ETI
ELECTRONICS TODAY INTERNATIONAL

THE ELECTRONICS, SCIENCE & TECHNOLOGY MONTHLY

JANUARY 1992 £1.60

PHOTOGRAPHIC ENLARGER TIMER
Accurate times with digital readout

FARADAY
A tribute to a genius

AUDIO MIXING DESKS
An introductory guide

LED STAR
A festive design

LABORATORY POWER SUPPLY
Making use of your free sticker

FREE PCB FOIL

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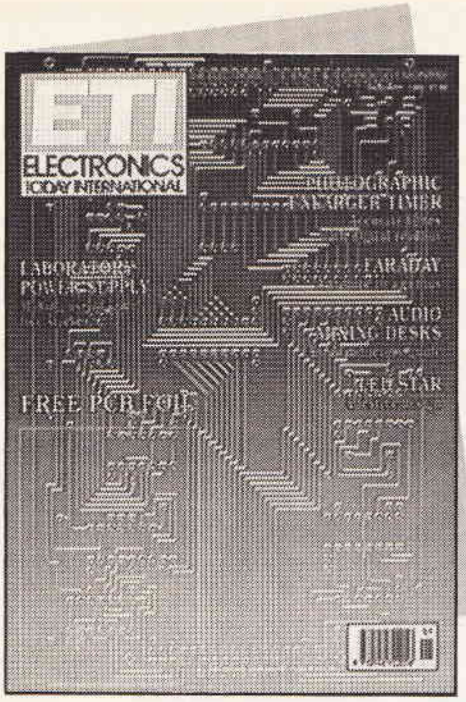


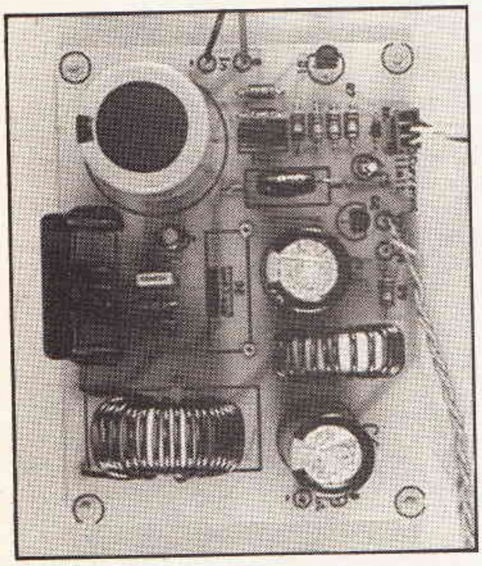
Contents

JANUARY '92 **VOLUME 21 No 1**

Regulars

Features & Projects

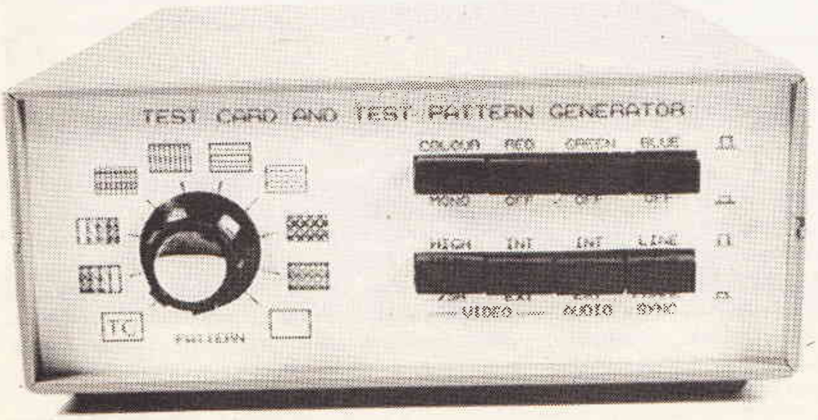
The Editor and Staff at ETI would like to wish all the readers A Merry Christmas



Laboratory Power Supply Page 16

Faraday Page 47

Enlarger Timer Page 31



Test Pattern Generator Page 52

Editorial

The seasons greetings to you all.

In a few months time, ETI will celebrate 20 years of existence. It has seen many changes in style, editorship, ownership and content but despite varying economic climates you the buyer and reader has ensured its continued survival.

I undersand there is a band of individuals who can still boast of having every copy of ETI – such loyalty is indeed gratifying. Whether you have every ETI, been a past editor,staff member or a contributor, it would be great to hear from you to celebrate this anniversary. I am often asked what happened to old 'thingy' who did that 'whatsit' years ago.

Ringing the Changes

With the seasons spending underway, thoughts turn to buying the latest hi-tech gadget for a friend, partner or even oneself. Just what you buy could be affected by its continued existence. It may be 'out-of-date' next year. The pace of technological advance (sometimes said to be following an exponential increase) is so fast that most electronic items have a 'built-in' redundency time. For some consumer electronics manufacturers this is down to 6 months. We find ourselves being forced to decide the point of entry in this technological race accompanied by all the risk factors associated with it. The next generation might be cheaper and a different colour!

The paradox is with the buyer who given the chance, would choose the once-off investment like the everlasting car or light bulb but after a period of time becomes tired with experiencing the same effects and so wants a change. Static design, no development and total reliability are no options for a manufacturer and so at last we become consumers to stimulate our senses, satisfy our well-being and keep the economy going.

And finally,I must apologize to you all and Ray Marston for the non appearance of Test Gear Basics this month. This was due to lack of space and upholding the coverlines.

Paul Freeman

OPEN CHANNEL

If you're one of those drivers with a super-loud in-car hi-fi system, and you play it at around 100dB while you're driving you'll have noticed, no doubt, how it is that ambulances, fire engines and (worst of all) police cars on emergency calls seem to nip up on you out of fresh air. Music from your in-car system drowns out noise from emergency vehicles' sirens, so you don't hear a warning before they arrive. Result: you look a fool and the emergency vehicles are delayed till you get your act together and move out of their path.

Currently, ambulances in the East Sussex area are being used to test a new system designed to overcome the problem of dozy in-car entertainment enthusiasts. The system, called early warning advance code (EWAC) uses transmitters in emergency vehicles and corresponding receivers in vehicles. Receivers, on picking up an emergency signal, override in-car sound sources instead playing a warning that emergency vehicles are coming through.

Initially, this is being tested on cars belonging to the various public services but, if successful, it will probably be the sort of gadget fitted to all car sound systems as a legal requirement on manufacturers. Joking aside, such a system could be installed easily into all new vehicles and sound systems, such that motorists — whether or not the car's sound system is on — could be warned long before conventional warnings reach their ears. That's no bad thing.

European LCDs?

Philips is setting up a factory to develop and manufacture active matrix liquid crystal panel displays. The displays, up to 14inch, will be the first made in Europe and herald at least a partial stem to the flow of eastern-produced LCDs.

While Philips has initiated the factory in its own name, it is not against other European manufacturers joining in and supporting the venture. Previously, European manufacturers have only just been arguing about the best way forward: which technology to use, where to do it, who has control and so on. Philips, realising you can take a horse to water but you can't make it drink, has simply taken the bull by the horns and placed all its eggs in one basket.

Finally, while I'm in metaphor-mode, remember that if three dogs chase a rabbit they cannot kill it, and wanton kittens make sober cats. If you get my drift.

On the Lines

Amstrad is currently developing (with GEC Marconi) a videophone aimed at mass-markets. If rumours are to be believed the videophone will have a three by four inch flip-up colour LCD screen and an in-built video camera. It's being designed to operate on existing telephone lines, and Amstrad's aim is to get it to the market with a price of around £300.

If the videophone (due for launch near Christmas 1992) can be developed and produced with these criteria it should shake up the telephone market considerably. Amstrad always has been a company which develops innovative products and has considerable experience doing so. In fact, to borrow an advertising slogan from one of Amstrad's competitors; if anyone can, Amstrad can.

Unfortunately for Amstrad though, innovative products aren't always the products which make sustained fortunes. Amstrad made its name in cheap and cheerful audio products many years ago (I've still got a twenty-year-old Amstrad Multiplex 3000 stereo tuner — remember those — which I use in my study). Alan Sugar himself, I am sure, would agree that Amstrad audio products were never what you might call hi-fi, but they worked and served a purpose. Once entering computer and, lately, satellite receiver areas, Amstrad left the audio arena behind; despondent of low profit margins and rapidly changing fads.

This year, it looks as though Amstrad is about to make its first ever trading loss, however. Computers and satellite receivers, it seems, don't have such high profit margins either. So where does this leave Amstrad? Looking at audio products again, would you believe? However, equipment will be made in China by a separate company, and simply badged with the Amstrad names (either Amstrad, Fidelity and, perhaps, Sinclair).

On the Satellite Front

Talking about Amstrad's satellite receiver business prompts me to look at receiver sales nationally. Some 430,000 systems had been installed in the UK up to the end of August 1991 (when last figures were released). With the traditional expected rise of system sales coming up to Christmas, it's more than likely over 750,000 systems will have been installed within the year.

This means Sky, with its bold prediction of over two million receivers picking up its broadcasts from the Astra satellite by the end of 1991, will be more than vindicated.

With the launch of the Comedy Channel, Sky's total line-up of six channels, coupled with another five channels from various UK-based satellite broadcasters makes an impressive array of services from a single-dish installation.

Returning to Amstrad, it's easy to see that its newest satellite product; a video recorder with in-built satellite receiver and decoder is going to be a winner, and can only further boost sales into a market still just in its infancy. It's arguable, I suppose, but it's my feeling that the name Amstrad could become synonymous with satellite receivers as a generic name rather than a trade name, in much the same way as hoover has become a generic name for vacuum cleaners — whether or not it has been made by the Hoover company.

Sign of the Times

Thomson, current owners of Ferguson in the UK, is about to close down the last wing of the television manufacturing company with the loss of some 700 manufacturing jobs. This is something of a telling tale when, after all, Ferguson in 1982 had 7000 manufacturing jobs. Ferguson's last factory has been losing money since long before Thomson took over, but it is a sad indictment of British manufacturing capabilities (albeit French-owned) when numerous Japanese television manufacturers have set up shop in the UK and make significant profits from doing so.

Keith Brindley

ETI NEWS

WORLD'S FIRST FULL MOTION VIDEO ON A TFT PORTABLE COMPUTER

Dolch Computer Systems has introduced the first ever implementation of Full Motion Video in colour on its PAC 386 and 486 portable PCs, using a Thin Film Transistor (TFT) flat panel colour display, which exceeds all standards of the Multimedia PC Marketing Council. It is available as an option on existing Dolch PAC models for £3750.00.

FULL MOTION VIDEO

"Full Motion Video" is used in mobile multimedia computing systems which until recently has only been possible on a conventional CRT display. Dolch established the vehicle for this breakthrough when it introduced the world's first implementation of Chips and Technologies' VGA flat panel controller in April 1991. Using the Sharp 640×480 TFT colour flat panel, this second generation TFT technology yields a 24,389 colour palette display with response time of better than 40ms.

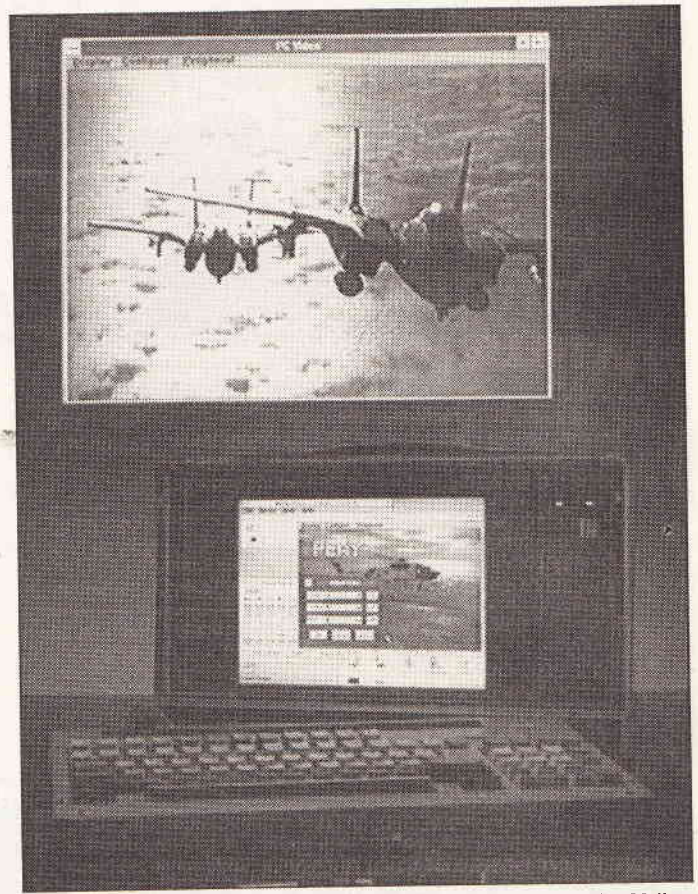
The video picture can be input from any PAL, SECAM or NTSC compatible analogue source. Presented within the Multimedia Extensions of Microsoft Windows, the image can be scaled, positioned and shown with any number of freeze-frame video windows. Images may be cropped, panned and saved in any popular format: TARGA, VGA, TIFF, PCX . . . and graphics may be superimposed for titling and annotation.

The education, entertainment, and corporate presentation segments are each expected to be major contributors to dramatic growth in the Multimedia market.

Establishing industry-wide support for Multimedia applications, Microsoft joined with 11 other leading industry PC suppliers to establish The Multimedia PC Marketing Council. The Council uses an 'MPC' trademark as a symbol of multimedia plug-and-play functionality in the same way VHS signifies compatibility between video cassette recorders, and video tapes.

DOLCH POWER PORTABLES

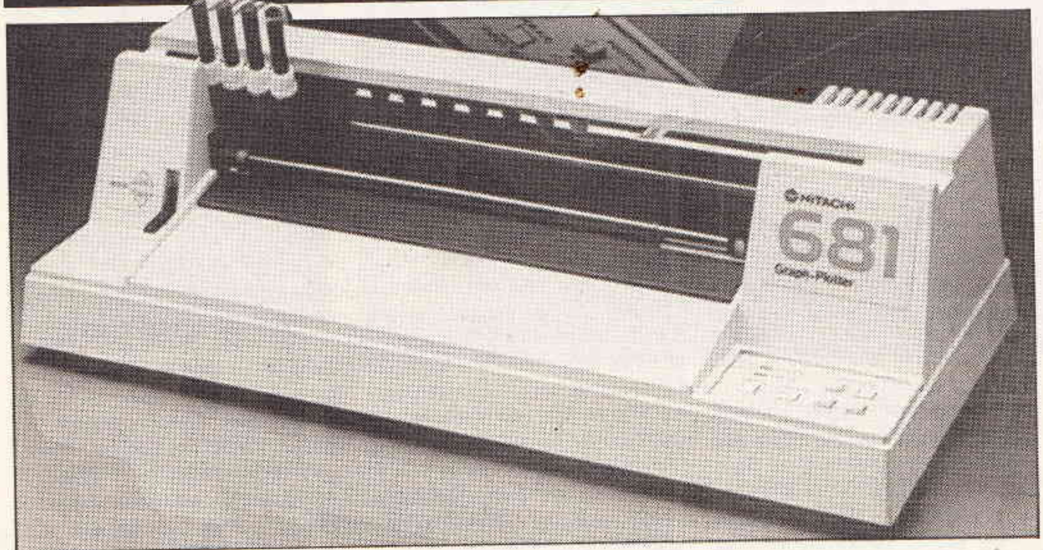
For over 4 years, Dolch Computer Systems has consistently led the industry in high performance portable computing. As a matter of record, third party tests by major media expects have shown that Dolch offers four out of five fastest portables in the world. With models ranging from 386SX machines running at 20MHz to 486DX machines running at up to 50MHz, the Dolch power portable is an ideal platform for multimedia computing.



Dolch Computer Systems manufactures and markets a range of high performance 386 and 486 mains powered portable computers. The parent company, now based in Milpitas, California, was founded in 1976 by Volker Dolch, a German pioneer in microprocessor-based instrumentation.

Further information: Dolch Computer Systems (UK) Ltd. Tel: (0908) 690880.

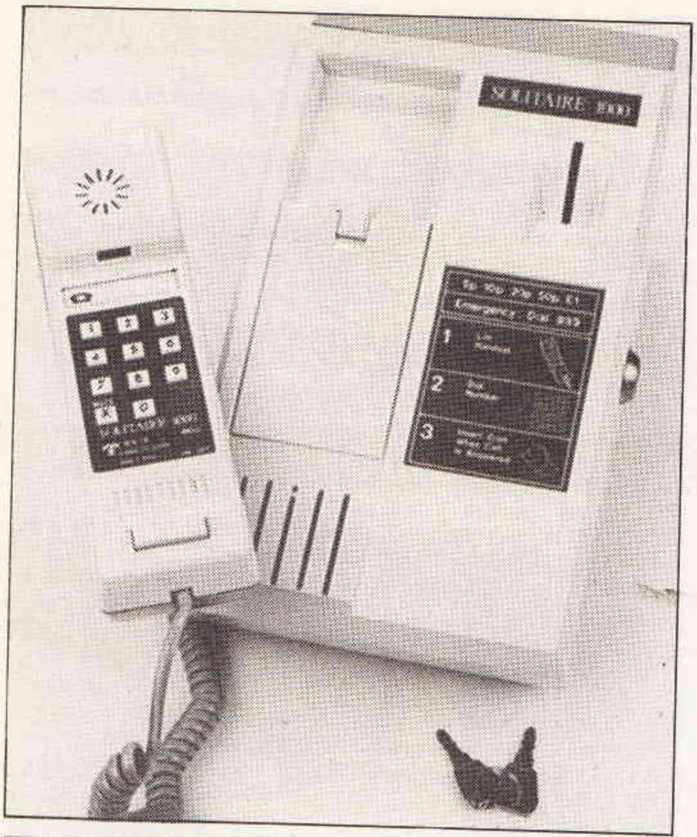
HIGH SPEED A3/A4 PLOTTER



The Hitachi 681-XA Plotter is now available from Thurlby-Thandar Ltd. This is a high speed model in a compact format, that adapts to most computer systems. The Plotter features a four pen, four colour system and has a plotting speed of 400mm (15.7in)/s maximum in the axial direction and 565mm (22.2in)/s maximum at 45°.

The 681-XA has a distance accuracy of 0.3% of shift distance ±0.2mm, repeatability 0.2mm with a pen exchange accuracy of 0.2mm. This makes it an instrument for detailed CAD drawing. The effective plotting area is 404×277mm (15.9×10.9in) allowing A3 or A4 paper to be used. Various pens including disposable ink, fibre, ball-point and ink can be used.

The 681-XA supports HP-GL based plotting commands and is therefore able to use comprehensive libraries of application software. RS-232C and Centronics 8-bit parallel interfaces are provided. A buffer memory of 6655 bytes is standard. The 681-XA costs £495 plus VAT. Contact: Thurlby-Thandar Ltd. Tel: (0480) 412451.



NEW LOW COST PAYPHONE

The new low cost payphone from Maplin Electronics will be a boon to many landlords, parents and small business, faced with an ever increasing phone useage bill. The Solitaire 1000 payphone from Rathdown Industries is a plug-in payphone with multicoin operation. It includes for the first time payphone and call barring functions, ideal for the supervised environment where control of telephone usage is necessary, for example in the domestic or shared accommodation situations.

Some of the features include: pay-on-answer operation, table top or wall mounting, using prompts by LED's and tones, programmable for rates, owner selectable options for non-cash calls ie local/STD; peak/cheap, inductive coupler for hearing aid working, and microphone mute for private local conservation. The unit can also be programmed for owner-mode international calls only, and owner mode by PIN access from the telephone. The multi-coin cashbox has a capacity for up to 100 coins.

The Payphone 1000 costs £119.95 (Special offer).

EASY ISDN TESTER

Trend Communications has released an innovative ISDN hand held tester which is believed to be one of the lightest and smallest Basic Rate testers for ISDN currently available.

The Trend aurora^2 responds to the PTT engineers need for an easy to use tester for engineers, who have only had to test analogue circuits in the past and now need to install, commission and test digital/ISDN services at the S/T and U reference points.

The Trend aurora^2 can perfom voice and data transmission tests and conforms to CCITT recommendations 1.420 and 1.430.

For further information please contact: Sharon Bernstein TOP Counsel. Tel: 071 924 4043.

MORE CONTROL FOR PREMIUM RATE LINES

BT is giving customers greater ability to choose and control the kind of premium rate services phoned from their lines.

New initiatives will separate adult and most chatlines from general information and family services, and will provide extended call barring facilities.

A new two prefix system for premium rate services operated over BT's lines will come into effect in early December.

The new prefix — 0891 — will be restricted to general information and family entertainment services. The 0898 prefix will continue to be available for any premium rate services, including adult lines and chatlines.

The 0891 prefix will be governed by new provisions in a revised Code of Practice being drawn up by the premium rate industry's watchdog ICSTIS — the Independent Committee for the Supervision of Standards of Telephone Information Services.

The code will forbid provision of adult, chatline and most live conversation services over lines using the new 0891 prefix.

Customers served by digital exchanges — at present able to opt for a blanket barring of calls to all premium rate numbers — will have two barring options. They can keep access to 0891 numbers while preventing calls to 0898 lines; or bar calls to all premium rate service lines.

Call barring for premium rate services was first introduced in February 1991, and allows customers to bar calls to all such services operated over BT, Mercury Communications Ltd and Vodafone lines. The prefixes currently concerned are 0898, 08364, 0839 and 0881.

There is no charge for installing or removing call barring. It is available to all 12 million BT customers served by digital exchanges.

Duncan Ingram, manager of BT's Callstream service which supplies lines to premium rate service providers, said: "Our research has shown customers want this extra choice. Many had found full call barring too sweeping. Although they might not want to contact adult or chatline services they still wanted to be able to call services they found useful or informative, such as travel and weather information, or charitable organisations.

"We are pleased that our continued technical advances and network modernisation mean that we can now offer this extra choice for our customers."

FIRST TIME LINEAR OPTOCOUPLER

Siemens has introduced what is claimed to be the world's first true linear optocoupler. Designated IL300, this device departs from the usual output transistor configuration. Exhibiting a change of transfer gain of just 0.005%/°C, the device almost eliminates the large variations in current transfer ratio usually associated with optocouplers.

The phrase 'linear optocoupler' has always been something of a contradition. However, this optocoupler uses an optical feedback loop to neutralise gain and offset drift caused by temperature and LED degradation.

The optocoupler contains a CaAlAs infra-red LED that irradiates two separate isolated PIN diodes. One photodiode supplies an output signal and the second a feedback signal to control the LED drive current via a single external operation amplifier circuit. This arrangment compensates for the LED's inherent non-linear time and temperature characteristics.

Using a type 741 operational amplifier with an IL300 would create an isolation amplifier with a linearity exceeding 0.1%. With OP-07 devices, the linearity approaches 0.01% (12-bit linearity). Using chopper-stabilised op-amps, performance will far exceed even 12-bit linearity.

The IL300's stability and isolation characteristics suggest it could apply to usage in industrial sensors, medical transducers and mains-powered switched mode power supplies as well as audio for signal interfacing and digital telephone isolation.

£250,000 SCHEME FOR SCHOOLS' TECHNOLOGY

BT has launched a major new scheme — Project Gemini — to encourage understanding and awareness of electronic communications across the school curriculum.

A total of £175,000 funding will be available during the course of the project, which will run for two years under the supervision of the National Council for Educational Technology (NCET). Schools, LEAs or consortia within education will be able to bid for money from this fund to undertake work relating to electronic communications. Provision of a project manager and other running costs brings BT's total support to £250,000.

BT's Chairman Iain Vallance commented: "Gemini will help provide UK schoolchildren with access to the tools necessary for handling and processing electronic information. For the future, we must look to a new generation who have grown up confident in their use of communications technology."

The four aims of Project Gemini are:

to support children's learning
to encourage, develop and disseminate effective uses of electronic communications
to promote the development of wider expertise in the use of electronic communications
to develop materials that will be of wider benefit.

It is intended that work undertaken by the projects should cover all abilities, all phases (including teacher education) and aspects of working with children with special needs.

Results of the work — whether resource material, teaching programmes or training courses — will be published and disseminated widely, to ensure maximum impact from the project.

SIXTEEN CAMERAS RECORDED ON A SINGLE VIDEO TAPE

The Javelin Uniplex can record up to sixteen black and white or colour cameras onto a single video tape. Unlike quad splitters, or other simple multi-screen display units, Uniplex records a full screen camera image to each frame of tape. Recorded images can be replayed on a single monitor, as a full screen display or in a choice of different modes from 16 individual cameos to four way split, nine way split, 8+2, 12+1, 4+3, or picture in picture.

Uniplex is also capable of expanding the image on screen by providing a full electronic times two zoom. By using the pan and tilt facility, precise positioning of the zoom within the field of view is also possible.

A remote keyboard adaptor allows the keyboard to be located up to 300 feet from the Uniplex or enables a second keyboard to be used with the system. A multiport controller allows an operator to control up to 16 Uniplex systems and 256 cameras from one keyboard.

Ideal for multi-camera applications, Uniplex is compatible with all CCTV equipment including the latest colour cameras and new format Super VHS video recorders.

For further information contact Javelin Electronics, California, USA. Tel: (213) 327 7440.

CALCULATOR SIZED DIGITAL MULTIMETER

Maplin Electronics has introduced the all-new calculator sized, auto-ranging digital multimeter in a plastic wallet. The leads are permanently connected and fold up into the wallet. The meter has a 3½-digit LCD panel and reads DC/AC volts, resistance and includes a continuity buzzer. A three position slide switch and push-button select up to five ranges. A second push-button operates as range hold with the option of auto or manual range finding.

The ranging is automatic (input dependent) but can be manually bypassed with the 'range hold' button. In addition to the display and range indication, there is a 'low battery' warning on the LCD panel. The meter is supplied with batteries (replacement type SG13), test leads and instruction manual.

DC Volts: Range: 1mV to 200V; AC Volts: Range: 1mV to 400V; Resistance: Range: 0.1Ω to 2MΩ; Overload protection: 400V RMS; Continuity test: Buzzer sounds if resistance under 200Ω

The pocket DMM costs £16.95 (incl VAT).

NEW GENERATION OF PUBLIC PAYPHONES

BT today announced the introduction of a new generation of user friendly payphones which will offer a choice of up to three payment methods in a single model.

The announcement comes at a time when BT's quality of service results show more than 95 per cent of its 97,000 payphones are working at any one time.

The company has signed an initial contract worth more than £10 million with Landis & Gyr Communications (UK) Limited for several thousand of the new payphones, which will accept a combination of payment methods — coins, BT Phonecards and credit cards. At present, most BT public payphones accept either coins or BT Phonecards, and a thousand also accept credit cards.

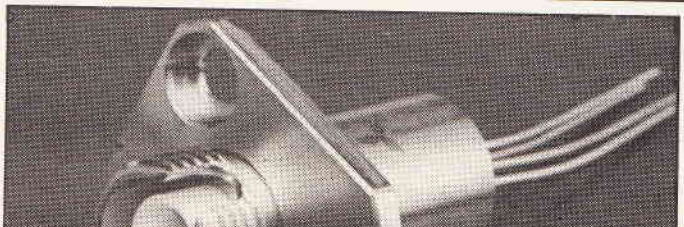
The new multi-payment payphones, which will be rapidly brought into service from 1992, are the result of extensive research carried out by BT.

CIRCUIT DRAWING PACKAGE

CADsoft Systems announce the release of their Schematic Drawing Package for the Amstrad CPC6128 and PCW8256/8512 computers. The package runs under CP/M+ and consists of a Schematic Editor, a Print Program and a Symbol Library. The symbol library contains mosts of the commonly used component symbols such as resistors, capacitors, transistors, logic gates etc, and can be customised and expanded by the user. Diagrams of up to 50×50 inches can be drawn with typically over 5000 objects per drawing. A novel printing technique ensures excellent printout quality, even on the most basic of dot matrix printers.

The package costs just £29.99 with a £5.00 discount for registered users of any other CADsoft product. For further details, send an SAE to: CADsoft Systems, 18 Ley Crescent, Tyldesley, Manchester. M29 7BD.

1km CAPABILITY LASER DIODE MODULE



Mitsubishi Electric has released a low cost, high performance laser diode module for connecting a 1.3μm wavelength light source to a single mode optical fibre. It will be used in applications requiring high speed data transfer in computer mainframe networks up to 1km in length.

The module is available in two power output versions: The FU-16SLD-N1 has a maximum optical power output of 2.5mW and the FU-16SLD-N3 has a rating of 0.5mW. Both diodes have a maximum threshold current of 20mA and a typical operating current of 30mA. Typical values for operating voltage and rise-and-fall time are 1.2V and 0.3ns respectively. Tracking error is 0.5dB.

The laser diode is housed in a metal case for good optical isolation and each module incorporates a photodiode for monitoring purposes. This consumes a typical current of 1 or 0.6mA respectively for the FU-16-SLD-N1 and FU16-SLD-N3 models.

For further information contact: Mitsubishi Electric UK Ltd. Tel: 0707 276100.

ETI NEWS stateside

New data acquisition system-chip

A US company has integrated a fully differential self-calibrating 12-bit plus-sign A/D converter, sample-and-hold amplifier, memory, digital control circuitry, and extensive analogue functions to form a data acquisition system chip that can replace hybrid ICs and board-level products.

Operating at 5V, the LM12458 performs high-speed, high-precision conversions (8.8 microseconds for 13 bit; 4.2 microseconds for 9 bit (8 bit plus-sign) on up to eight programmable channels. The power consumption is 25mW maximum. The board or hybrid-level hardware that the LM12458 replaces would consume at least 10 times as much power and require multiple ±5, 10 or 15V supplies.

Up to 32 consecutive conversions, using two's-complement format, can be stored in an internal 32-word FIFO data buffer. An internal 8-word RAM can store the conversion sequence for up to eight acquisitions throughout the 8-input multiplexer.

