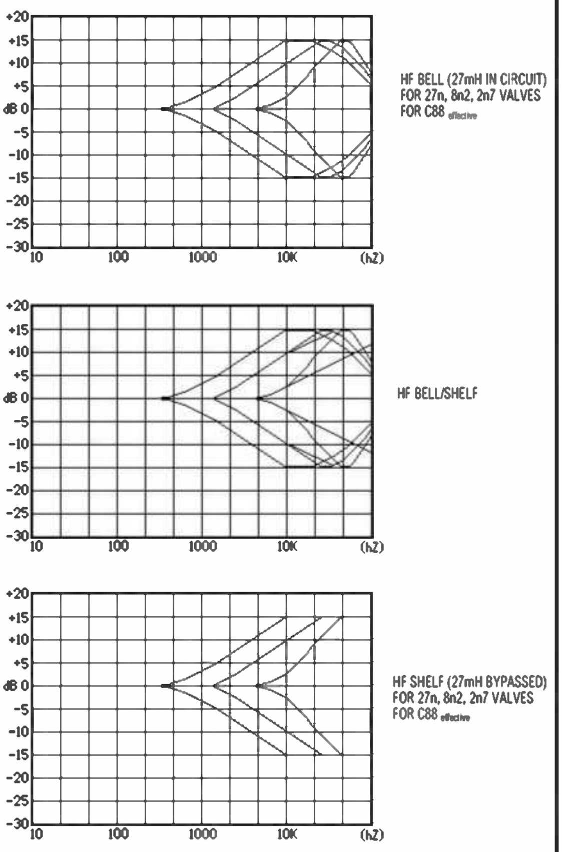


Fig.11a HF equaliser response curves (inductor circuit.

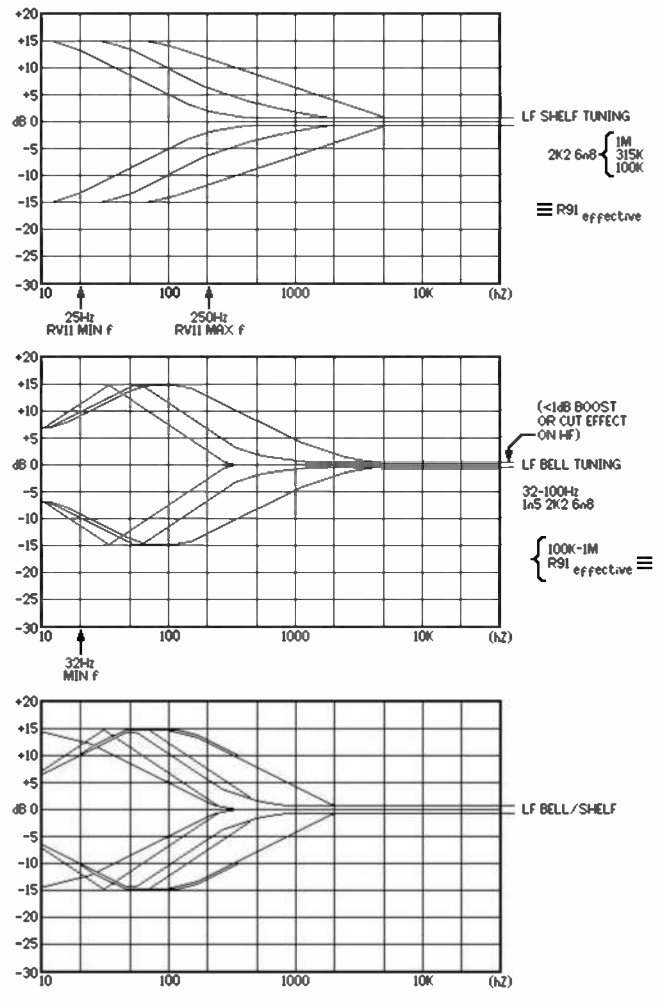


Fig. 11b LF Equaliser response curves (frequency tuning

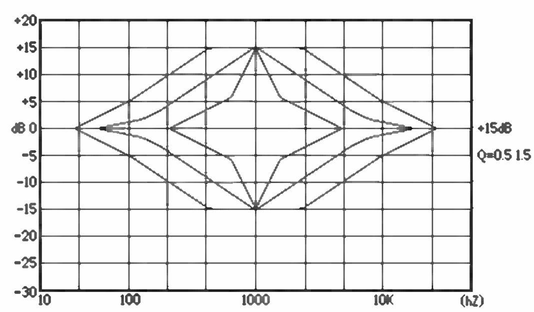


Fig. 11c Response curves for parametric equaliser (frequency fixed, Q varied full cut and boost)

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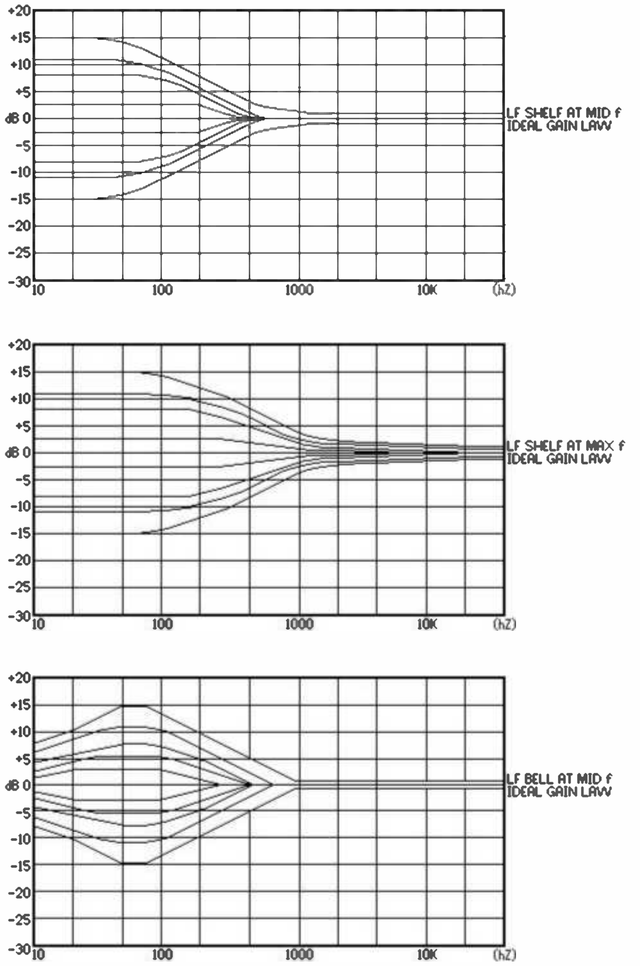


Fig. 11d LF Equaliser response curves (ideal gain law)

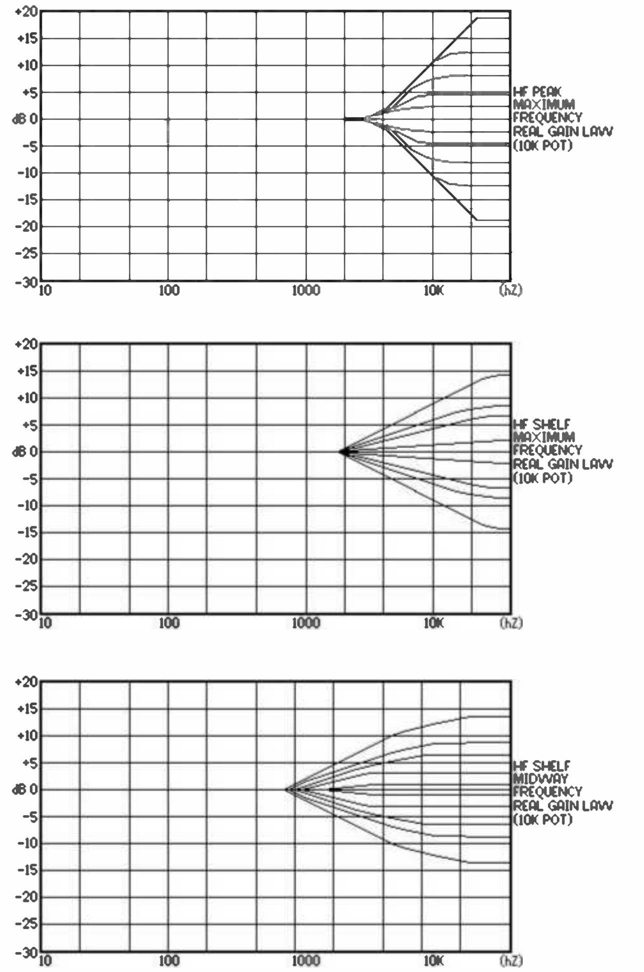


Fig. 11e HF Equaliser response curves (various boost/cut ratios)

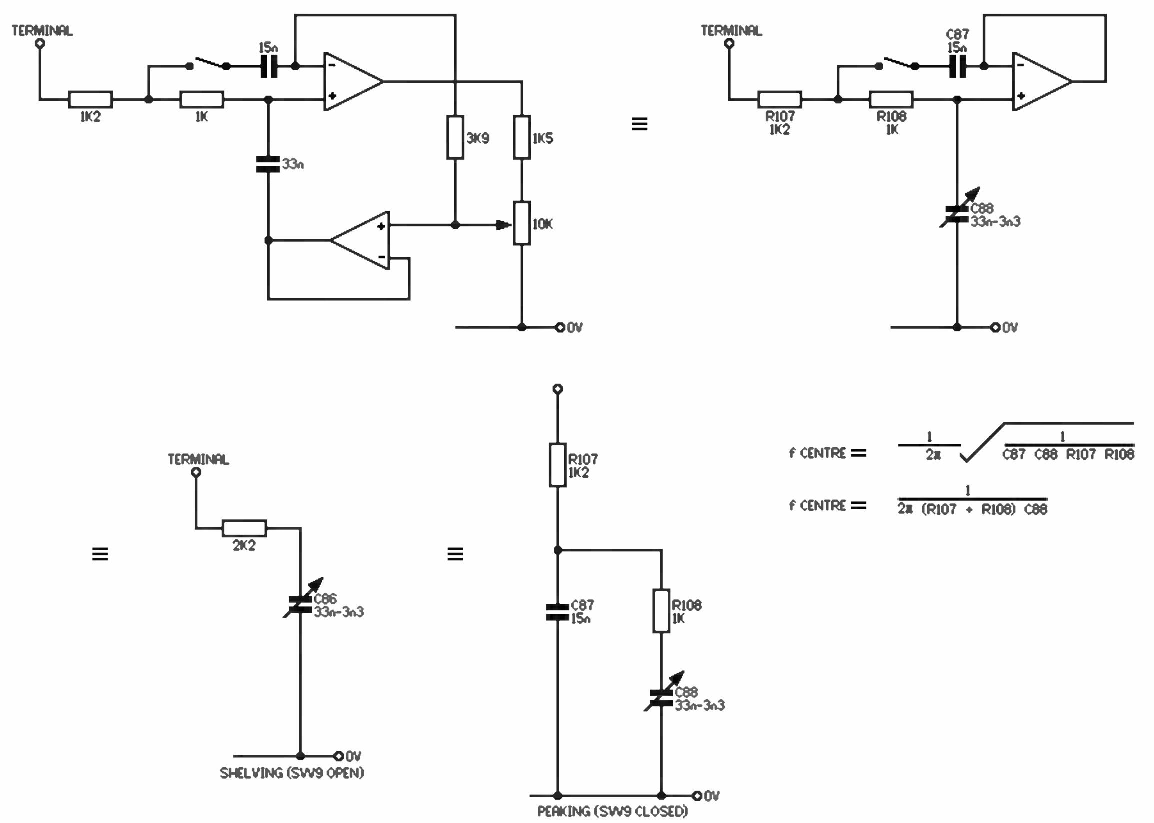


Fig.12 HF equaliser in schematic form

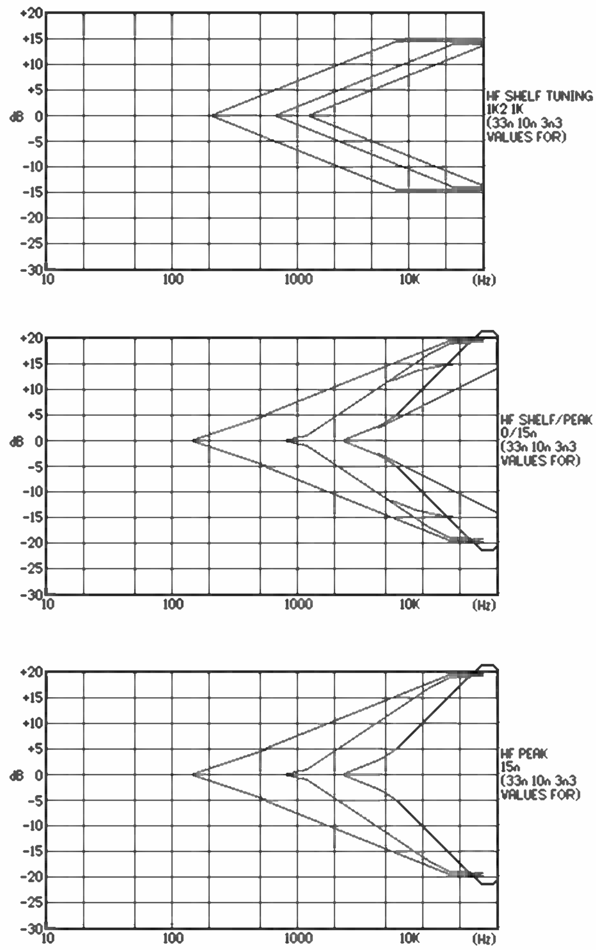


Fig 13a HF Equaliser response curves (Frequency tuning)

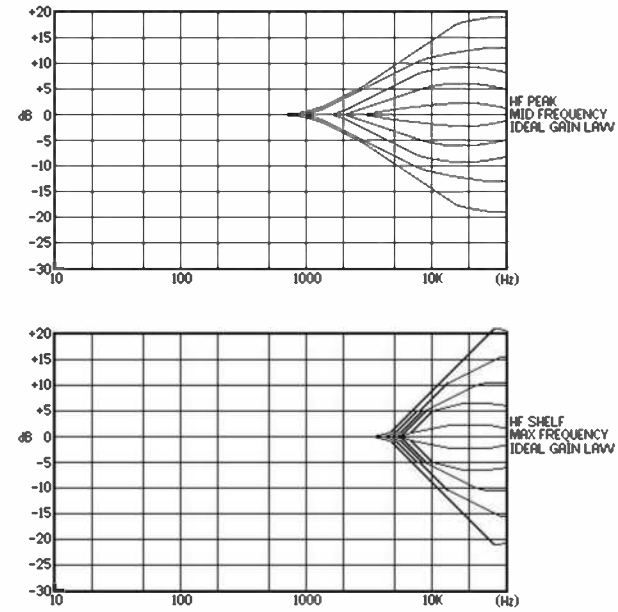
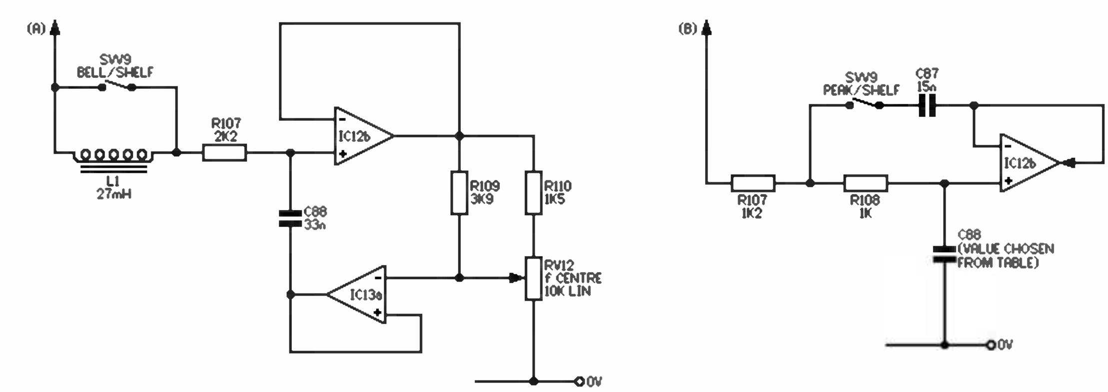


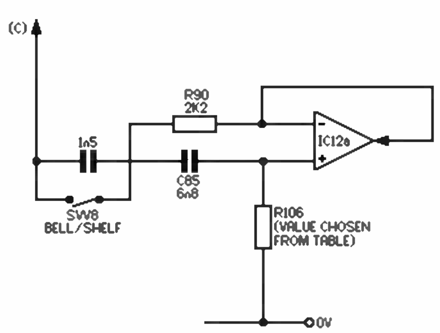
Fig. 13b HF Equaliser response curves (various cut and boost ratios)

Errata

Last month, figure 1 should have included diode D7 in series with D1, D2.