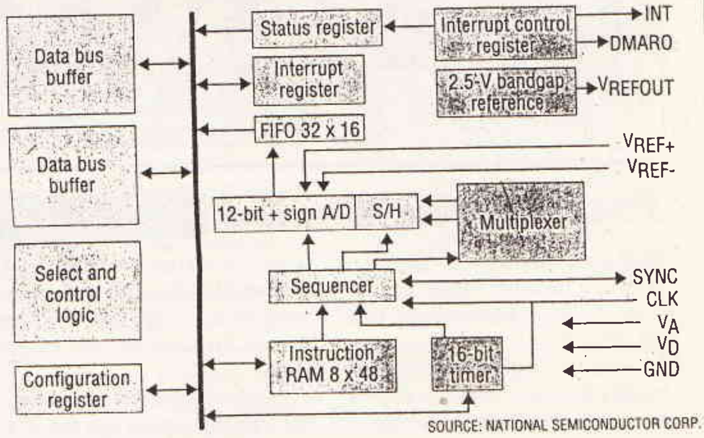
A system's host processor does not need to control the data-acquisition chip on a real-time basis. The LM12458 can store instructions, sequence these instructions, and store the results in an on-chip memory.

A sequencer and a 16-bit timer control the conversion cycles and the 16-bit programmable length FIFO memory (32-word length maximum) is used for onchip data storage. By storing multiple conversion results on-chip, this relieves the external microprocessor from servicing the converter after each cycle.

National Semiconductor Corp. Santa Clara, California.

DATA-ACQUISITION CHIP PACKS MEMORY

The LMI2458 is equipped with 32-word FIFO and 8-word RAM



SOURCE: NATIONAL SEMICONDUCTOR CORP.

Overcoming PWB problems

To overcome problems posed by high-density, surface-mounted boards, researchers at Rensselaer Polytechnic Institute have devised a non-contact technique to probe test points on such dense boards.

This laser-based electrical testing of functional PWBs — described by RPI researchers at an International Electronics Manufacturing Technology symposium in San Francisco — uses a plasma technique to probe signals generated by the electronic circuitry on the board.

The plasma, a hot and highly conductive ionized gas, is created by focusing a high-power Nd:YAG laser beam on highly conductive metal foil, such as tungsten or copper. This narrow stream of laser-induced plasma provides a conductive pathway between the point on the board and a specialised electrode. The system was developed under a contract from Digital Equipment Corp.

The electrode is connected to an oscilloscope and serves as the probe, while the PWB is mounted on a positioning system. The plasma technique provides a non-loading conductive path for a period of 10 to 20 microseconds. Signals appearing at the contact point of interest on the board can be monitored or probed during this period without affecting the operation of the devices under test.

The researchers have successfully accessed complex boards with 20-mil line widths and spaces to confirm the non-contact observability of the technique. High-frequency boards to show the plasma technique can maintain signal integrity at 500MHz.

Welding flexible substrates

A new approach to forming metal contacts in electronic circuits could result from a novel elastic substrate. Using a new method, gold films have been welded together under normal room conditions by pressing them together with small applied loads.

With current technology, extreme physical conditions of one kind or another are required for bonding metals; soldering and welding require high temperatures while room-temperature welding requires extremely high pressures.

The key ingredient in the new process is a material called polydimethylsiloxane (PDMS), which can be formed into thin elastic membranes. When exposed to oxygen at high temperatures, PDMS forms a silicon dioxide layer suitable for electrical isolation. Metals do not adhere very well to the silicon dioxide layer, requiring the application of an exotic process called 'self-assembled monolayers' developed at Harvard University's chemistry department.

Chemists have found that certain complex organic compounds can 'self-assemble' into complex structures on the molecular level with a wide range of useful chemical and physical properties. A self-assembled structure is able to form a strong bond between the silicon dioxide and a thin gold layer vacuum-evaporated on top. The resulting composite material is so flexible that the gold layer 'flows' around surface impurities that normally prevent metal bonding, allowing two gold/PDMS films to weld together on contact. The composite material, developed by Dow Corning of Midland, Michigan, could be the basis for novel electronics devices.

Research on noise

A new model of neuron behaviour confirms that noise plays a crucial role in natural-information-processing systems.

Complex system analysts at Los Alamos National Laboratories found that a simple two-state model of a neuron would faithfully reproduce experimental data from live neuron studies only when a specific noise term was added.

While neuro-physiologists have long known that noise is a prevalent component in all nerve transmissions, it was assumed that neural systems had simply developed a tolerance for noise. If the new model turns out to be correct, it conclusively proves that noise is a crucial computational element in the brain's functioning and would have to be introduced if it did not occur naturally.

The discovery reinforces recent attempts to circuit designers to include noise as a computational element in digital circuits. The model also gives a clue to one possible role for noise in neuron dynamics — it provides a significant stabilizing factor. Since neurons are essentially dynamic systems with two stable states, firing or resting, the model is based on a dynamic system characterised by a pair of potential energy wells. Input, in the form of a regular sinusoidal oscillation with noise added, drives the system back and forth between its two energy wells.

Not only is a fairly large noise term required to reproduce experimental results, but the presence of noise also makes the output stable even with large variations in the configuration of the potential wells. Thus, even though individual neurons can vary widely in their physical parameters, their noise-induced dynamics make them perform within tight margins.

READ\WRITE

ETI LETTERS

Praises All Round

Here from a slow constructor, is a belated thank you to some of your present and past advertisers.

Firstly, to ILP for ten years of trouble-free hi-fi from the easiest kits a lazy audiophile evercame upon.

Secondly to Wilmslow for putting true studio quality speakers into easily assembled flatpack kits. Their Volt drive units have had excellent reviews, and I can vouch that their top-of-the-line speaker at £700 almost equals the famed Quads in my opinion at £1600 for transparency and far surpasses Quads in power handling. With these Wilmslow units coupled to an A R Cambridge CD player, I feel equiped to judge any audiophile class amplifier without being let down by either the front end or the speaker end of the chain.

So thirdly thanks to Hart Electronics for building me the JLH amplifier kit. (shame I know that I didn't build it myself). The Hart kit is professionally finished, and the performance is Jaguar class: relaxed, powerful smooth and involving. The JLH amp effortlessly performs the ultimate magic: simply dissolving away your back wall, and puts you up there on stage among the singers.

Thank you also to ETI, for holding it all together. All the hi-fi goodies totalled around £2000. No doubt I could have spent the same money tramping the Tottenham Ct Rd area and eventually got something nearly as satisfying. But I know from experience that it would have taken a long time to audition all that stuff in the high street and I would have heard an awful lot of expensive rubbish before the end of it. What amazes me is the consistent high quality of the kits, the ease of ordering and assembly, and above all, the fun of reading the background articles.

Dr Nick Maroudas, Haifa, Israel

Thank you Dr Maroudas for your points, it is nice to hear the comments from a satisfied customer, people generally only put pen to paper because of their dissatifaction.

Hi-fi is a minefield of choice and quality. Technical specification aside, individual perception of quality sound must differ greatly and so there can never be an ultimate system for everybody. The companies you happen to have approached were able to deliver the goods to your satisfaction. When buying hi-fi equipment, the difficult equation is whether one buys on specification or on hearing the end result in a salesroom. It is advised that only an experienced constructor put together highly priced kits in audio, as there are so many pitfalls. — Ed.

Ideas Corner

In ETI March 1990 you published an article from Geoff Martin which was a collection of ideas and suggestions. This has led me to jot down lots of my grievances and ideas, which I feel may be worth airing.

Assuming I am a typical electronics hobbyist (a brave assumption!), I occasionally seem to suffer from such association whereby friends and relatives drop off the odd electrical gadget which has temporarily 'shuffled off its mortal coil' in the hope that I can resurrect the said gadget. Though care has to be taken when working with mains voltages, most of the devices (toasters, irons, etc) all seem to be fixable with a bit of patience, though others result in a quick aerial parabola to the nearest bin. I was just considering that since I (and I really mean 'we') will usually get such tasks sometime in our hobby that it may be sensible for a few articles on the do's and the dont's when repairing domestic appliances. Whilst not wishing to encourage the inexperienced 'means well' amateur, some tips and suggestions would be handy.

For example, in my experience two relatives and myself have repaired different automatic washing machines by simply replacing the contact brushes in the electric motor — at the average cost of £3 per machine plus our own time.

Whilst I am sure that the tradespeople would be abhorred at such a cheap fix ('gonna cost you at least a tenner for a call-out missus') and that other things may indeed be oiled or maintained by a qualified engineer, it doesn't take a highly qualified person to change electric brushes in a typical electric motor.

In a similar vein, my video is now 5 years old and is starting to occassionally chew tapes. Taking the lid off and cleaning the heads with proprietory fluid does not seem to ease the problem. Any tips on what is going wrong and/ or the best course of action to remedy it (I am not adverse to using the services of qualified tradespeople — I know my limit)?

The same machine also has very quiet playback sound levels — any idea what's wrong?

To change topics, congratulations to ETI for introducing the 'Blueprint' column (although I wrote to you some years ago and suggested the same idea). It is nice to think that a few hours struggling over a spec may bear fruit if used as a 'Blueprint' topic. My personal electronics tendency is towards digital systems and away from the analogue and audio scene, yet there are times when I need an analogue interface module which is beyond my personal knowledge. Such a forum for invoking the professional advice from an expert in a particular field is to be welcomed.

As you peruse through the projects in old electronics magazines, some names crop up over and over. It would be nice to have some articles on such electronics hobbyist — to give them a platform to muse over our hobby and where it is going, and perhaps to give an insight into how they do what they do. In a similar vein, a dissection of what goes on at ETI when a constructional project is submitted would be interesting — it may even stimulate new article authors.

I must mention that I thought the 'EASi' articles were superb — any chance of the author submitting a cut-down version for the intercom units alone?

My underlying electronics interest is in Home Control — I have not built anything substantial towards this aim but the ideas are beginning to coagulate. It struck me that in quite a few of the 'home' constructional projects some extra design could be included to facilitate easy connection within an overall controlling framework. For example, a project to provide an immersion temperature controller could route the command signals to some standard socket which is not actually used in the standalone project but is left as a built-in contingency. There must be standards for such interfaces, though I know of none. If there are no standards, why can't we define one for common inclusion by project authors where feasible.

My initial thoughts are for a standard 12 volt supply for control electronics (for easy replacement of power supply by a car battery) and opto-isolators for each (digital) signal as a safety device.

If this were adopted then perhaps in the future project authors would supply some type of 'device-driver' software with their standalone project for rapid inclusion into a home-control application.

The most difficult aspect of device production for myself is in designing and building PCBs — they always take up too much room and some tracks always seem to come adrift. Do other hobbyists use the new PCB design software and from that how do you produce a PCB — approximate costs would also be nice.

The birth of my first son three years ago and that of my second son just over a year ago has had a dramatic curtailing effect on my hobby. Though the whole process of child rearing is fraught with potential dangers, highly publicised events such as in cot deaths leave you worried at times. Although not intended as a failsafe device, it would be useful to have some sort of 'micro-movement' monitor to detect a sleeping baby breathing or moving and to sound an alarm if nothing is heard for a preset period. I imagine that detection of such a signal would be the major task in such a project. As a first attempt, how about an inflatable mattress with inbuilt air-pressure sensor? I think my hearing is quite good, but both my sons breath so gently when asleep that it takes significant effort to detect them breathing.

Back to the home-control theme: has anyone designed a low-cost multiple-input temperature monitor (say, significant to 1 degree celsius) with the separate monitor points being distributed over all rooms in a house? On similar theme, are there any door locks that you can buy where you can detect if the lock is locked? Normal reed-relay detectors will tell you when the door has been opened, but with prevention being better than cure, it would be nice to know that you have it least locked up the house before retiring to your bed (how many times have you discovered an unlocked door the next morning, even with the best of diligence?).

How on earth do those anti-theft devices work which are attached to garments in shops or books in a library? The individual labels must be passive components of some sort of radio-frequency set-up. Would it not be sufficient to short out the copper tracks to break the security (or am I asking questions which for security should not be answered in public)?

Having fumbled with several different battery connections, how about the battery manufacturers provide standard screw terminals on their larger batteries for convenient connection? In small applications I can see the minuses for this point, but a set of auxiliary connections on (say) a car battery would be really useful.

Finally, a recollection from some years ago — how about one of those 'jacob's ladder' circuits with the high voltage sparks as seen in old Frankenstein films. I've always thought that one of these would scare off all my relatives who visit us with toaster in hand!

Sorry about the discontinuity in all this, but I thought it may stimulate others.

Mungo Henning

Your points have been noted with interest Mr Henning.

OK readers, your comments are always welcome.

Long Distance Infra-red Communication

For nearly two years we have been applying ourselves to Long range infra-red communication with cheap lenses and milliwatt power as means of communication and have finally acheived our goal of reaching a distance of one mile.

This has all been acheived with a 100 milliwatt IR diode, one PIN diode detector, a basic audio amplifier and home made Fresnel lenses.

The transmit diode was pulsed at 800Hz by a simple CMOS nand gate oscillator driving a switching transistor.

The cost is mainly determined by the lenses, ignoring the hardware, and should be quite low. We managed several hundred yards using two 30mm plastic inspection lenses.

To acheive the one mile we designed our own Fresnel lens of 9 inch diameter. The results could be classified as S3 on the amateur radio scale in somewaht less than satisfactory conditions regarding topography and a slight ground mist.

If any plastic lens manufacturer out there has any 10 inch or larger Fresnels in production in the hobbyiest price range, then who knows we might see an upsurge in bush telegraph hitherto neglected. Best regards G0IIT, G8KBC.

Wilkinson, D Barford, Alford, Lincs

I may have just the answer here. Many years ago I bought a plastic Fresnel lens that was at the time available in a 'surplus' shop for a few pence (It may have been Proops Bros.). It was from an overhead projector and about 10 inches square — a standard item in these machines. I hope this gives you a lead. Let us know of your findings and results of your experimentation. By the way, how do you make a Fresnel lens at home? — Ed.

Early Magnetrons

The interesting article by A P Stephenson is imprecise on the invention of the magnetron and the impressive contributions to its development by Drs Randall and Boot. The magentron was invented by Albert Hull working with General Electric in the United States in 1921. The probable first public use of the name he devised was in his paper published in the Journal of the American Institute of Electrical Engineeers (AIEE) in September 1921; details are also available in a number of patents granted about that time. The early magnetrons usually used a split cylindrical anode with external tuned circuits connected to the segments which determined the resonant frequency; decimetric wavelengths were possible.

Randall and Boot were well aware of magnetrons and made two very significant improvements described in British patents 588,185 and 588,186; the patents were filed in 1940 and 1941 but secrecy delayed publication until 1947. Both patents refer to 'high frequency oscillators of the magnetron type' The first patent is directed to the use of magnetically coupled resonant cavities within the body of the device as described in Stephenson's article.

The second patent is directed to the use of secondary emission for the production of the electrons from the cathode. In a cavity magnetron many high velocity electrons return to the cathode and this heavy bombardment provides an exceptionally high emission of electrons and accounts for the high efficiency of the device. As the electrons in a cavity magnetron are produced by secondary rather than thermionic emission it is not necessary to heat the cathode.

The inter cavity strapping, which prevents oscillation mode changes in the cavity magnetron, was an important invention in its own right and is described in British patent 588,916 by James Sayers. Randall, Boot and Sayers were each made a substantial tax free award for development of the magnetron when inventors were compensated for their contributions to the war effort. (Nowadays the awards would not buy a house!)

The split anode magentron produced low power but never-the-less was the basis of the first portable multi-channel microwave link, the British army's Wireless Set No. 10. The portable cabins with two dishes enabled secure ten channel telephone links to be set up rapidly between the British High Command and the front line immediately after D Day until the war ended. General Montgomery usually praised his troops rather than his equipment but he made an exception in the case of the No. 10 set. The set operated at 10cm and used a multiplexed pulse position modulation system.

Guy Selby-Lowndes, Billingshurst, West Sussex

Answer to puzzle No 1.

F	A	R	A	D
A	T	A	R	I
R	A	D	I	O
A	R	I	N	D
D	I	O	D	E

Answer to puzzle No. 2

The names of the famous scientists were Andre Ampere, Michael Faraday, Georg Ohm, Alessandro Volta, and James Watt, so the names of the delegates can not be any of these combinations.

Georg's statement to Michael and Andre involves one of these equations:

$V = IR$ (volts = amps × ohms) or $P = IV$ (watts = amps × volts)

In the first case, Georg is Volta and then Michael is Ampere and Andre is Ohm, or vice versa. In the second case, George is Watt, Michael is Ampere and Andre is Volta (Andre Ampere is not allowed).

Mr. Watt addresses Georg, so Watt can not be Georg and the second case above is not allowed. Therefore Georg is Volta.

Michael addresses Herr Ohm so, from the first case above, Michael must be Ampere, and Andre is Ohm. This leaves Alessandro as Watt and James as Faraday.

The names signed in the visitors' book were: Michael Ampere, James Faraday, Andre Ohm, Georg Volta and Alessandro Watt.

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E9107-2 Temperature Controller — Probe PCB .... F
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2

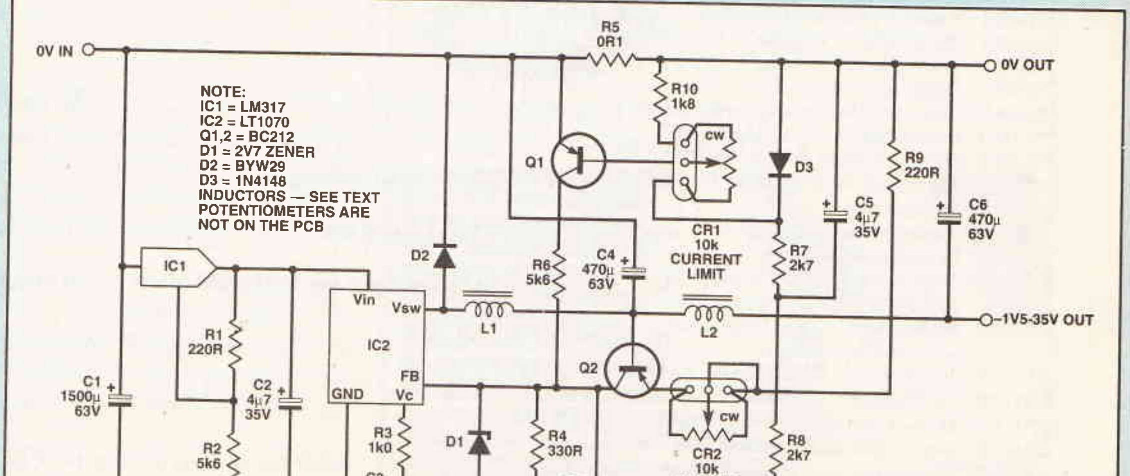
Switched Mode Laboratory Power Supply

Andrew Armstrong constucts, using our free copper-clad board and foil, an efficient bench supply.

The final circuit design has turned out very similar to the initial design published last month. The new design is shown in Figure 1. The most obvious changes are to the values of R3 and C3. These components set the response time and overshoot of the control loop, and correct choice is important to ensure that the output of the supply responds to changes in demand adequately, while avoiding oscillation of the control loop.

Experiments with the first prototype unit produced instability at certain combinations of output voltage and load current, and at one particular setting a clean sine wave at a frequency of about 3kHz and an amplitude of approximately 200mV was produced on the output terminals, superimposed on a 20VDC output. This was clearly unacceptable, so experiment with a number of values resulted in the components now chosen.

The compensation components required to ensure stability over the full range of output voltages and currents slow the response of the power supply to load variations. In order to prevent the output from varying to widely, with step variations of load current, a large value of output capacitance is required. The 470µ capacitors used in the output filter supply load current variations during the time that it takes the control loop to respond. A 2A step of load current produced a 500mV variation with a time constant of approximately 1ms. This is more than good enough



PROJECT

for the application, particularly when one considers that few circuits under test will make quite such abrupt changes in current demand.

Two components have been added to the circuit. R10 limits the range of the current-set potentiometer, so that the output current cannot be raised above approximately 5A. In the feedback loop, capacitor C7 has been added to prevent spikes and interference on the feedback from upsetting the control.

Current Limit

The current limit circuit here is not intended as a precision constant current source; it is merely intended to provide an extra protection to the load, because this supply can provide more current than most laboratory power supplies.

It might appear on looking at the circuit that it should limit the current abruptly, but this does not happen, because the circuit relies upon the g_m rather than the hfe of the transistor. The transistor is being operated at a very low current, down on the very gently sloping area of the conduction graph for the base-emitter junction. Therefore, a significant change in voltage across R5 is required in order to lower the output voltage to a nominal level. In percentage terms, the limiter works more efficiently at higher currents.

Using the power supply in the laboratory for applications not requiring a precision current source, the current limit circuit has proved effective in avoiding damaging at least one circuit under test.

In Operation

It has not been possible in the short time since this power supply design has been finalised and assembled to amass a lot of operating experience, but initial results are good. No output voltage drift has been noticeable, and output ripple at either switching or mains frequencies is too low to measure. The heatsinks on the PCB have not yet justified their existence — they have shown no sign of getting very warm.

Initial tests have indicated that no noticeable radio interference is radiated by the unit, so it is a lot cleaner than the switched mode power supplies incorporated into many desktop computers.

The overall circuit of the power supply unit is shown in Figure 2. A dual-pole on/off switch is used — the same one that I put into the unit when I first built a power supply in that case a number of years ago. The neon lamp and the mains transformer are also the originals. A slow-blow mains fuse is used to avoid the fuse blowing at switch-on when C8 is being charged from zero volts.

A brand-new reservoir capacitor replaces one ten years old and twice as large. The new capacitor also has a lower esr (equivalent series resistance) than the old one — a factor which is particularly helpful for switched mode power supplies. A low esr capacitor is also incorporated on the PCB to minimise the noise on the unregulated supply when the switched mode regulator IC draws sharp pulses of current.

The voltmeter on this particular unit is best described as vintage, and like many vintage items, it still works well. As an alternative to calibrating it by using a preset potentiometer which might be prone to drift, a series resistance consisting of two resistors in parallel is used.

To calibrate the meter, this is what you do: set the power supply output voltage to a known figure, measured on the most accurate multimeter available to you. Choose a fixed series resistor which causes the meter to deflect almost but not quite to the scale marking corresponding to the output of the unit. Then select a resistor to go in parallel with this (probably a much higher value) in order to move the meter needle the last little bit to the correct scale marking.

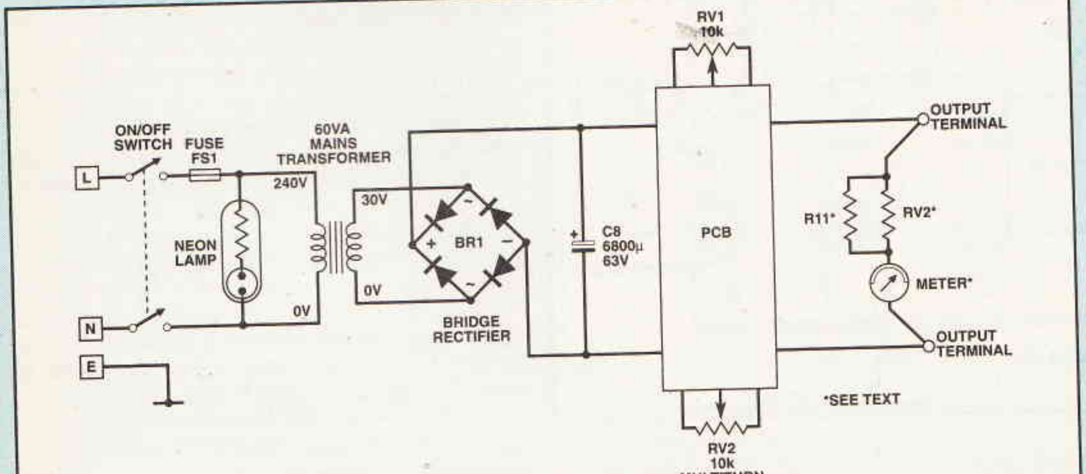
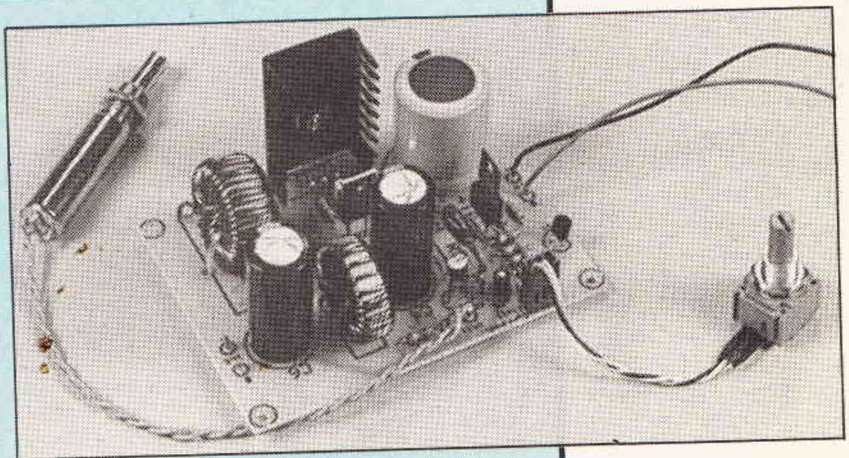


Fig.2 Power supply unit and output monitoring



Assembly

When the PCB has been etched, the holes should be drilled according to the drilling instructions in Figure 3. It is important to drill the holes to size first because if holes have to be drilled out after components have been fitted, damage can result. Just to be on the safe side, it is advisable to check that the components with larger mounting holes actually fit before soldering anything down.

Assembling the PCB presents few problems. IC2 and D2 should be mounted on heatsinks, the tabs of which should be folded over underneath the PCB to hold the heatsink firmly.

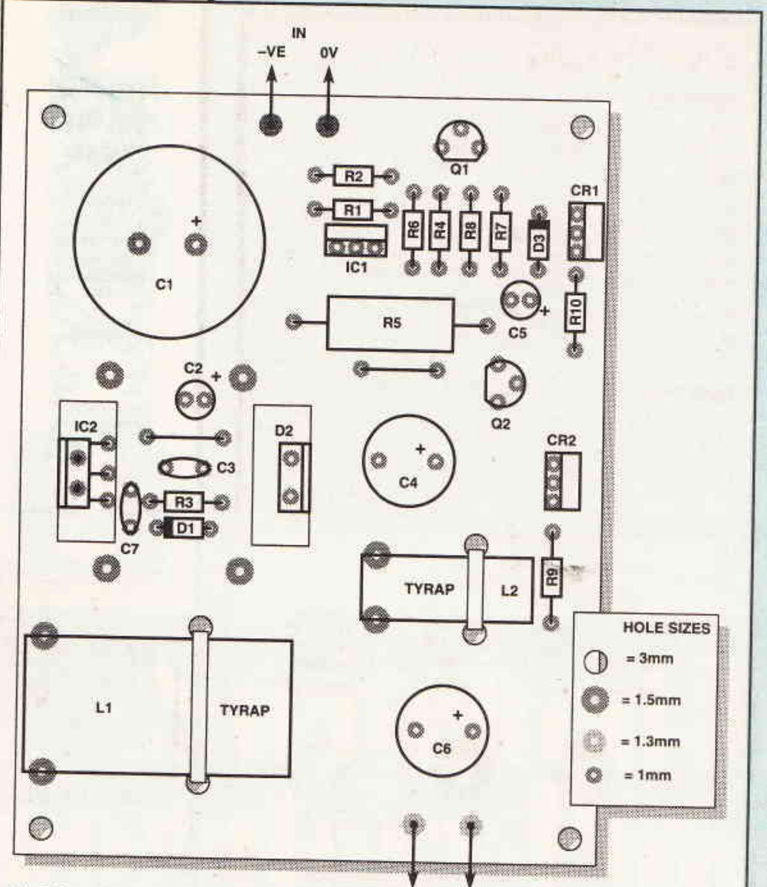


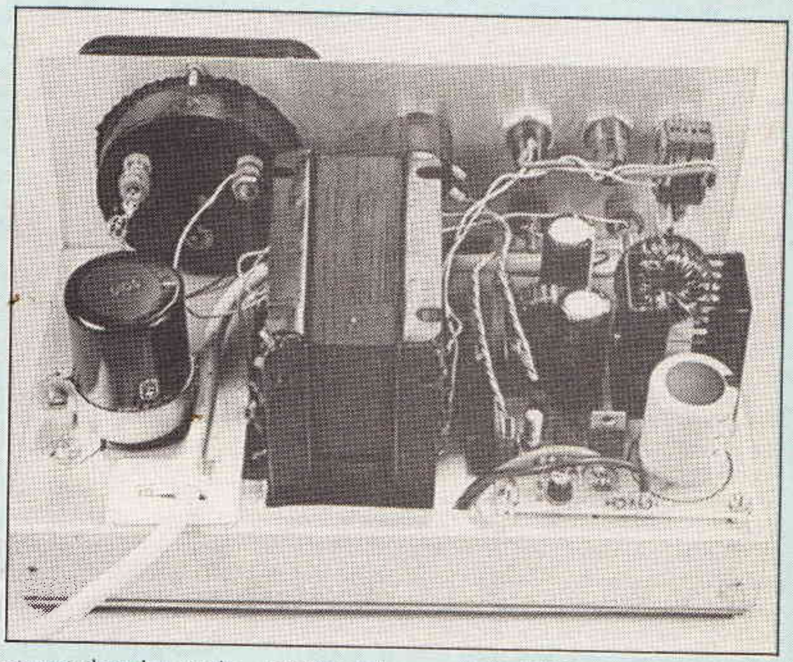
Fig.3 Component overlay and drill hole sizes

The front-panel layout I have used on my supply is shown in Figure 4. Because this case was purchased from an amateur radio rally about 20 years ago, it is unlikely that a case, or even the same furniture, for an identical front panel will be available. However, something of a similar size would be suitable — the major considerations in choosing the case should be that the transformer and the PCB can fit comfortably inside the case, and that there is room on the front panel for the controls, the terminals, and the voltmeter. Unless you have a voltmeter just like mine, you will need to choose whichever you prefer from a range of several suitable meters available from suppliers such as Maplin. It is not necessary that the meter is supplied with a scale covering the required range — it is possible to recalibrate the meter if you have a steady hand, by applying a known voltage to the meter circuit and marking the scale with an Indian-ink pen.

Component choice

My power supply uses a separate switch and neon indicator, because that is how it was built originally. Nowadays very smart illuminated rocker switches are available, and you may prefer to use one of these instead. In any event, it would be better to obtain all your front panel hardware before cutting any of the holes, just in case the hole sizes shown in the catalogue do not tell the whole story.

A 30V transformer should be used for this project. The choice of current capacity depends on how much output power is required at higher voltages. The regulator IC can only supply approximately 5A maximum, regardless of how much is available from the transformer, so at low output voltages, the maximum output current will be limited by the LT1070. At higher output voltages, however, the available current may be limited by the VA rating of the transformer. Typically a 60VA transformer rated at 30V can provide approximately 1.5A DC if a bridge rectifier and reservoir capacitor are used to provide the DC. The voltage on the capacitor when 1.5A of DC is drawn is likely to sag to a little over 30V, so a power of perhaps 50W is available in DC. if 5A at 12V is required from the power supply, this is an output power of 60W. Assuming an efficiency of 80% from the power supply, 75W of DC is drawn from the reservoir capacitor. If this level of output power were required, a 100VA mains transformer would be necessary. The 60VA transformer mentioned above would supply this much power for short periods, but it would rapidly overheat.



The inductors should be wound using enamelled copper wire, preferably of the self-fluxing variety. In order to fit on all the turns required on the two inductors, the coils should be wound as neatly as possible with turns tightly adjacent. It is to be expected that a second layer of winding will be required about a quarter of the way round the inductor. Despite the fact that the insulation is self-fluxing. it is advisable to strip it with a knife before soldering.

The control potentiometers are connected to the PCB by means of Molex connectors. A multiturn potentiometer is recommended for the voltage adjustment, though a single-turn pot would be acceptable — it will merely be more difficult to set the exact voltage that you want. 10k pots are used in both positions, and wired the same way round, so if single-turn pots are used, either one can be plugged in to either socket, and the power supply will still work. This is something to look out for if it seems that the current and voltage potentiometers are not working as expected.

The small knobs used for voltage and current in this design were selected after considerable ergonomic experimentation, and have been found to work well.

PROJECT

If a lower output power supply is adequate, a lower power transformer can clearly be used. It is also possible to reduce the value of the reservoir capacitor, because the current drawn from it will be less, so that a lower value will provide the same level of ripple voltage. A reduction to less than half the capacitor value is possible if the transformer rating is reduced from 2A to 1A, because of the contribution to smoothing made by the board-mounted capacitor.

If a maximum output current of 2.5A is sufficient, the LT1071 switched mode IC can be used. If available, it is slightly cheaper. If this lower current level is required, the value of R5 should be increased to 0R22.

Though not originally intended for use this way, if a 4700µ capacitor (eg Maplin part no JL43W) is mounted on the board a 2.5A regulated supply could be made without the need for an external reservoir capacitor.

Testing

Unless you are using the exact recommended diode, check before testing the power supply that D2 is inserted the right way round. The first prototype failed, and damaged IC2 in the process, because the layout symbol for D2 on the CAD system was reversed. It looked right, so I assembled it wrongly and it short circuited the output of the LT1070. This has been corrected on the present PCB design, of course.

To test the supply, first of all connect up the mains transformer, rectifier and reservoir capacitor, but do not connect the PCB. Switch on and check that the voltage on the reservoir capacitor is approximately 1.5 x the rated AC voltage of the transformer. If the recommended 30V RMS mains transformer is used, the voltage on the reservoir capacitor should be approximately 45V.

Assuming that the voltage on the reservoir capacitor was correct, discharge it through a resistor and then connect the regulator PCB. Connect a load resistor somewhere in the range of 12 to 47 R, with an adequate wattage. Set the voltage and current potentiometers to minimum, switch on, and slowly advance the current potentiometer, while measuring the output voltage. A voltage of approximately 1.4V should be obtained either immediately or after a small amount of rotation of the potentiometer. The voltage should not increase further. If it does, it is possible that the voltage adjustment potentiometer is connected the wrong way round.

With the current limit set near maximum, adjust the voltage potentiometer to check that the correct range of output voltages is obtained. The supply is designed to provide at least 1.5V to 35V, but if the reservoir capacitor voltage is sufficient the output will be able to be adjusted up to 40V, though significant current drain at this voltage will cause the output to sag, and will superimpose ripple from the reservoir capacitor on to the output.

With the output voltage set to 30V, reduce the current limit setting to check that at some point it reduces the output voltage (this test will work better with a lower value resistor).

If all is well at this stage, the output terminals can be connected, and the voltmeter calibrated if this has not been done previously. The power supply is now complete.

PARTS LIST

RESISTORS

R1,9	220R
R2,6	5k6
R3	1k
R4	330R
R5	0R1 2.5W*
R7,8	2k7
R10	1k8
RV1	10k potentiometer
RV2	10k multiturn potentiometer*

CAPACITORS

C1	1500µ 63V 0.4" pin spacing
C2,5	4µ7 35V
C3	220n

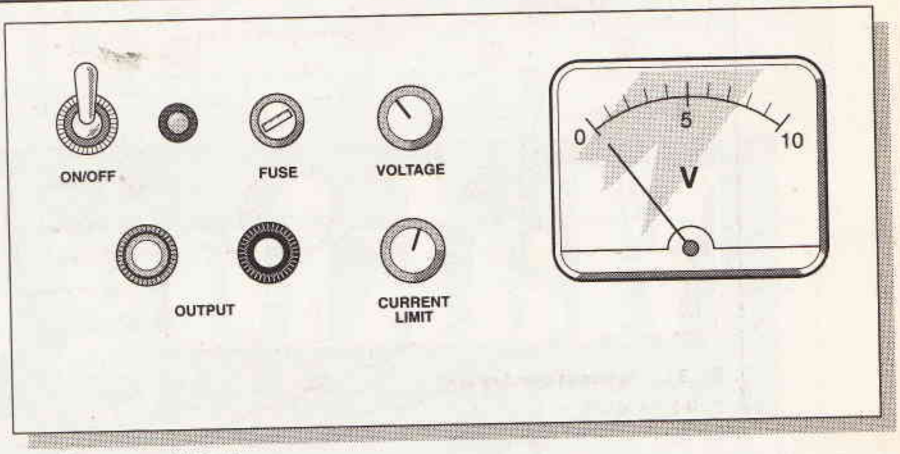


Fig.4 Front panel details

C4,6	470µ 63V
C7	4n7 poly or ceram, 0.2" pin spacing
C8	4700µ or 6800µ 63V*

SEMICONDUCTORS

D1	2V7 zenner
D2	TO220 50V 5A 50ns switching (or better) fast diode eg BYW29 or similar
D3	1N4148
BR1	Bridge rectifier rated at 3A, 50V or better.
Q1,2	BC212
IC1	LM317
IC2	LT1070

MISCELLANEOUS

30V rms mains transformer, VA rating as required. (30VA to 100VA suggested range)*
Two vertical PCB mounting heatsinks eg Cirkit 21-08006
Two 3-pin 0.1" Molex connectors (both halves.
Illuminated double pole switch (or switch plus neon lamp)
20mm panel mounting fuseholder
20mm 500mA T (slow blow) fuse.
Two knobs, one with pointer.
Two insulated terminals, one red, one black.
M3 nuts and bolts, wire, solder etc.

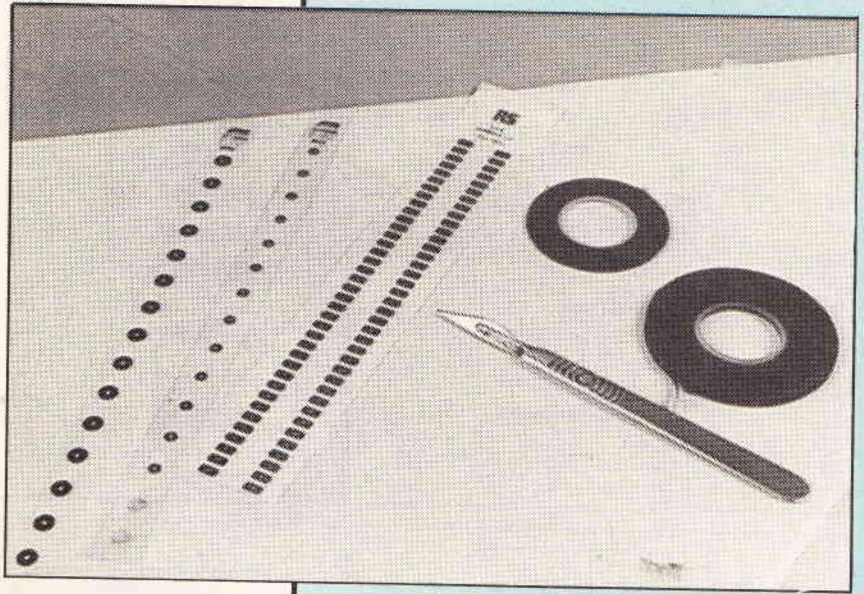
*see text

BUYLINES

Most components are easily obtainable. The BYW80-150 diode, available from Maplin, is suitable for this power supply. Maplin also stock a range of bridge rectifiers, the exact choice of which depends on the transformer rating chosen.

The original capacitor for C1 was obtained from Farnell. The 2200µ capacitor from Maplin (part no JL38R) is a reasonable substitute.

So far, I have only found the LT1070 available from Farnell. A kit of parts will be available from Mainline Electronics — next month.



1. Basic kit of tape, transfer, grid draughting sheet and scalpel

explained last month. After exposure to a light or ultra-violet source the sticker has to be removed from the board slowly and carefully to avoid stretching. It can be placed to one side without putting finger prints on it as you may want use it again. Once the board has been made it is then time to refer to the article by Andrew Armstrong on making the Laboratory power supply on page 16.

Taped And Foiled Again

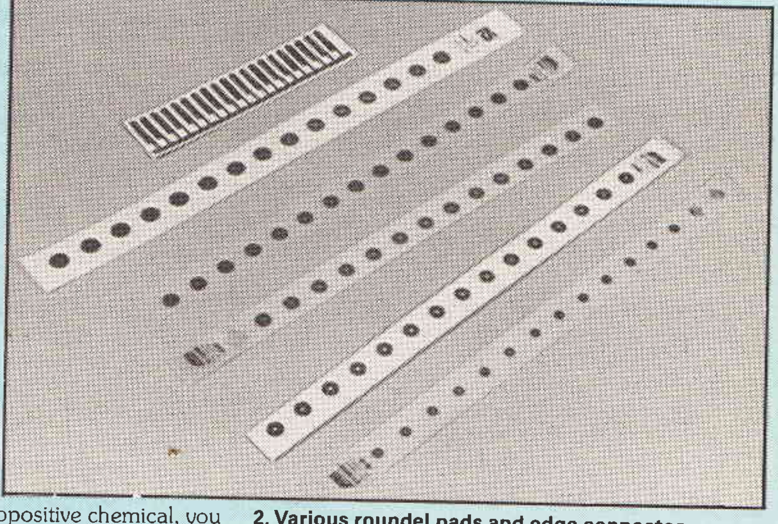
It is worthwhile saying something on how foils are made in general but to those who are old hands at draughting PCB designs, this can be ignored.

An old standard method for the preparation of professsional and amateur PCB designs was and in some cases still is the use of tape and transfer mounted on clear or semi-transparant plastic sheet. The vast majority of home and domestic users will use 1:1 draughting transfers, this means the design is actual size. It is attractive because when mounted on acetate

Making PCBs at

Geoff Martin continues with his home guide on making PCBs.

It is now time to use your free foil given away with this issue. As you see it comes in the form of a sticker. This is a different approach to the production of PCBs using a normal acetate film. In fact so attractive is the offer to you that we are considering making it a regular appearance within the magazine.



2. Various roundel pads and edge connector transfers

Preparing for exposure

Assuming you have followed our guidelines in last months ETI to prepare the free copper-clad board by spraying the cleaned surface with photopositive chemical, you are now ready to place the foil over the sensitised surface. If you didn't manage to obtain last month's ETI with its free copper-clad board, an alternative is to use pre-sensitised board if to hand.

In a darkened room carefully peel off the backing sheet to the sticker and place on the prepared copper surface making sure it is positioned squarely on the surface without any wrinkles and without thumbprints.

A serious alternative and one where the foil can be used many times is to find a thin sheet of acetate and stick the foil to it. It should be emphasised the sheet must be thin but rigid to keep the printed trackwork as close to the copper as possible when exposing. This minimises any diffraction effects and will give a sharper image. It is also important to make sure when sticking to acetate that no air bubbles manage to find their way in.

Whether you use our sticker as it is or by the normal masking method, the rest of the operation is as we

sheet, no photographic reduction is required so reducing complexity and expense. If accuracy is called for particularly with double sided boards then twice size or even four times final size is adopted. This would have been standard for industrial designs, even for the older integrated circuits. The reasons for this is ease of working and as photographic reduction is employed any error of positioning will be reduced by half or four fold.

Before any work should proceed, an essential for the drawing board is a draughting grid with horizontal and vertical lines spaced at 0.1inch (2.5mm equivalent) to position components. The reason for this 'imperial' size is historic. The Americans pioneered the design and packaging of integrated circuits and went for 0.1 inch pitch for spacing between pins of ICs. Having some old A3 imperial graph paper to hand is so much the better. The grid is also available on a durable plastic sheet for more professional use.

PROJECT

Transfers of various sizes are now commonly available to rub down on the draughting film. As always you get what you pay for and cheap 1:1 transfers do not always stay where they are required and also split sometimes when subjected to track tape. Twice up transfers are more expensive but are generally better quality. Round pads or roundels are sometimes available in tape form and will resist breaking.

Track tape comes in various widths according to your needs and can be laid and cut with a scalpel or a sharp disposable modelling knife.

When planning a design it is wise to sketch out on paper the various component positions and inter-connections. Work out the best routes to take to minimise the number of wire links that have to be fitted later, assuming a single sided board is to be designed. This out of anything else can be the greatest stimulating challenge to exercise the brain. Can a single sided design be acheived without the use of a wire link or jumper? A pencil sketch will also show up wasted areas.

If designing at home most people would design the board looking from the soldered side to produce a

Home

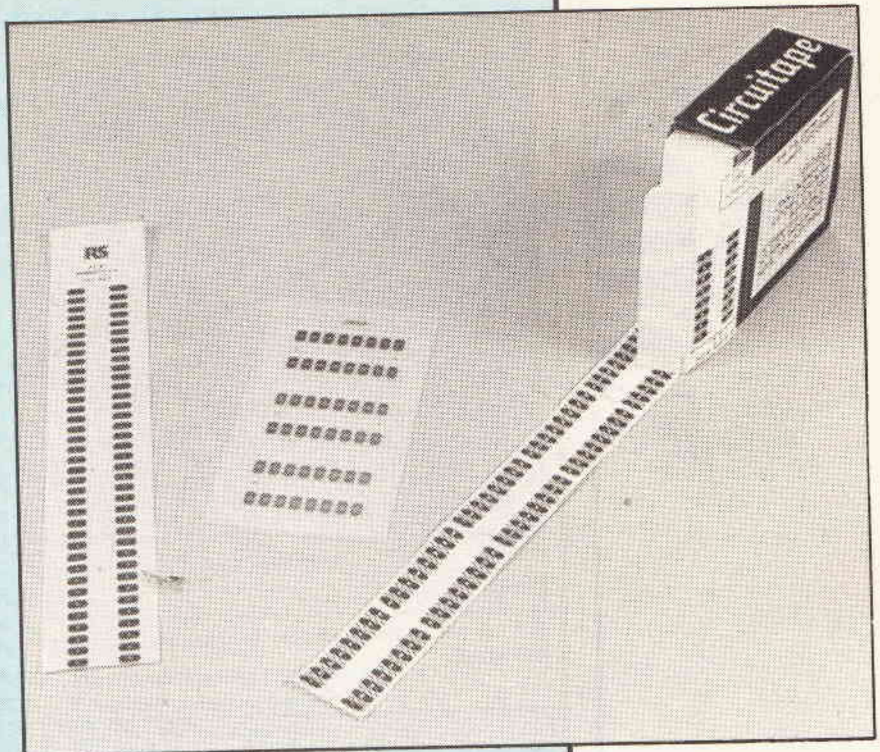
straight contact print on the copper board. This is fine provided it is remembered that all mirror positions of pins, particularly for ICs are adopted. Some may go for a design as if looking from the component side. The important aspect here is stick to the design you are happy with, and when finished indicate clearly which side is which.

The most difficult area to design around is the IC. Very often routes have to go between pins. IC rub-on transfers with feed-thru tracks are available at 1:1 2:1 or 4:1 and are very helpful in this respect to avoid track contact. It is advisable that no more than three tracks go down the centre of the IC if possible.

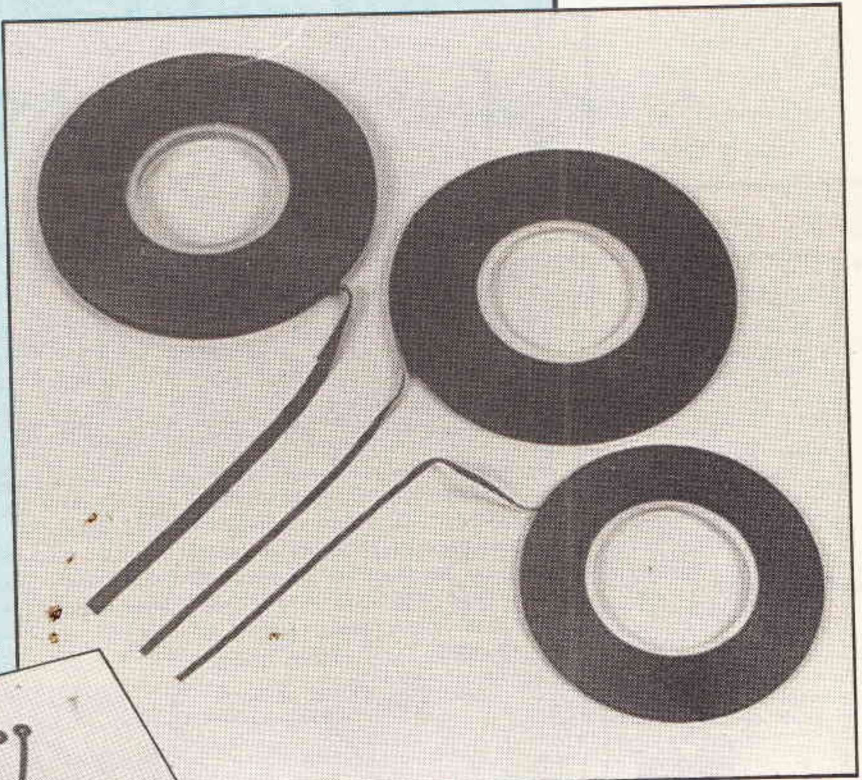
When designing your trackwork geometric neatness will pay off in many ways. Avoid the temptation to take the shortest route for you may find it has to be altered later. Track tracing at a later stage, especially with digital circuits is eased with neatness. Another bonus from pencilled designs and pre-planning is the final design comes out clean without the dirty grey and sticky track marks left by altering routes halfway through. The choice of squared or round cornering with tracks is left to the individual.

When skilled at laying tape, tight corners can be acheived and saves time.

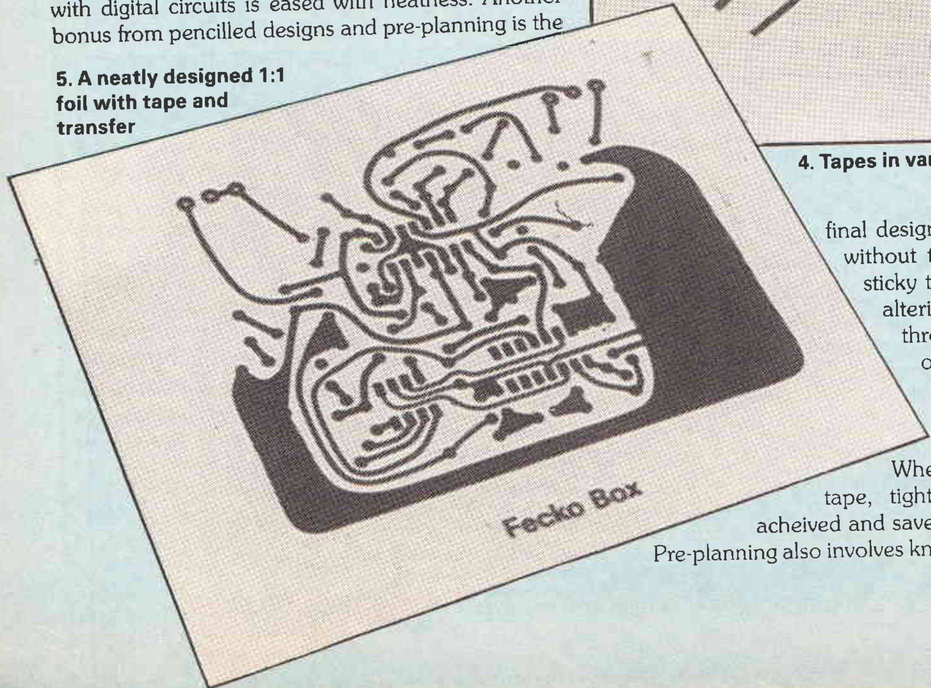
Pre-planning also involves knowledge of compo-



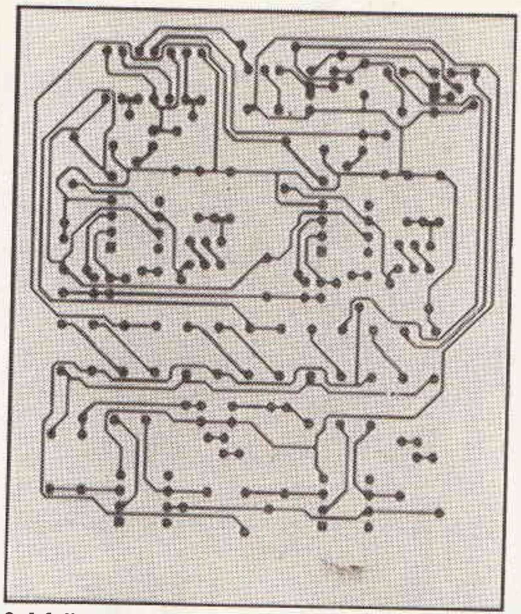
3. A variety of dual-in-line IC pads



4. Tapes in various widths



5. A neatly designed 1:1 foil with tape and transfer



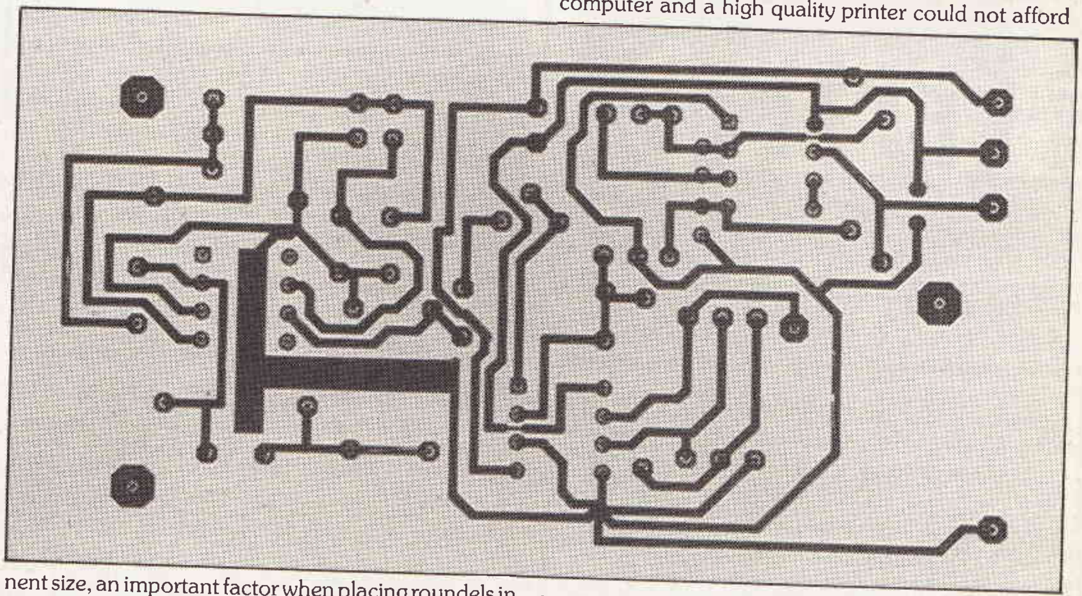
6. A foil where the tracks are too thin and roundels too small

For double sided board designs corner marking of both sheets is essential for alignment when developing. As an insurance policy, larger roundels should be placed on the topside to ensure drill-through connectivity later.

The last parts to the design are really cosmetic. Think about any large areas of board not covered. Very often these areas are masked off with wider black plastic tape and can act as earth planes. There is less copper to etch later on and saves on Ferric Chloride.

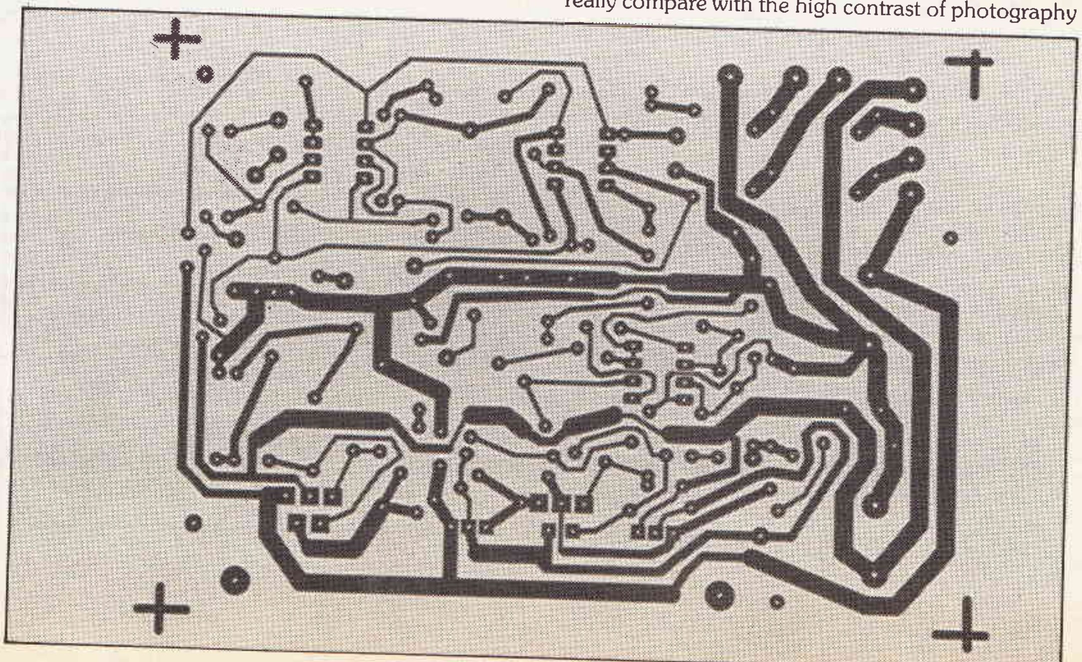
CAD Design An Alternative

The design of PCBs is increasingly being carried out on computer. There are many advantages to this, the principle one being the great time saver. Integrated circuits and PCBs have been designed on computer for some time and until recently CAD software has remained within industry owing to cost. But the price of software and computer hardware has dropped and this has provided the amateur with yet another powerful tool. A barrier still exists though in producing the final product, a foil on acetate sheet. Recent correspondence in ETI has highlighted the problem. Although the cost of individual software alone does not amount to much, an amateur at home without a computer and a high quality printer could not afford the initial costs just to produce a PCB on computer and even then is only a paper print out. Various methods of obtaining a foil from a paper printout have been discussed under the Read/Write column but none can really compare with the high contrast of photography

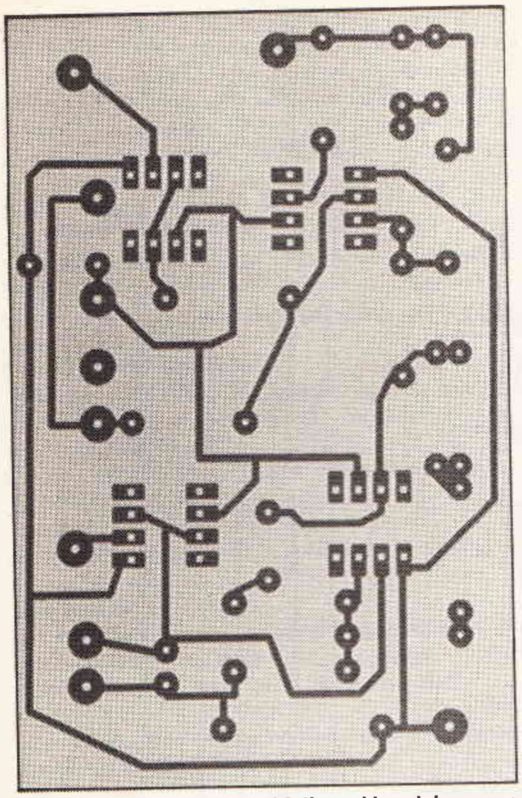


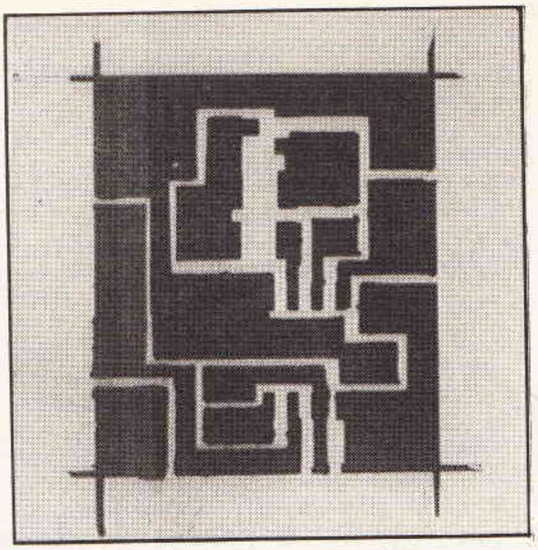
Computer design by pen plot

nent size, an important factor when placing roundels in their positions. The most troublesome component for variable size is the capacitor, so it might in some cases pay to lay out a series of joined roundels to accomodate various sizes. So looking at your existing component stock or component catalogues for pin positions is important.



PROJECT





8. **Two computer designed foils and hand drawn pen and ink surface-mount design on the right**

or tape-on-acetate.

Finally, just to recap briefly for those that missed last months article, here is a list of essential items in order to produce a PCB.

Essential Equipment

- Copper clad board
- Cleaning materials
- Plastic Measuring Cylinder
- Plastic developing trays
- Photoresist positive spray
- Good even or diffused light source
- Caustic soda crystals
- Ferric Chloride crystals
- PCB Foil (or means to produce one)
- PCB mini-drill (12V) and bits

If produced carefully, you can take pride in what can look like a professional job.