Figure 2 amendments include: replace R78 with R96-47k, C87-100n with C91-100n and C87-100µ with C82-100u. '*fitted only if RV11 omitted' refers to R106 not R91. HF SHELF/BELL EQUALISER should read LF SHELF/BELL EQUALISER.





(a) HF EQUALISER WITH C87 OMITTED, R108 ALSO REPLACED BY SINGLE 2K2 RESISTOR AND 27MHz INDUCTOR TO ACHIEVE TRUE BELL TYPE RESPONSE.

(b) HF EQUALISER WITH VARIABLE FREQUENCY CONTROL, RV12, (AND IC13a, R109, R110) OMITTED AND REPLACED BY 'FIXED' CAPACITOR TO GROUND JOIN AT POINT X.

(c) LF EQUALISER WITH VARIABLE FREQUENCY CONTROL, RV11 (AND R91 - R93) OMITTED AND REPLACED BY FIXED RESISTOR R106.

Fig. 14 Possible modifications to the standard equaliser

PROJECT

Four Channel Remote

An effective way to control and dim four sets of lights independently. A description by Ken Blackwell.

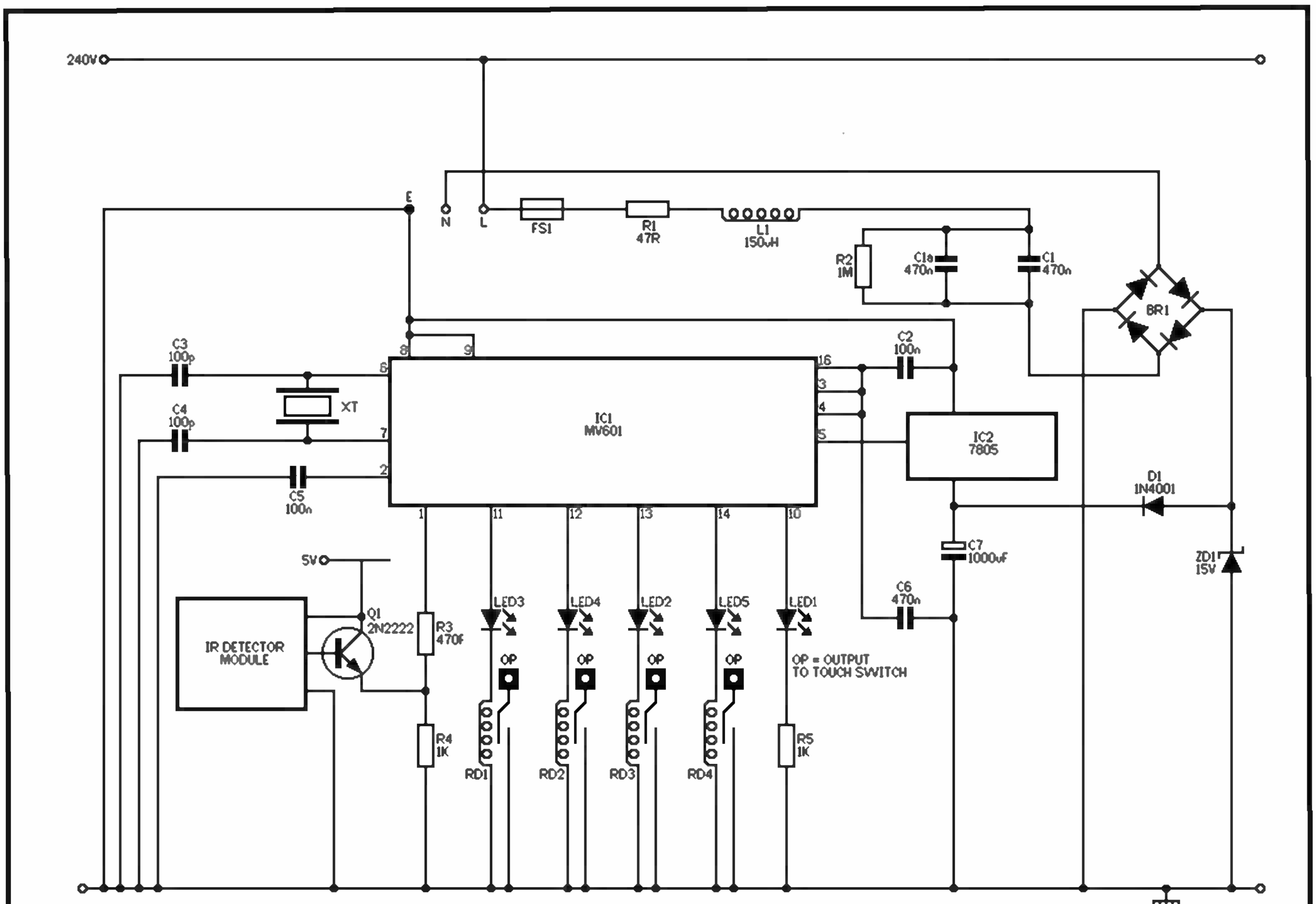


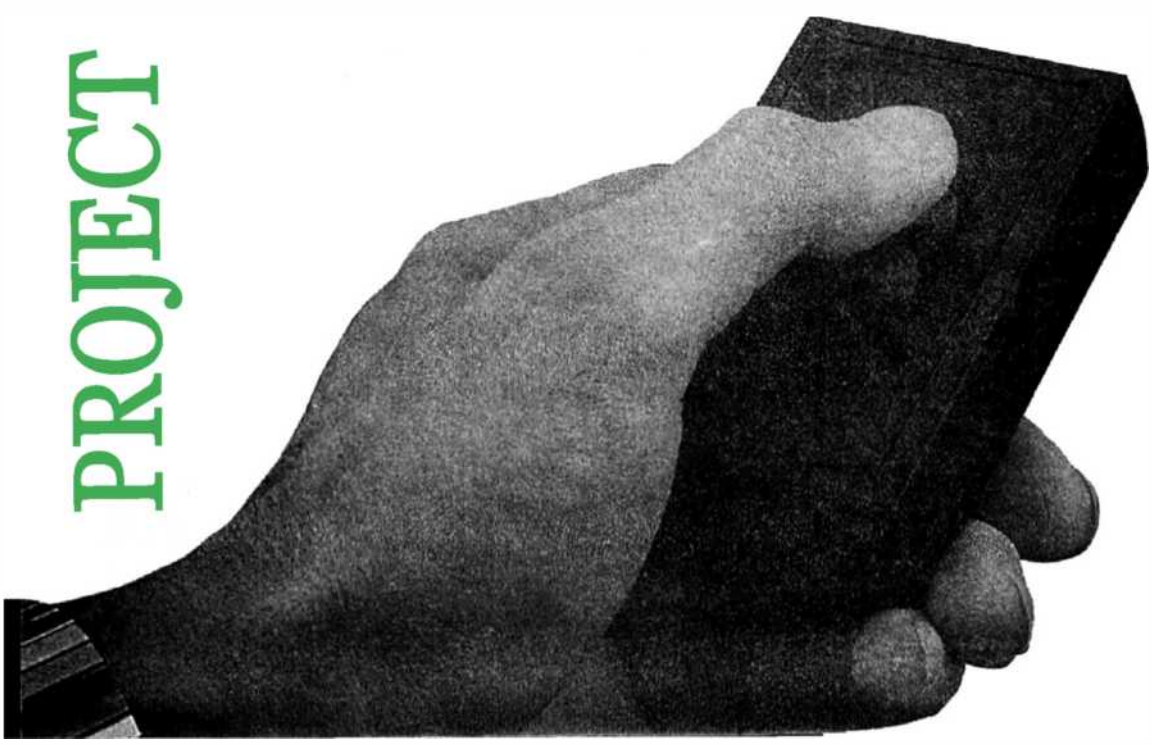
Fig.1 Circuit of the Infra-red remote receiver

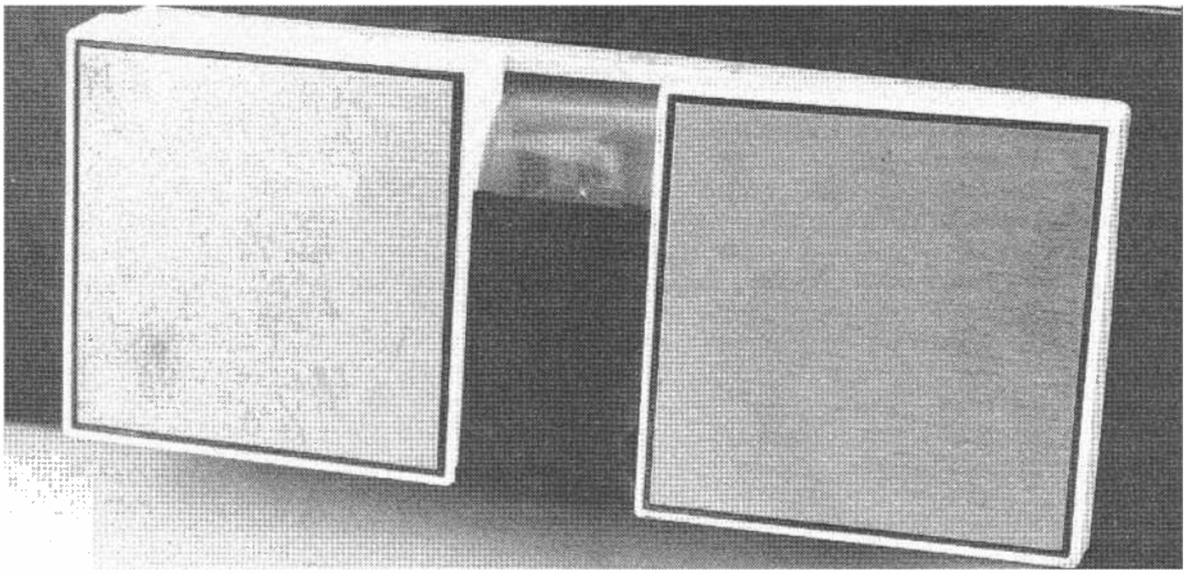
Predictably in the future, domestic remote controlled lighting and dimming will be as common as the television remote control and with the availability of multi programmable transmitters on the market, eventually all domestic systems will be programmed into one master transmitter.

With mains lighting, the design criterion requires that the lighting system must not depend entirely on remote control.

Manual switching is the most convenient simple method of switching, the remote operation is the added practical refine-ment of modern living, and probably only used during relaxation times or as an aid to the unfortunate handicapped or bed-ridden patients. The greatest advantage is the means of controlling the dimming level of lighting from a position of relaxation.

In the case of the following Infra-Red remote design any





HOW IT WORKS
IR RECEIVER

Mains power is connected to the terminal block 240V AC and is fed through to the bridge rectifier via a 47R wire-wound resistor and a choke. The choke removes most of the AC noise, then to the capacitors which charge and discharge a limited current. The bridge rectifier changes the AC sine wave to DC. The zener diode reduces the voltage to a manageable 15V. The current passes through the 1N4001 rectifier diode to continue to smooth and remove AC pulses. Finally, voltage is smoothed by the 1000u capacitor. As the components in this circuit are rated at 5 volts, a voltage regulator 78L05 feed is connected to the positive line at the 1 000u capacitor junction.

The receiver is designed to match the PPM output signals generated from the IR transmitter by receiving the word notations on ABCD only. The Tandy receiver/demodulator unit receives the IR signals generated by the transmitter, any unwanted noise or signals are filtered leaving a clean square wave pulse. This pulse is amplified by Q1 to eventually pass a signal to IC1 pin 1.

The configuration of the MV601 chip is set to give stable momentary outputs to the four relay positions. The stability is derived from the 500kh ceramic resonator.

Each LED will illuminate as a signal is received. As the reed relay operating resistance is very high, the outputs from IC1 will directly drive each relay without any current amplification. A protection diode is integrally built into the relays.

As each relay operates, earth potential is connected to the touch plate (being hard wired to the touch plate on a dimmer switch), giving the effect of manually touching the switch plate.

This receiver has been designed to minimise the passive components used by installing 'off-the-shelf' units such as the Tandy receiver/demodulator. This unit obtains the same results as a complex IR preamp integrated circuit with its array of passive components.

SIL connectors are used for the relays giving a plug in connec-tion and allowing a combination of various positions in which to place up to four relays thus allowing more than one receiver circuit in any one room.

Control Dimmer

combination, MANUAL 'OR' REMOTE switching and dimming can be operated from each separate touch dimmer switch.

From customers various comments and the practical operation of remote lighting, I have used a guide line to bring to attention the main practical points desired by the customer, to form a suitable remote domestic lighting control, whilst not interfering with any manual switching. They are:

a) Cost effectiveness
b) Must be manual and remote. Not either one or the other.
c) Easy to operate multi-coded transmitter.
d) Dimming and switching function.
e) Compact.

The remote system is coupled to control a suitable easily available touch dimmer switch, manufactured by Home Automation. These units are very attractive cost effective units, obtainable in either silver or gold coloured brushed anodized aluminium touch plates, rated at maximum 200 watts each unit.

You could also experiment with other makes as most of them work on the same principle.

Basic Operation.

By parallel earthing the dimmer switch touch plate via a normally open reed relay switch will exactly duplicate the touch switch operation, mechanically.

From a relay pulse or tap, the lighting turns 'On'. A further pulse or tap switches 'Off'. Relay held in, or finger held on switch, controls the lighting level. Release at desired light level. It must be emphasized that by pulsing manually just one Infra Red transmitter button,(one channel) control over all these various dimmer switch functions via the receiver reed relay, a full control can be obtained. Further dimmer switch connections can be added to each decoded relay output, to make a total of four coded relay positions on each receiver, giving 800 watts of controlled lighting.

Operation

The transmitter, the construction of which appears next month, together with cover PCB, operates four channels and basically of standard construction, with a couple of selected components to give increased range. Push switch connections are made to operate only digital ABCD logic outputs, thus allowing only one of the four relays to operate at each desired selection.

The receiver is mains powered and converted to give a DC supply output via a zener voltage of 15 volts at 35mA, then again regulated to supply various components with a smooth 5 volt supply. Detection of infra red pulses are amplified and filtered by the Tandy IR Detector unit, a hybrid receiver/ demodulator. These output signals are transistor amplified and passed to the remote control receiver IC pin I. With matching pulse position modulation, the momentary switch selected ABCD logic couples directly to one of four

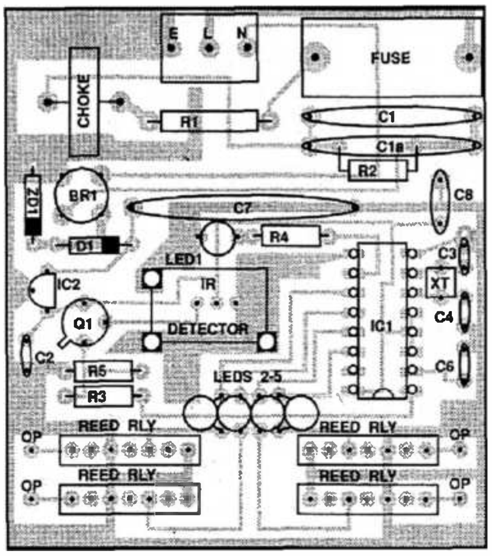


Fig.3 Component Overlay of receiver.

miniature 5V DC plugin reed relays. The normally open relay contacts, close, making an earth connection to the appropriate dimmer switch touch plate, completing the dimming/switching cycle.

Receiver Construction

NO SETTING UP REQUIRED

WARNING. MAINS POWER ON CIRCUIT USE CAUTION DURING OPERATION. Assembly is straight forward and if each component is double checked during assembly for correct polarity no problems will be encountered.

Start from initial mains 240 volt power input connector and solder the components in the operating sequence finally fitting the reed relays. Not only will these procedures safe-guard damaging components, but it will enable testing voltages from mains down to the final 5 volts DC before any semiconductors are fitted. Solder the components in order, working from the mains connector-fuse-47ohm resistor -choke -two 470n/250v capacitors -1M resistors -Bridge rectifier (imperative that must be positioned top right hand side). Zener diode -diode -finally 1000u electrolytic capacitor, observing polarity. This completes the high voltage conversion. Connect mains power to connecting block ensuring correct polarity.