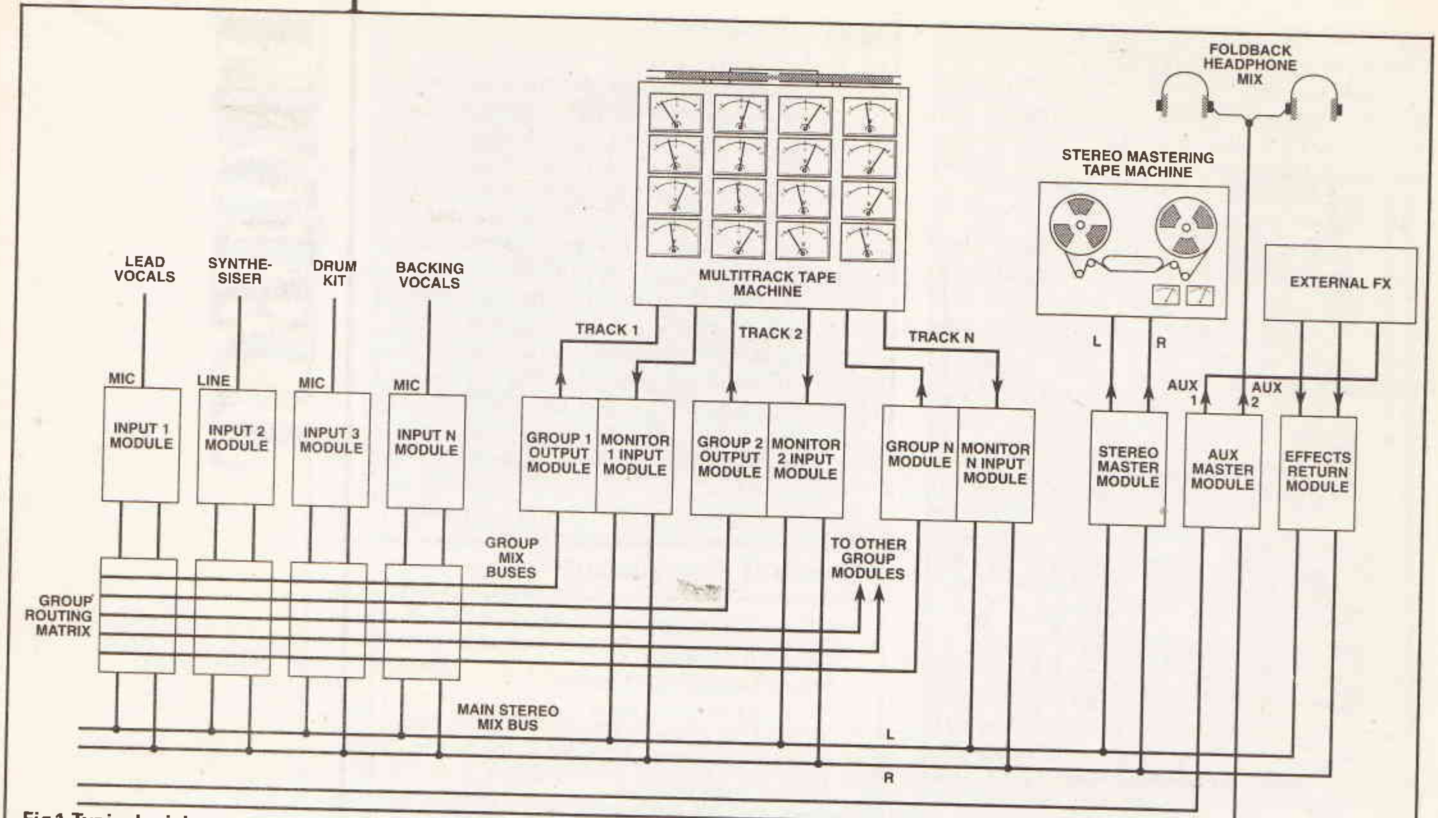


Fig.1 Typical mixing console

Introduction to Audi

Mike Meechan begins a new series on audio mixers culminating in how to build your own high quality desk.

Most of the population enjoy music. Whether it be classical, jazz, folk, rock, pop or some of the more modern derivatives which purport to be music, most of us listen to it in one form or another as a source of pleasure. The days of the vinyl-covered mono record-player, tinny medium wave and the radiogram are long gone, replaced nowadays in most homes by NICAM compatible television, compact-disc players, RDAT and state-of-the-art amplifiers, tuners and speakers.

No matter what type of programme material and in what size, shape or format the consumer chooses as the listening medium, all recorded music must have been processed in an audio mixer of one form or another. The mixer is one of the most important but often forgotten tools of the recording industry. In the studio environment, where it should be appreciated, it is regularly taken for granted. Away from this environment, many laymen will be completely ignorant of its very existence.

In this short series of articles, I hope that I shall be able, firstly, to dispel some of the mystique surrounding these beasts of many control knobs, flashing lights et al which lurk in semi-darkened, accoustically-treated rooms and secondly, to raise the level of appreciation of the various technical problems which have to be surmounted before a high quality and marketable design is realised in practice.

The circuitry of a mixer arguably represents the ultimate in audio electronic circuit design. Unlike in a domestic hi-fi, even one with any great pretentions to quality, signal degradation perpetrated in the mixer circuits, and hence at the point of origin, is completely irretrievable. The seemingly simple concept of the amplifying, processing and summing together of what may be a large number of low level signals is in reality a very difficult process when the practicalities are explored. Input signals to be processed vary in level from the faintest pianisimo of a triangle being stuck to the tremor-inducing fortissimo of a kettle drum being pounded. Equalisation (EO) must be unobtrusive as far as noise and phase distortion are concerned but yet effective and flexible when required, a signal must remain electrically isolated from its neighbour until the engineer decides when and in what proportion it shall be mixed, headroom should be maximised throughout the mixer and generally the design should introduce as little noise and distortion as possible, the output signal being as true a reproduction of the input as the designer can make it. The only other proviso, and a very important one, is that the console should cost as little as possible to produce and manufacture and utilise existing, cheap technology. This is probably one of the most important considerations as far as the commercial manufacturer is concerned — it would be financial disaster to market a mixer which was 6dB quieter but 20dB more expensive than its competitors as only -60dB of customers would be interested in buying the product. It is relatively easy to use the latest, low-noise op-amp to create an input stage of esotoric qualities — quite another to justify the use of 500 or so of these devices in a mixing desk of average proportions. With all of the above mentioned points firmly in mind, let us take a leisurely stroll through the various parts which constitute your basic, run-of-the-mill modern mixing console. It should be noted that not every facility mentioned will be applicable to every type of

MIXERS

desk -we will run through the various types at the end of the series. Figure 1 shows a typical Mixing Console.

Before we start in earnest, some mention will be made of terms which will crop up frequently in the text and which really need to be understood to a greater or lesser extent before any proper appreciation of the design criteria involved can be made.

Noise Figure

This is the difference between, measured in dB's of the thermal noise voltage of the amplifier source (given by 4kTBR) and the equivalent input noise of the amplifier. A good microphone preamp might have a noise figure of 3dB.

Equivalent Input Noise

This is the noise voltage measured at the output of the amplifier and is the noise which would need to be applied to the input of a perfect, noiseless amplifier to give the measured noise of the practical amplifier in question. The gain of the real amplifier is subtracted from the noise voltage at the output to give the Ein. It is sometimes known as Total Noise Referred to Input and a typical figure might be −121dBu.

Headroom

This is the difference between the maximum undistorted signal at a particular point in the circuit and the normal peaks of the signal. A good design will have high level signals with adequate headroom flowing in the busbars. This minimises the effects of noise whilst allowing flexibility. The maximum signal level allowable is dictated by the power supply rails of the electronics - this is usually a unipolar supply of +24V or a +/−20V bipolar supply. A typical value for headroom might be 16dB, but the actual figure will vary depending on where in the console we measure it — the input stages where the signal level is less controlled will usually have more headroom than at the output.

Probably one of the most important parts of the mixer and certainly one of the components which ultimately determines both how flexible and how noise-free the console as a whole is in the input channel, shown in block schematic form in Figure 2. A normal Mic/Line Input will consist of the parts shown.

o Mixers

Input Channel

Low Noise Input Stage

Even a completely digital desk, that is, one where the mixing is done in the digital domain, must have at least one analogue component and that is the front end of the mic input where the signal is in analogue form — there are as yet no digital microphones. Modern mixer input stage designs almost exclusively use discrete transistors — sometimes in a matched monolithic package such as that found in the LM394 — in a long-tailed pair configuration because of the noise penalty which op-amps would introduce if used directly to amplify such low level, low source impedance signals. This differential input stage, in conjunction with an op-amp to give the required extra gain, is used to electronically unbalance the input signal. The use of input transformers seems to have lost vogue somewhat as they are expensive to manufacture, offer a serious weight penalty and have distinct shortcomings where low frequency linearity is concerned. When they are used, they have some very important functions. The first of these is to provide good input balance so that common mode pickup from the microphone lead is rejected. The transformer should also provide around 10 to 16dB of gain for the input signal where voltage gain as in any transformer is a function of the turns ratio, Ns/Np. They must also transform the low impedance of the microphone, typically in the region of 200R, to an input impedance of normally 1k2. Finally, they should provide a source impedance which will optimise the noise performance of the op- amp. The impedance is transformed (because of the conservation of energy) by the square of the input impedance. The input stage must also provide a 48V supply for the phantom powering of microphones. Figure 2 shows a typical transformerless, electronically-balanced mic input stage.

The switching between the Mic and Line input in the channel is not normally done electronically, ie with analogue switches (4016) as it is unlikely that the console operator will wish to change signal sources when the desk is being used dynamically. Switching opens up a whole new can of worms and will be dealt with as a separate issue. This Mic/Line switch is normally arranged to alter the gain of the stage although different manufacturers adopt different approaches.

There is also a separate Gain control which alters the stage gain from about +20dB to about +70dB.

Equalisation

This is the rather grand name given to the tone control section of the channel and is almost always truncated to 'EQ'. In the main, it is slightly more sophisticated

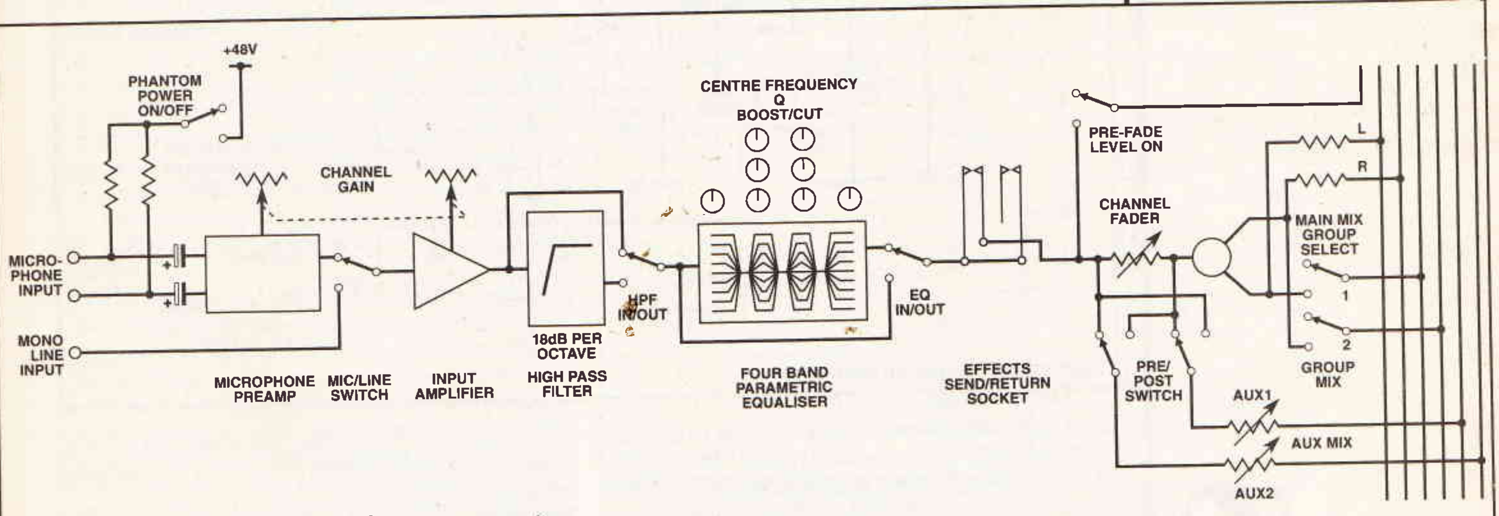


Fig.2 Block schematic of input module

than the tone controls found in domestic equipment, having one or more "Parametric" mid frequency sections, where the parameters of Q, filter centre frequency and boost or cut are all user variable. Most parametric sections have the response known as 'bell' while the LF and HF sections have the more common 'shelving' characteristics found in Baxandall type controls. Figure 3 gives a graphical representation of these responses. There will also be an EQ IN/OUT button so that A/B comparisons can be made and this means of course that the section must have unity gain. Some

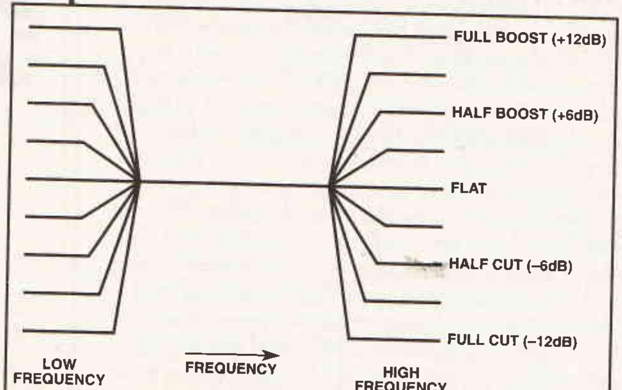


Fig.3 Gain/Frequency plot of typical 2 Band shelving (Baxandall) type equaliser

sections will also have a switchable high pass filter which will roll off at 18 or 24dB per octave those frequencies below 80Hz or so.

Auxiliary Mixing Bus

These are busses separate from the main mixing busses and are used to create effects send mixes,(eg for reverbration), foldback mixes, monitor mixes and clean feed mixes. There may be as many as 16 different AUX mixes, able to be selected as either PRE or POST FADER so that the final level is dependant or independant of the CHANNEL FADER. Pre-fader aux sends are normally used as foldback or clean feed sends whilst Post-fader sends are used to feed effects units so that the effect will be attenuated by the same level as the dry signal. The number ultimately contributes to the overall flexibility of the desk as a sound engineer will tell you. We shall deal with the three main uses separately.

Effects Send Mix

This will normally be a mono mix of all channels which have to be sent to an external effect unit, normally something expensive such as digital reverbration, so alleviating the need for separate FX for each channel so requiring. The EFFECTS RETURN will normally be in stereo.

Foldback Mix

This is used to create a mix so that the artists can hear what they are originating from their instruments, this being especially important if an artist is adding material to a mix of instuments already done and so has to be in sync. It is sometimes called a Monitor Mix where the mixing is for live concert and whole mixers are sometimes dedicated to the task at a large gig.

Clean Feed Mix

This is used to sum all of the channels bar this one so that the performer hears everything but his own contribution. This means the mix sent to them is Clean of their own contribution.

Cue Mix

This is similar to the clean feed mix but will also include a contribution from the TALKBACK MIC mounted on the desk.

Prefade Level (PFL)

This allows the engineer to monitor a particular channel in isolation without affecting the rest of the mix. Pressing any PFL button on the console will assert logic within the desk which will cut the normal stereo mix from the loudspeakers and replace it with the PFL of the particular channel chosen.

Panpot

Or Panoramic Potentiometer to give it its full name. This control electrically positions a single source of sound across the panorama from the left to the right stereo channels. A major requirement of this control is that when positioned full left or full right, the gain from the input to the output is unity, but when positioned centrally, the gain from input to each output is −3dB. Figure 4 shows a common arrangement where RV1 is a dual linear pot wired in reverse so that when one wiper is at minimum resistance, the other is at maximum. The signal can thus be panned full left or full right. In the central position, the signal fed to each opamp input resistor is 0.707 (−3dB) of Vin due to the bridging resistors.

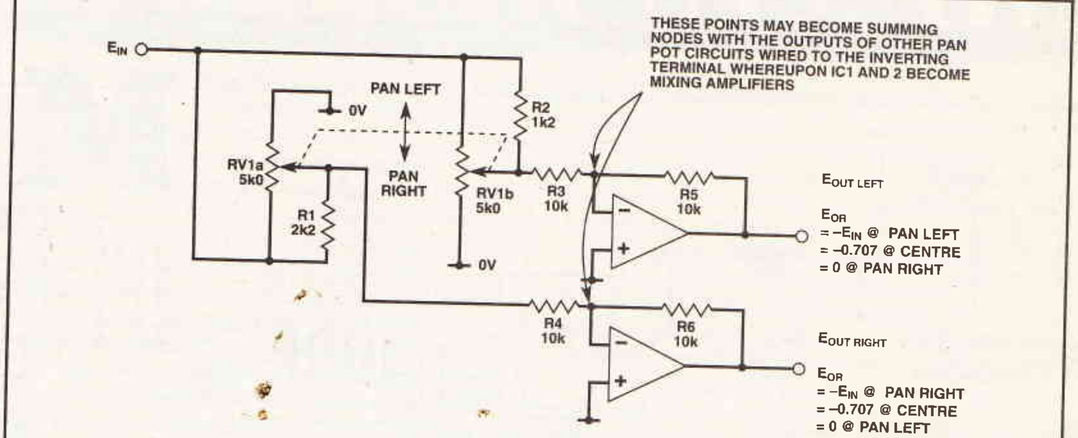


Fig.4 Stereo Panpot arrangement

Routing

Each channel will normally have a bank of pushbuttons — up to 16 or 32 depending on the size and complexity of the desk — which constitute the group routing matrix. These are used to group together signals before they are outputted from the desk to a multitrack tape machine. This means that although, for example, 4 input channels are used for backing vocals, these can be switched to groups one and two, mixed together and then outputted to a tape machine. In this way, the backing vocals occupy only two precious tracks of the multitrack. Conventionally, odd numbered groups are left in the stereo field and even-numbered are right.

Channel Fader

This is a long throw linear pot which controls the channel signal level fed onto the main stereo mixing bus. With the fader positioned about two thirds of the way from the bottom, gain from input to output is normally arranged to be 0dB, with the channel fader able to give another 10dB or so of gain if required. The fader may incorporate a backstop switch which can be used for a variety of purposes including remote starting or stopping of tape machines or record decks or to mute local or remote loudspeakers to prevent howlround.

Miscellaneous Channel Input Facilities

The channel will normally have an overload indication of some sort which will warn of the imminent onset of clipping. There may also be a LINE/RIAA switch if the input is stereo. This allows the connection of a stereo tape machine or record deck.

Having looked at the normally included features which comprise a good channel input module, we can now look at the other modules to be found in a medium-sized mixing console with a better understanding of the features and attributes which they must possess in order to be flexible and again maintain the best noise performance.

Group Module

Mention was made in the preceeding section of the pushbutton group routing matrix to be found on each channel module. The group module sits across the corresponding group bus and sums together all of the channel sources selected to that group. This signal is then outputted from the console and used as a track on a multi track recording. Thus a console to be used with a 16 track tape machine would need 16 group modules.

The summing together of the sources selected for a given group introduces noise and crosstalk problems quite similar to those encountered on the main stereo mix bus. These we will cover more comprehensively and in much greater depth at a later point. Clearly, the number of sources which are switched to a particular group mix bus will vary depending on the circumstances prevailing when a mix is done eg how many backing vocalists, how large a percussion section etc. Two very simplified group routing matrices, namely constant current and virtual earth mixing use different techniques to obtain the same objective.

With constant current mixing, the bus driving resistors are connected to ground when a source is not selected so the impedance of the bus remains constant. Both source impedance and bus impedance are low in value.

Figure 6 shows a virtual earth implementation of the group routing matrix. The mix busbar is at virtual earth and the routing switches only select drive resistor Rx when that channel is selected to the group thus offering a slight improvement in noise performance when only a small number of channels are selected.

Monitor Module

These are input modules fed from the multitrack tape machine, there being as many monitor as group modules. They are similar to input channel modules but have a much simplified control section, normally comprising a simple 2-band EQ, pan pot and rotary level control. A "MONITOR SOURCE" switch selects whether the group input (record input) or replay output is monitored and applied to the stereo mix bus.

Master Module

A block diagram of a typical master module is shown in Figure 7. Its function is to sum together all of the channel sources present on the main stereo mix bus, control the overall level via large left and right linear faders and electronically balance the signal ready for application to the appropriate channel of a stereo mastering tape machine. It contains also the logic circuitry which controls switching of the PFL, TAPE and MIX signals used for the studio monitoring.

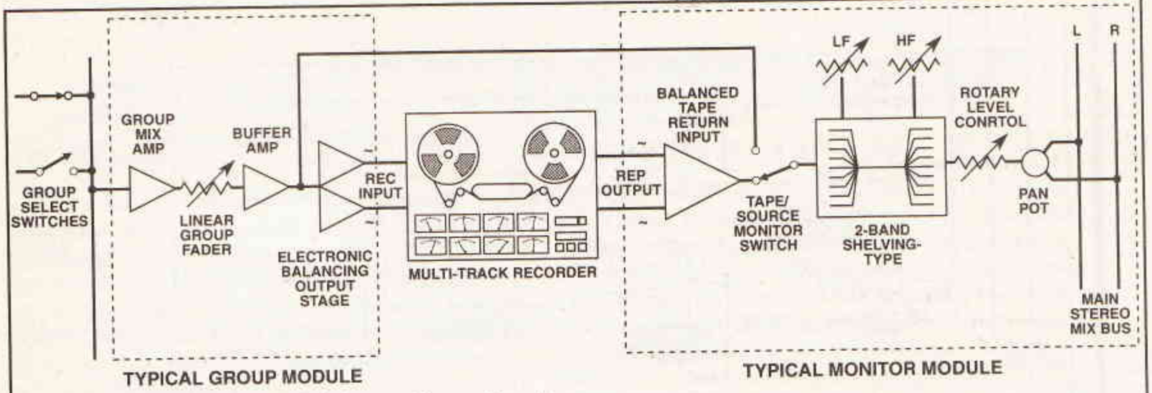


Fig.5 Group and monitor module (normally combined)

There will also be Master modules for each of the Aux sends, used as described before to generate headphone feeds for performers and to create Effects mixes.

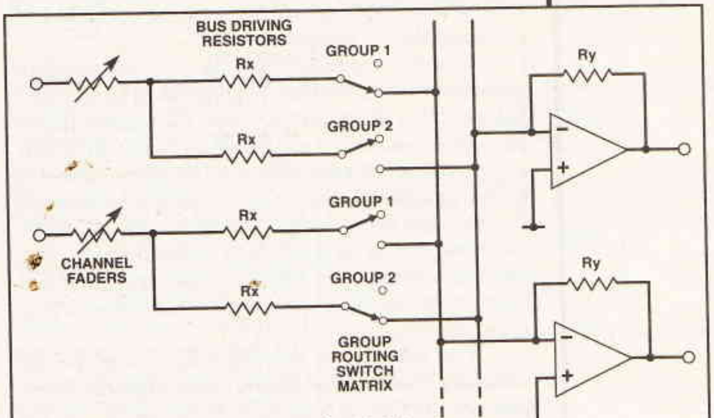


Fig.6 'Virtual Earth' group routing/mixing bus

Miscellaneous Mixing Console Facilities

FX Return Module

We mentioned earlier that one or more of the Aux sends may be used as FX sends. It follows therefore that we must have some way of getting these processed signals back into the mixer and onto the main stereo mix bus. This is done using, surprise, surprise, an Effects Return module. This is similar in design and facilities to the monitor module, having perhaps simple EQ, pan and level controls and is in fact small enough to be incorporated as a sub-section of the master section, although this is not always the case.

Switching

As we said earlier, switching it not quite the simple process that it should be in a perfect world such as ours. No matter how we implement this function, there will always be some compromises in performance or reliability. If we look in the first instance at the normal way of switching ie with a basic mechanical switch, this will become much more apparent. Switches are basically nasty mechanical or perhaps electromechanical things full of the imperfections associated with devices of this sort. They create noise, they become unreliable in operation after a very finite period (or perhaps even earlier if they are cheap as well as nasty), they are bulky in terms of occupying space on a PCB and they may well be expensive to boot. Sadly, the very nature of a mixing console means that their use is extensive in its design. This means ultimately that we may end up with an inherently noisy or unreliable design since the inclusion of large numbers of mechanical devices in any piece of electronic apparatus (and we have more than our fair share as it is, what with connectors, pots and faders) is a major contributory factor in the overall dependability of the apparatus.

One way round this problem is to use analogue switches which themselves are controlled by mechanical switching. The critical signal then never passes through a mechanical contact of any sort and operating a switch electrically lends itself readily to control by a microprocessor or other digital device. As is usually the way with these things, analogue switches are not quite the answer to a maiden's prayers that we may have first thought on initial ponderance since they themselves introduce quite distinct problems of their own.

It is because in this application that we are unusually interested in keeping noise, crosstalk, distortion and the like at unbelievably low levels that the problems of using analogue switches become appreciable. The major one is in the manner in which these devices create clicks or glitches on their outputs when switching takes place since the control signal being applied couples capacitively to the channel, which causes ugly transients on the signal. These transients are caused by charge transferred to the channel through the gate channel capacitance at the transitions of the gate. Slowing down the gate signal gives rise to a smaller amplitude glitch but of longer duration so that the area under the graph is the same as in the previous case. We therefore implement analogue switching more as a fast mute, where a rising or falling waveform, rather than a step waveform, is used to control the gate of the FET. Figure 8 shows two examples of FET analogue switches.

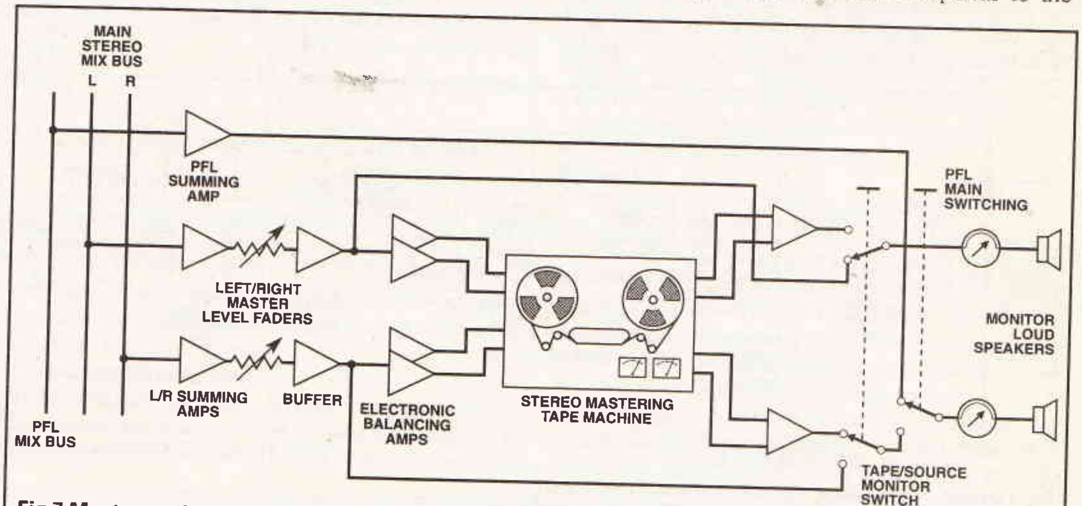


Fig.7 Master module showing PFL switching

Metering

The two types of metering used are VU and PPM (Volume Units and Peak Programme Meter respectively). These can use either moving coil movements or LED's for display purposes, although PPM's are almost always moving coil instruments. These meters are rather more accurate than those found on domestic recording equipment.

The essential difference between the PPM and the VU meter is in the signal processing circuitry used for measuring the level of the signal and in the ballistics of the meter movement, both of which are carefully specified.

The VU meter must present an overall impedance of 7.5k at 0VU to a 600R source. 0VU represents +4dBm (1.288V rms) at 1kHz when this criterium is satisfied. If used with a different source impedance, this is no longer true. The meter responds to the energy of waves and the ballistics are such that if +4dBu 1kHz tone is applied, the pointer will reach 99% of its final deflection in 0.3 seconds. It is cheap, easy to line up and requires no auxiliary power.

However, as many readers will realise from their own experiences of this type of meter, it has a log scale which is difficult to read (being expanded at one end of the scale and cramped at the other) and meter deflection depends upon energy.

The PPM has many more elements. Figure 9 shows the various parts. The meter is effectively isolated from the signal source since the high impedance amplifier means that no power is drawn from the source. The full wave precision rectifier captures both positive and negative-going peaks and the time-constant network provides the necessary ballistics of 2.5ms electrical rise time (which increases to 80ms when the mechanical slugging of the meter is accounted for) and 1s fall time. The log amplifier means that the scale is marked in a linear fashion as Figure 9 shows. PPM 4 represents 0dBu on this meter. These characteristics make it infinitely preferable in most instances to the VU meter. It is, however, difficult to line up, requires a power supply and is much more expensive.

The majority of readers will have never seen a large mixing console in the flesh, so to speak, the sight of them being limited to their appearance in promotional pop videos (Genesis and Abba seemed to have had a thing about them in the early eighties) and at concerts where the sound mixing engineer is sometimes visible to the crowd. Both scenarios use mixers with very different facilities and different mode of operation, although of course, certain features, as we have already mentioned, are common to both. We shall now look at the different modus operandi employed in each and see why they are different. Their use in the first example given is in multi-track recording.

Recording on more than two tracks is highly advantageous. Those of you out there who may possess a small mixer/multi-track combo will know why this is so. For those of you who don't, it can be summed up in one word — flexibility. A musical collage of instruments and vocals can be built up piece by piece and over a period of time, mistakes can be rectified and previously-recorded tracks enhanced with no effect to other tracks etc etc. In fact, this sequence can continue almost ad infinitum (or ad nauseum if you happen to be the remix engineer!) until acceptable results are achieved.

Multi-track recording is normally done in two quite distinct steps, these being recording and mixdown (although the recording of live concerts sometimes breaks this rule).