Before proceeding ensure that the voltage across the electrolytic capacitor is no more than 15V DC. Solder in the 5 volt regulator. Before proceeding, check for the existence of 5 volts between earth and LH pin. Solder the remaining components into circuit board. Plug in IC1. Plug in Reed relays to desired SIL outputs. If correctly assembled LED 1 will illuminate. On a signal from the transmitter (to be featured next month with accompanying cover PCB) one of the four LEDs will illuminate via a relay, whilst LED 1 turns OFF. OP (Relay Outputs) via earth, are hard wired connections to the dimmer switch touch plates. Sub miniature single strand wire is suitable.

Worth-while Tips.

LEDs are normally supplied with the live side leg the longer of the two. The tag on the transistors is the emitter facing towards ground potential. Tantalum capacitor+ mark towards R6. IC1 pin 1 nearest XT. SIL Reed relay 5volts Live connection opposite "S" mark on side of relay. Increase range of receiver by installing a red plastic lens available from Maplin. Part number FA95D.

PARTS LIST RECEIVER

RESISTORS

R1	47R 2W
R2	1M
R3	470R
R4, 5	1K

CAPACITORS

C1, 1a	470n 250V AC
C2, 5	100n min disc ceramic
C3, 4	100p min disc ceramic
C6	470n min polyester
C7	1000u 16V electrolytic

SEMICONDUCTORS

IC1	MV601 Plessey IR receiver
IC2	78L05 5V regulator
Q1	2N2222
ZD1	15V zener 1.3W
BR1	W004
D1	1N4001
LED1-5	Red LED rectangular 5mmx2mm
IR1	Infra-red detector module Tandy GP1V52X

MISCELLANEOUS

FS1	1A fuse and holder
L1	Mains choke 150uH
XT1	500kHz ceramic resonator
RLA1-4	(4 pins used) SIL PCB miniature 5V SPNO relay

3-pin mains connector block
DIL socket 16-pin
32 pin low profile socket

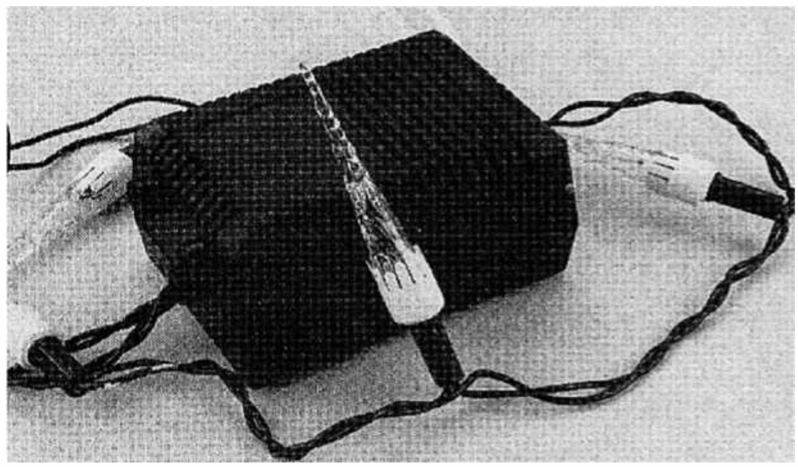
BUYLINES

Most of the parts are available from Rapid Electronics. The Infra-red receiver module is from Tandy Stores. The choke is from Maplin (JL72P). The MV601, resonator and MV500 are available from Electromail. A kit of parts (excluding box and battery) for £25 is available from ADVF Service, 131 Aldermans Drive, Peterborough, Cambs PE3 6BB

Fading Festoonery

A seasonal project to provide some extra glitter on the Christmas tree by Richard Sagar.

There are plenty of flashing LED circuits about that can be used for the star on the top of your Christmas tree. One problem with LED arrangements is that they can barely be seen during bright daylight hours, or when the tree is brightly illuminated by a nearby lamp. The circuit in Figure 1 is designed to give a pleasing flash, well more of a twinkle really, and can power mains lights and hence be bright enough for use at any time of the day.



Mains Control

To switch a high voltage (mains) bulb a Silicon Controlled Rectifier (SCR) is generally employed, here a triac, as these are capable of switching currents in amps or 10s of amps range and voltages of 100's or even 1000's of volts. Being silicon devices with no moving parts they are also faster to switch and more reliable than relay and other mechanical switches. The standard way of giving a dimmed effect using an SCR is to switch the bulb on and off at high speed, using the full supply voltage, and making the percentage of time spent on longer for a bright glow, or shorter for a dim glow. This technique is also used for speed control in motors as it gives better control at low speeds than would be

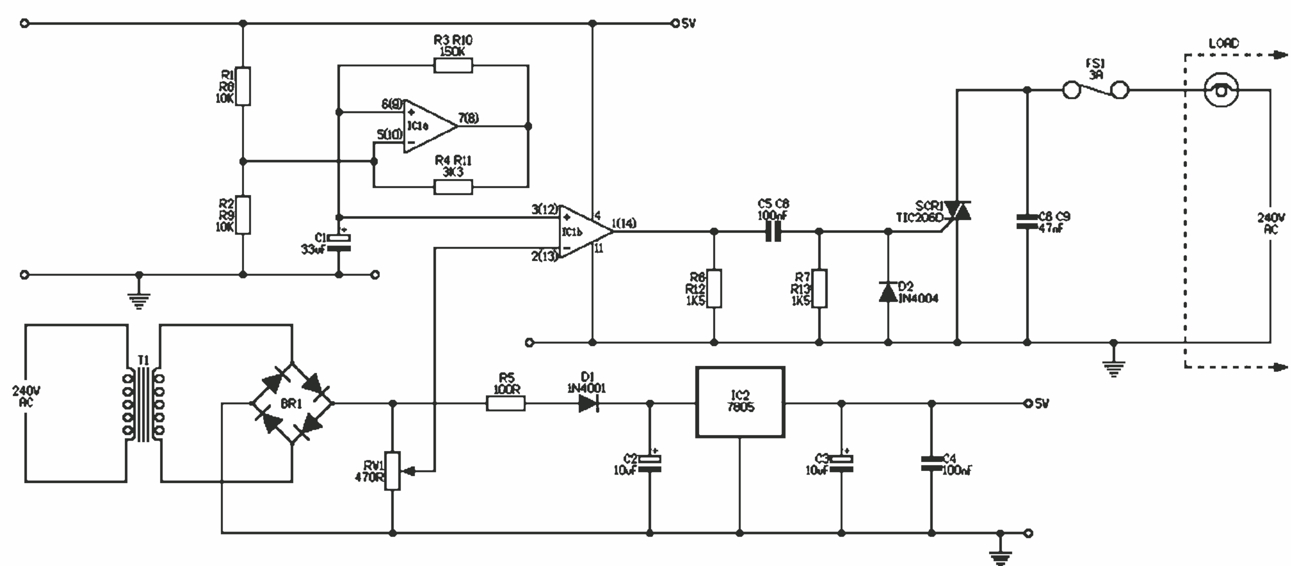


Fig.1 Circuit of oscillatory fading lights

How It Works

IC1b is used as an astable oscillator, the oscillations depend on the signal at pin 6 ramping up and down to cross the voltage at pin 5, causing the output to change state. This only works because R4 provides hysteresis to the circuit, giving the voltage on pin 5 a different value when the output (pin 7) is high, to its voltage when the output is low. Consider the case when the output is high; assuming the output is 5V (the positive supply), then R4 will effectively be in parallel with R1, making the voltage at pin 5 approximately 60% of the supply voltage.

When the output is low, R4 is in parallel with R2 and the voltage at pin 5 will now only be 20% of the supply voltage.

Figure 2 shows how the voltage on pin 6 changes in relation to the output voltage. Normally on flasher circuits it is the voltage at pin 7 that is used to flash the LED's, but in this case the voltage at pin 5 is used to give the aforementioned 'twinkle'. The sawtooth waveform cannot be used directly to drive the light bulb, as the current and voltage are far too low.

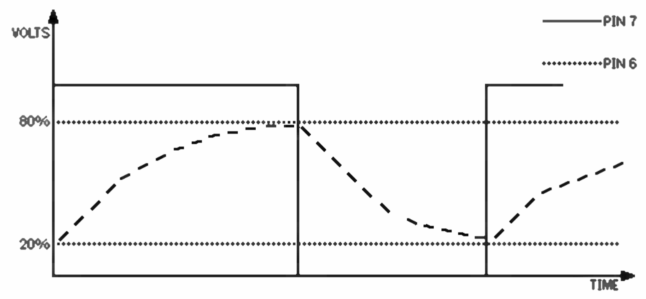


Fig.2 Oscillatory waveforms.

given by dropping voltage across a resistor, it is also more efficient as less energy is wasted through I^2R losses. One interesting point about the SCR is that once the device has been turned on (with a pulse on its GATE input of 1V-2V at 10mA) it will remain on when the gate input is disconnected, as long as the current through the main terminals continues to flow. In AC circuits such as this there is no real problem as the supply regularly turns itself off (100 times a second), however any circuit that used a DC supply would need some additional circuitry to switch off the load current and hence tum off the SCR. Figure 3 shows the voltages at the important points in the circuit. Figure 3a is the rectified output of the transformer, before smoothing. This signal is it is known) which is exactly what we require to give the dimming effect. Note that the comparator output is fed through_ capacitor C5 before driving the GATE input ofthe triac. This is to allow the GATE current to fall quickly back to zero (Figure 3c) after the positive transition o(the comparator, this prevents the triac being held on past the zero crossing of the load current, which would keep the triac switched-on continually again no good for a dimming circuit.

Power Supplies and Interference

The transformer should have an output of 9V to 12V. The bridge can either be a bridge rectifier in a pack or made-up of four diodes and need only be rated at 1 amp. Obviously care must be taken when connecting up the transformer primary and it may be advisable to find a sealed unit that provides the low voltage output and no access to the 240V primary. The 5V supply for the op-amp circuit needs to be stable, to generate a good sawtooth waveform, however the not smoothed transformer signal (Figure 3a) is required to generate the switching signal for the comparator (IC la). To allow both to be provided R5 and D1 are used to separate the bridge and the regulator portions of the supply circuit. It is worth noting that the voltage at the input to the regulator (IC2) needs to be 7V or over, so the current through R5 and hence the volts drop across it cannot be too high. Smoothing of the supplies is provided by both large electrolytic and

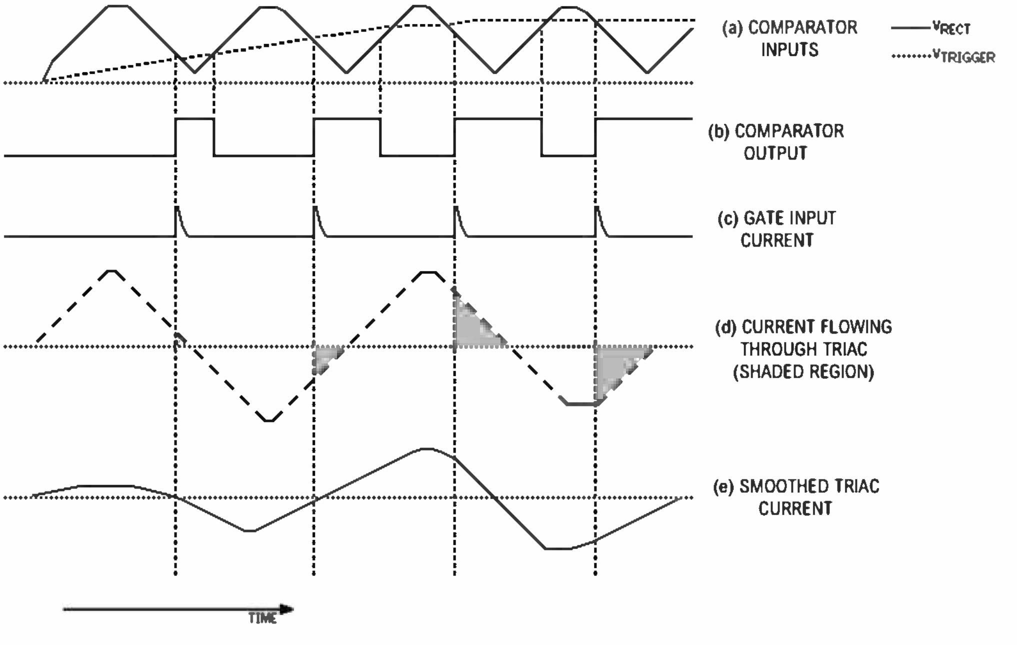


Fig.3 Comparison of triggering points.

used for determining when to apply pulses to the GATE input ofthe triac. A pulse needs to be provided at least once per mains cycle otherwise the triac will spend all its time switched off. By comparing the size of the voltage on pin 5 of IC1 ($V_{trigger}$) with the rectified transformer output (V_{rect}) the time at which the triac is switched on will change, earlier in the cycle for high values of $V_{(trigger)}$ and later for low values of $V_{trigger}$ (Figure 3b). This gives the effect of varying the ratio of the ON to OFF time of the triac (the MARK-SPACE ratio as smaller value ceramic or polyester capacitors. The electrolytic capacitors provide smoothing of the mains ripple, whereas the smaller capacitors are used to remove high frequency noise that the fast switching ofthe triac can induce. The capacitors should be kept as close to the supply connections on IC1 as possible. In parallel with the triac is a further smoothing capacitor which smooths the current through the load (transforming Figure 3d into something more like Figure 3e, to reduce the sharp current spikes that cause radio frequency interference.

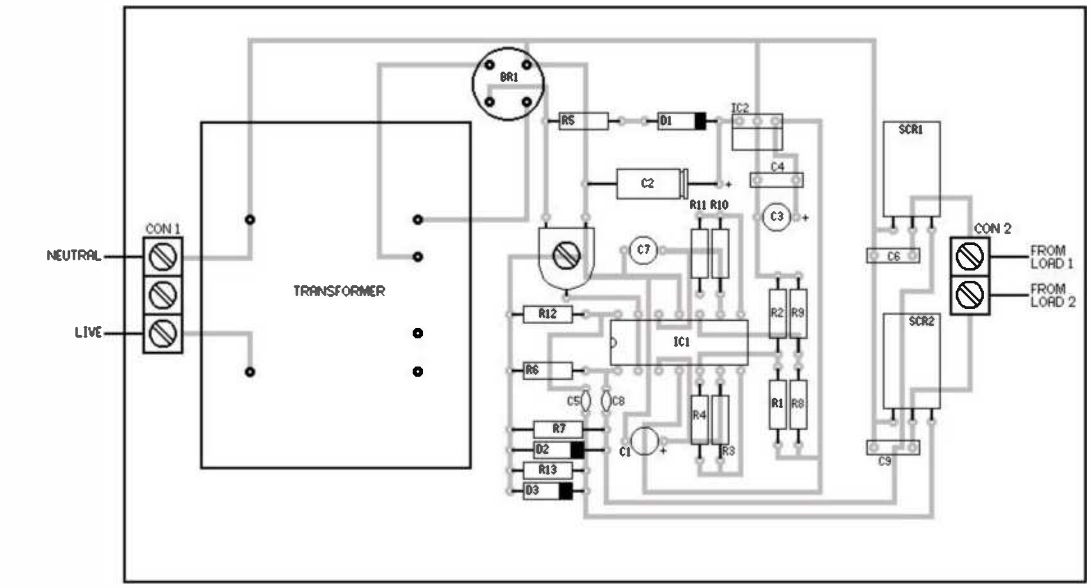


Fig.4 Component Overlay

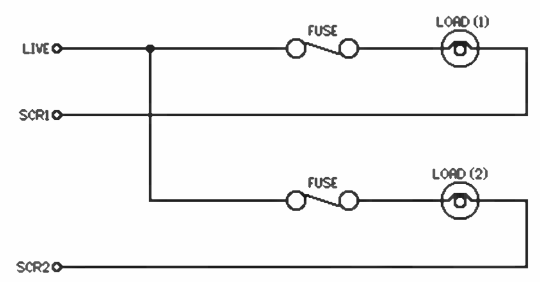


Fig. 5 Fuse and load connections

The triacs used have a rating of five amps which is fine for Lighting circuits, however in the excitement of experimenting with the unit it is all too easy to run round the house connecting everything to it, and the simple mistake of connecting a hair drier to the unit could ruin your whole days work (or even your Christmas). It is therefore necessary to place a 3 Amp fuse in series with the triac, as shown in Figure 1, this will also protect the circuit from the usual mains faults.