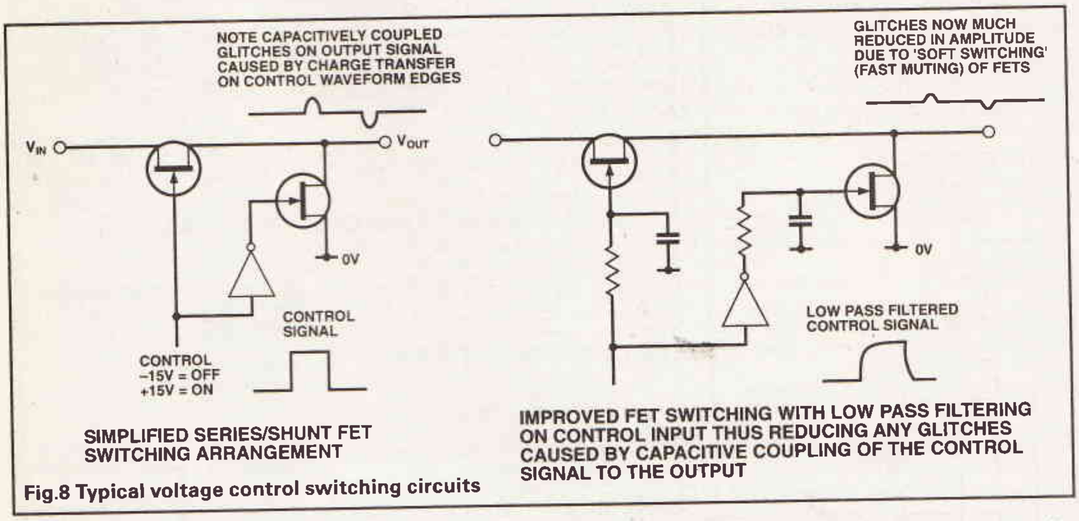


Fig.8 Typical voltage control switching circuits

Recording

It is normal for only one or two tracks to be recorded at any one time, although a large drum kit — bass, snare, hi-hat etc — may occupy up to five tracks of a 16 or 32 track recording, each individual drum sound being allocated its own track.

Input channels are used for the recording process because the sound will normally be sourced from a microphone and the input channel is the only module where a microphone preamp is fitted. Major manipulation of the signal is avoided at this stage so that the signal recorded is as much a replication of the original as possible. We make use of the group routing matrix, allocating individual sounds or groups of sounds to a particular track of the multi-track. It follows that any console designed for use with an 8-track recorder must have an 8 group routing matrix as a minimum specification.

Multi-track machines are somewhat different from the average domestic stereo cassette or open reel recorder in that they can both record and replay different tracks simultaneously, for example we could be monitoring (replaying) tracks 1 to 6 whilst recording on tracks 7 and 8. We can therefore replay already-recorded material to an artist who will then accompany this, his or her contribution being recorded on any vacant tracks so configured. It is in this way that the tracks are laid on tape until all of the tracks of the multi-track are eventually filled and the recording is taken to completion. Tracks to be replayed during this operation are inputted to the desk through Monitor modules which can be thought of basically as input channels which are permanently configured for line inputs and have many of the input channel facilities omitted, there usually being only an LF and HF shelving-type EQ and a rotary gain control.

Once recording is complete, we can proceed to mixdown. Each track of the multitrack recording is now inputted to the console via the Line Inputs of the each channel input module. The facilities which the input channel affords the engineer are now used to the fullest extent. It is at this stage that any tonal correction is made, external processing such as echo, phasing, reverb etc is added and ultimately, the level of the track in the final stereo mix is fixed. The engineer will experiment with different levels and stereo field placements using the channel fader and panpot respectively. Any number of experiments can be made since the multitrack master remains untouched during all of this.

In a live concert situation, especially one where the stage output is to be recorded on multitrack for future broadcast or for storing on some other playback medium, slightly different demands are put upon the sound desk. Relative levels of each instrument in the final stereo mix heard by the paying public will be set beforehand during the synonymous 'sound check', as will all of the foldback and monitor mix levels. In actual fact, a separate mixer may be allocated the task of providing all of the monitor and foldback mixes if the gig is a particularly large one. Subsequent adjustments will be made in real time while the concert is in progress, the sound engineer normally being situated 'front of the house' where he will be able to achieve the best subjective and qualitative assessment of the sound mix being perpetrated.

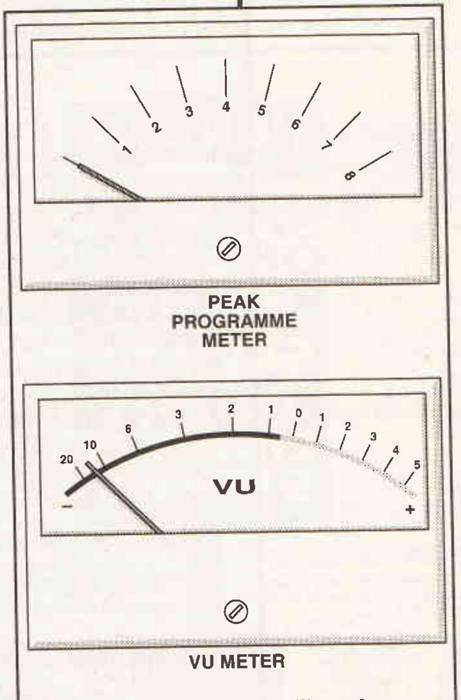
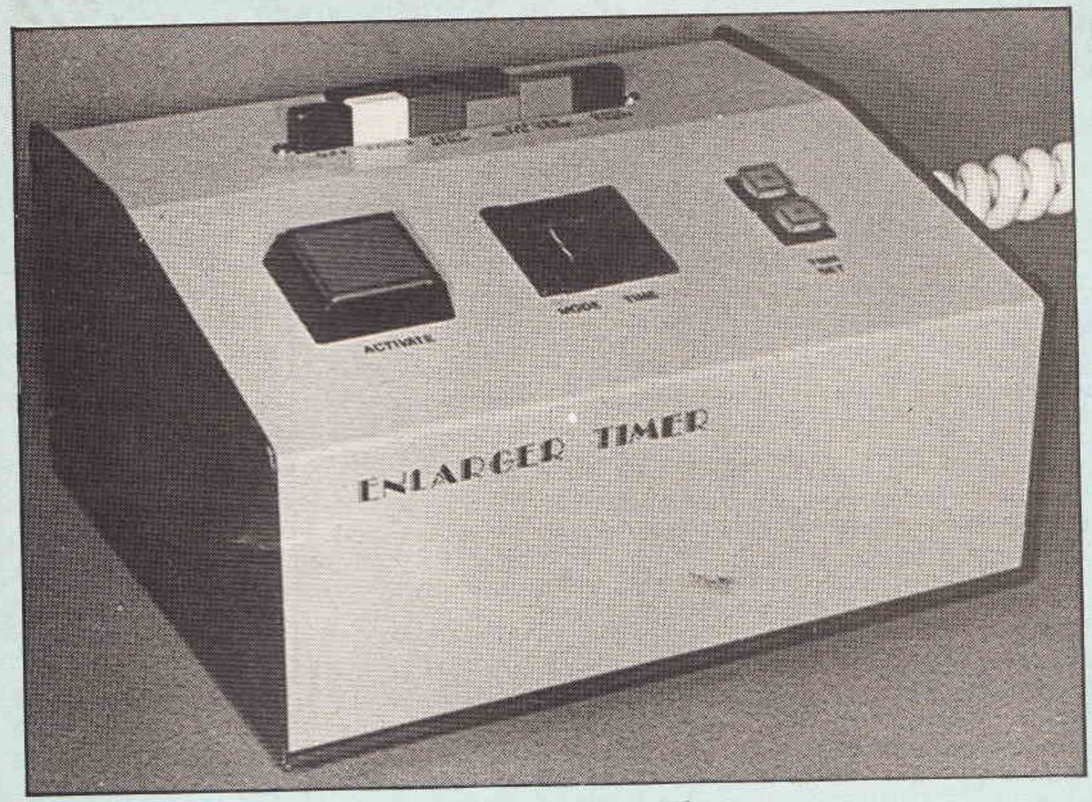


Fig.9 PPM and VU meter calibaration

Now that we have some basic understanding of the elemental architecture of a sound desk, we are well primed for next month's Part 2 which will cover digital mixing desks and describe the ways in which digital control and computers can be used to enhance the performance of the console whilst easing workload for the engineer.



PROJECT

Digital Enlarger Timer

An accurate timer for the darkroom by Chris Bowes.

The Enlarger timer described in this article has been designed, after a great deal of research to provide the ultimate in ease of operation. As a result, although the circuitry is rather complex, virtually all of the operational problems which have been encountered with commercially designed timers have been overcome.

One of the major problems with a number of commercially designed enlarger timers has been that they rely upon an analogue time delay circuit, usually involving some form of resistor/capacitor timing network, to provide the timing function. As a result they are somewhat difficult to set accurately, once the correct exposure time has been determined.This is because determining the correct exposure requires the making of a test strip, using some external form of counting or timing. It is not necessarily the case that the timing inscribed upon the rotary potentiometer used to set the time on the timer will accurately correspond with the timing or counting used to expose the test strip.

The design described in this article overcomes the operational problems involved in using an Enlarger Timer principally by using a digital timing circuit, to ensure the length of time for which the enlarger light is on can be set accurately. The same timing circuit is also used to provide a pulsed 'bleep', at one second intervals in the TEST STRIP mode, so that the marking off of the test strip is done accurately with respect to the exposure time steps used to determine the elapsed exposure time. Thus the time obtained from examination of the test strip can be accurately transferred to the output of the timing circuit. A feature of this timer is that each function is set by simple operation of a single array of interlocked push buttons, without disturbing the time set for any of the exposure functions. A further refinement in this design is when the enlarger light is off, the time set on the internal calibration is displayed digitally together with, as well as an indication of which function has been selected by the function select push buttons. When in the timing mode with the enlarger light on, the display changes to indicate the elapsed exposure time. An audible 'bleep' will be emitted from the timer at one second intervals to assist in 'dodging'.

The unit can also be used to control the dark room safelight which may be selected to be on all the time or to be automatically turned off when the enlarger light comes on.

Functions

The main functions of the unit are best summarised as follows:

OFF

The unit is completely turned off and no functions are operational.

FOCUS

When selected the enlarger light is turned on and no timing functions are available.

TEST STRIP

The enlarger light is turned on at the first operation of the 'start' switch and a bleep output is emitted at the end of every second. The counter display counts the number of seconds which have elapsed since the the enlarger light was turned on. The enlarger light is turned off by a second operation of the start switch.

EXPOSE. 1.

In this position the enlarger is turned on by operation of the 'start' switch and remains on until the time preset by the time selection circuit has expired. At the end of the pre-set time the enlarger is switched off.

EXPOSE. 2.

The circuit operates in the same way as for the EXPOSE I, function except that an audible bleep is emitted every second.

The functions are selected by means of a five button switch array, arranged so that operation of one button releases the other interlinked buttons. The first seven segment LED module in the display matrix is wired to show the function selected under darkroom conditions. The display shows F when the FOCUS function is selected, t for the TEST STRIP function, E for EXPOSURE 1 and E. when the EXPOSURE 2 is

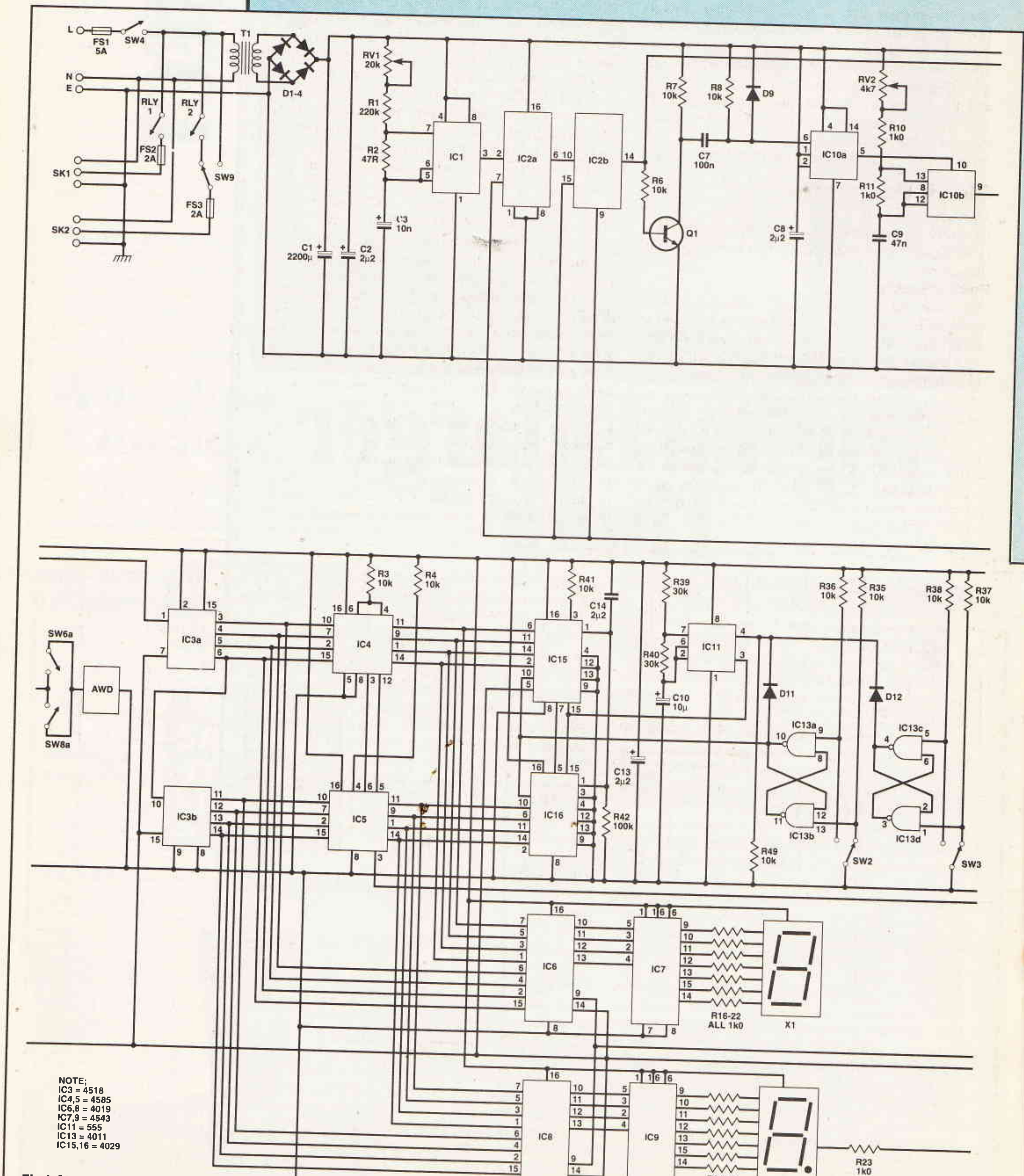


Fig.1 Circuit diagram of timer

selected. The timer's seconds display decimal point is illuminated when the enlarger is turned on. At 'switch on' the timer is automatically set to give an exposure time of 8 seconds. (Which is generally of the order of the correct exposure time for black and white materials). This can then be altered between 1 second and 99 seconds by operation of the timer selector + and – buttons. These are operational at all times, except when the enlarger lamp is on during a timing function The 'start' switch is automatically disabled when operation of it would either upset the operation of the circuit, or an incompatible function, such as the FOCUS operation, has been selected. In order to avoid confusion these switches are internally illuminated when operation will effect the operation of the circuit and the internal illumination of any switch is turned off when that switch's operations are disabled.

Circuit Description

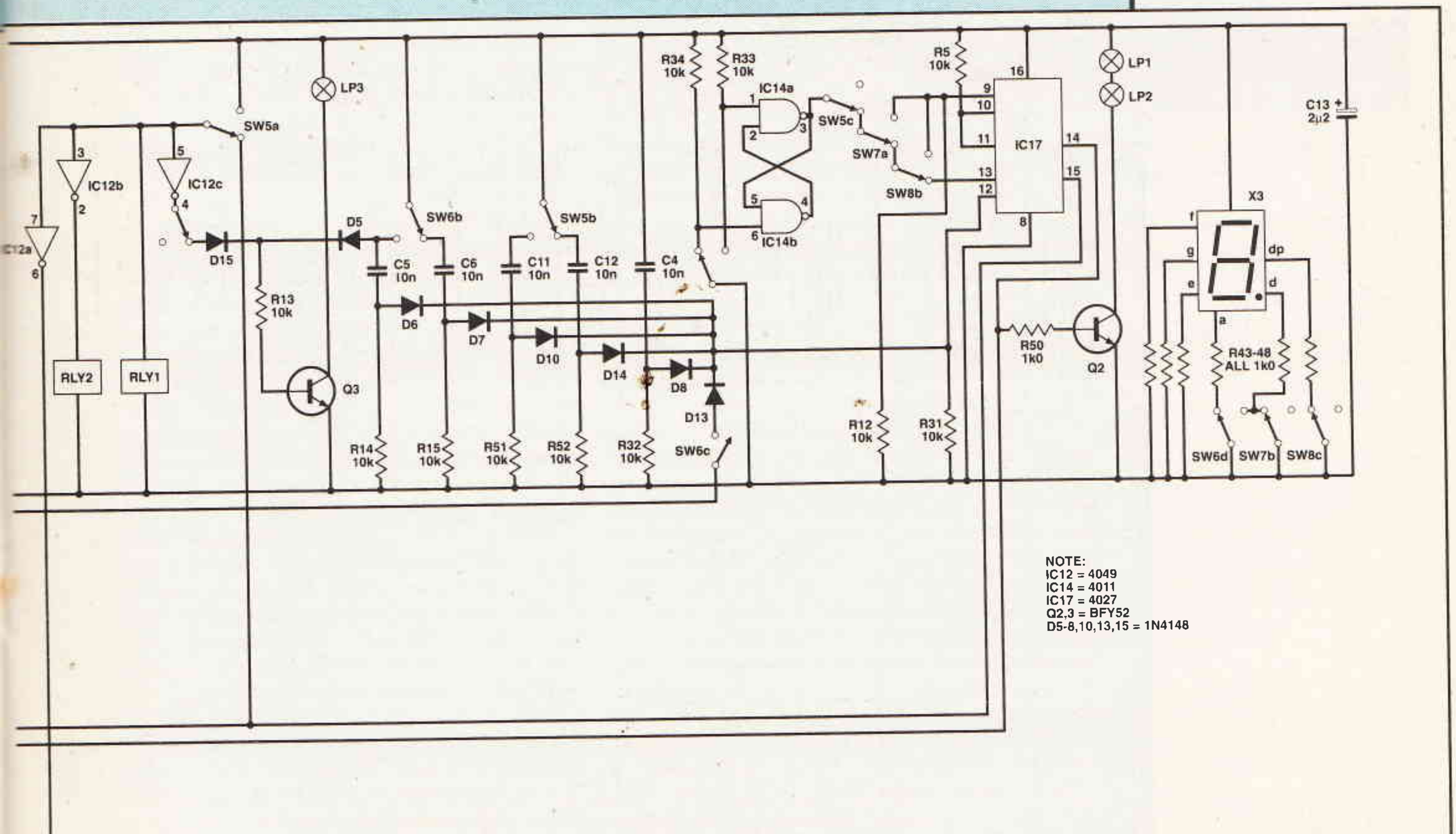
The circuit diagram for the enlarger timer in shown in three sections in Figure 1. In considering this circuit it is probably easiest to break it down into fairly small constituent parts.

Power Supply

The power supply circuit for this project is conventional. FS1 is a standard 5 amp fuse which is used to protect the entire circuit. The power from the mains input lead is switched by SW4, which is one of the interlinked function selectors. From here the power is connected to the two relays and the safelight function switch, SW9, as well as being passed through the transformer T1. The transformer reduces the 240 volts AC mains supply to 9 volts AC. this, being rectified by the bridge rectifier (D1-4) and smoothed by capacitor C1 to provide 12 volts DC. C2, and C13 are 2.2u tantalum capacitors, each mounted on one of the two main printed circuit boards used in this project. These decoupling capacitors smooth out glitches on the power supply lines, caused when digital circuits, switching off and on.

Clock Circuit

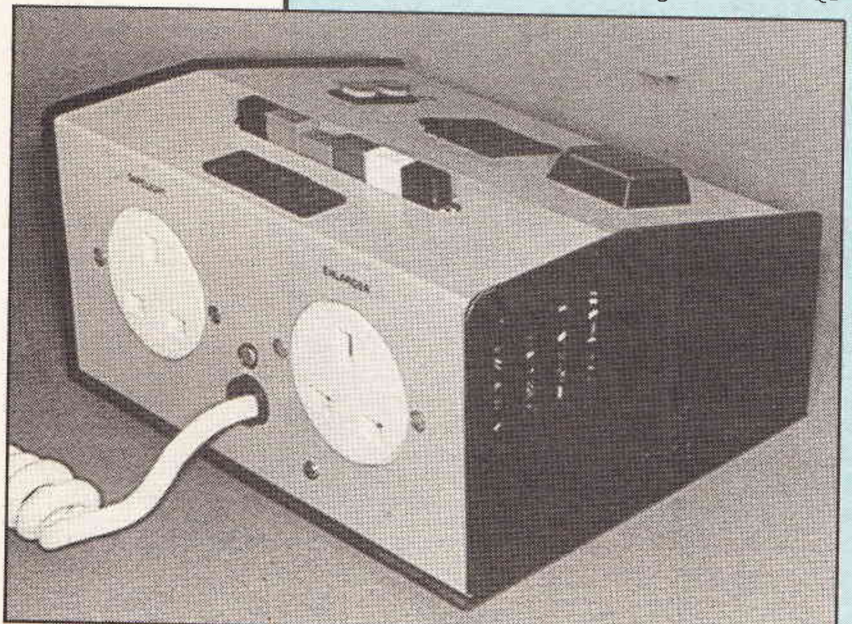
In order to improve the accuracy of the timing of this project the clock circuit used to generated the one second pulses, which drive all of the timing functions, is slightly unconventional in that the one second pulse is derived from a much faster clock circuit, utilising IC1, IC2a and IC2b. IC1 is a CMOS 555 timer which is configured in the Astable mode. The output frequency of the clock pulses derived from this circuit are set by means of RV1, R1, R2 and C3. These values have been chosen so that the output frequency from IC1 can be adjustable by means of RV1 and set to an accurate frequency of 256Hz. This frequency has been chosen so that when the clock pulses have been fed through the two cascaded binary counters, (IC2a and IC2b), the output frequency from Pin 14 of IC2b will be 1Hz which can be accurately set by adjusting RV1. These counters are inhibited from operation when the enlarger light is switched off by connecting Pins 7 and 15 (the master reset input connections) to the not-Q output of the enlarger lamp controlling flip-flop (IC17). This output is in the Logic 1 condition at all times, except for when the circuit is set to turn the enlarger lamp on. When the MR inputs are in the Logic 1 state all of the inputs (O_0 to O_3) are forced to the Logic 0 state. When the MR input falls from the Logic 1 state to the Logic 0 condition the counters are allowed to function normally and the outputs (O_0 to O_3) are allowed to switch between the logic states in the normal binary progression. This unusual configuration has been chosen in order to increase the accuracy of the timing provided by the enlarger timer, since, by using this circuit, the maximum deviation from the



accurate time for any exposure is reduced to the duration of one output pulse from IC1. This means that the inaccuracy of any timing function will never be more than 1/256th of a second. The output from the one second clock generating circuit is fed to both the sound generator and counter/timer circuits.

Sound Generating Circuit

The Sound Generator Circuit is used to produce the audible bleeps which are emitted when the enlarger lamp is turned on when the TEST STRIP or EXPOSE 2 functions have been selected. It is operational during all of the times when the enlarger lamp is turned on, simply being turned off by means of SW6a and SW8a when not required. The production of the audible bleep is initiated by a positive going pulse at the output of IC2b. This occurs at the end of each second of the timing period. This rising pulse is applied, via R6, to the base of Q1 and causes the voltage at the base of Q1



Q1 to rise to a point where the transistor switches. This causes a current to flow through R7 via the collector and emitter of Q1 to ground. This causes the voltage at the collector of Q1 to fall to virtually 0 volts and triggers the circuit comprising C7, R8 and D9 to produce a negative going pulse at the trigger input (Pin 6) of IC10a. This is one half of a CMOS 556 dual 555 timer, connected as a monostable. This trigger pulse causes the output at Pin 5 of IC10a to swing from the Logic 0 state to the Logic 1 state for a time period determined by the values of R9 and C8.

The output from IC10a is fed to Pin 10, the reset input of the same integrated circuit, which is the other half of the dual timer. IC10b is set up as an Astable circuit and changing the state of the reset input from Logic 0 to Logic 1 state allows IC10b to produce a square wave output at Pin 9 which has a frequency determined by RV2, R10, R11 and C9. The component values have been chosen to produce an output frequency of approximately 3kHz, which is matched to the optimum frequency for the audible warning device. RV2 has been included into the circuit to tune the output frequency of IC10b to accurately match the optimum frequency (that which gives the loudest noise) of the audible warning device. When the reset input of IC10b is triggered back from the Logic 1 state to the Logic 0 state, the circuit is inhibited from functioning and the output falls to remain in the Logic 0 state until the logic state of the reset input (Pin 10) returns once more to the Logic 1 state. This circuit is thus triggered so as to produce an audible bleep from the AWD for a set period of time, every time the output of IC2b goes from Logic 0 to Logic 1, but ignoring the occasions when the output of IC10a changes from the Logic 1 state to the Logic 0 state. SW6a and SW8a are used to disconnect the AWD from the output of IC10b except for when the appropriate functions (TEST STRIP and EXPOSE 2) are selected.

Exposure Timing Circuit

The exposure timing circuit, which is active when either of the EXPOSE functions is selected, consists of two clock circuits, one driven by the 1Hz clock generator circuit under the control of IC17, which controls the enlarger lamp, and a second clock circuit, the value of which is set by the TIME + and TIME – switches. The states of these two clocks are continually monitored by a comparator circuits. When both clock values are the same (which occurs when the exposure time matches the preset exposure time) the A=B an output of the comparator circuit is used to switch the flip flop and extinguish the enlarger lamp.

The one second pulses, from the clock generator circuit, are counted by means of IC3, which is a 4518, dual BCD counter. The two counters within this integrated circuit are cascaded together by connecting the O_3 output of IC3a to the clock input of IC3b. The count modes of the integrated circuits are set by the connection of Pin 2 of IC3a to the positive power supply rail and Pin 9 of IC3b to the 0 volts power supply rail. The effect of this is to cause the counter to advance by one, through the range from 0 to 99, every time that the output of IC2b goes from the Logic 0 to the Logic 1 state. The master reset inputs of IC3a and IC3b, like those of IC2a and IC2b, are connected to the not-Q output of the enlarger lamp controlling flip flop. When the enlarger lamp is off these inputs are in the Logic 1 state, which causes the outputs O_0 to O_3 of both IC3a and IC3b to be forced to the Logic 0 state. When this output of the flip flop goes from the Logic 1 state to the Logic 0 state this allows the counters to function normally, and count from 0 to 99 in binary form. The outputs from this binary elapsed time counter are fed to the 'A' inputs (A0 to A7) of the comparator circuits (IC4 and IC5) which are two 4585 binary magnitude comparators, cascaded so as to provide an eight bit magnitude comparator.

The '0' inputs (B0 to B7) of this comparator circuit are connected to the outputs of the second counter circuit, which consists of IC15, IC16, IC11 and IC13. IC's 15 and 16 are 4029 pre-setable, BCD up/down counters. The circuit operates with these IC's connected in the parallel clocking mode to facilitate the up/down control of the circuit. This second counter circuit operates in two basic ways. When the enlarger timer is first turned on a short positive going pulse, generated by C14 and R42, is applied to Pin 1 of both IC15 and IC16. This is the parallel load (PL) input to the IC and the pulse causes the logic state present at the parallel load inputs (P_0 to P_3) of the counters to be loaded into the output latch and to appear at the outputs (O_0 to O_3) of both IC's. The Parallel Load inputs of IC16 are all set to the Logic 0 state by the connection of Pins 3, 4, 12 and 13, to the 0 volts line. IC15 is set to be preloaded by the PL pulse to an output state of 8 by the connection of the P2 input (Pin 3) to the positive power supply line via the pull up resistor R41. and the connection of the other parallel load inputs (P_0, P_1 and P_3) to the 0 volts line.

The second way in which the cascaded counters can be altered is for them to be made to count up or down under the control of the + and – time select switches, SW2 and SW3. Each of these switches operates an anti-bounce circuit comprising a cross coupled pair of NAND gates (IC13a and b in the case of SW2) and IC13c and d (in the case of SW3). These circuits are necessary to avoid the problems which would otherwise be caused by the circuit counting the bounces of the switches when they are operated. In each case the cross coupled NAND gate circuit is arranged to give a Logic 1 output when its associated switch is operated. The outputs from these two circuits are combined by means of D11 and D12 which, together with R49, form a simple OR gate, the output of which is used to cause the reset input (Pin 4) of IC11 to go from the Logic 0 state to the Logic 1 state whenever SW2 or SW3 are operated. R49 is used as a pull down resistor to force the reset input of IC11 to the Logic 0 state, when neither SW2 or SW3 are operated.

(pin 15) of both IC15 and IC16. The carry function which causes IC16 to advance by one pulse at the appropriate transition of O_3 of IC15 is accomplished by the connection of Pin 7, the not-TC output of IC15, to Pin 5, the not-CE pin, of IC16.