Setting Of RV1

The variable resistor, RV1, controls the height of the signal (V_{rect}) feeding pin 2 of IC1a. Referring to Figure 3a $V_{trigger}$ should not be greater than the peak value of V_{rect} otherwise the comparator will not switch during that cycle, the triac will not be triggered and the lamp will remain off. Using an oscilloscope the two signals can easily be displayed one on top of the other and the pot adjusted to make V_{rect} big enough. If an oscilloscope is not available setting up is still possible using a voltmeter as follows: (1) measure the two voltage levels of pin *5* on IC I, which should be approximately 20% and 80% of the supply voltage, as mentioned above; (2) Measure the voltage at pin 2 of IC1 (using the DC range of the voltmeter), this will be the average value of the waveform V_{rect}. For a rectified sinusoid the peak value is (n/2)00V and hence the pot can be adjusted until the voltmeter reading is high enough to satisfy V_{rect} greater than $V_{trigger}$.

Practical Aspects

The best use for the circuit is in conjunction with a set of fairy lights, or to be more accurate two sets of fairy lights. The reason for specifying a quad op-amp was to allow two copies of the circuit in Figure 1 to be built up easily. Two slightly different values of the combination C1/R3 can be selected so the two 'twinkles' change at different speeds and give quite a soothing Christmas effect, even if I do say so myself.

Another important practical aspect of any mains control is to make sure the electronics is housed within a good insulating box or case. As this design is solely for Christmas lights, it would be wise to house power supply and control circuits in the one box, leaving just a 'mains in' lead and 'controlled mains' out lead.

PARTS LIST

RESISTORS

R1,R2,R8,R9	10k
R3,R10	150k
R4,R11	3k3
R5	100R
R6,R7,R12,R13	1k5
RV1	470R

CAPACITORS

C1	33uF 16V
C2,C3	10uF 16V
C4,C5,C8	100nF
C6,C9	47nF 400V

SEMICONDUCTORS

IC1	LM324
IC2	7805
BR1	1A 50 PIV bridge
D1	1N4001
D2	1N4002
SCR1	TIC 206D

MISCELLANEOUS

T1	9-12V secondary, mains input transformer
FS1	Fuse 3A and fuse-holder

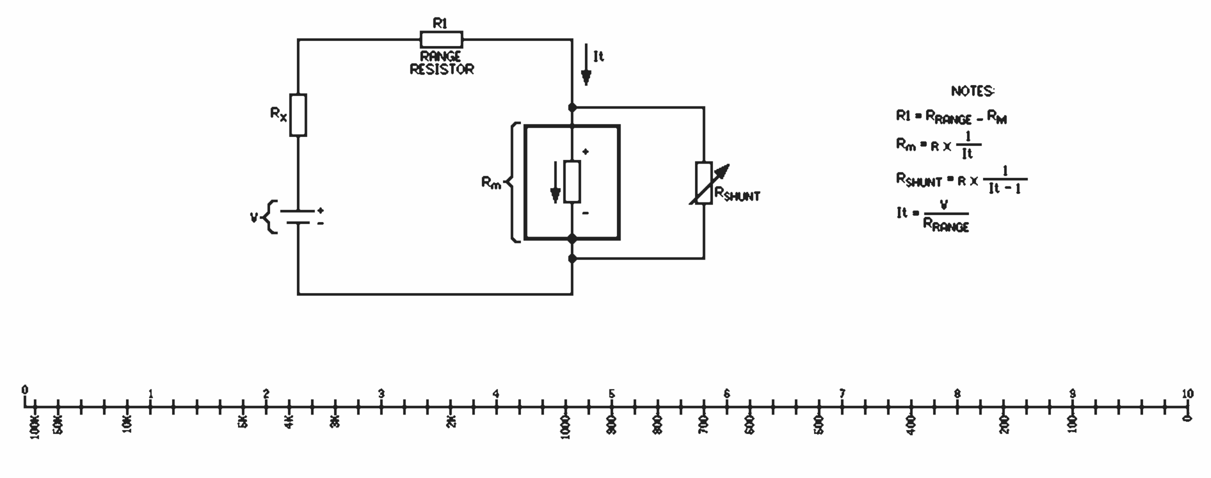


Fig.18(a) Basic circuit and formulae, and (b) standard calibration scale (compared to a linear voltage scale) of a series-type ohmmeter.

Basic Multimeter Circuits

Ray Marston takes a further look at analogue meter circuitry.

2

The last episode of this 'test gear' series outlined the main principles of the moving-coil meter and showed how it can be used to make AC and DC voltage and current measurements. This month's article continues the theme by showing how it can also be used in ohmmeter and multimeter applications, and concludes by introducing various other types of electro-mechani-cal 'moving-pointer" meter.

The Series-type Ohmmeter

There are several ways of using a moving-coil meter to read resistance values. The best known of these uses the basic 'series connected' ohmmeter circuit of Figure 18a, which is used in most commercial analogue multi-meters. This battery powered circuit has a variable shunt wired across the meter and has a range-setting resistor wired in series with the combination. In use, the X terminals are first shorted together, causing a current (I) of V/R_{range} to flow in the meter, and the variable shunt is then trimmed to bring the meter pointer to FSD; since zero ohms are connected across the X terminals under this condition, this is called the 'set zero'! operation. The unknown resistor (Rx) is then connected in series with R1 by fitting it across the X terminals, and the new current reading (i) noted; the value of Rx can then be calculated from

$Rx = R_{range}([I/i] - 1)$

If Rx has the same value as R_{range} the "i" value will equal 1/2, and the meter will give a centre scale reading.

Consequently, when designing such meters, the R range value is used to set the instrument's center-scale value.

All meters of the Figure 18a type generate a scale shape ofthe exact form shown in Figure 18b, with a zero to the right with the 'range' value in the dead-center of the scale, and with X10 and X0.1 values at 9% and 91 % of FSD respectively. Consequently, this scale can be applied to any series-type ohmmeter, provided that its values are all multiplied by an appropriate amount. For example, the old Avo-minor used a centre-scale value of 113 ohms, and the Avo 8 uses a center-scale value of 2000 ohms, and many other meters use center-scale values of 285 ohms, but all use the precise scale shape shown in Figure 18b.

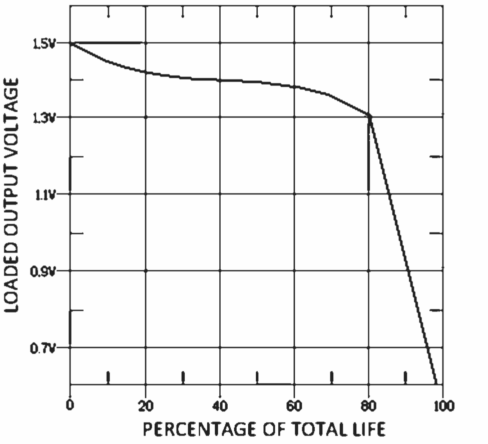


Fig.19 Chart showing how the output voltage of a lightly loaded 1.5 volt zinc carbon cell varies over its working life.

Superficially, the Figure 18a circuit looks easy to design, but in practice matters are complicated by the facts that the design must allow for large variations in battery voltage and R_{shunt} (and thus Rm) values, and by the fact that the circuit's mid-scale value is set by the combined values of the fixed R1 and the variable Rm. Figure 19 shows how the voltage of a 1.5V zinc carbon cell varies with usage; clearly, an ohmmeter designed for operation from such a cell should have its component values optimized for operation at 1.4V, but should be capable ofoperating over the range 1.1V to 15V. To design a circuit of the Figure 18a type, the meter's basic sensitivity and 'r' value must first be known and the battery voltage and mid-scale 'range' resistance decided on; the circuit's component values can then be calculated. Figure 20 shows a practical 3-range series-type ohmmeter, designed around a 50µA, 3k0 meter; on each range, SW1a selects the range resistor and battery, and SW 1b selects the zero setting R_{shunt} resistors; note that the circuit uses a 10.5V supply on the 'x100' range, and that all shunts are wired in series across the meter. Figure 21 lists the full set of calculations made while converting the basic circuit of Figure 18a into the practical design of Figure 20. Thus, on the 'x1' (1K) range, the design is first optimized for 1.4V operation (using the formula of Figure 18); at 1.4V the meter needs a FSD value of 1400uA, so R_{shunt} (= R5 + RV3) needs a value of 111.1 ohms, and Rm equals I 07.1 ohms: consequently, 'R1' (= R3 of Figure 20) needs a value 893 ohms. Once the R1 value has been settled, new sets of calculations must be made for 1.5V, I .2V, and I. IV operation. to enable the spread of R_{shunt} values and percentage mid-scale errors to be determined, as shown. Thus. R_{shunt} must be variable between at least 103 and 143 ohms. and the circuit's mid-scale reading is 0.7% low (at 993 ohms) at 1.5V and 29% high (at 1029 ohms) at 1.1 V. Similar sets of calculations are made on the 'x10' and 'x100' ranges; the 'x100' range design is optimized for 10V operation.

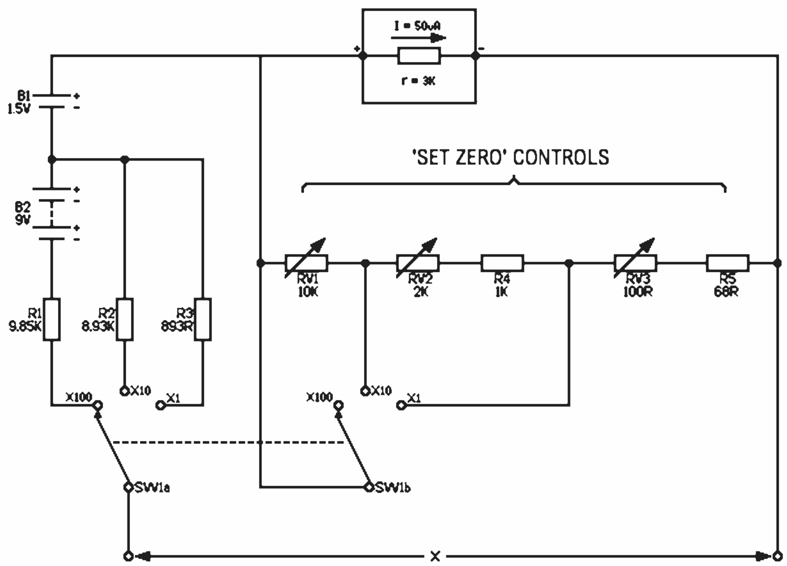


Fig. 20 This ohmmeter spans 100R to 1M in three ranges.

The Parallel-type Ohmmeter

Another well-known ohmmeter is the parallel (shunt) type, which can be used to measure low values of resistance. Figure 22 shows the basic circuit; in use, SW1 is first closed and the meter calibrated by trimming RV1 to set the meter to read FSD with the X terminals open circuit; under this condition the meter current equals 1, and the effective FSD 'resistance' value equals r. The unknown resistor (Rx) is then connected across the X terminals, so that it shunts the actual meter and reduces its current reading to 'i'. Rx can then be calculated from:

$$Rx = r \times (I/[I-i])$$

Thus, the meter reads half-scale when Rx = r. In practice, the effective r value can be varied by wiring a shunt across the meter, and the circuit can be used to measure very low values of resistance. Nowadays this circuit is obsolete, and it is presented here purely as a matter oftechnical interest.

Meter Overload Protection

Moving-coil meters are delicate instruments and can easily be damaged by large overload currents. If the meter is used in conjunction with a swamp resistor, excellent overload protection can be gained by connecting a pair of silicon diodes as shown in Figure 23. Here, the swamp resistor is split into two parts (R1 and R2), with R2,s value chosen so that 200mV is generated across the diodes at FSD; at overloads in excess of twice the FSD value the diodes start to conduct, and thus limit the meter's overload current; R1's value is chosen to limit the diode overload currents to no more than a few mA.

Multi-function Meters

A single moving-coil meter is often built into an item of test gear and used to act as a multi-function 'volts and current' meter. The designing of such meters is usually quite a simple matter, the basic principle being that all multiplier and shunt resistors are permanently wired into circuit, the meter simply being switched in series or parallel with the appropriate element. Thus, if a common measuring point can be found the switching can be made via a single-pole switch. as in the case of the Figure 24 circuit, which uses a single meter to monitor the output voltage and current ofa regulated power supply unit. If a common measuring point can not be found, the switching must be done via a 2-pole multi-way switch, as in the case of the circuit of Figure 25, which can monitor several independent DC voltage and current values.

RANGE	BATTERY VOLTAGE	MID-SCALE RANGE VALUE	METER FSD CURRENT (uA)	Rshunt VALUE (Ohms)	Rm VALUE (Ohms)	NOMINAL R1 VALUE (Ohms)	MID SCALE ERROR
x1 (1K) RANGE	1.5V	1K	1500	103.5	100	900	-0.7%
	1.4V	1K	1400	111.1	107.1	893	0%
	1.2V	1K	1300	130.4	125	875	+1.8%
	1.1V	1K	1200	142.8	136.4	864	2.9%
x10 (10K) RANGE	1.5V	10K	150	1500	1000	9000	-0.7%
	1.4V	10K	140	1667	1071	8930	0%
	1.2V	10K	120	2143	1250	8750	+1.8%
	1.1V	10K	110	2500	1364	8636	2.9%
x100 (100K) RANGE	11V	100K	110	2500	1364	98.64K	-0.14%
	10V	100K	100	3000	1500	98.50K	0%
	9V	100K	90	3750	1667	98.33K	+0.17%
	8V	100K	80	500	1875	98.12K	+0.37%
	7V	100K	70	7500	2143	97.86K	+0.64%

Fig.21 Design-calculation chart for the 3 - range ohmmeter.

Analogue Multi-meters (VOMs).

Modern analogue multi-meters (called Volt-Ohm Meters, or VOMs, in the USA) are provided with a good selection of ohm and AC and DC volt and current ranges. Such meters are usually such excellent value-for-money that it is simply not cost-effective for the amateur to consider building, rather than buying, a multimeter, and this situation has pertained for at least twenty years. Figure 26, for example, shows the awkward) meter with a similar specification. There are occasions, however, when it is worthwhile building a multimeter; these are usually when a meter with special ranges is required, or when a use is wanted for a spare meter. or when the need is felt for a challenging or educational construction project. In such cases the do-it-yourself 18 range meter of Figure 27 may be considered; it uses a readily available 50μA meter, which is protected by a couple of silicon diodes, and

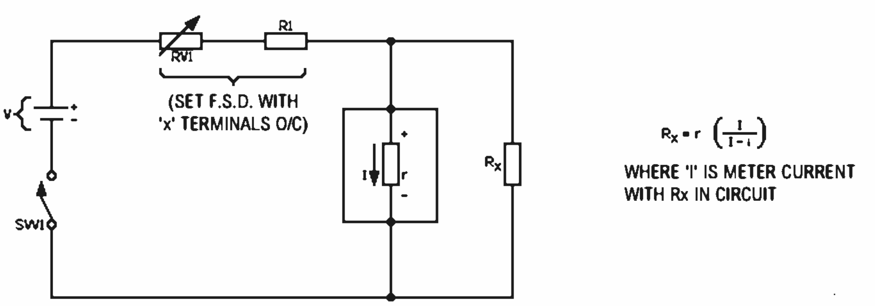


Fig.22 Basic circuit of the parallel-type ohmmeter.

circuit of a popular medium-priced British-built 18-range instrument of the 1970's, the Avo Multi-minor Mark 5. This ancient and obsolescent instrument uses half-wave rectification on its AC voltage ranges (as in Figure 15), and has a basic sensitivity of 1k/volt on the AC ranges and 10k/volt on its DC voltage ranges. Even so, note that it uses a special moving-coil meter which, with a swamp resistor fitted, has an FSD sensitivity of 100mV, and uses a purpose-built 2-pole 18-way range switch that can handle currents up to 1 Amp and has 1kV of insulation between switch contacts. Also note that it uses a variety of odd-valued precision resistors, and that the 7M5 resistor needs an insulation rating of at least 750 volts. The amateur has no chance of buying such components at an affordable price.

Modern multi-meters are an even greater challenge; they use the latest technology, usually have between 18 and 40 ranges, and typically cost less than half as much as it would cost the amateur to make a homebuilt (and usually ugly and has a sensitivity of 10k/volt on its AC voltage ranges and 20k/volt on its DC voltage ranges.

The reader should have little difficulty in following the circuit of Figure 27. The multimeter's DC current circuitry is derived from Figure 10, its AC voltage section from Figure 13, and its ohms section from Figure 20. No attempt has been made to provide the reader with a rigid range-switching diagram, but switching problems have been eased by provid-ing separate terminals for the 1 Amp and 1kv inputs. so range switches need maximum current ratings of only 100mA and contact insulation ratings of 250 volts.

Using A Multimeter

Analogue multi-meters are fragile and easily-damaged instruments: when using them, always remember the following basic rules.

(1). Most analogue multi-meters arc designed to operate with their faces in one specific physical orientation, usually horizontal. If such meters are sloped at an angle or are placed vertically when in use, measurement accuracy may be impaired.

(2). When measuring an unknown voltage or current, always set the meter to its highest range and then work down the ranges until the right one is found.

(3). When measuring an in-circuit voltage, connect the meter across the voltage source, as shown in

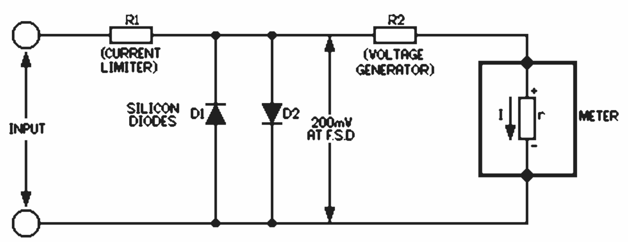


Fig.23 Meter overload protection given via silicon diodes.

Simple volt-current-ohm moving-coil meters are the most widely used types of electro-mechanical analogue meter used in electronics, but they are not the only ones. The following list gives brief details of a few other popular variations and types worthy of mention:

dB Meters. In AC signal-voltage measurement, the decibel or dB is used as a means of expressing the relative ratios of signal strengths, a value of 1 dB representing a ratio of1.122. Thus, a signal that is 1dB up on a 10V reference has a strength of 10 x 1.122 = 11.22 volts, and one that is 1 dB down on the same reference has a strength of 10/1.122 = 8. 91 volts. The scale of any linear AC voltmeter can be graduated in dB by selecting an arbitrary '0 dB' reference voltage and then calculating the appropriate positions for the dB graduation marks. Figure 29 shows an example of such a scale applied to the 10V range of a meter; in this case 7.94V has been selected as the '0 dB' reference value, because it is precisely 2 dB down in 10V

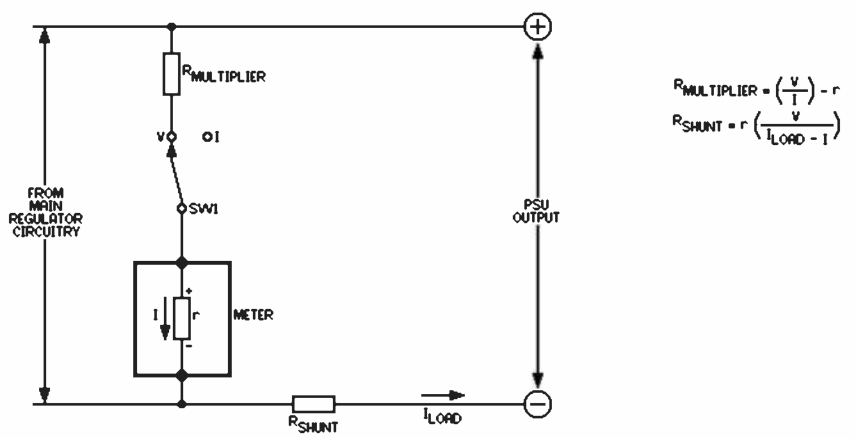


Fig.24 Example of a single meter used to read both V and I in a PSU.

Figure 28a. Always remember that the voltmeter's input impedance (the product of its 'V' range value and its ohms-per-volt sensitivity) will shunt any resistance that it is connected to and will thus reduce the apparent value of its generated voltage; allow for this 'disturbance' effect when taking measurements.

(4). When measuring an in-circuit current, connect the meter in series with the current source as shown in Figure 28b. Always remember that the current meter will generate a significant volt drop (usually between 100mV and 500mV at FSD), and that if it is used in low voltage circuits its presence may have a disturbing effect on the magnitude of the test currents.

(5). When measuring an in-circuit resistance always isolate the resistance from all other circuitry and then connect the meter across the resistor, as shown in Figure 28c. Never try to measure the value of a resistance that has a voltage source applied to it. Always remember that the ohmmeter is itself a voltage generator, and that when connected to a semiconductor junction its readings may depend on the polarity of connection: thus, a diode may give a low reading in one direction and a high reading in the other.

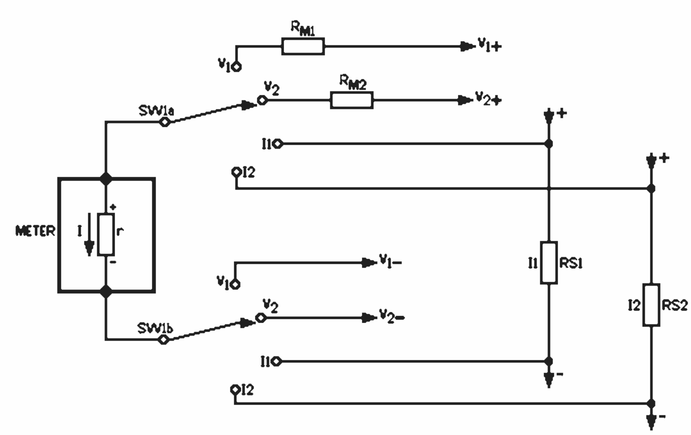


Fig.25 A single meter used to monitor two 'V' and two 'I' ranges in an instrument.

and thus enables the meter's FSD point to be used as the '+2dB' point. The table lists the positions for the dB graduation points in terms of percentage of FSD.

Watt-meters. A true watt meter makes independent meas-urements of a load's voltage and current, and gives an output

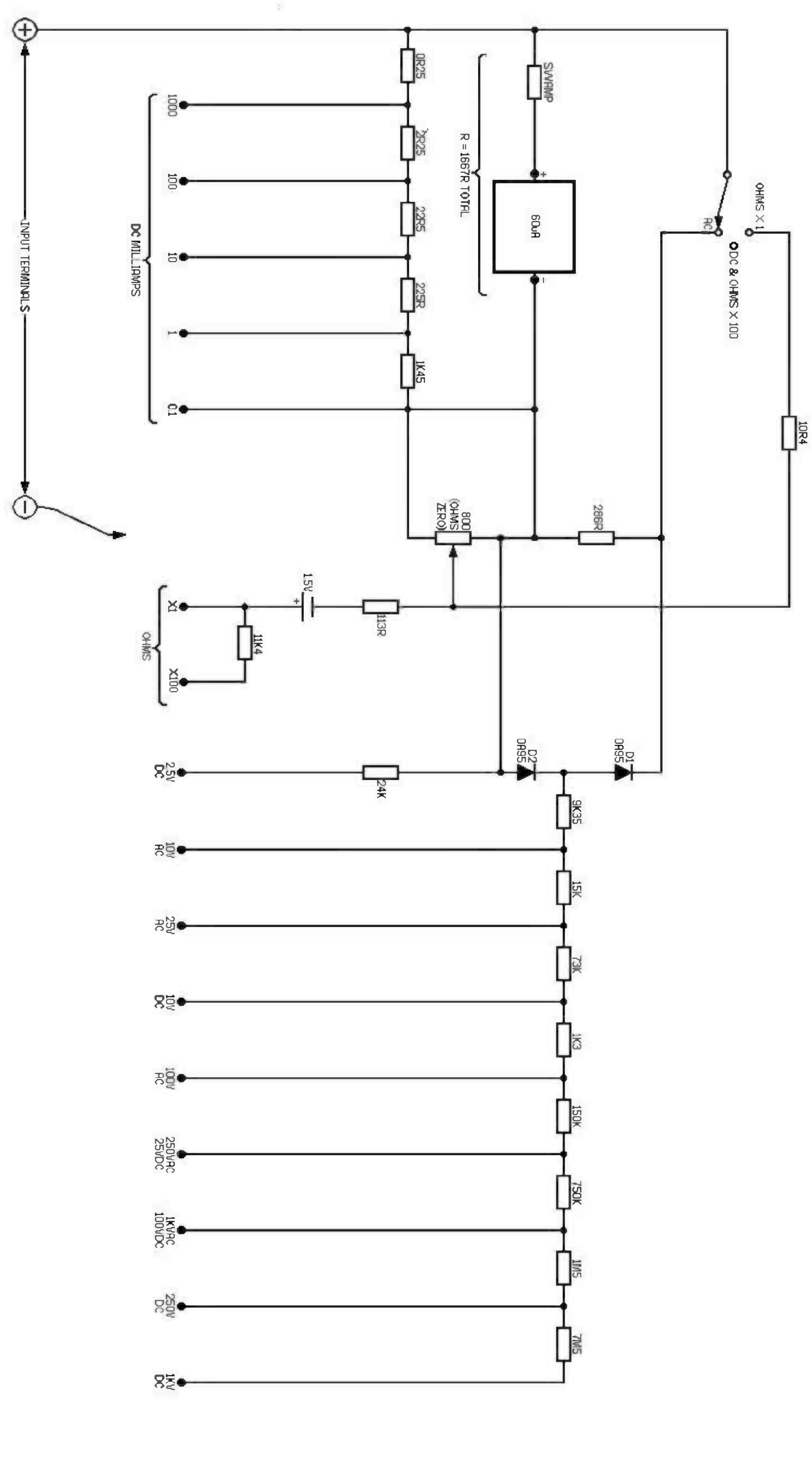


Fig. 26. Circuit of the 18-range Avo Multiminor Mark 5 of the 1970's era (reproduced by courtesy of Avo Limited, Dover, UK).

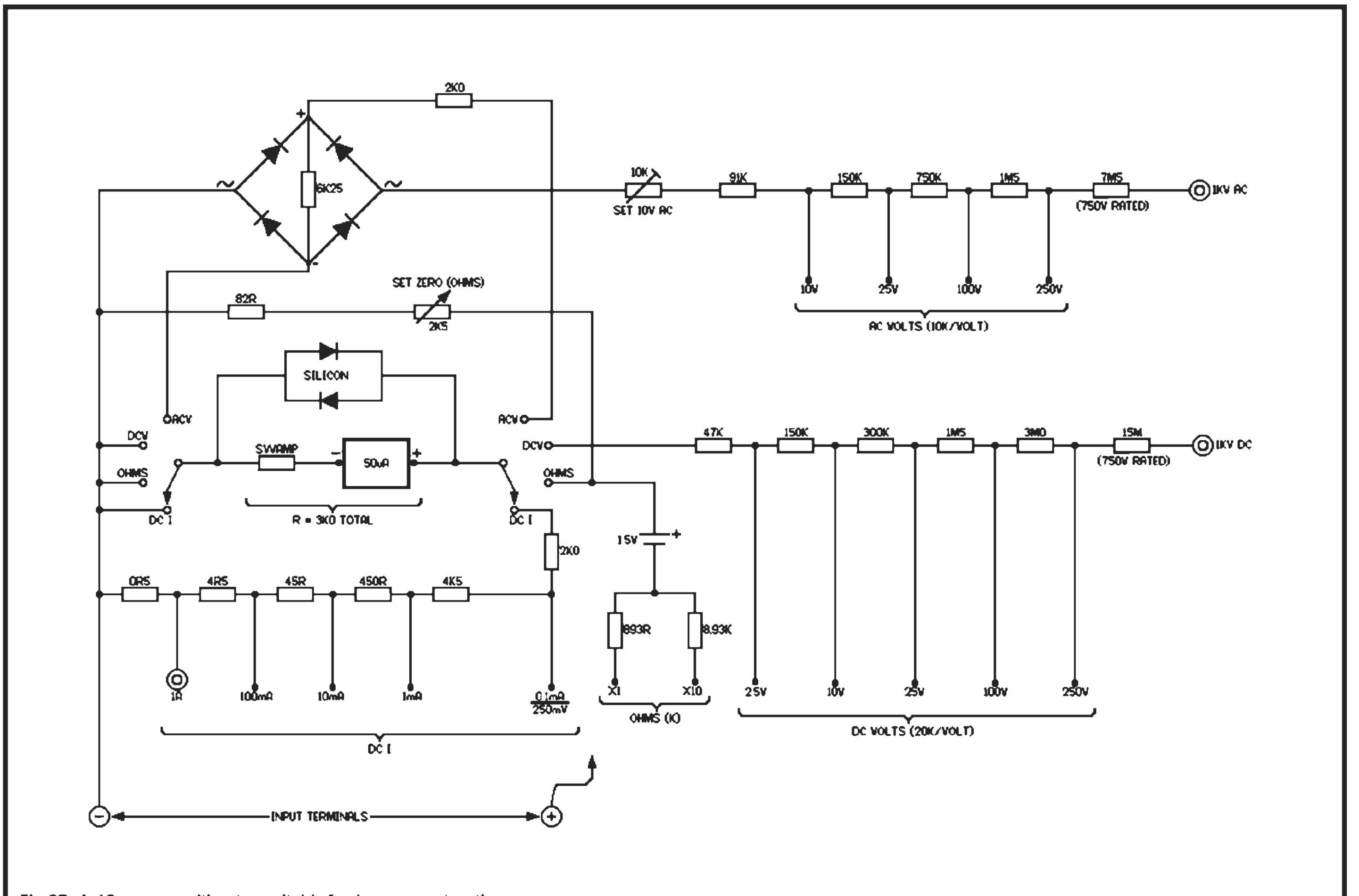


Fig.27. A 18-range multimeter suitable for home construction.

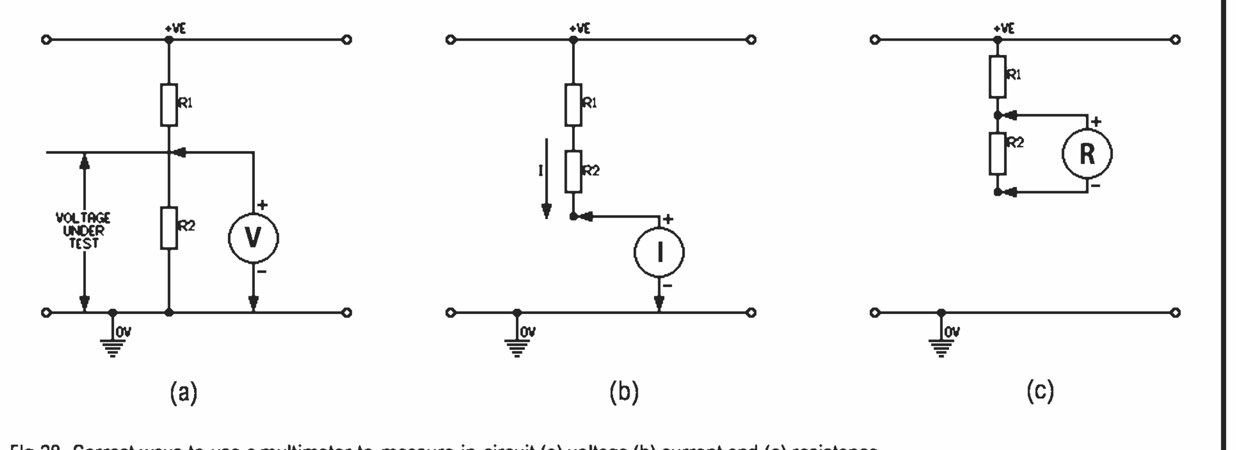
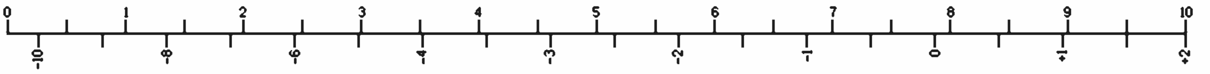


Fig.28. Correct ways to use a multimeter to measure in-circuit (a) voltage (b) current and (c) resistance.

reading that is equal to their product and is independent of variations in load resistance. Such meters are expensive. If power measurements are to be made into a fixed load resistance, however, an inexpensive pseudo-watt-meter can be made by simply using an AC voltmeter to monitor the resistor's output voltage, as shown in Figure 30, and calibrating the meter scale on a basis of W=(V2)/R. Such a meter has a non-linear scale, as shown, since its voltage reading is proportional to the square root of power.

Thermocouple Meters. Thermocouple meters are often used as RF current or power indicators at frequencies up to hundreds of MHz, or as wide-band AC/DC transfer standards in electrical calibration work. They consist of a thermocouple (a junction of two wires made from dissimilar metals, which generates a cross-junction voltage when heated) that is connected directly. to a moving-coil meter, and an exter-nally energised 'heater' that is in thermal contact with the thermocouple. When an external current is fed through this second pair of wires it causes the thermocouple to heat up and generate a proportionate current in the moving-coil meter. This current is proportional to the true RMS input current, and is not influenced by the shape or frequency of the waveform, and such meters can thus be used at frequencies from DC to hundreds of MHz. These meters have a square-



% FSD	dB	% FSD	dB	% FSD	dB
100	+2	50.1	-4	25.1	-10
89.1	+1	44.7	-5	20.1	-12
79.4	0	39.8	-6	15.9	-14
70.8	-1	35.5	-7	12.6	-16
63.1	-2	31.6	-8	10.0	-18
56.2	-3	28.2	-9	7.9	-20

Fig.29. A dB volts scale compared with a linear 10V scale, using 7.94V as a '0dB' reference, to give a value of +2dB at FSD.