In order to prevent the counter from advancing when its output value is not shown on the display, the circuit is inhibited from operating by connecting Pin 5 of IC15 to the not-Q output of IC17, the enlarger lamp controlling flip flop. This function operates in reverse to that of IC2 and IC3 in that Pin 5 of IC15 is a count enable input, which causes the counter to advance under the control of SW2 and SW3 whenever it is in

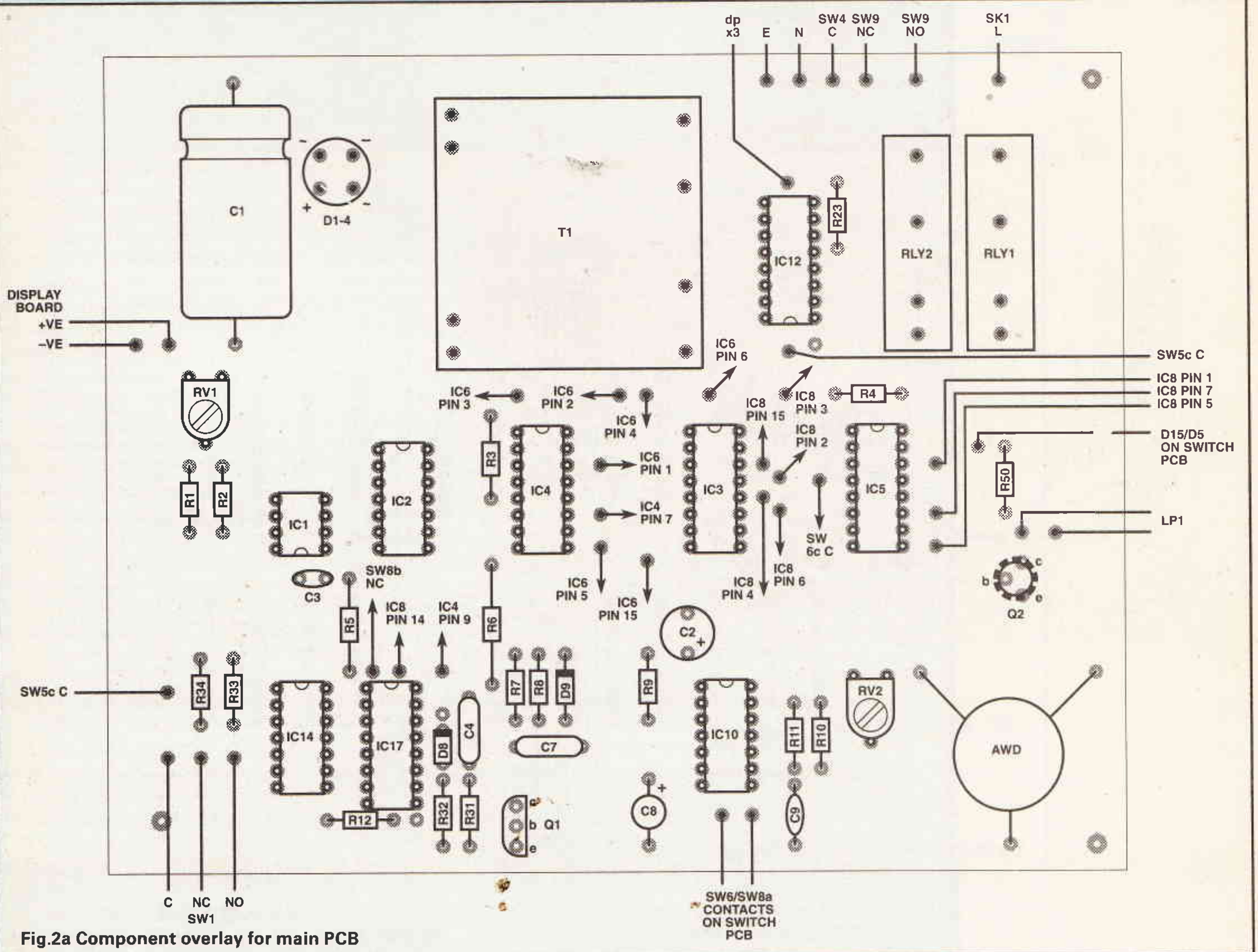


Fig.2a Component overlay for main PCB

The output of IC13a (the anti-bounce circuit associated with the 'time +' switch) is also fed to Pin 10 of IC's 15 and 16. This is the up/not down input which controls the direction of the counting of the two circuits. When it is in the Logic 1 state the clock circuit will count up one count for every pulse input to the clock input of IC15 and when the direction selector input pin is in the Logic 0 state then the circuit will count down one unit for every input pulse.

IC11 is a CMOS 555 timer circuit, configured in the Astable mode, which is used to output a clock pulse to drive IC's 15 and 16 whenever SW2 or SW3 is operated. The component values of the timer frequency setting chain (R39, R40 and C10) are not critical but those shown in the circuit diagram have been chosen so as to give an output clock pulse frequency which is neither too fast nor too slow. The output pulses from IC11 are fed in parallel to the clock input connections

the Logic 1 state and to prevent counting from occurring when this input is in the Logic 0 state, which occurs whilst the enlarger lamp is on. Pin 9 is the binary/decimal selector input, which is connected to the 0 volt line for both IC15 and IC16, so as to set the counter to work as a decimal counter. The outputs (O_0 to O_3) are fed both to the comparator circuit (IC4 and IC5) and to the display circuit.

IC4, and IC5 are connected to form an eight-bit binary comparator circuit, which compares the outputs of the two clock circuits. When the output of IC3a and IC3b (representing the time for which the enlarger lamp has been on) is the same as the output for IC15 and IC16 (which represents the time pre-set for the enlarger lamp to be on) are equal the A=B output (Pin 3 of IC5) changes from Logic 0 to Logic 1. This signal is fed to IC17 via the function selector push button array. This causes the enlarger lamp to be turned off and the system to be re- set, when the time preset into ICs 15 and 16 has elapsed, in the EXPOSE 1 or EXPOSE 2 modes.

Display Circuit

The display circuit comprises three, seven segment, common anode, LED displays, which are set up to indicate both the function selected and the appropriate time data. The simplest display is that of X3 which is that used to indicate the function selected as shown in Table 1.

Function	Display	Segments Illuminated
FOCUS	F	a, e, f, g
TEST STRIP	t	d, e, f, g
EXPOSE 1	E	a, d, e, f, g
EXPOSE 2	E.	a, d, e, f, g, dp.

Table 1.

volts supply line. In this configuration the outputs (O_a to O_g) are driven to produce the appropriate switching of the segments of X1 and X2, corresponding to the binary information available on the inputs (I_0 to I_3). As with the other display each of the segments is driven through a 1k dropping resistor in order to reduce the operating current of the LEDs in the seven segment display to a safe level. Because all of the displays used in this project are common anode displays, IC7 and 9 have been set up to drive them in an appropriate manner by connecting Pin 6 to the positive power supply rail, so that the outputs (O_a to O_g) are in the Logic 0 state when the display segment is illuminated.

Selection of which of the two sets of time data is to be fed to the display driver IC's (IC7 and IC9) is determined by the logic state of the switch enable inputs S_A and S_B of the selector IC's (IC6 and IC8). The S_A inputs of both the IC's are connected the Q output of IC17 and their S_B inputs are connected to the not-Q output.

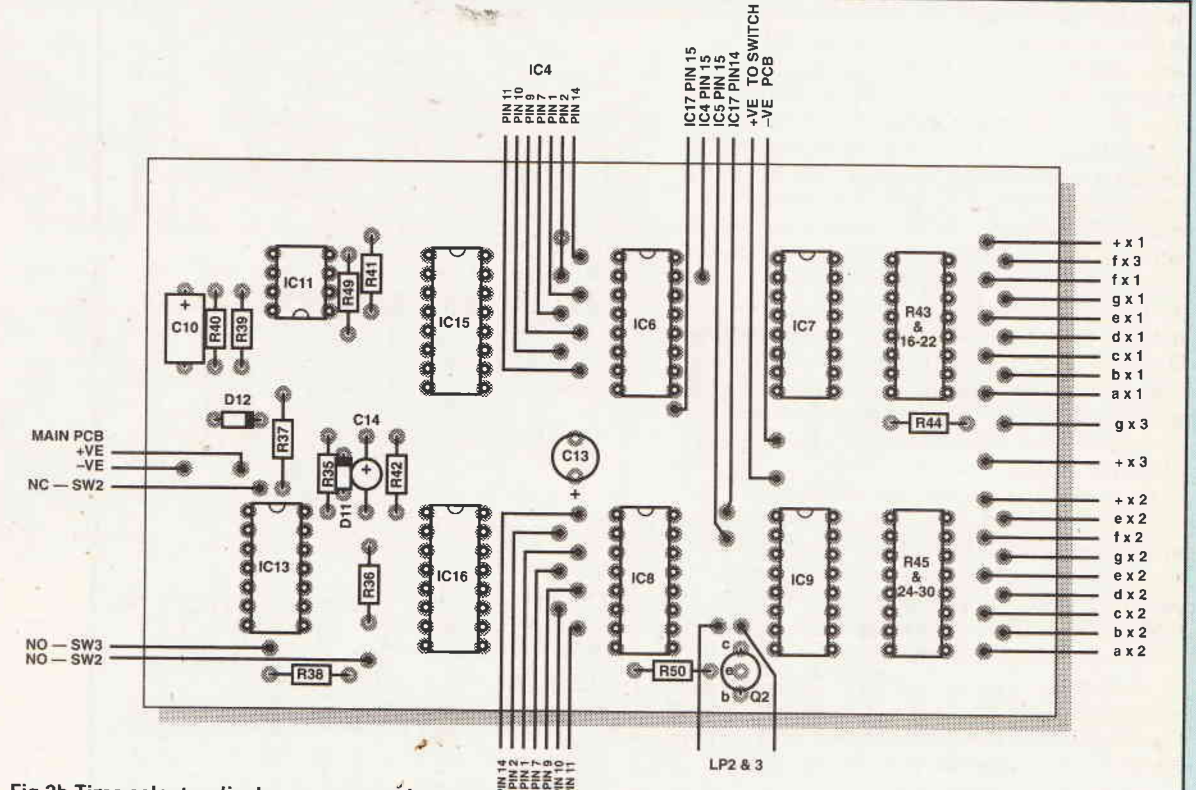


Fig.2b Time selector display component layout

In order to achieve this state segments e, f, and g are permanently energised, whilst segments a, d, and the decimal point are selectively energised by means of SW6d, SW7b and SW8c. In each case the segments are connected to ground, either directly or through the switches, by means of the 1k resistors R43 to R48 which are used to reduce the current flowing through the circuit to a safe level. The second display (X1 and X2) is used to indicate the time data in such a manner that when the enlarger lamp in on the output from the time elapsed clock (IC3a and IC3b) is displayed but whilst the enlarger lamp is off then the preset time (the output from IC15 and IC16) is displayed. The devices used to perform the required switching function are two 2019, 4 x 2-input multiplexers (IC6 and IC8), each of which is connected so as to select sets of outputs from the two clocks. The outputs (O_0 to O_3) of the selector ICs are fed to the inputs (I_0 to I_3) of IC's 7 and 9 which are 4543 BCD to seven segment latch/ decoder/driver circuits. These are configured so that the latch and blanking inputs are disabled, by connecting Pin 1 to the positive power line and Pin 7 to the 0

This arrangement ensures that the S_A and S_B inputs are always in the opposite logic state, thus ensuring that the output of the elapsed time counter is displayed when the enlarger lamp is switched on in the TEST STRIP and EXPOSURE modes and that at all other times the output from the pre-set exposure setting time counter is displayed.

Allied to this is the operation of the illuminating circuit for SW2 and SW3. These switches are only illuminated whilst their output is displayed on the displays (X1 and X2). To achieve this the lamps are connected in series with each other (so as to reduce their light output) to the collector of Q2. The base of this transistor is connected via R50 to the not-Q output of IC17. When this output is in the Logic 1 state (which occurs when the enlarger lamp is switched off) a current is allowed to flow through the base/emitter junction of Q2. This in turn allows a much larger current to flow through the collector/emitter circuit, illuminating the lamps as it does so. The switching action of the transistor occurs when the base/emitter voltage exceeds 0.7 volts and R50 is incorporated in the circuit so as to reduce the voltage output from the not-Q output of IC17 (which is at 12 volts) to the requisite 0.7 volts required to cause Q2 to switch.

The state of the enlarger lamp in indicated on the display by means of the illumination or otherwise of the decimal point of X2. This is achieved by connecting it, through R23 which is the standard dropping resistor required to reduce the current flowing through the LED, to IC12a which inverts the logic signal used to operate the relay used to switch the enlarger lamp off and on. (The inverter is necessary because of the fact that the display is a common anode type and in order to operate the display circuit it's input must be forced to the Logic 0 state, which allows the current required to illuminate the LED to be 'sunk' to ground through the dropping resistor R23.

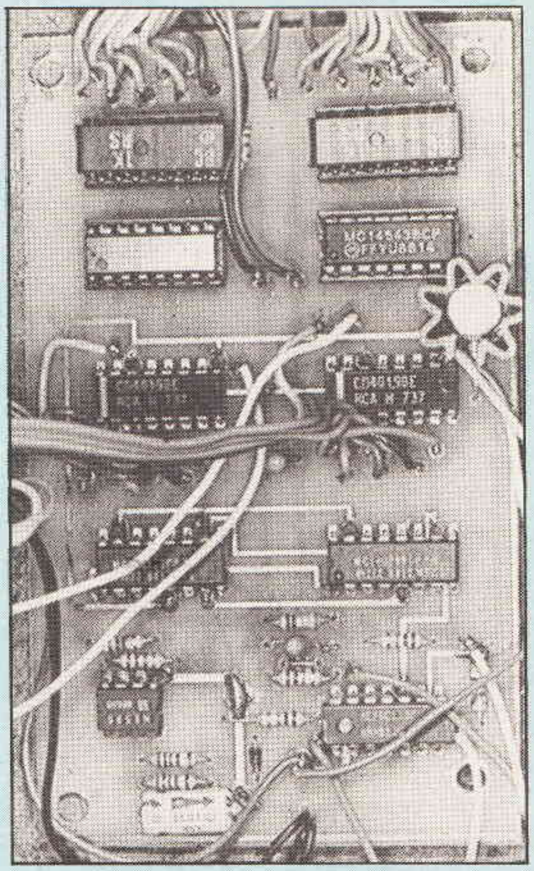
Lamp Control Circuit

The basic control of the illumination of the enlarger lamp is achieved by toggling IC17, which is a 4027 J-K flip flop. Because this integrated circuit is a low current device, the output from this integrated circuit is used to drive a solid state relay (RLY1) which is connected so as to control the mains driven lamp, which is connected to SK1. Although the basic functions involving the timing of the exposures are controlled by IC17 there is one exception to this rule in that, in order to reduce circuit complexity the illumination of the enlarger lamp in the 'FOCUS' mode is driven directly by connecting the input of RLY1 to the positive power supply line through SW5a. This is a SPCO switch, interlinked with the other function selection switches, so that it's normally closed contact is connected to the Q output of IC17 but when it is operated it's normally open contact is connected to the positive power supply line, thus driving the relay directly. In order to provide the function which causes the safelight to be turned off when the enlarger lamp is turned on a second solid state relay RLY2 is connected via an inverter (IC12b), to the input of RLY1. This arrangement ensures that when Relay 1 is energised Relay 2 is de-energised and vice versa. To disable this function SW9 is a second SPCO switch which is connected so as to cause the safelight socket SK2 to be connected either directly to the live power line or via RLY2.

FS2 and FS3 are two anti-surge fuses connected so as to protect the relays in the event of a fault occurring in the enlarger (which is connected to SK1) or the safelight (which is connected to SK2).

IC17 requires somewhat complex switching in order to achieve the various functions required for this project. These are controlled by the selector switches (SW5 to SW8). In order to understand the operation of this part of the circuit it is necessary to understand the desirable operational features designed into this project.

One major requirement is that the enlarger lamp must always be off when the enlarger timer is initially turned on and that the lamp should be extinguished whenever a function is changed, except when changing between the two EXPOSE functions (EXPOSE 1 and EXPOSE 2). The easiest way to achieve this is by causing a short, positive going pulse to be applied to Pin 12, which is the CD (clear direct) input of IC17. This is achieved by means of a number of capacitor/resistor circuits. C4 and R32 are used to initiate a positive going pulse when the power is first turned on and the combinations of C5 and R14 and C6 and R15, cause a positive going pulse to be generated whenever SW6 changes state. C11 and R51 and C12 and R52 similarly cause a positive going pulse to be generated when SW5 changes state. The outputs of these various pulse generator circuits are combined by means of diodes D6, D7, D10, D14 and D8 which form a very



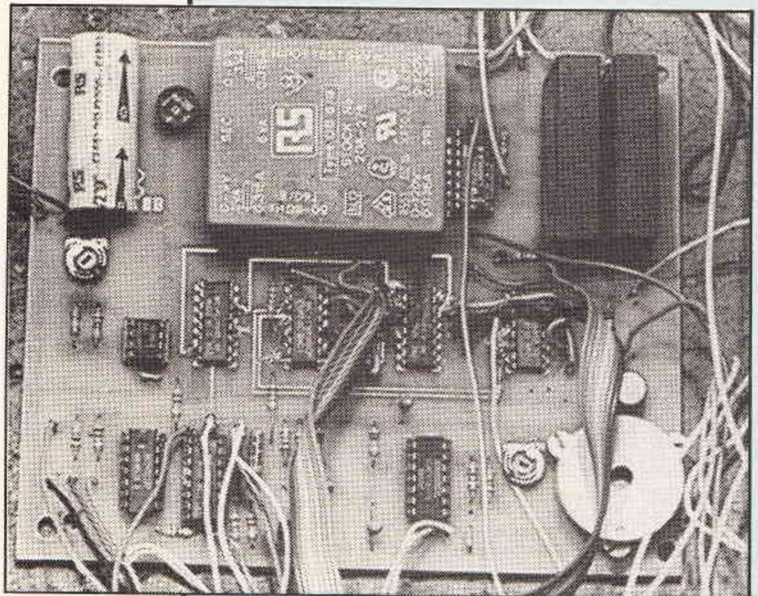
simple OR gate. This allows all of these signals to be routed to the clear direct input (Pin 12) of IC17, without the output from each circuit interfering with the other circuits. R31 is a pull down resistor which is used to force the clear direct input to the Logic 0 state at all times except for when a pulse in being produced by any of the networks described before.

All other timing functions are initiated by the operation of the 'START' switch, SW1. In order to provide a single, clean pulse at each operation of this switch it is connected firstly to an anti-bounce circuit consisting of IC14a and IC14b and their associated pull up resistors, R33 and R34.

When SW1 is operated it causes Input 1 of IC14a to be forced to the Logic 0 state. This causes the output at Pin 3 to rise to the Logic 1 state, where it remains until SW1 is released. This causes Pin 6 of IC14b to be forced to the Logic 0 state which in turn causes the output at Pin 3 of IC14a to be forced to the Logic 0 state once more. The output from this anti-bounce circuit is routed via SW5c, SW7a and SW8b to the appropriate inputs of IC17. This anti-bounce circuit is necessary since the logic circuits used in this project operate at a very high speed and would respond to each of the bounces made by the switch contacts as they close. This would lead to unreliable operation of the circuit.

When the TEST STRIP function is selected by the operation of SW6 the pulses obtained from the output of IC14a are routed by the switching circuitry to the CP input (Pin 13) of IC17. Each successive pulse from the anti-bounce circuit causes IC17 to change state, with the Q output of IC17 going from the Logic 0 state to the Logic 1 state and then from the Logic 1 state to the Logic 0 state every time a pulse is input to the CP input. The not-Q output of IC17 is always in the inverse state to the Q output. When the TEST STRIP function is selected it is important that the output of the comparator circuit (IC4 and IC5) is not allowed to affect the operation of the flip flop. This is achieved by the normally closed contact of SW6c being opened by the operation SW6 which occurs when the TEST STRIP function is selected.

When the 'FOCUS' function is selected (which occurs when SW5 is operated) the solid state relays are driven directly from SW5. In order to prevent any pulses from SW1 affecting the operation of IC17 when this mode is selected, the connection between the output of IC14a and the inputs to IC17 are disabled by means of the operation of the normally enclosed contacts of SW5c.



When either of the two exposure functions are selected (which occurs when either SW7 or SW8 are operated). The start input switch is required to operate the set direct (SD) input (Pin 9) of IC17 but any further pulses must be ignored so that the flip flop is reset only by a Logic 1 signal being applied to the clear direct input (Pin 12) of IC17 from the A=B output of the comparator circuit. In order to achieve this the output of IC14a is routed to the set direct input (Pin 9) by the switching circuit and SW6c is used to route the output from the comparator circuit, through D13 to the clear direct input (Pin 2). R12 is a pull down resistor which is used to keep the SD input of IC17 at Logic 0 except when it is receiving a pulse from the output of IC14a directed to it by SW5c, SW7a or SW8b.

The lamp illuminating the start switch must be on only when SW1's operation will have any effect on the circuit. The basic logic to the operation of this lamp is that it should be on when the enlarger lamp is off, except whilst the TEST STRIP function is selected (in which case it should be on all of the time) or the FOCUS mode is selected (in which case it should be off all of the time). This state is achieved by driving Q3, the transistor controlling LP1, either through IC12c or via the normally open contact of SW6. SW5d is used to turn the lamp off when the FOCUS function is selected and D15 and D5 are used to enable the various signals which operate the lamp to be combined, without them having any effect on the operation of any other part of the circuit. The two sets of signals required to drive the transistor are fed from the junction of D15 and D5, through R13 to the base of transistor Q3 which is used in the same way as Q2.

Construction

This is a complex project, but construction of it will be found to be relatively straight forward, provided that the printed circuit boards shown in Figure 2 are used. One of these circuit boards is used to provide the complex connections necessary for the switch mechanism, whilst the majority of the circuitry is carried on the other two printed circuit boards.

A fair amount of interwiring is necessary to connect the various PCBs together. This was considered to be a reasonable trade off in order to make the construction process simpler and to facilitate the construction of the project's 'dark' version by omitting all of the components carried on the display and time pre-setting PCB. (This modification is described at the end of the article.)

Both the main circuit board and the display/time pre-set boards are double side printed circuit boards and these, like the single sided switch PCB, should either be obtained from the magazine's Printed Circuit Board Service or made, using the track patterns shown in Figure 3. When manufacturing the double sided boards great care must be taken to ensure accurate registration between the upper and lower track patterns, since these boards, especially the display/preset board, are somewhat closely packed. Once the boards have been manufactured and drilled then the components can be inserted upon them as shown in Figure 2. When fitting the components onto the circuit boards the order in which the components are inserted into the board's holes does not really matter but it will be found to be more convenient to install the components in ascending order of size. It is important to ensure that any polarised components (Eg. capacitors, diodes, transistors and integrated circuits) are mounted with the correct polarity. A number of the components carry connections from one side of the board to the other it is impossible to mount some of the integrated circuits in carriers. IC carriers can only be used where all of the connections to the integrated circuit concerned are made solely to the underside of the printed circuit board. Any integrated circuit carrying connections to tracks on the upper side of the PCB must be soldered directly onto the printed circuit board. Where component connections are made to tracks on both the upper and lower sides of the printed circuit board care must be taken, when soldering, to ensure that both connections are sound. This is important since these component pins are used to transfer signals from one side of the board to the other. It is important to remember to attach the heat sinks to Q2 and Q3, preferably using a dab of thermally conductive compound to aid heat transmission, before installing these components.

Before attempting to install the interlinked switches (SW4 to 9) onto the Switch PCB it is necessary to make up the entire switch mechanism, mounting the switches together on the switch carrying bar and connecting them to the interlocking bar as detailed in the supplier's instructions. It is important the switches specified in the components list are used since it can not be guaranteed that switches from any other source will have identical pin spacings to those for which the PCB was designed. The operations of SW4, SW5, SW6 and SW7 and SW8 are linked together by means of an interlocking bar. SW9, which is mounted onto the same mounting bar, is however not interlinked with the other switches. In order to accommodate this arrangement it will be necessary to cut the interlocking bar to the correct length, so that it interlocks SW4 to SW8 but does not affect the operation of SW9. When the switches have been assembled together on the switch carrying bar and the interlinking mechanism has been tested to ensure that it works correctly, then the unit can be offered up carefully to the switch printed circuit board. When all of the switches have been inserted into the appropriate holes on the circuit board, the switch pins can then be soldered onto the PCB and the other components, including the wire link, can be installed in the positions shown in Figure 3c. These can then be soldered into place. Although the resistors and capacitor are not polarised, care must be taken when installing the diodes to ensure that they are installed onto the printed circuit board with the correct polarity.

Once the three PCB's have been prepared they should, after a thorough visual inspection to check for solder bridges, broken tracks, and incorrectly inserted components be connected together so that the project can be tested for correct functioning. The three printed circuit boards will be installed at different locations inside the case so it is advisable to establish the correct lengths of cable before connecting the circuit boards and the three display modules together. Although the PCBs have been designed so that they may be connected together with ribbon cable it is not essential that such a cable should be used. It is recommended that as many different colours of wire should be used for interconnecting the boards, switches and displays.

Mains voltage is present on the main printed circuit board and on SW4 and SW9. Great care must therefore be taken when checking this unit. If you have any reason to doubt that you will be able to handle these items without endangering yourself it is advisable to delay installation of T1 until after the testing of the low voltage side of the project has been completed. The project can be quite successfully operated by means of a temporary connection between a suitable 12 volt AC source and the transformer secondary connections. The unit should be carefully tested by operating each of the switches in the correct sequence, to ensure that the circuit operates as described above. If part of the project fails to work correctly it should be possible to diagnose the reasons for incorrect operation by referring to the circuit description above.

The Case

Because this project is mains driven and is likely to be used in proximity to liquids it is important that the case design and construction should be carried out with great care and it is impotant the case should be made of metal and that an effective earth connection should be made between the case and the earth pin of the plug used to connect the project to the mains socket. Further protection can be afforded by installing the supply to the dark room via a RCCB (Residual Current Circuit Breaker) or fitting an RCCB plug as the mains input to project. For this reason the recommended case for this project is a metal sloping front case.

Before the project can be installed into this case it will be necessary to carefully cut the requisite holes at appropriate places in the case. Holes are required for the two mains sockets (SK1 and SK2), the mains inlet cable (which should be accommodated in a strain relief cable clamp), the row of function switches (SW4 to SW9), the activating switch (SW1), the time increase and decrease switches (SW2 and SW3), the display (X1 to X3) and the three fuse holders (FS1, FS2 & FS3). When cutting holes for these components ensure that sufficient clearance is left between the case mounted components. Clearance includes case mounted components and also between components and the PCBs as well. This is particularly important in the cases of SK1, SK2, SW4, SW9, since the sockets and switches carry mains voltages which could cause irreparable damage to the low voltage components on the PCB in the event of an accidental short circuit occurring between one of these components and the PCB.

Once the holes have been made to accommodate the panel mounting components, holes should also be drilled in the appropriate points for the securing screws holding the two sockets and the function switch assembly. Once the case has been prepared it may be lettered using rubdown-lettering which should be protected by several layers of spray on varnish. Once the varnish has dried the case mounted components may be installed and the two printed circuit boards mounted on the case, using stick on, stand off feet. The main circuit board is accommodated in the base of the case specified and the smaller printed circuit board, containing the time setting and display circuitry, should just fit in the front of the upper part of the recommended case. It is important that main printed circuit board is mounted in such a way as to avoid the risk of the mains voltage carrying tracks inadvertently coming into contact with the metallic part of the case.

For an effective earth to both parts of the case, the earth lead from the incoming mains cable should be connected to a solder tag on the case lid. It is important, and vital for safety reasons, to ensure that the bolt used for this earthing purpose is in good electrical contact with the metal of the case and the integrity of this connection must therefore be checked, with a resistance meter, before the case is considered to be effectively earthed. The second part of the case will have to be earthed at a similar point with a similar piece of mains earth wire. Check also the earth connection is sound.

In Use

This project has been designed with ease of use as part of it's specification. In order for the unit to be used it must be plugged into the mains supply by means of the input cable. The enlarger is plugged into SK1, and any switch in the lead turned to the ON position, with the safelight is plugged into SK2. When the function switches are arranged so that SW4 (the on/off switch) is in the OFF position then the unit is switched off and both the enlarger and the safe light will be also off. In order to turn on the unit it is necessary for any of the function switches to be operated. The most logical one of these to select at the beginning of a printing session is the FOCUS function. When the unit is turned on by operating the FOCUS switch the display should indicate F08. (The decimal point of the display showing the unit seconds will be illuminated to indicate the enlarger lamp is on). If the safelight function switch (SW9) has been set to the position which automatically turns off the safe light when the enlarger lamp is on then the safe light will be extinguished. The lamps illuminating SW2 and SW3 will be illuminated, because these switches can be operated in order to change the time setting, but SW1 will not be illuminated since operating it will have no effect on the

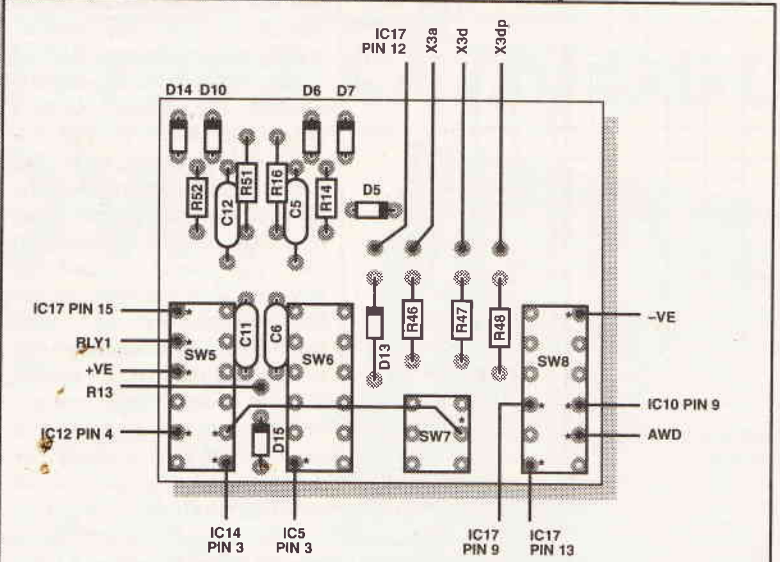


Fig.2c Enlarger timer switch layout

PARTS LIST

RESISTORS

(All 1/4 watt 5% tolerance unless otherwise stated)

R1	220k
R2	47R
R3-8,12-15,31	
38,41,49,51,52	10k
R9,42	100k
R10,11,23,44,46-48,50	1k
R16-22,R24-30,43,45	1k*
R39,40	30k
RV1	20k Miniature Horizontal Preset
RV2	4.7k Miniature Horizontal Preset

*Part of DIL resistor block
(Contains 8 × independent 1k resistors)

CAPACITORS

C1	2200µ/16V Electrolytic Capacitor
C2	2.2µ/16V Tantalum Capacitor
C3	0.01µ MDC
C4	0.01µ MDC
C5	0.01µ MDC
C6	0.01µ MDC
C7	0.1µ MDC
C8	2.2µ MDC
C9	0.047µ MDC
C10	10µ/16V Electrolytic
C11	0.01µ MDC
C12	0.01µ MDC
C13	2.2µ Tantalum Capacitor
C14	2.2µ Tantalum Capacitor

enlarger lamp. This function enables the enlarger to be focused without causing any disturbance to the time which may or may not be set into the enlarger timers memory.