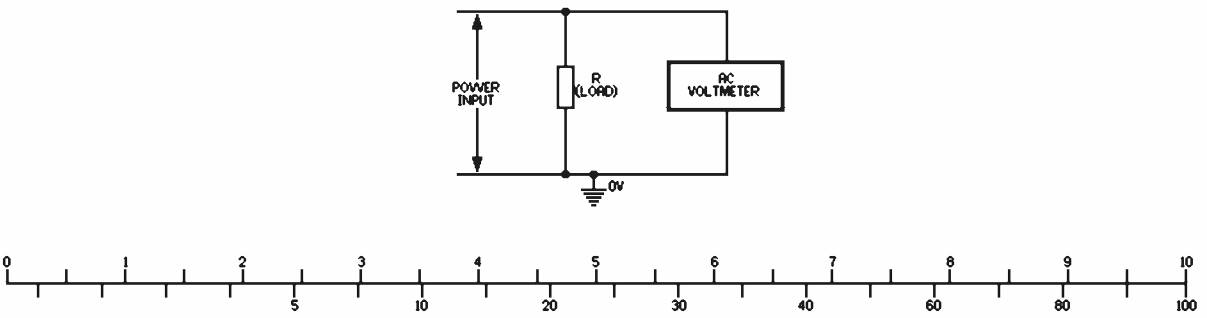


Fig.30. Basic circuit and typical non linear scale of a simple pseudo-watt-meter.

law scale. The thermocouples are very fragile and easily burnt out.

Moving Iron Meters. These meters are widely used as AC or DC volt or current meters in low-accuracy applications, etc. They have a fixed coil (through which the measured current flows) and a balanced iron vane that carries a pointer and deflects when the coil is externally energised. Such meters are cheap and robust but have a low sensitivity. They respond equally well to AC and DC; their scales are non-linear, and are cramped at the low end.

Electrostatic meters. These are usually built to read voltages in the 1kV to 30kV range. In essence, they act as one fixed and one movable set of capacitive vanes; a pointer is fixed to the movable vane, which is deflected electrostatically when an external voltage is applied. Such meters respond to both DC and AC voltage (they draw zero current from DC sources and a frequency-dependent current from AC sources. Their meter scales are non-linear, and are cramped at the low end. Such meters were once widely used for high voltage measurement, but they are now rarely used.

The next episode of this series will look at electronic analogue meter circuitry.

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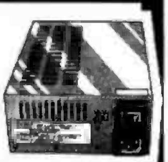

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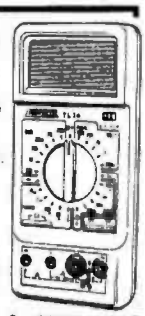

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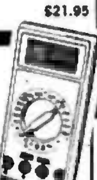

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Communications Link by RS232

Testing

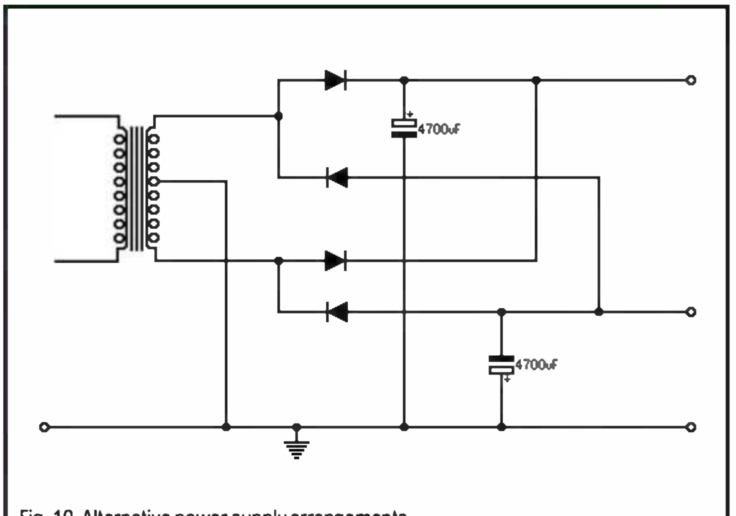


Fig. 10. Alternative power supply arrangements

2

PROJECT

A project where 'Device Shall Speak Unto Device' Commentary by Keith Garwell.

We continue our RS232 link by looking at the testing procedure. Connect the power lines +12, -12, +5, and 0 volts either direct or via the mother board depending on the decisions arrived at earlier. If you have a frequency meter then the rest is easy. Connect it between the link marked OSC and the link marked 0V on the placement diagram (Figure 15). Adjust the 10k preset until the required frequency of 38.5kHz is obtained and that's all there is to setting up.

Failing a frequency meter then the first step is to check that the oscillator is running. A 'scope is handy at this point but if no 'scope is available use a conventional (moving coil is conventional to me - that dates me doesn't it!) meter between the OSC and 0V links. The voltage should be approximately half the working voltage ie. 2.5 volts as the oscillator has an even mark to space ratio. If you don't have a moving coil meter use a DVM but if it gives a silly answer it may be because of interaction between the oscillator and the sampling system in the DVM. If this is the case connect a large capacitor across the DVM (a 1uF or thereabouts is OK) and a 470k approx in series with the OSC connection to filter out the oscillator frequency. If the oscillator isn't running check the component placements particularly for chips the wrong way round. Given the oscillator is running and no frequency meter is available the next job is to set its frequency as accurately as possible. The modus operandi is to connect a meter between bit 7 of the receiver and 0V then repeatedly send alternate bursts of@ signs ASCII 40H ie. 01000000 followed by a burst of SOHs ASCII 01H ie. 0000000 1, with a short break between. Do this continuously and adjust the preset until bit 7 changes between 0 and 1 as the burst of characters are received. Then determine the positions of the preset at which this fails and finally set the preset midway between these two extremes.

This done, check with the meter that bit 1 is also changing between 0 and 1.

This data sending is obviously most easily done using a computer! What is required is a burst of @ about 1 second long, a short pause of at least 2 characters duration followed by a burst of SOH followed by a pause. About 300 characters are a suitable burst length. As an illustration it can be done in the following way using an IBM PC or look-alike.

Connect the board to the PC (see 'In Use') for details and switch on the power to the board. Switch the PC on as well! Set up a file with about a250@s in it. If you want to use your favourite word processor by all means do so but be sure there are no embedded format characters, it should be a straight

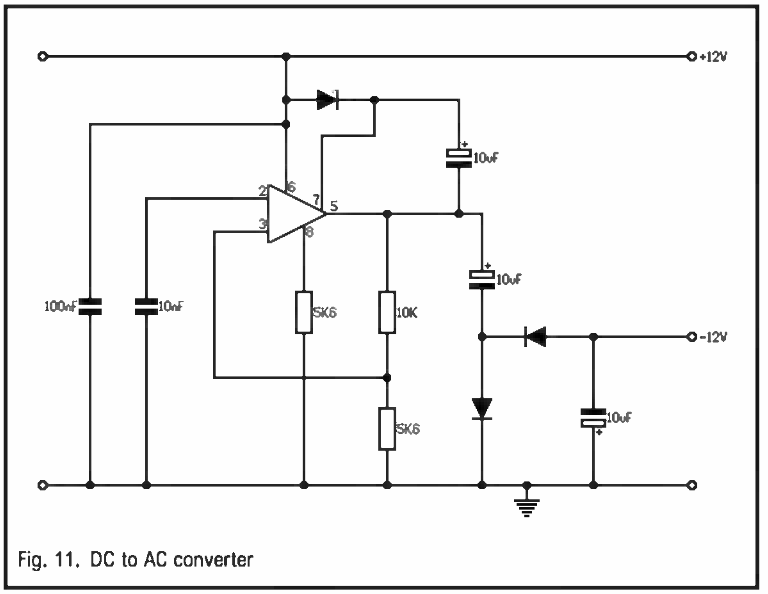


Fig. 11. DC to AC converter

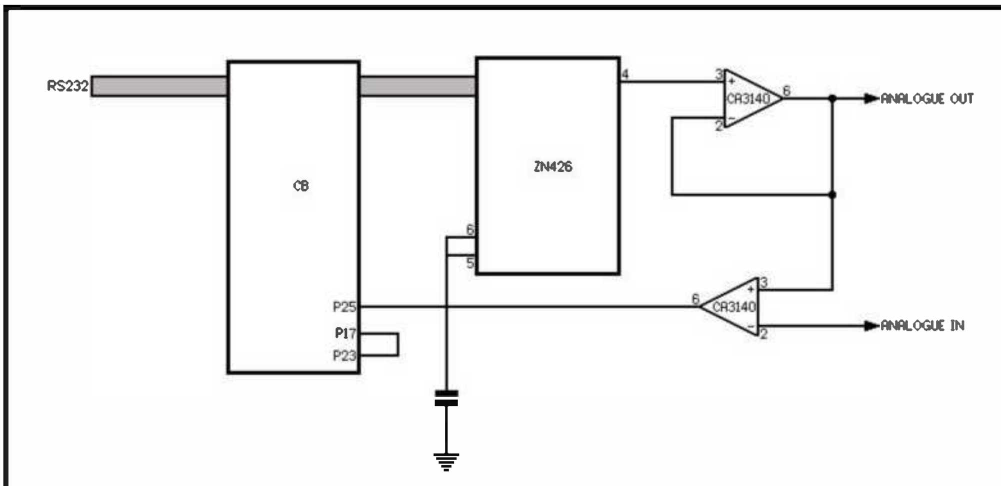


Fig. 12. Analogue output and analogue in viaconversion board.

ASCII file without carriage returns or line feeds. Alternatively the built-in DOS commands will do it as follows - (depressing the Enter key after each command is implied).

COPY CON AT

Followed by typing two and a half lines of @ signs then control and Z then enter.

The file AT thus contains the @ signs. Now for the file containing the SOH or 0 1 characters. Your favourite word processor may not be able to do this! But the operation is similar to the previous one viz.

COPY CON SOH

Type 5 lines of control and A then control and Z then enter. Control and A is usually shown as "A so the there are only 40 real char-acters per screen line hence 5 lines to make it the same length as the AT file. The number of characters doesn't matter within a few, just so long as it takes about a second to send. Excluding the time to get the file.

Now make a batch file the contents of which are as follows-

COPY CON SENDALTS.BAT
:AGAIN
COPY AT TO COM1:
COPY SOH TO COM1:
GOTO AGAIN

Now set the Baud rate word length etc with the MODE command by typing -

MODE COM1 : 2400,N,8,1,P

Now set it all in motion by typing -

SENDALTS

The batch file will read the two files from disc and send them. The disc reads giving the required short pause between sending each block. This pause is important as it forces the conversion board to resynchronize. Without it the characters will just pour out continuously and twiddling the preset will _cause synchronization to be lost.

When ready stop the batch file running by pressing CTRL and C.

In Use

The computer end - setting up. All the remaining explanations will be illustrated using an IBM PC or look-alike hereinafter referred to as the PC. Other machines will have similar commands although the command names may not be identical. Only the commands are given below, pressing Enter to activate the command is implied.

First the RS232 computer link must be set up to correspond to our board. (Not Baud! and surely not bored!). To set up the first channel on the PC the MODE command is used as follows -

MODE COM1:2400,N,8,I,P

If it were the second channel then COM2: would be used. In fact I use a batch file (a file containing system commands, often referred to as the System Control Language) called M2400.BAT containing -

ECHO OFF
MODE COM1:2400,N,8,I,P

Then all I have to do to set up the link is type M2400. Alternatively the Mode command can be inserted in the system start-up file AUTOEXEC.BAT so that the PC is automatically set correctly at switch-on.

Before I forget the P at the end of the MODE command causes the receiver to ignore time-outs. By way of explana-tion the program which drives the RS232 in the PC will only wait a limited amount of time for an incoming character before it gives up and returns a null (a character of zero). Without the P every null character would be inserted into the file (see below). The next job is to make up the connecting cable. The cheapest possible cable 'is ideal! Only 3 wires are used so a very thin mains cable would do if you have some and only a short length is required. However mains cable is not the cheapest solution if you have to go out and buy. In this case the four wire cable often referred to as signal cable or burglar alarm cable is the cheapest (Maplin). The connectors used for RS232 on a computer are D type plugs, the standard being a 25 pin. An alternative sometimes . used, especially on physically small machines is a 9 pin D type.

As well as the two data lines and the common ground or 0V these plugs carry control signals intended to show the state of readiness (status) of the computer and attached modem. These control lines must be correctly driven otherwise the link will not run. In our case this is achieved by linking some of the lines together.

For a 25 pin socket the connections are:

Pin 2 is the transmit or output and is connected to P10 on the conversion board (CB).

Pin 3 is receive or input and goes to P18 on CB.

Pin 7 is the common and goes to 0V that is P12 on CB.

Pins 4 and 5 are Request To Send and Clear To Send, RQS and CTS and should be linked together.

Pins 6, 8 and 20 are respectively Data Set Ready, Data Carrier Detected and Data Terminal Ready, DSR, DCD and DTR and should be linked together.

For a 9 pin socket the connections are:

Pin 3 is transmit and goes to P10 on CB.

Pin 2 is receive and goes to P18 on CB.

Pin 5 is the common and goes to 0V that is P12 on CB.

Pins 7 and 8 (RQS CTS) should be linked together.
Pins 6, I and 4 (DSR DCD DTR) should be linked together.

The Computer End -Driving The Link

There are three approaches to the problem. Use the features built in to MSDOS to link communications with files. Design the handling into the program(s) which will use the Conversion Board using communications commands. Drive via the BIOS (Basic Input/Output System a part of MSDOS) interrupts from the program(s) using the board.

By sending or receiving a tile via the communication link using MSDOS commands. Given that the name of the file to be sent is TX.DAT and that any data received is to be inserted into the file RX.DAT then the commands are:

COPY TX.DAT COM1:
or
COPY COML: RX.DAT

In the first case the whole tile contents will be sent as one block without pause. Whilst for the receiver command the PC will buffer up the data and only establish the file upon receipt of the normal PC file terminator ASCII 26 (generated by control and Z and represented on screen by Z. Note it is not necessary for the data to be a continuous block the receiver will sit for ever collecting characters until the terminator is received.
The second method is to use BASIC or any other language which will handle the communications port. GWBASIC which is often supplied with a PC is suitable. The file is opened with the statement:
OPEN 'COM!: J400,N,8,l' as file number, length
Then use statements to write/read to the specified file number as for any other file.
The third method is perhaps more appropriate to machine code but will usually be available in compiled languages. It consists of making calls to interrupt 14 in the BIOS with certain contents in the machine registers. For example7
To initialize the communications to 2400B,NP,8 bits,! SB call interrupt 14H with AH=0, bX=0, AL=l01000! I (A3Hex). On return from the routine AX will contain status information.

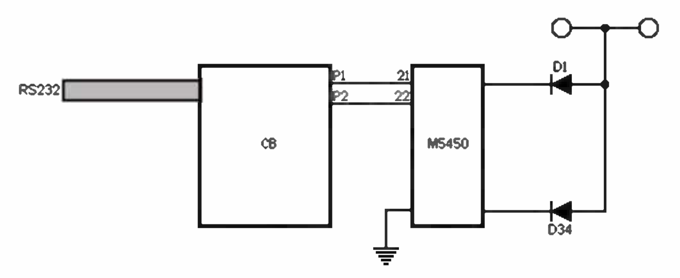


Fig. 13. LED driver with common anode configuration.

To send a char call interrupt 141-I with AX=OIH, DX=0, AL= char to be sent. AH contains status on return.

To receive a char call interrupt 14H with AH=02H, DX=0. On return AL=char received, AH=status. Note that if a char is not received within the. 'specified' time-out the routine will return with a null character. The 'specified' time is set as part of the initializing routines when setting up the PC in the first place and is usually stored in battery backed RAM.

As A Converter From Centronics To RS232

This was the original reason for the existence of the converter board. I use a Dragon micro for various jobs from time to time and often wanted to pass data to a PC for processing. However the Dragon only has a Centronics printer connection. Centronics implies a particular connector and style of data handling for 8 bit parallel data. I must be honest and admit that I don't know where the name came from. I suspect it was an original manufacturer. Anyway the interface has become a 'standard'

I'm sure it could be a good idea to go over the operation of the Centronics printer interface so that we can see how it applies to the conversion board. It is also typical of the way in which many parallel interfaces work.