When the 'TEST STRIP' function is selected, by operating SW6, the lamp illuminating SW1 will be illuminated and the enlarger lamp will be turned off, as will the decimal point of the time digital display (X2). If the safe light has been selected to be turned off when the enlarger lamp is turned on, by the setting of SW9, then the safe light will be turned on. The display X3 will change to show 't'.

To start the test strip timing process it is necessary to operate SW1 once. As soon as the switch has been operated the lamps illuminating SW2 and SW3 will be extinguished, the decimal point on display X2 will be on, indicating that the enlarger lamp will be illuminated, the enlarger lamp will be turned on and the safelight may be turned off, if this has been selected by operation of SW9. The display X1 and X2 will start to count up at one second intervals and at the point of transition when the display goes to read the next second a short audible bleep will be heard from the audible warning device. This is used to indicate that the opaque material shielding the enlarger lamp from the photographic paper being exposed should be moved forward one step. The process is stopped by a second operation of SW1. As soon as this is operated the enlarger lamp will be turned off, the time displayed on X1 and X2 will return to the time pre-set in the enlargers memory and the switches SW2 and SW3 will once more be illuminated.

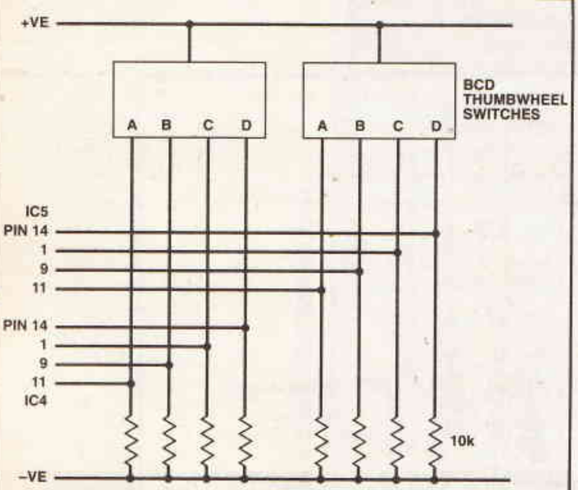


Fig.3 Alternative switch based system for setting exposure time

The operation of the two exposure modes, EXPOSE I (selected by operation of SW7) and EXPOSE 2 (selected by the operation of SW8) are identical, with one minor exception. When either of the exposure modes are selected the display X3 will change to show 'E' (for the EXPOSE 1 function), or 'E.' (for the EXPOSE 2) function. The exposure mode is started by operation of SW1. As soon as SW1 has been operated the enlarger lamp will turn on, the lamps illuminating SW1, SW2 and SW3 will be extinguished and the displays shown on X1 and X2 will start counting up at one second intervals to show the time of exposure which has elapsed. The decimal point of display X2 will be illuminated to indicate that the enlarger lamp is on. When the value of the time counted on the display is equal to the time which was previously set on X1 and X2 then the enlarger lamp will be turned off and the lamps illuminating SW1, SW2, and SW3 will be illuminated. At this point the displays X1 and X2 will in fact have been changed so that they no longer show the figure stored in the counter which counts the amount of time elapsed, but the displays will now indicate the value locked into the enlarger timer's 'memory' and which determines the length of time for which the exposure will be allowed to proceed. Because these two values are always identical at the point of switching, the transition from displaying one set of values to displaying the other set of values will not be noticed.

The only difference between the EXPOSE 1 and EXPOSE 2 functions is that for the EXPOSE 2 function an audible bleep will be emitted at the end of each second whilst the exposure is proceeding with the enlarger lamp on. The fact that this is due to occur is denoted by the illumination of the decimal point in display X3.

Should any of the function buttons be operated to change the function in use when the enlarger lamp is illuminated (except for changing between the two EXPOSE functions) then the system will be reset, so that the enlarger lamp is extinguished, SW1, SW2 and SW3 will be illuminated, and the display will return to indicating the value in the timer memory.

The safe light may be selected to be on at all times (with SW9 in the up position) or so that the safelight will be turned off whilst the enlarger light is on (with SW9 in the down position). This facility has been included in order to increase the convenience of the photographer since it is in fact easier to focus the exposed image with the safelight off. A secondary effect is that, since the enlarger timer operates almost silently in the FOCUS and EXPOSE 1 functions the absence of the safelight's illumination will be noticed by the photographer, thus enable him or her to know instinctively whether the enlarger light is on or off.

When this project was tested it was found that, under certain conditions, external electronic noise (such as that caused by the turning on of motors or domestic equipment, such as cookers), could occasionally cause the enlarger timer to trigger. If this should prove to be a problem it is suggested that a suitable mains interference suppresser (such as RS stock code 239-646) should be installed in series with the mains input power lead to the project.

Some Photographers who work with colour media may be concerned about the possibility of stray light from the illuminated switches and display fogging the material, which is normally processed in complete darkness. There are two possible solutions to the problem which have been incorporated into the design of this project. The first solution is to install an additional switch between the positive power supply line and the common positive connections of the lamps and displays. This can then be used to switch off the displays and switch illumination at sensitive points in the process. An alternative modification is to replace the circuitry associated with the displays and the electronic time selection process with two BCD coded switches,

SEMICONDUCTORS

D1-4	WOO5 Bridge Rectifier
D5-14	1N4148 (10 off)
Q1	ZTX300
Q2,Q3	BFY52 (2 off) Fitted with heatsinks
X1,2,3	Panel Mounting, common Anode 7 Segment, LED displays

INTEGRATED CIRCUITS

IC1	555 CMOS Timer
IC2	4520 dual Binary Counter
IC3	4518 dual BCD Counter
IC4,5	4585 4 bit magnitude comparator
IC6,8	4019 quad 2 input multiplexer
IC7,9	4543 BCD — 7 segment latch/decoder/driver
IC10	556 Dual CMOS Timer
IC11	555 CMOS Timer
IC12	4049 Hex inverting buffer
IC13,14	4011 quad 2 input NAND gate
IC15,16	4029 Synchronous up/down, binary/BCD counter
IC17	4027 Dual J K flip-flop

MISCELLANEOUS

FS1	5A anti surge fuse and holder
FS2,3	2A anti surge fuse and holder (2 off)
T1	240V primary 12V secondary
RLY1,2	2.5A solid state relay (2 off)
SW1	Large push to change over Illuminated switch — Red
SW2,3	Push to change over Illuminated switch — yellow
SW4,9	Mains SPCO interlocking switches (2 off) — see note
SW5,6,7,8	Interlocking switches — see note

Interlocking mechanism for SW4-8 — see note
Knobs for SW4-9 — see note

SK1,2	Panel mounting 13A sockets

Case (RS. STOCK CODE 507-444)
Mains Cable, Plug, PCBs

Note
The interlocking switch mechanism for the function selector array consists of the following items available from Maplin Electronics:

SW4,9	Mains Latchswitch (FH74R) (2 off)
SW5,6,8	Latchswitch 4 pole (FH68Y) (3 off)
SW7	Latchswitch 2 pole (FH67X) (1 off)
	Latchbracket 6 way (FH80B) (1 off)
Knob for SW4,9	Rct Latchbutton Black (FH61R) (2 off)
Knob for SW5	Rct Latchbutton White (FH64U) (1 off)
Knob for SW6	Rct Latchbutton Grey (FH62S) (1 off)
Knob for SW7,8	Rct Latchbutton Red (FH63T) (2 off)

These items must all be assembled together in accordance with the manufacturer's instructions prior to insertion into the switch interconnecting PCB.

of the type which indicate the value in digital form on the face of the switch, as shown in Figure 4. If this option is selected it will not be necessary to manufacture the printed circuit board for the display and electronic time preseting circuitry. The main printed circuit board has been designed with this option in mind which is why the project has been constructed with the amount of wired interlinking between boards.

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BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made in USA*
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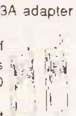

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286 AT PC
286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included)

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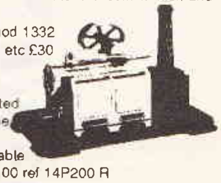

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Star Of The Month

Gary Price constructs a multicoloured LED star for the festive season.

PROJECT

Here is a seasonal mini project for you to construct to decorate the Christmas tree — a glittering star.

The circuit is a six-pointed star consisting of 73 LEDs of three different colours. It is intended to be used as a Christmas decoration, and when placed at the top of the Christmas tree provides a very attractive display.

switching circuit and a display in the shape of a star. The star consists of 73 LEDs, which are divided up into eight channels, each channel is controlled by one of the eight data bits of the EPROM. By using the full eight bits of the EPROM some very stunning patterns can be achieved.

The power supply is quite ordinary, with a 240V-6V transformer, bridge rectifier and a reservoir capaci-

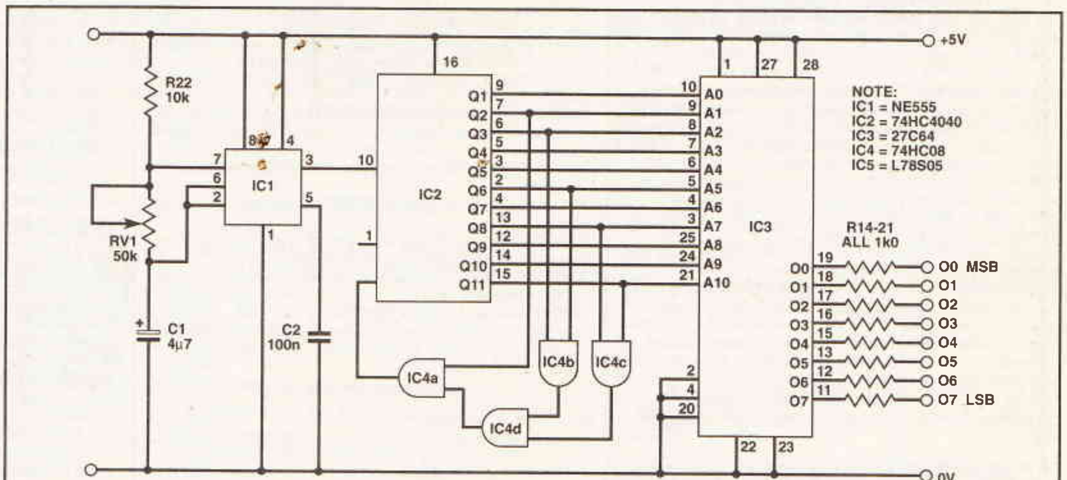

Fig.1 Sequencing circuit

The star cycles through 20 patterns, each one different from the last, and in total there are more than 1000 steps to the complete sequence, which can last up to 10 minutes, depending upon the speed of operation. When the sequence is finished, the circuit resets and the whole sequence of patterns starts again.

The circuit consists of power supply, controller,

tor. IC5 is a 5V (2A) regulator which needs a medium sized heatsink, while C4 and C5 provide the decoupling.

The controller is the heart of the circuit which uses a CMOS 555 wired in astable mode for the clock, this is adjustable from 2.8Hz to 30Hz (approx) by RV1 given by the equation (1.44/(Ra+2Rb)C). This frequency is used to clock IC2 which is a 12-bit binary counter (12th bit is not required) and the outputs from IC2 form the address bus for the EPROM. Each time IC2 is clocked its binary output will advance by one, and the data in the EPROM at that particular address will appear on the data bus. This will continue until 1190th (binary 10010100110) count when the quad AND gate IC4 will reset IC2 back to 0, and the whole sequence starts again.

The switching circuit is simply a buffer to allow the LEDs to be turned on and off from the outputs of the EPROM. This is based on a transistor acting as a switch with the LEDs in the collector load in series with a current limiting resistors.

I have produced a PCB for the star, but the rest of the circuit must be built on VERO board or something similar.

When building the star, be sure to connect the two sides of the board at the four points via holes. The star also needs nine connection wires, one for the +5V and eight for the respective channels, starting with the centre LED being driven by Q1, and Q1 being driven from IC3, pin 19 (via R14). Use thin green cable so the wires can be neatly bundled together and will not look out of place on the tree.

Any EPROM could be used instead of a 64K, but the pin-out may be different. The data for the EPROM is shown on the next page in the form of a HEX dump. All that remains now is to check out the sequencing to make sure the LEDs have been placed the correct way round.

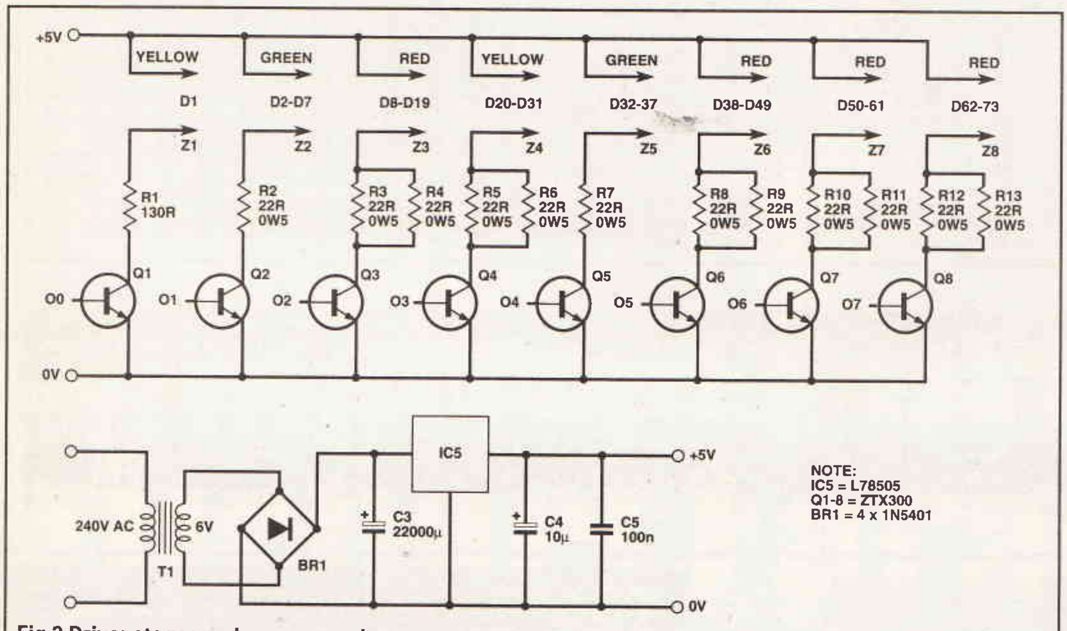

Fig.2 Driver stages and power supply

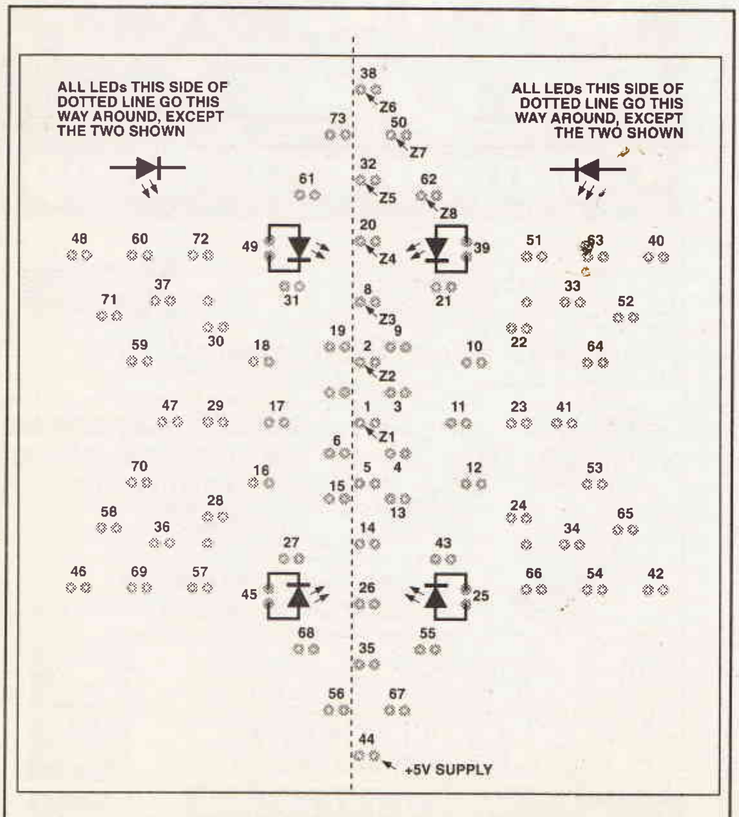

Fig.3 Component overlay for LED star

PARTS LIST

RESISTORS	
R1	130R
R2-13	22R
R14-21	1k
R22	10k
RV1	50k pot
CAPACITORS	
C1	4.7µ
C2,5	0.1µ
C3	22,00µ
C4	10µ
SEMICONDUCTORS	
LED1,20-31	Yellow LED
LED2-7,32-37	Green LED
LED8-19,38-49, 50-61,62-73	Red LED
IC1	NE555
IC2	74HC4040
IC3	27C64
IC4	74HC08
IC5	L78S05
Q1-8	ZTX300
BR1	4 × 1N5401
MISCELLANEOUS	
T1	240V-6V, 6VA

STAR
Size of EPROM=64K (1FFF)

ADDR	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	00	80	C0	E0	F0	F8	FF	F8	F0	E0	C0	80	00	00	80	C0
0001	E0	F0	F8	FF	F8	F0	E0	C0	80	00	00	80	C0	E0	F0	F8
0002	FF	F8	F0	E0	C0	80	00	00	80	C0	E0	F0	F8	FF	7F	3F
0003	1F	0F	07	00	00	07	0F	1F	3F	7F	FF	7F	3F	1F	0F	07
0004	00	00	07	0F	1F	3F	7F	FF	7F	3F	1F	0F	07	00	00	07
0005	0F	1F	3F	7F	FF	7F	3F	1F	0F	07	00	00	07	08	10	20
0006	40	80	80	40	20	10	08	07	07	08	10	20	40	80	80	40
0007	20	10	08	07	07	08	10	20	40	80	80	40	20	10	08	07
0008	07	80	80	40	20	10	08	07	07	00	80	80	40	20	10	08
0009	07	07	00	80	80	40	20	10	08	07	07	00	80	80	40	20
000A	10	08	07	07	00	80	80	C0	E0	F0	F8	FF	7F	3F	9F	CF
000B	E7	F0	F8	FF	7F	3F	9F	CF	E7	F0	F8	FF	7F	3F	9F	CF
000C	E7	F0	F8	FF	7F	3F	9F	CF	E7	F0	F8	FF	7F	7F	3F	1F
000D	0F	07	00	07	07	08	10	20	40	80	80	00	07	07	08	10
000E	20	40	80	80	00	07	07	08	10	20	40	80	80	00	07	07
000F	08	10	20	40	80	80	00	07	07	0F	1F	3F	7F	FF	F8	F0
0010	E7	CF	9F	3F	7F	FF	F8	F0	E7	CF	9F	3F	7F	FF	F8	F0
0011	E7	CF	9F	3F	7F	FF	F8	F0	E7	CF	9F	3F	7F	FF	F8	F8
0012	F0	E0	C0	80	00	07	08	10	20	40	80	07	08	10	20	40
0013	80	07	08	10	20	40	87	08	10	20	40	87	08	10	20	47
0014	88	10	20	47	88	10	27	48	90	27	48	97	28	57	A8	57
0015	A8	50	A0	40	80	84	84	86	86	87	87	83	83	81	81	80
0016	80	C4	C4	C6	C6	C7	C7	C3	C3	C1	C1	C0	C0	E4	E4	E6
0017	E6	E7	E7	E3	E3	E1	E1	E0	E0	F4	F4	F6	F6	F7	F7	F3
0018	F3	F1	F1	F0	F0	FC	FC	FE	FE	FF	FF	F8	F8	F9	F9	F8
0019	F8	F8	F0	E0	C0	80	00	F0	F0	F0	1F	1F	1F	F0	F0	F0
001A	1F	1F	1F	F0	F0	F0	1F	1F	1F	F0	F0	F0	1F	1F	1F	F0
001B	F0	F0	1F	1F	1F	F0	F0	F0	1F	1F	1F	F0	F0	F0	1F	1F
001C	1F	F0	F0	F0	1F	1F	1F	F0	F0	F0	1F	1F	1F	F0	F0	F0
001D	1F	1F	1F	84	84	82	82	81	81	84	84	82	82	81	81	84
001E	84	82	82	81	81	C4	C4	C2	C2	C1	C1	C4	C4	C2	C2	C1
001F	C1	C4	.C4	C2	C2	C1	C1	E4	E4	E2	E2	E1	E1	E4	E4	E2
0020	E2	E1	E1	E4	E4	E2	E2	E1	E1	F4	F4	F2	F2	F1	F1	F4
0021	F4	F2	F2	F1	F1	F4	F4	F2	F2	F1	F1	FC	FC	FA	FA	F9
0022	F9	FC	FC	FA	FA	F9	F9	FC	FC	FA	FA	F9	F9	F4	F4	F2
0023	F2	F1	F1	F4	F4	F1	F1	F2	F2	F4	F4	F2	F2	F1	F1	F4
0024	F4	F1	F1	F2	F2	E4	E4	E2	E2	E1	E1	E4	E4	E1	E1	E2
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0028	82	84	84	82	82	81	81	84	84	81	81	82	82	E0	E0	E0
0029	1F	1F	1F	E0	E0	E0	1F	1F	1F	E0	E0	E0	1F	1F	1F	E0
002A	E0	E0	1F	1F	1F	E0	E0	E0	1F	1F	1F	E0	E0	E0	1F	1F
002B	1F	E0	E0	E0	1F	1F	1F	E0	E0	E0	1F	1F	1F	E0	E0	E0
002C	1F	1F	1F	E0	E0	E0	1F	1F	1F	38	70	E0	C0	80	00	07
002D	07	00	00	87	87	80	80	C7	C7	C0	C0	E7	E7	E0	E0	F7
002E	F7	F0	F0	FF	FF	F8	F8	7F	7F	78	78	3F	3F	38	38	1F
002F	1F	18	18	0F	0F	08	08	07	07	00	87	87	CF	CF	FF	FF
0030	FF	CF	CF	87	87	00	00	00	87	87	CF	CF	FF	FF	FF	CF
0031	CF	87	87	00	00	00	87	87	CF	CF	FF	FF	FF	CF	CF	87
0032	87	00	00	00	87	87	CF	CF	FF	FF	FF	CF	CF	87	87	00
0033	00	00	CF	CF	CF	30	30	30	CF	CF	CF	30	30	30	CF	CF
0034	CF	30	30	30	CF	CF	CF	30	30	30	CF	CF	CF	30	30	30
0035	CF	CF	CF	30	30	30	CF	CF	CF	30	30	30	CF	CF	CF	30
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003B	87	48	30	48	87	87	48	30	48	87	87	48	30	48	87	87
003C	48	30	48	87	00	80	C0	E0	F0	F8	FF	7F	3F	1F	0F	07
003D	80	C0	E0	F0	F8	FF	7F	3F	1F	0F	07	80	C0	E0	F0	F8
003E	FF	7F	3F	1F	0F	07	80	C0	E0	F0	F8	FF	7F	3F	1F	0F
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0040	80	7F	7F	7F	80	80	80	7F	7F	7F	80	80	80	7F	7F	7F
0041	80	80	80	7F	7F	7F	C0	C0	C0	3F	3F	3F	C0	C0	C0	3F
0042	3F	3F	C0	C0	C0	3F	3F	3F	C0	C0	C0	3F	3F	3F	C0	C0
0043	C0	3F	3F	3F	C0	C0	C0	3F	3F	3F	E0	E0	E0	1F	1F	1F
0044	E0	E0	E0	1F	1F	1F	E0	E0	E0	1F	1F	1F	E0	E0	E0	1F
0045	1F	1F	E0	E0	E0	1F	1F	1F	E0	E0	E0	1F	1F	1F	F0	F0
0046	F0	0F	0F	0F	F0	F0	F0	0F	0F	0F	F0	F0	F0	0F	0F	0F
0047	F0	F0	F0	0F	0F	0F	F0	F0	F0	0F	0F	0F	F0	F0	F0	0F
0048	0F	0F	F8	F8	F8	07	07	07	F8	F8	F8	07	07	07	F8	F8
0049	F8	07	07	07	F8	F8	F8	07	07	07	F8	F8	F8	07	07	07
004A	F8	F8	F8	07	07	07	00	FF	FF	FF	FF	FF	FF	FF	FF	FF
004B	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
004C	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
004D	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
004E	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
004F	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0050	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF

ATARI ST EPROM PROGRAMER
By G.A.Price. 1991.

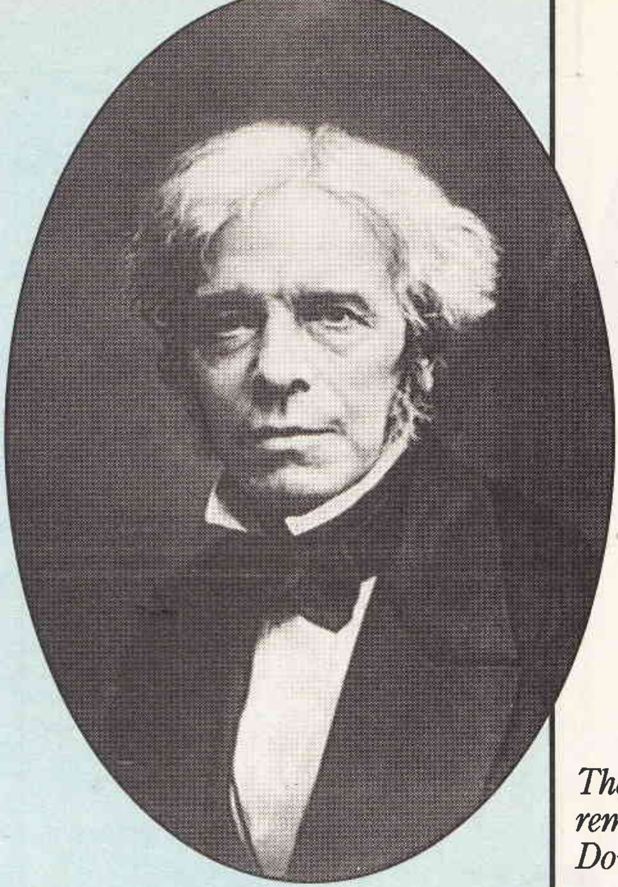
Table 1: HEX dump for LED star

The life of Michael Faraday comes close to the life of the perfect scientist. His career rises from complete obscurity to dominate the study of electromagnetism in the 19th century. His life is not torn apart by financial ruin or domestic tensions. Neither does he engage in enraging individuals of different scientific viewpoint. Instead he goes out of his way to preserve the tranquillity of an often volatile scientific community by deliberately not seeking controversy. Also, he writes up his experiments with great diligence so that his scientific life is anything but a mystery. One problem, if any, is that a detailed study of his productive output is a major undertaking.

Also, he rises to success as a great communicator. In his position of dominance at the Royal Institution, he succeeded in projecting out into Victorian society the dynamism and vitality of science. This provided as it were a powerhouse of development and influence which would pervade most of the major strata of scientific endeavour of his day.

Also, while honours and fortune waited for him beyond the confines of the Royal Institution, he chose to remain within it. This indicated that he knew he was content — he knew that it was the aspect of exploring science via his experiments that gave him the core of his satisfaction in life.

Michael Faraday is therefore in some ways an 'archetype' individual — one who fitted entirely into the mould that scientific society needed in its day. Also, it is



The achievements of a remarkable man by Douglas Clarkson.

Michael Faraday – Experimenter and Thinker

recognised by modern biographers that much of the image of Michael Faraday supplied by his immediate Victorian biographers is distorted. They, for example, chose to ignore aspects of theoretical work which he had engaged upon at numerous times during his career. The true picture of Michael Faraday is one of a scientist whose work shows many clear insights into the physics of the 20th century. Also, he achieved much of his work on a very meagre budget so that privation in science is not a new thing.

Michael Faraday was born on the 22nd of September 1791 in the village of Newington, South London. As one of four children, times were often hard as his blacksmith father became ill and could not work. Michael's only education was in the Sunday School of the Sandemanians, a small Christian sect. The philosophy of this group was to profoundly affect the way he interpreted the scientific nature of the physical universe. He was drawn to books and learning and became apprenticed at the age of 14 to a bookbinder — taking advantage of his situation by reading various books being rebound.

His interest in science appears to have been fired by an entry he read in Encyclopaedia Britannica on electricity. This stimulated him to experiment with crude electrostatic generators and to build a weak voltaic pile. Faraday's scientific awareness must have been strikingly acute. After attending a series of Sir Humphrey Davey's lectures on chemistry at the Royal Institution in 1812, he sent a bound copy of the notes he made to Davey, seeking employment at the Institution. When a vacancy arose Davey duly appointed Michael Faraday as a laboratory assistant. Thus in 1813 began an association with the Royal Institution that was to last over 40 years.

The Royal Institution was in many ways at the hub of scientific circles. After being set up by Count Rumford in 1799, its founder soon departed to Paris to marry Anne Lavoisier. Davey became director of the Institution in 1804 after he had established his reputation as an excellent communicator of science to the general public. The environment of the Institution was to provide Faraday with an ideal framework within which he could 'read the book of nature' — ie through experiment determine the scientific facts of the universe.

He also chose to be loyal to the Institution. Offers of professorships in the emerging Universities of London did not tempt him. He gave lectures only at the Royal Institution, so that his eminence became identified totally with its framework.

In an age when scientific workers were avid recorders of their work, there is a great deal not only of records unique to Michael Faraday but which interlink him to numerous other scientific workers. Modern day biographers still tend to look at aspects of his life under

FARADAY

a microscope seeking out meticulous details of activity and involvement. This can be carried out to too great limits. All the time it is required to do this against a perspective of the great man in all his various modes of action and function.

Biographers, for example, map with great deliberation the developing scientific relationship between Faraday and Davey as Faraday begins steadily to demonstrate his unique scientific abilities. This is interesting enough in the sense that it provides a reference for his other activities, but it does not give insight into the deeper philosophical nature of the man. Initially it was in the field of Chemistry that Faraday was to demonstrate significant ability following in the experimental brilliance of Sir Humphrey Davey. Significant work was undertaken by Faraday in synthesising compounds from Chlorine which previously had been discovered by Davey. Faraday was the first to synthesise compounds of Chlorine and Carbon, synthesising Benzine in 1825. Davey's invention of the safety lamp was a major milestone in the development of the industrial revolution and saved many lives in the bleak and dismal conditions of Britain's coal mines. This was the crowning achievement of Davey's career. In this development, Faraday was an admiring observer.