There are 8 data lines along with their own returns to 0 volts, +5 on a data line indicates logical true or 1. Imagine the sequence. The processor puts the appropriate voltage levels on the 8 data lines for the first character. To ensure that the printer does not misread any of the data whilst it is in a state of change the processor applies a signal to a 'strobe' line to indicate that the data is no longer in a state of change and can be read by the printer. Before changing the data for the next character the OK signal is removed from the strobe line. The sequence is then repeated .for each character.

This arrangement works admirably so long as the printer can handle the characters more quickly than the processor can send them otherwise data will be lost. As it happens this state of affairs is very unlikely. The printer is a mechanical device so will be much slower than the processor. Consequently there must be some. means of slowing down the processor. On the Centronics interface this can be done in either of two ways. There are two other lines, one called BUSY, and one called ACKNOWLEDGE (usually abbreviated to ACK) both under the control of the printer. +5 on the busy line indicates to the processor that the printer is unable to accept further data while 0V on the acknowledge line indicates to the processor that the data has been received and the printer is ready to accept further data. Putting it round the other way, +5 on the acknowledge line indicates the primer is not ready. Whichever one is used the other must be set to the not true condition. If the busy line is to be used then ACK must be set to NOT ACK ie. to +0V. Conversely if ACK is 10 be used then BUSY must be set to NOT BUSY.

In our case we use the busy line. The connections between the Centronics socket and the conversion board are shown in the following table where CS indicates the pin number on the Centronics socket and CB indicates the connection number on the conversion board.

CS	Use	CB
1	Strobe (N)	23
2	Data 1	25
to		
9	Data 8	32
10	Ack (N)	not used
11	Busy	16
19	Gnd or 0V	12
20		
to Not used		
29		

In use set the PC to read data from the RS232 line for example with the command;

COPY COM 1: MICRO.DAT

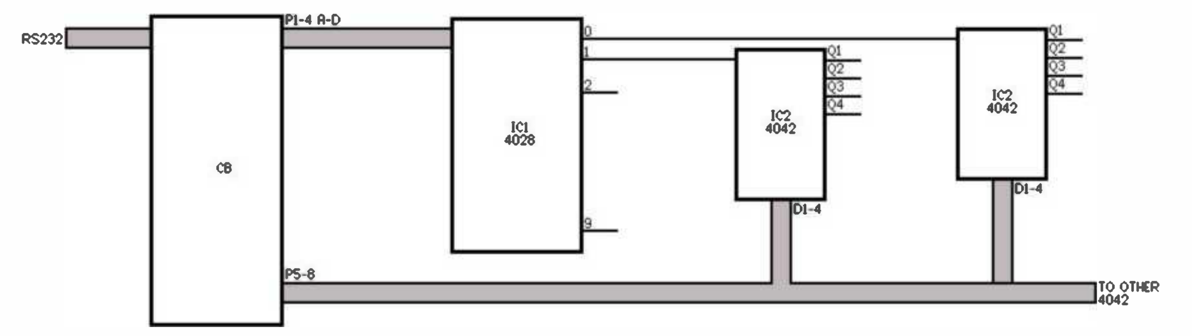


Fig. 14. 40 line driver arrangement In bundles of four.

The PC will sit patiently waiting for data.

Now fire up the micro so that it behaves as though it were passing data to the printer. When it has finished the terminating character 26 must be sent. The PC will put the data away in the file MICRO.DAT.

As A Digitiser

Figure 12 shows the arrangement required to provide analogue output and analogue input via the conversion board and RS232 link. The shaded bars indicate connections of more than one line.

The analogue output is quite straightforward. A character sent to the conversion board via RS232 appears on pins P8 to P1 (LS pin first) this is coupled to the input pins of the ZN426 (Maplin) where it is converted to an equivalent analogue voltage at the output. NOTE. On DAC chips the MS. bit is often labeled 1 and the 1s bit 8. The conversion is in the range 0 to 2.55 which corresponds to the possible character values of 0 to 255.

The analogue output is buffered by the CA3140. This particular op-amp has the advantage that it includes 0V in its operating range. It isn't absolutely essential but the output impedance of the ZN426 is 10K and for accuracy the load resistance would need to be of the order of 220K at least. For the sake of the few coppers that a 3140 costs the 'old halfpence of tar' really applies. The 3140 also offers the facility for scale changing if required. It is as well to run the 3140 from more than 5 volts if possible because the output of this op-amp will not get closer to the positive rail than 2.25 volts which with a maximum output from the ZN426 of 2.55 gives 4.8 which at 5 volts only leaves 0.2 volts spare. That is sailing close to the wind!

The analogue value will appear immediately the character is sent from the PC (well nearly), so there's a simple waveform generator.

The analogue input is less straightforward, in fact its positively crooked! From Figure 12 it will be seen that the analogue input is compared with the analogue output by means of the second CA3140.

The result of comparison, the output of the 3140, is connected to one of the inputs to the conversion board. I have shown the connection as being to bit 1 and what follows assumes this to be the case. However it need not be, any bit will do, especially if it is more convenient because you are using the bit for something else.

Figure 12 also shows the signal RXDR Receiver Data Received tied to TXS the Transmit Strobe. Thus sending a character to the DAC will result in RXDR going low and loading the comparator output into the transmit buffer. When RXDR goes high the character will be sent. Thus bit 1 of the character being returned to the PC will indicate whether the analogue input is less than or greater than the analogue output.

From this arrangement it is possible to determine the actual value at the analogue input by means of a little software routine. The demonstration code is written in BASIC. Note, my WP interprets the hash sign as a pound sign, it should be written hash 1 and input hash 1 in line 120.

```
10      DIM UD(9)
20      UD(I)=&H40 : UD(2)=&H20 : UD(3)=&HI0 :
        UD(4)=&H8
30      UD(5)=&H4 : UD(6)=&H2 : UD(7)=&HI :
        UD(8)=&HI
40      OPEN 'COM1 : 2400,N,8' AS #1
100     CV=&H80 : LC=0
110     FOR I = 1 TO 9
120     WRITE # 1,CHR$ (CV) : INPUT #1,RX$
130     IF ASC(RX$) = 0 THEN CV = CV - UD(LC) ELSE
        CV = CV + UD (LC)
140     NEXT
150     RETURN "CV contains the current value"
```

It works by what is known as successive approximation. But before attempting to get it working check the code, particularly in lines 40, and 120 which is the input/output and a place where different dialects of Basic will probably differ. It can be called as a subroutine at line 100.

On entry CV is set to &H80 where the most significant bit is a one. This value is sent down the line and the returned value will indicate whether it is too large or too small in line 130 and the value is adjusted by adding or subtracting the next bit by adding or subtracting &H40. Then round the loop again until all 8 bits have been done. The answer given can be one bit too small, 0.01 volt too small. This is because the comparator only returns too large or too small there is no equal return.

Whilst on the subject of digitiser if you haven't experimented with them before you may wonder why it sometimes can't make up its mind and keeps returning two answers which differ by 1. This is because if the analogue voltage is just exactly equal to one of the possible answers circuit noise can make the answer swing either way. In other words if the analogue value is exactly 1.82 you may get answers of 1.81 or 1.82.

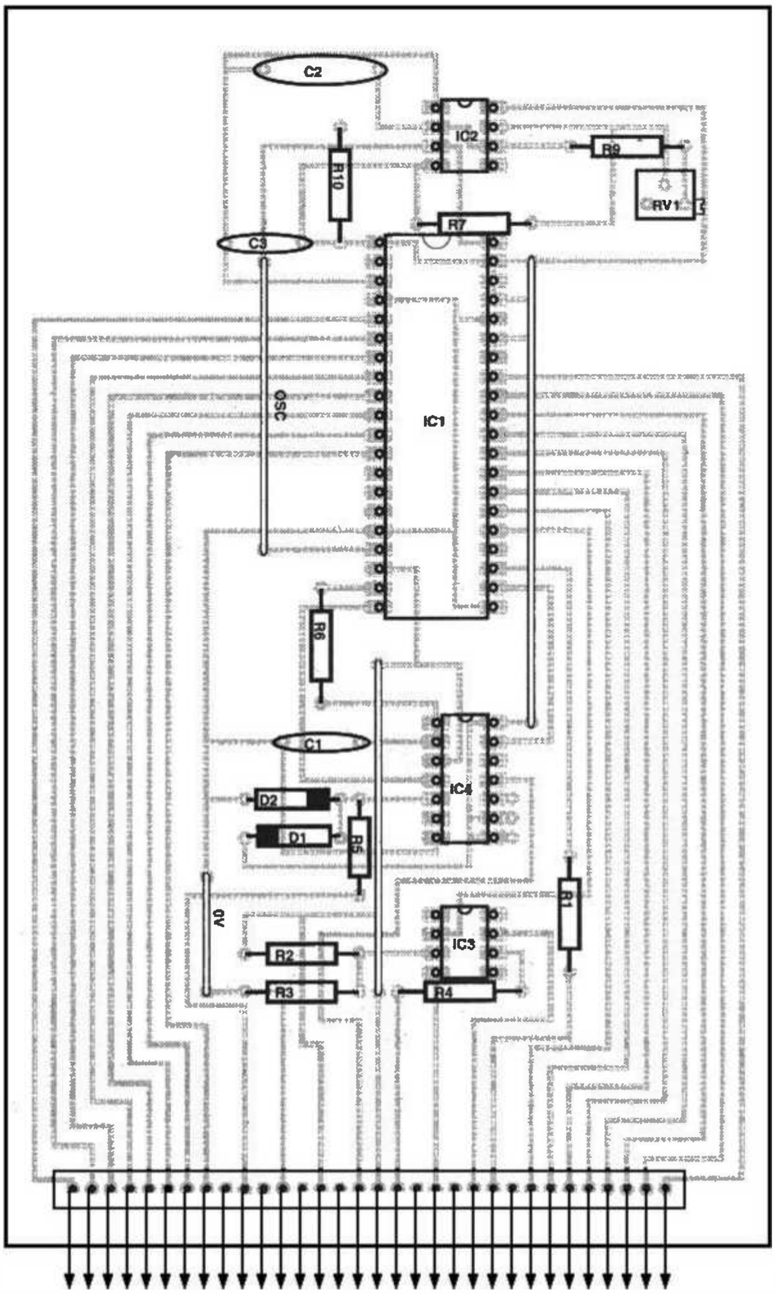


Fig. 15. Component overlay.

A Lots-of-LEDs driver

A very handy device is the M5450 (Maplin) which will drive 34 LEDs. Only one additional component is required to set the current through the LEDs. This is enough to drive four 7 segment displays with decimal point if required. If such displays are used they must be common anode. As an alternative to LEDs, resistors may be used in which case 34 logic outputs are available.

Figure 13 shows the outline detail of the arrangement. The M5450 is a serial device. It has one data input (pin 22) and a clock input (pin 21)., A transition from low to high clocks in to a 34 bit shift register whatever level is on the data input. Thus 34 transitions shift in 34 data bits. Two addi-tional bits are required, one before and one after the 34 data bits, both of which should be ones, making 36 bits in all. The 36th transition gates the shift register data into the output buffer to drive the LEDs. There is no intermediate condition at the output. The data changes only on the instant of the 36th clock pulse.

The output of the conversion board provides 8 lines, one of which must provide the common clock pulses. The remaining 7 are each able to supply data to an M5450. This will give the capability of driving 7 M5450s each in tum driving 34 LEDs or logic outputs. I make it 238 LEDs in total.

Since the clock input requires a level change for each data bit to enter the shift register in effect two characters have to be sent for every bit, a total of 38 characters plus the extra bits for gating the output buffer thats 72 altogether plus a final bit to restore the clock to its starting condition, 73 characters. As the system is running at 2400 Baud thats 240 characters per second so in fact it takes less than a third of a second to update 238 LEDs or logic outputs.

Referring to Figure 13 again where bit 0 is connected to the clock and bit 1 to the data. As an illustration suppose the first 4 bits to be entered into the M5450 are 0110 then the characters sent would be -

xxxxxx00
xxxxxx01
1st bit transferred
xxxxxx10
xxxxxx11 2nd bit
xxxxxx10
xxxxxx11 3rd bit
xxxxxx00
xxxxxx01 4th bit

Note two points.

First that since only the first two character bits are used to drive the M5450 it doesn't matter what the value of the others are, indicated by an x in the above. This means that the remaining 6 bits can be used for something else, for example to drive up to 6 other M5450s as suggested above. The clock can be common to all.

Second that the data shifted in is most significant bit first so the first data bit sent will appear on output 34.

Just to reiterate the actual pulses applied to pin 22. The first is a dummy, not used, the 2nd will appear as output 34. the 35th as output bit 1 and the 36th will gate the data onto the output lines.

As A Logic Driver

In the previous example (Figure 13) the data could only be changed to all the M5450 ie. all the lines. Certainly the same data could be rewritten so in effect only one output need change but they would all have to be written to. This example, Figure 14, can drive up to 40 lines in bundles of 4 lines. The 4 line blocks are directly addressable and so can be written independently, It works like this.

The processor drives the Conversion Board CB as in all the other examples. The first four bits of the output from CB drives a 4028 which is a 4 line to IO line multiplexer. In other words any number between 0 and 9 being applied to the inputs A to D will select the corresponding output line 0 to 9. Applying 15 to the input will leave all the output lines unselected (at 0V). Each of these ten lines can be connected to the enable input of a 4028 quad latch. So any one of ten latches can be addressed directly,

The remaining 4 output lines from CB are linked to the 4 inputs of the 4042 latches in parallel. These multi-line highways are indicated by the shaded bars in Figure 14.

The four outputs (Ql-4) plus the four inverted outputs from each 4042 are available four driving logic. For example the eight outputs from IC2 and 3 could drive a ZN426 digital to analogue converter. The outputs from other 4042 could drive analogue switches which could be used to switch the output of the DAC to up to 32 destinations.

An alternative technique is to use 4 quad latches, the first two driving a DAC as before. The second pair acting as the, address to drive multiplexing switches. This in fact is a technique proposed for remotely driving a theatre lighting system.

In action a similar driving technique can be used to that of the previous system, by sending pairs of characters. For example to set the output of IC2 to 0110 send the following characters:

01100010 1st character selects latch and applies data

01101111 2nd character deselected latch keeping data constant.

In action the MS four bits of the character act as the data and the Is. four bits select the quad latch to which the data is directed. The second character carries the same data but the address bits contain 15 which deselected the quad latch. Thus any latch can be set up by means of only two characters allowing much faster operation. The DAC data should only be changed when its output is not directed to any destination otherwise the destination will receive the change noise.

References -1. Newchapel Observatory & Natural Sciences Centre. Newchapel, Stoke on Trent ST7 4PT.

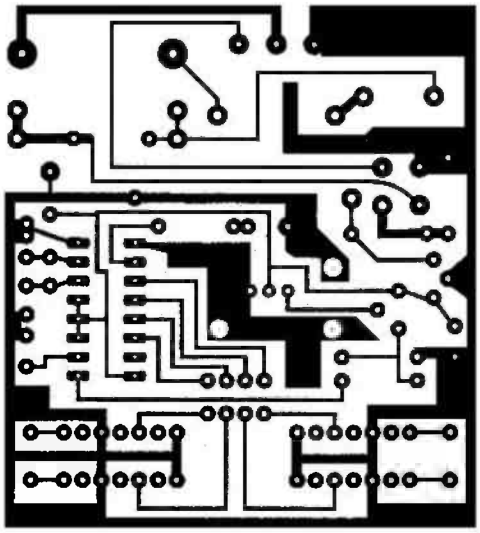
PARTS LIST

IC1	UART IM6402 or AY 31015
IC2	CMOS Timer TLC555
IC3	FET OP-AMP CA3140
IC4	CMOS Quad NAND 4011
D1,D2	Diode 1N4148
R1,R4,R7,R9	3k3
R2,R3	470R
R5,R6	10k
RV1	10k Square 22 turn Cermet preset
C1,C3	100nF radial Metalized Polyester film
C2	2200pF Polystyrene

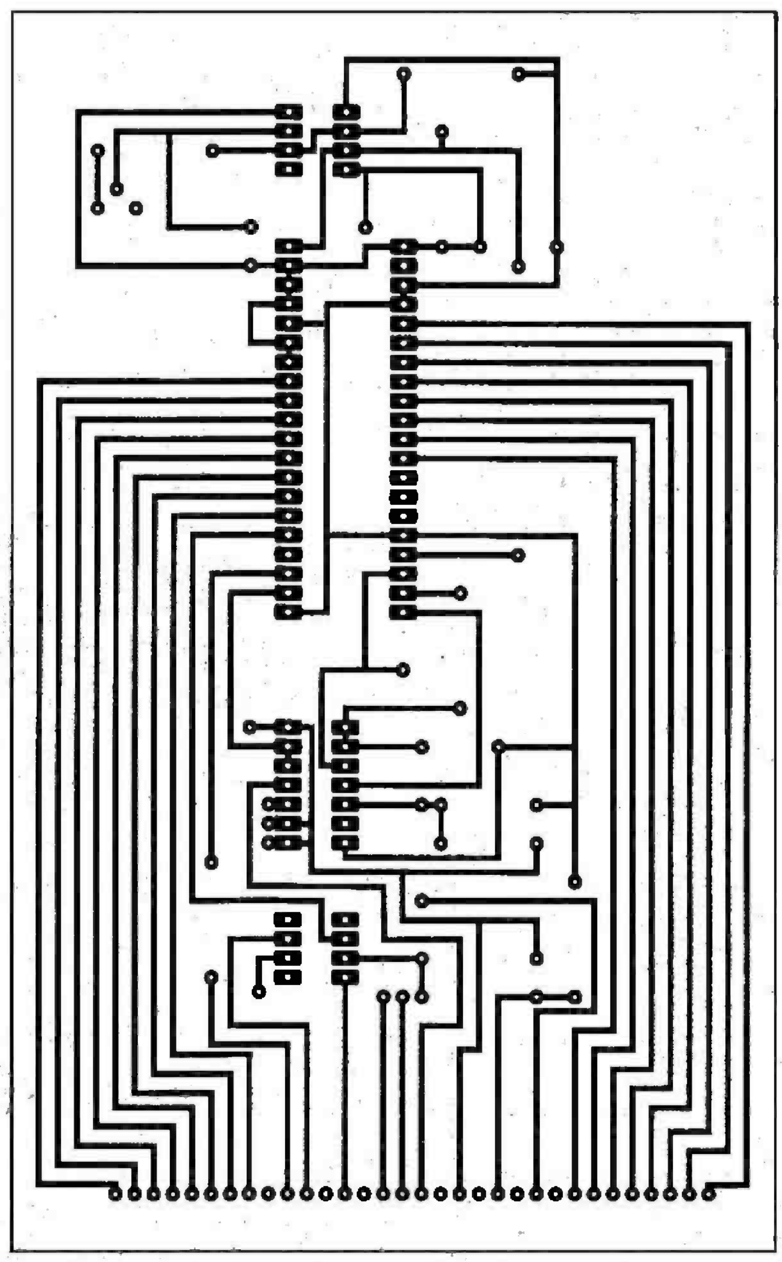
All resistors are Metal Film 0.6W.
PCB Connector is DIN 41612 Indirect Card-frame connector right-angled-plug 32way.

PCB Foils

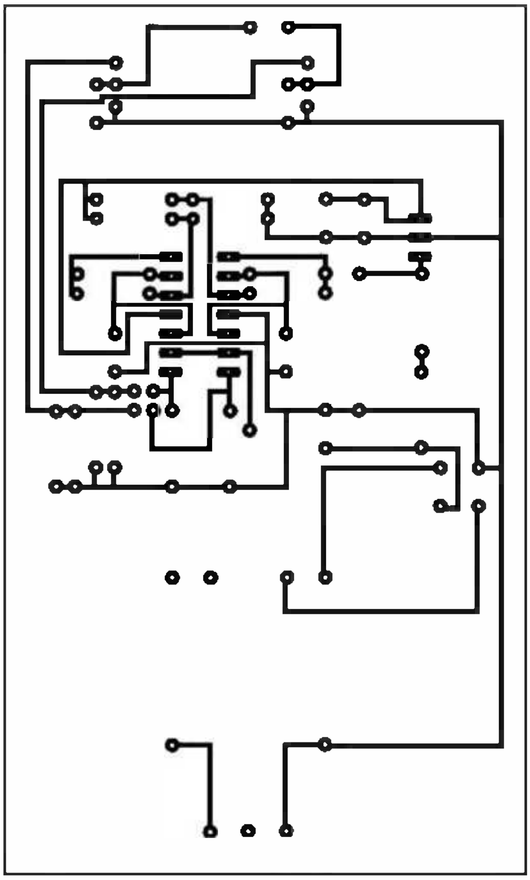
The PCB foil patterns presented here are intended as a guide only. They can be used as a template when using tape and transfer for the creation of a foil.



Infra-red receiver



RS232 Interface



Fading Festoonery

Automatic Audio Response Measuring System-Dec '92
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The prices for the UK in pound sterling are:
Compensated measuring microphone with cable and plug £ 39 Software £ 29
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All three items together to the favorable price of £ 79 (saving £ 8). Complete kit or ready build PCB please enquire.

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PCB Service January

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E9212-2 Communications Link by RS232 L
E9301-2 Fading Festoonery .... G
E9301-FC Infra-Red Receiver .... F

PCBs for the remaining projects are available from the companies lists in Buylines.
Use the form or a photocopy for your order. Please fill out all parts of the form. Make sure you use the board reference numbers. This not only identifies the board but also tells you when the project was published. The first two numbers are the year, the next two are the month.
Terms are strictly payment with order. We cannot accept official orders but we can supply a proforma invoice if required.
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E9108-2 Model Speed Controller-Main Board .... F
E9108-3 Model Speed Controller-Power Supply .... F
E9109-1 Geiger Counter .... E
E9109-2 Hemisync Waveform Generator Board .... G
E9109-3 Hemisync Pulse Generator Board .... F
E9109-4 Hemisync Power Supply Board C
E9109-5 Nighfighter Main Processor Board .... O
E9110-1 Freeze Alarm .... E
E9110-2 Document Saver .... E
E9110-3 Prototype Designer .... J
E9110-4 Nightfighter - Sound to Light (2 sided) L
E9110-5 Nightfighter - Ramp Generator Board .... F
E9110-6 Nightfighter - Cyclic Crossfade (2 sided) .... M
E9110-7 Nightfighter- Strobe Board (2 sided) .... J
E9110-8 Nightfighter - 8 Channel Triac Board .... N
E9111-1 Digital Code Lock L
E9111-2 Switched Mode Power Supply .... E
E9111-3 Nightfighter Mode Selection (2 sided) .... J
E9111-4 Nightfighter- Display Board (2 sided) .... M
E9111-5 Nightfighter - Bass Beat Trigger (2 sided) L
E9111-6 Nightfighter- Sequence Select (2 sided) .... H
E9111-7 Nightfighter - Master Controller PSU .... K
E9111-8 Nightfighter- Output Switch (2 sided) .... M
E9112-1 Nightfighter Sensor Switch Master Control (2 sided) L
E9112-2 Nightfighter Sensor Switch Channel Control (2 sided) L
E9112-3 Nightfighter Sensor Switch Sound Trigger .... H
E9112-4 Nightfighter Connector Board .... F
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E9112-6 Nightfighter 8-Channel Input Interface (2 sided) .... P
E9112-7 Power On and Overload Regulator .... P
E9201-1 Laboratory Power Supply .... F
E9201-2 Test Card Generator Board .... M
E9201-3 LED Star (2 sided) L
E9201-4 Enlarger Timer Main PCB (2 sided) .... N
E9201-5 Enlarger Timer Selector Board (2 sided) .... K
E9201-6 Enlarger Timer Switch PCB .... E
E9203-1 MIDI Switcher- Main Board L
E9203-2 MIDI Switcher- Power Suply .... E
E9203-3 Sine Wave Generator (surface mount) .... F
E9204-1 Auto Car Lights .... F
E9205-1 Bat Detector .... E
E9205-2 Pond Controller .... F
E9206-FC Stereo amplifier .... G
E9206-2 Xenon flash trigger Main Board .... J
E9206-3 Xenon flash trigger Flash Board .... F
E9206-4 Scanner for audio generator .... D
E9207-1 Improved Rear Bike Lamp .... D
E9207-2 Mini Baby Bug Monitor C
E9207-3 Ultrasonic Audio Sender (2 boards) .... H
E9207-4 Camera Add-on unit (4 boards) .... O
E9207-5 AutoMate 5V/48V Mixer power supply .... J
E9207-6 AutoMate Precision 17V power supply .... J
E9207-FC Surround Sound Decoder .... F
E9208-1 Dynamic Noise Limiter .... F
E9208-2 Touch Controlled Intercom (2 boards) .... H
E9208-3 MIDI Keyboard .... K
E9208-FC Battery charger .... F
E9209-1 Intercom for light aircraft .... H
E9209-2 Alarm protector C
E9209-3 Temperature controller .... M
E9209-FC 45W Hybrid power amp .... F
E9210-1 Universal I/O Interface for PC (2 Sided) .... N
E2910-2 Rapid Fuse Checker .... E
E9210-3 Heartbeat/Audio Listener .... E
E9210-FC Wizards Hat .... E
E9211-1 Electronic Die .... E
E9211-FC Car Alarm .... F
E9212-1 Digital Circuit Tester .... F
E9212-FC Mains Inverter .... E

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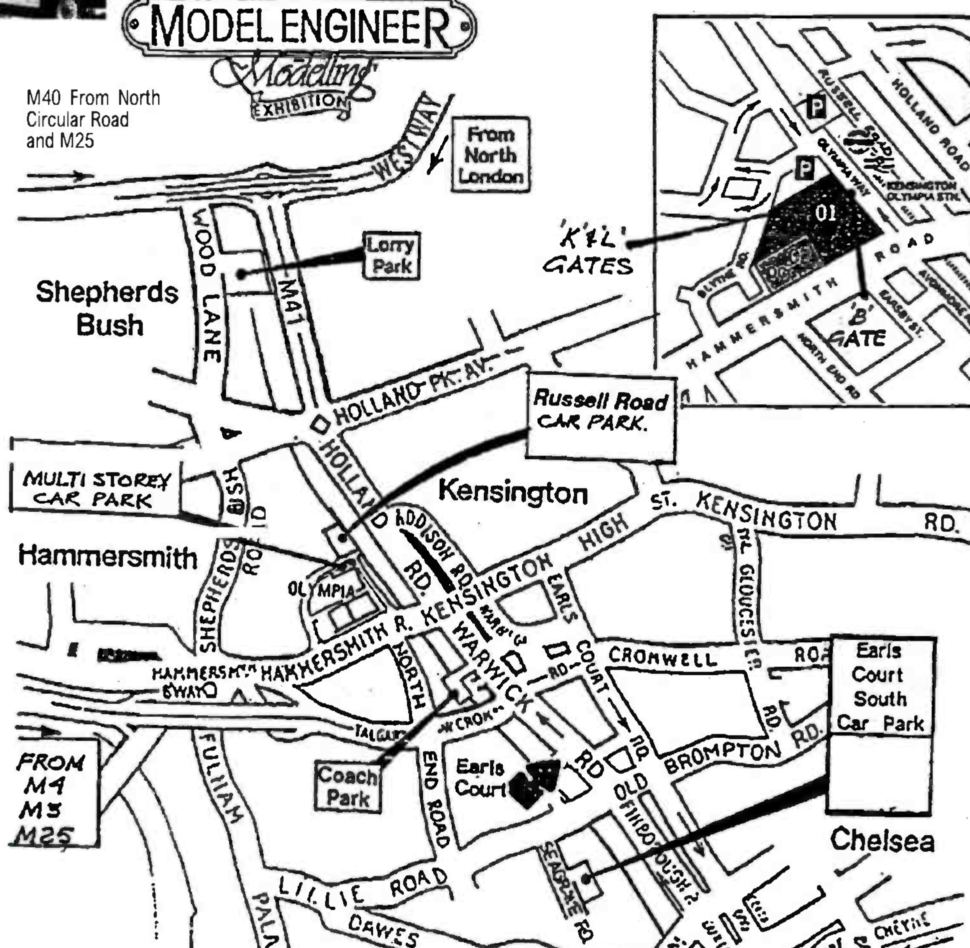

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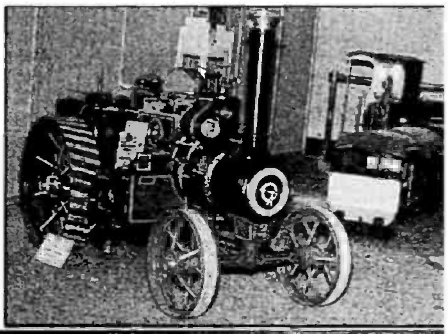

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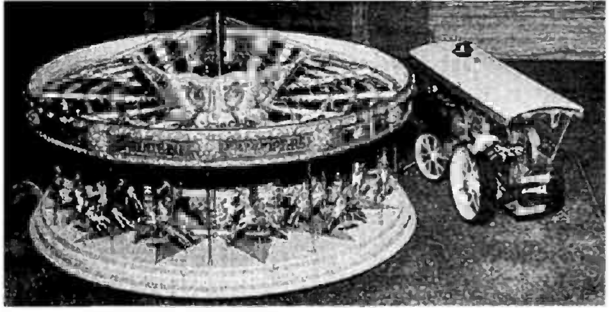

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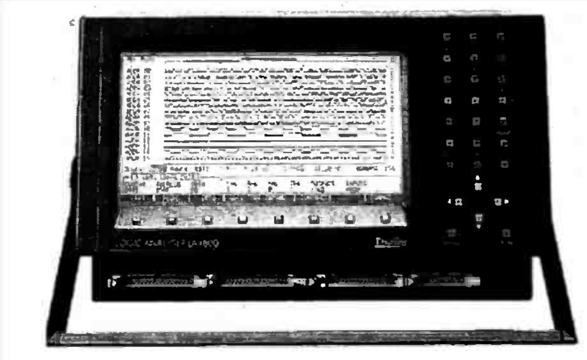

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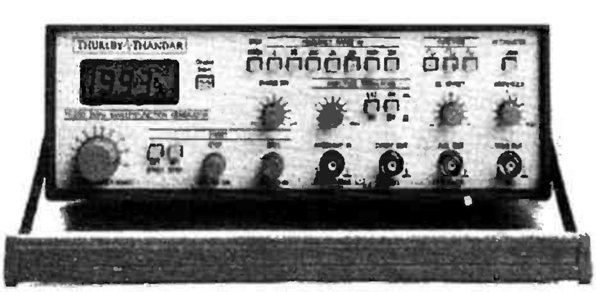

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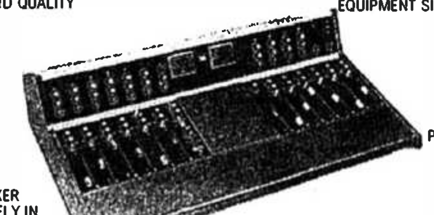

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Next Month

Just to make sure we give you a complete helping hand with our Infra-red remote control project, ETI next month will not only contain details of the transmitter but will also give you the PCB on the front cover.
If you have ever fancied being accompanied by other musical instruments with just a whistle for a tune or an acoustic guitar then maybe our Sound to MIDI project is for you. A one-man-band could take on a new meaning.
We continue with the EPROM programmer project providing software and constructional details, and we also have yet another computer controlled lightshow.
A project for beginners next month is an alarm for detecting pools of water in the kitchen. AU this together with more on multi-meter circuits in our February issue.
Out at your newsagents 011 January 1st.

The above articles are in preparation but circumstances may prevent publication

Last Month

Our December issue featured:

20/50/100 watt Mains Inverter
The Auto-Mate Mixing Desk Part 8
Digital Circuit Tester
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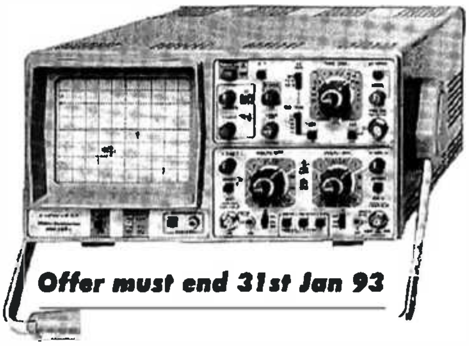

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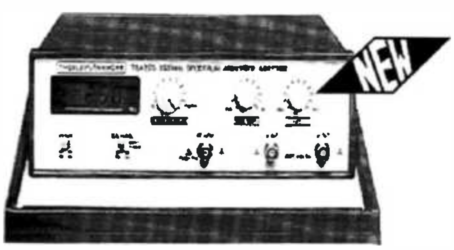

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