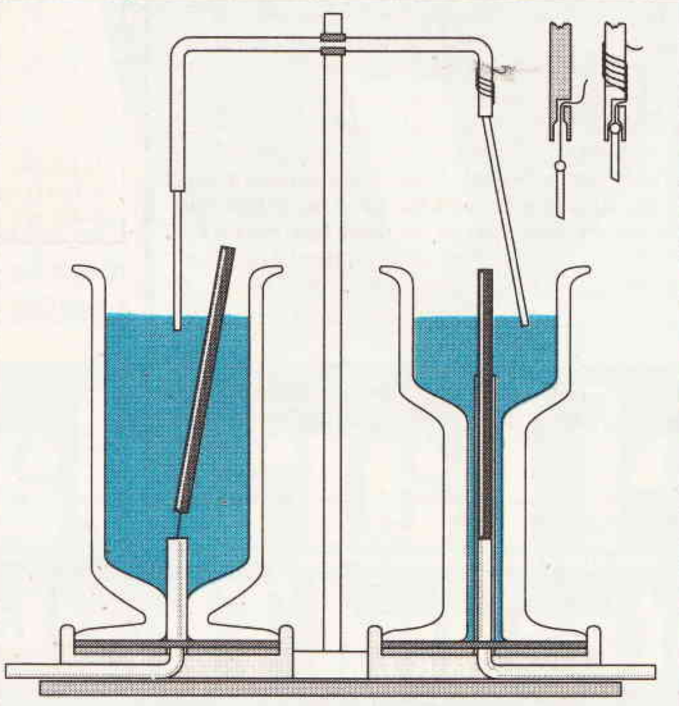


Fig.1 Diagram showing Faraday's laboratory rotation apparatus

In terms of tracking important turning points, it was the reported discovery of Hans Christian Oersted in 1820 of the ability of an electric current to deflect a magnetic compass which directed Faraday into the field of electromagnetism. Not only was Faraday's interest turned in this direction, all over the world the race began to unravel electromagnetism's secrets. Ampere in France began his researches at this point and shortly after Oersted's discovery published an account of the circular nature of magnetic field around a current carrying conductor. Yet in all of Europe at this time it was the comments of Faraday in papers published in 1821 and 1822 on Ampere's explanation of the origin of the magnetic field which were to direct Ampere to formulating a more exact model of his early experimental observations. Faraday was himself prompted to write these articles by Richard Phillips, the editor of Annals of Philosophy. It is assumed by many scientific historians that Faraday was responsible for channelling Ampere from highly speculative generalisations to a more logical and precise proof and validation of his work.

Faraday married in 1821, just as his prospects were on the up and his work in electromagnetism was beginning in earnest. This must have been an exciting time in his life. Sarah Faraday also belonged to the Sandemanian Christian sect. She apparently had little documented involvement with Faraday's work. It was to become the ultimate honour to be invited back to his upstairs house within the Royal Institution after evening lectures. No doubt she would have been introduced to some of the finest minds of science over the long and fruitful period of Faraday's reign. Unfortunately Faraday had no children, but his fondness for educating children can be observed in the famous set of Christmas lectures which continue to be broadcast from the Royal Institution in the guise of a TV blockbuster every year.

Faraday was intuitively aware of the possibility of using electric current to produce motion in a wire placed in an magnetic field. In 1822 he published details of his 'rotation apparatus' which consisted of two beakers of mercury through which current could flow as represented in Figure 1. In one beaker a magnet was free to rotate about a pivot point and in the other beaker the magnet was fixed centrally while a wire was able to pivot around the magnet. The mercury was used to complete the electric circuit in the system. While Faraday developed a laboratory demonstration device, he also developed a smaller pocket sized rotation device which he loaned extensively to interested scientific colleagues. This consisted of a single beaker with a fixed vertical magnet and a rotating wire as shown in Figure 2. Faraday was very aware that demonstration of scientific principles was an essential feature of their acceptance by the scientific community. In this experiment Faraday had constructed the first electric motor.

Faraday is also known for his discovery of electromagnetic induction. His initial experiment on the 29th of August 1831 had used a primary winding round a coil which could be connected to a battery and a secondary coil connected to a galvanometer. His initial delight at detecting current in the secondary circuit was changed to puzzlement when an equal and opposite response was observed when the circuit was broken. The simple coil design that he used is shown in Figure 3. The iron ring core which Faraday used has thankfully been preserved. After using a powerful electromagnet initially, Faraday discovered later that year that when a permanent magnet was moved in and out of a coil, a current was generated in the coil. Faraday rapidly went on to determine factors affecting such processes. He noticed the size of the current was dependent on the rate of change of lines of magnetic flux across the area involved.

While Faraday's diary indicates with meticulous preciseness what it was that he was undertaking, there is scant information as to what prompted him to undertake such electromagnetic induction work. Entries in 1831 up until the electromagnetic induction insert include acoustical figures, an aurora seen at Woolwich, Thermo-electric effect, Crispations, Ridges on sand at Hastings, Copper-plate printing and ignition of hot vapours. Various clues such as correspondence with researchers working with large coils may be valid. Perhaps Faraday scanned through some of his previous diaries from around 1822 which contain extensive references to coil devices. Another possibility is Faraday's association with Charles Wheatstone.

Charles Wheatstone introduced Faraday to aspects of sound generation and sound resonances.

Wheatstone's father owned a famous musical instrument business in London which boasted an 'Enchanted Lyre'. This took the form of an ancient lyre which was suspended in a room by brass wires. These wires were in turn connected to sounding boards of a range of musical instruments in an upstairs room. Thus the 'enchanted lyre' was a wonderful example of sound resonances. Faraday knew Wheatstone well and must therefore have been familiar with such a device. This could have sown the seed in Faraday's mind of lines of magnetic force producing comparable resonance effects. Whatever prompted Faraday to begin his work in this field, he devoted all his experimental studies during the remainder of 1831 to this subject area. Faraday soon realised that by rotating a copper disk between the poles of a permanent magnet a continuous current could be generated. Thus the first dynamo was developed. While Faraday drew valuable insights from the experience of Wheatstone in the area of sound resonances, there is every indication that Faraday had a key role in directing Wheatstone to investigate the world of electromagnetism and lessen his interest in acoustics.

The period around the mid 1830's was one in which interest in the telegraph began to increase sharply. Wheatstone was involved in this activity in partnership with a certain William Cooke. Part of the 'appropriate technology' of telegraphy was to make the impedance of the reception equipment similar to that of the transmission lines. Faraday was no doubt able to advise Wheatstone as to how to wind coils of wire to achieve this. A major obstacle to the full development of electromagnetic machinery was the dependence on batteries to supply current. The initial work of Faraday in turn initiated significant research and development in this area. The first practical 'magneto' system developed as a consequence of Faraday's initial discovery was that of Pixii developed in 1832. Such a development was very important for the telegraph, though it was not until 1866 that Wheatstone announced the self excited generator at the same period as William Siemens. While Faraday had discovered fundamental laws of electromagnetism, it was through individuals such as Charles Wheatstone that the great growth in electrical engineering took place. It would be a useful exercise to trace the line of commercial electrical engineering in Britain which began through the contact and involvement of Faraday. The Siemens company is certainly a golden legacy of the early work undertaken in Germany.

The association of Faraday and Wheatstone encompassed the investigation of a range of sources of electricity. There was at this time some doubt that electricity was the same irrespective of its source. This led Faraday to demonstrate that electricity from a range of sources — chemical, thermal, frictional etc produced the same effects of electrolysing water, making sparks and giving shocks. Investigations even included the study of electric fishes.

Following a breakdown in his health in 1839 due to overwork, the years up until 1845 show very little creative output. These 'empty' years were certainly a great loss to the scientific community. Faraday had previously expressed opinions on the Dalton model of atoms as being discrete distinct spheres of matter. His investigation of electromagnetic forces at the 'macroscopic' level convinced him that similar forces could be responsible for the separateness of atoms. He accordingly proposed that atoms were in fact centres of forces and not centres of matter. This theory was described as 'Boscovitch like' after the theories of Boscovitch, a Croatian scientist. In view of the modern Bohr model of the atom, this concept is remarkably appropriate. Most of the atom is empty space.

Faraday did all he could to learn from experimental evidence relating to electromagnetic induction. He initially formed a theory of 'electrotonic' state of particles and much later at the encouragement of William Thompson (later Lord Kelvin) investigated the effect of magnetic fields on the optical properties of materials, in particular aspects of polarisation of light. Using a piece of glass of high refractive index which he had produced some 20 years earlier, he succeeded on 13th September 1845 in rotating the plane of polarisation of light by suitably aligning the static magnetic field along the light ray. This is the so called 'Faraday Effect'.

Subsequent investigations of the effects of magnetic fields on a broad range of substances was to lead to the discovery of paramagnetic and diamagnetic materials. Paramagnetic substances conducted lines of magnetic force better than the surrounding medium while diamagnetic substances demonstrated an opposite effect.

By 1850 Faraday had developed a more expansive 'field theory' encompassing electrical and magnetic fields. James Clark Maxwell was later to admit after he had managed to express the interrelationships between the fields in his famous field equations that the foundations of his work had been laid by Faraday. While other experimenters may have been known for specific observations, Faraday intertwined a thread of deep scientific insight into his findings. There is a subtle 'rediscovery' of Faraday taking place at this time when the 200th anniversary of his birth is being celebrated. The fact that he now graces the new £20 note might mean that even the Treasury is beginning to become aware of the link between scientific research and the nation's wealth. Faraday's successor at the Royal Institution, John Tyndall, depicted Faraday in a brief biography as a mere experimenter who kept a detailed dairy of all his investigations. This limited viewpoint is now being considerably revised and the image of a more deep seated nature is emerging. In the pensive photograph of Faraday can be seen the mind of a man always full of thoughts and possibilities. Even during his photographic session, he still seems to have his mind on a problem which is evading solution. The great benefit in examining the scientific life of Faraday is that it links up so much of the wave of progress in electromagnetism in the 19th century. From the initial discovery of the electric motor and electromagnetic induction and all that these entail at a practical level to the future theories of James Clark Maxwell there is a linking thread provided by Faraday. Even in the triumph of Ampere can be traced the catalyst of Faraday.

In the closing years of his life, Queen Victoria granted him the use of a house at Hampton Court. After a life of great effort and labour, he died on August 25, 1867 — aged 76.

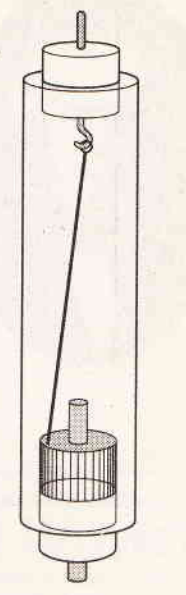


Fig.2 Diagram showing smaller pocket sized 'rotation' apparatus

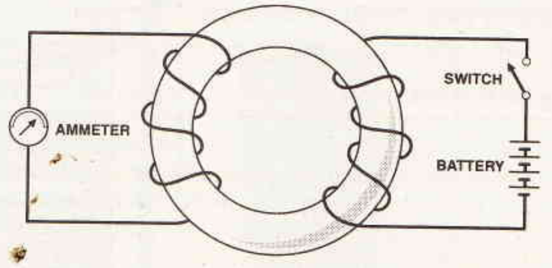


Fig.3 Faraday's initial electromagnetic induction experiment

The legacy of Faraday is very rich and the humble origins of Faraday presently does not go unnoticed by right wing politicians. So much can be gleaned from Faraday's period of involvement in science research and its communication to the greater world which is relevant to science today. In one regard there has to be a mechanism of communication of science and its concepts to the public which is appropriate and relevant. Also, there needs to be a mechanism wherebye the innovations of scientific discovery can be communicated out to where they can be 'earthed' or taken up by commercial development. The Royal Institution in Faraday's era certainly directly provided the first of these functions and to a significant extent the second through the significant amount of communication it gave rise to in scientific circles.

It would be very surprising if today a single individual could make momentous discoveries with the same level of resources as Faraday. What is most apparent, however, is that the teaching of science at numerous levels is at a level inferior to that demonstrated at the Royal Institution over 170 years ago. The bicentennary of Faraday's birth is just as much about demonstrating and communicating science as about scientific research and discovery itself.

Further Reading:

Faraday rediscovered, Essays on the Life and Work of Michael Faraday, edited by David Gooding and Frank A.J.L. James, Macmillan Press, 1985

Michael Faraday and the Royal Institution, John Meurig Thomas, Adam Hilger, Bristol, 1991

Faraday as a Natural Philosopher, Joseph Agassi, University of Chicago Press, Chicago, 1971.

ETI CROSSWORD No 1

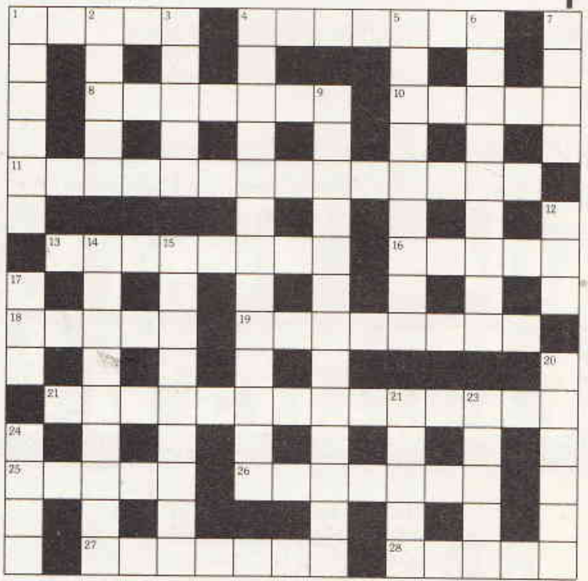
by Phasor

Clues across

1 A herald's tincture in the DISABLE input. (5)
4 Answers current queries. (7)
8 An ensemble before the interval is stabilising. (4-3)
10 Pleasingly and agilely quick. (5)
11 O grab a noble ale to calculate it logically. (7,7)
13 A cidery spirit, a part of Normandy — or is it yet another disc operating system? (8)
16 Not quite once, now. (5)
18 A shanty centrally renovated has rooms for guests. (5)
19 This at the races leaves a maiden's heart like this. (1-7)
21 Made into a whole with an untidy amphibian its a ZN425E. (10, 1-2-1)
25 Silver in use is a custom. (5)
26 He brings the post — no doubt about his gender! (7)
27 "... this, 1, 2, 3, 4, this, this, 1, 2, 3, ..." (7)
28 Fine clothing in rows and columns. (5)

Clues down

1 Flashy saint's gown, it controls digitally. (6)
2 A tailless monkey can write English in an Indian office. (5)
3 'E's an 'ap' hazard calculator. (5)
4 Argentinian head and figure is part imaginary. (6, 7)
5 A kind of diode catches fish or partridges. Its narrowly conical. (6-3)
6 A testimonial to steady potential. (9)
7 A tropical tuberous vegetable growing up from Yucatan. (4)
9 Reducing the Miller-effect rolloff raises the collector and load capacitor rolloff. It's long tipple stirred. (4-9)
12 This semiconductor device is a garden party cut short. (3)



14 Meet at ten, Dan, there's someone waiting. (9)
15 A pump or vintage radio like this is non-functional. Change one and its worth nothing. (5-4)
17 Georg started it — and there's no place like it! (3)
20 Depressed home of chips — its Andreas fault! (6)
22 Sad song by Dvorak is alternately melancholy and gay. (5)
23 Noter tunes from 130.812Hz to 440Hz. (5)
24 Make it zero. A set without a member. (4)

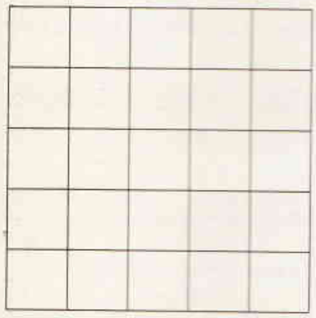
(Answers in ETI next month)

ELECTRONIC PUZZLES

by Phasor

1 — A word square

A 5 by 5 square in which the rows read the same as the columns . . .



A unit too large to be much used.
A heavenly computer?
Frequently 300MHz or less.
JFET positive (anagram).
One way traffic.

2 — A matter of unity

The Annual Conference of the International Association of Electronic Archivists was drawing to a close, and five of the younger delegates were gathered in the bar. It was a strange coincidence that Messrs Ohm, Volta, Ampere, Faraday and Watt each bore the surnames of scientists who had given their names to an electronics unit. By an even greater coincidence they also had the same set of forenames as their distinguished namesakes, though none had the same combination of forename and surname as the famous men.

Mr. Watt turned to Georg and enquired "I've had enough of archives. Why don't you and I try to make up a four at Bridge?"

"Suits me." said Georg and then, addressing the rest of the group, he asked "Anyone else for a game of Bridge?"

"Count me in" called Michael, "How about joining in with us, Herr Ohm?"

Alessandro produced a pack of cards and started to deal, while James ordered himself another drink.

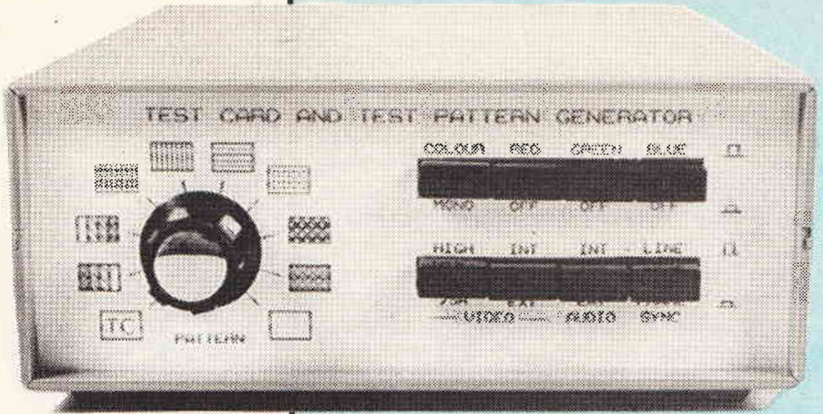
While the four were settling down, Georg said to Michael and Andre, "Just before we begin, let's drink a toast to the fact that your units (by which I mean the unit which your two surnames suggest) multiplied together are equivalent to my unit."

The Secretary appeared at the entrance to the bar at that moment.

"Before you leave, gentlemen," he announced, "I would be glad if you would sign your names in the Visitor's Book. Forenames and surnames, please."

With a flourish, he produced a leather-bound volume of undoubted antiquity. What five names did the delegates sign in the book?

(Answers on page 14)



Video Test Card And Test Pattern Generator

2

In this second part, Paul Stenning continues construction of this aid to TV servicing.

PROJECT

In Part 1 of the Video test card generator we presented the circuitry and its operation. Continuing with the construction, the interwiring is shown in Figure 1, thin coax cable is used for all signal wiring (proper 75R coax could be used for the video but it is not too important with the lengths involved), and standard hook-up wire for the remaining connections. The mains connections should be insulated, and the flex secured in some manner. No mains on/off switch or fuse were fitted on the prototype, however they could be fitted if required. The mains plug should be fitted with a 3 amp fuse.

Testing and Setting-Up

Due to the cost of the modulator and some of the IC's it is a good idea to check that the power supply voltages are correct before fitting these parts. Make sure none of the IC's except IC12 and IC13 are fitted, and that the modulator is disconnected. Give the PCB a final visual check over, in particular watch for solder bridges between IC pads and the tracks between them.

Connect the instrument to the mains, and switch on. Set your test meter to 20 volts DC or thereabouts, and connect its negative lead to the case of the modulator. Check for 12 volts ± 0.5 volts on pin 11 of IC9 socket, and 5 volts ± 0.25 volts on pin 20 of IC8 socket. If all is well switch off and wait a minute or so for the power supply capacitors to discharge, then connect up the modulator and fit the IC's. Most of the IC's are CMOS types but have protected inputs so static damage is unlikely, however the usual handling precautions against static discharge should still be taken.

Set SW2 to position 1 (full ACW); SW3, SW4 & SW5 on, SW6 off and SW8 & SW9 to internal (all buttons out). Connect the RF output socket on the modulator to your TV, cross your fingers and switch on. You will probably need to tune your TV to channel 36, although the channel you use for your video recorder should be somewhere near. You should get an audio tone from the speaker and a test-card picture. Don't worry at this stage if there is a buzz on the sound or no colour in the picture.

To avoid damage to components and misleading results, always use a proper trim-tool when making adjustments. Adjust RV1 for minimum buzz (or to the middle of the area of no buzz) on the sound. Adjust VC1 until the colour locks on, then set to the centre of the range where you get colour. Finally adjust L2. If you have a 'scope connect it to the Video Output socket and adjust for maximum amplitude on the colour burst, otherwise adjust for brightest colour and minimum 'herringbone' pattern on the picture. All that remains now is to check the various functions of the unit as detailed below. Once the unit has been tested, the PCB can be fitted in the case, and the unit finished off.

In Use

Firstly a word of warning. Anybody attempting to repair or adjust television sets, whether using this instrument or not, must be aware of the hazards involved. Many sections of TV circuitry operate at dangerous voltages (in the range of 100V to 30kV), and in many cases the internal chassis and metalwork is also at a dangerous (mains) voltage. For maximum safety the set should always be powered via a mains isolating transformer. If a transformer is not used, no test equipment should be connected to the set, except to external sockets, and very great care should be taken when making adjustments with the power on (the practice of disconnecting the mains earth to all the test equipment is extremely dangerous and should never even be considered). In any event always work with one hand in your pocket when the set is on, even with an isolating transformer the high voltages can be lethal. Care should also be taken when working near the power supply of video recorders, although in this case the rest of the circuit usually operates at more civilized voltages. The use of an Earth Leakage Circuit Breaker on the mains feed to the bench is also a sensible precaution.

In most cases the instrument would be connected to the equipment under test via its aerial socket, since this enables the whole signal path to be checked, also a fault in the equipment is extremely unlikely to damage this instrument when connected this way. Once the equipment has been proved to be basically sound, the instrument could be connected by the video/audio or SCART connectors if required.

SW2 selects which basic pattern is produced, as follows:

1. Test Card
2. Colour Bars 1 (Black to White)
3. Colour Bars 2 (White to Black)
4. Cross Hatch
5. Vertical White Lines
6. Horizontal White Lines
7. White Dots
8. Focus Grid (Fine checker board pattern)
9. Blank Raster (Sync & 0% video)
10. White Raster (Sync & 100% video)

If SW6 (Colour/Mono) is pressed in, the colour information will be removed from the picture, this will convert the Colour Bars to Grey Scale, and remove the herringbone patterning on patterns such as the Cross Hatch.

Pressing SW3/SW4/SW5 will remove the Red/Green/Blue colour completely, this is the same effect as switching off that colour gun inside the TV (with all three off there will be no picture). If this is used in conjunction with the White Raster pattern, the sets colour purity can be adjusted. It is also useful for removing the blue from the Cross Hatch when starting to set up the convergence. (If SW3, 4 & 5 are all switched off when SW2 is set to the test-card pattern, a faint pattern will still be present — this should be ignored).

The features of the Test Card require further comment. The overall size of the picture is slightly smaller than the minimum size of a transmitted picture. The TV's picture height, width and position controls should be adjusted such the whole test card is shown, but with the tips of the corners very slightly hidden by the rounded corners of the tube (you may find that some cheaper sets have the width adjusted wider than this, this is because the width of the picture on these sets varies with brightness). The overall brightness of the Test Card is about that of an average picture. The background is dark grey (25%) with a White Cross pattern, to enable the linearity to be checked.

The main area of interest on the Test Card is the centre section. Starting at the top we have a black rectangle within white to check the LF response, and a white needle pulse to check for reflections and instability. Next we have a 250kHz, 100% to 0% square wave to test the transient response, and below this are the eight colour bars. Next there is a six step frequency grating with frequencies of 0.5, 1.0, 1.25, 1.66, 2.5 and 5.0MHz. These enable the frequency response of the video circuits to be checked, the gratings up to 2.5MHz should be clear and sharp, but many sets will have trouble resolving the 5.0MHz. Finally there is a five step grey scale for adjusting contrast, with amplitudes of 0%, 25%, 50%, 75% and 100%.

I will not go into further details of which adjustments should be made with which pattern, if you have the service manual for the equipment this will give suggestions, otherwise it's a matter of experience and taste — if the set will give an acceptable picture on all patterns there can't be much wrong! Some sets may have trouble locking onto the output from this unit, in this case try switching off the sets AFC and tuning manually. Remember that a test pattern is intended to show the worst in a piece of equipment, at the end of the day the picture should be acceptable to the viewer on a normal programme!

As it's name suggests, the Scope Trig socket can be used to externally trigger an oscilloscope when trying to view the video signals inside the equipment. The output is 5 volts peak-to-peak at 10k, and can be switched to either line or frame sync by SW1. Bear in mind, though, that the outer of this socket is earthed inside the unit so you may be earthing the TV's chassis via the 'scope leads.

When using the video and audio output sockets it should be noted that the signals from these are always the internally generated ones, regardless of the positions of the Int/Ext Video and Audio switches; these switches only affect the output from the RF modulator. This can be useful if, for example, a video recorder under test is connected to the SCART socket, and the RF output connected to the workshop TV. The signal from the generator can be compared to that from the video recorder merely by operating the Int/Ext switches (no more fumbling with RF leads behind the TV!). The unit can also be used to enable the composite video and/or audio outputs from equipment such as video cameras and computers (and certain satellite decoders!) to be fed to a normal TV via the aerial socket.

Care should always be taken, particularly when working on faulty equipment, to ensure that no excessive voltages are applied to the unit, as this will almost certainly cause expensive damage.

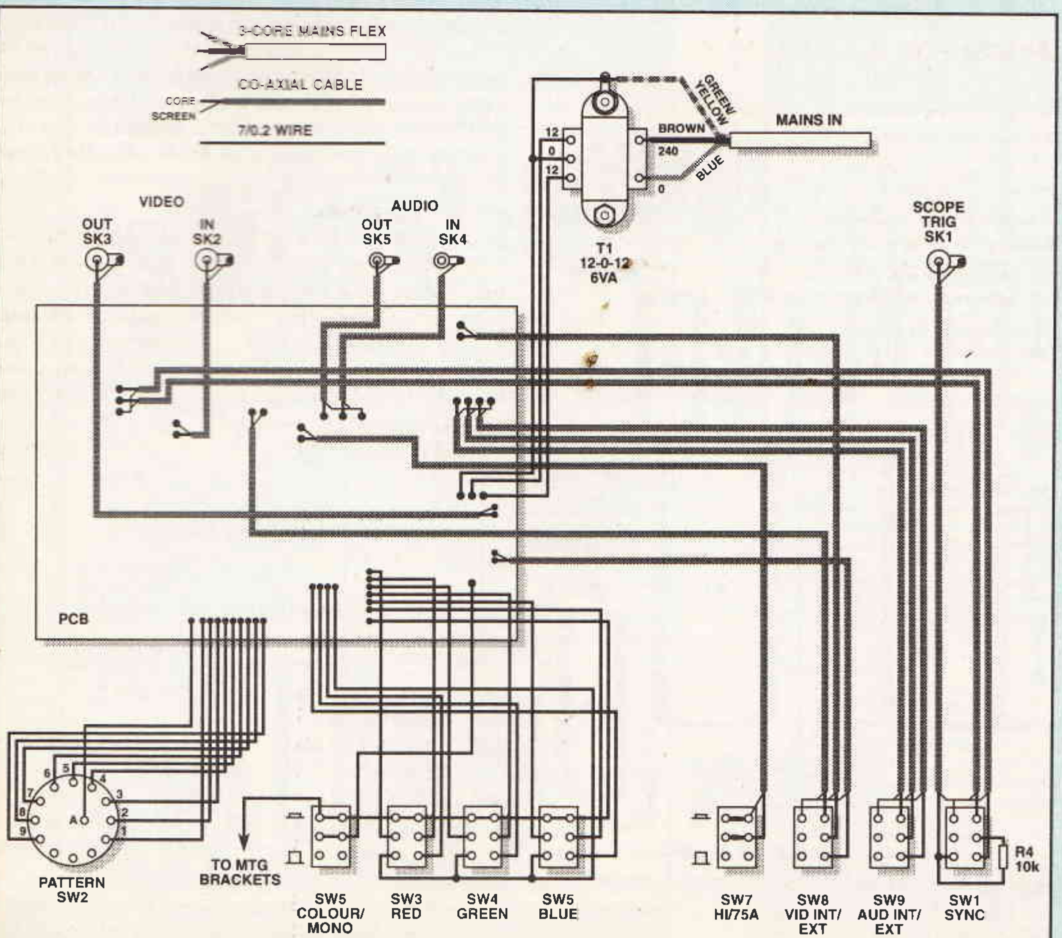


Fig.1 Interwiring diagram of Generator

PROJECT

PARTS LIST

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

R1,2,9,11-14,16,20,28,34	1k0
R3-8,10,23,24,45,46,50,54	10k
R15	3M3
R17,22,55	4k7
R18	36k
R19	620R
R21	910R
R25	10M
R26,33	1M0
R27,35	1k5
R29	6k8
R30,37,38	100R
R31	150R
R32	2M2
R36	3k9
R39	390R
R40	680R
R41	82R
R42,43,47,49,51,52	22k
R44	100k
R48	47k
R53	33k
RV1	2k2 Horizontal Preset

CAPACITORS

C1,2	1n0 0.2" pitch mylar
C3,4	47p 0.1" pitch ceramic
C5,12,13,15,16,18,20,22,23,29-34	100n 0.2" pitch disc ceramic
C6	330p 0.1" pitch ceramic
C7,8	5p6 0.1" pitch ceramic
C9,24,25	10n 0.2" pitch mylar/ceramic
C10	82p 0.1" pitch ceramic
C11	1000µ 25V radial elect
C14,17,19	220µ 16V radial elect
C21,28	220µ 0.1" pitch ceramic
C26	220µ 0.2" pitch disc ceramic
C27	100p 0.1" pitch ceramic
VC1	22p Trimmer

INDUCTORS

L1	Delay Line 270ns
L2	15µH Adjustable

SEMICONDUCTORS

IC1	74HC02
IC2	74HC4040
IC3,4	74HC4024
IC5	74HC00
IC6,7	27C128-15 150ns EPROM
IC8	74HC574
IC9	TEA2000
IC10	SAA1043
IC11	CA3240
IC12	7812
IC13	78L05
Q1	BC548

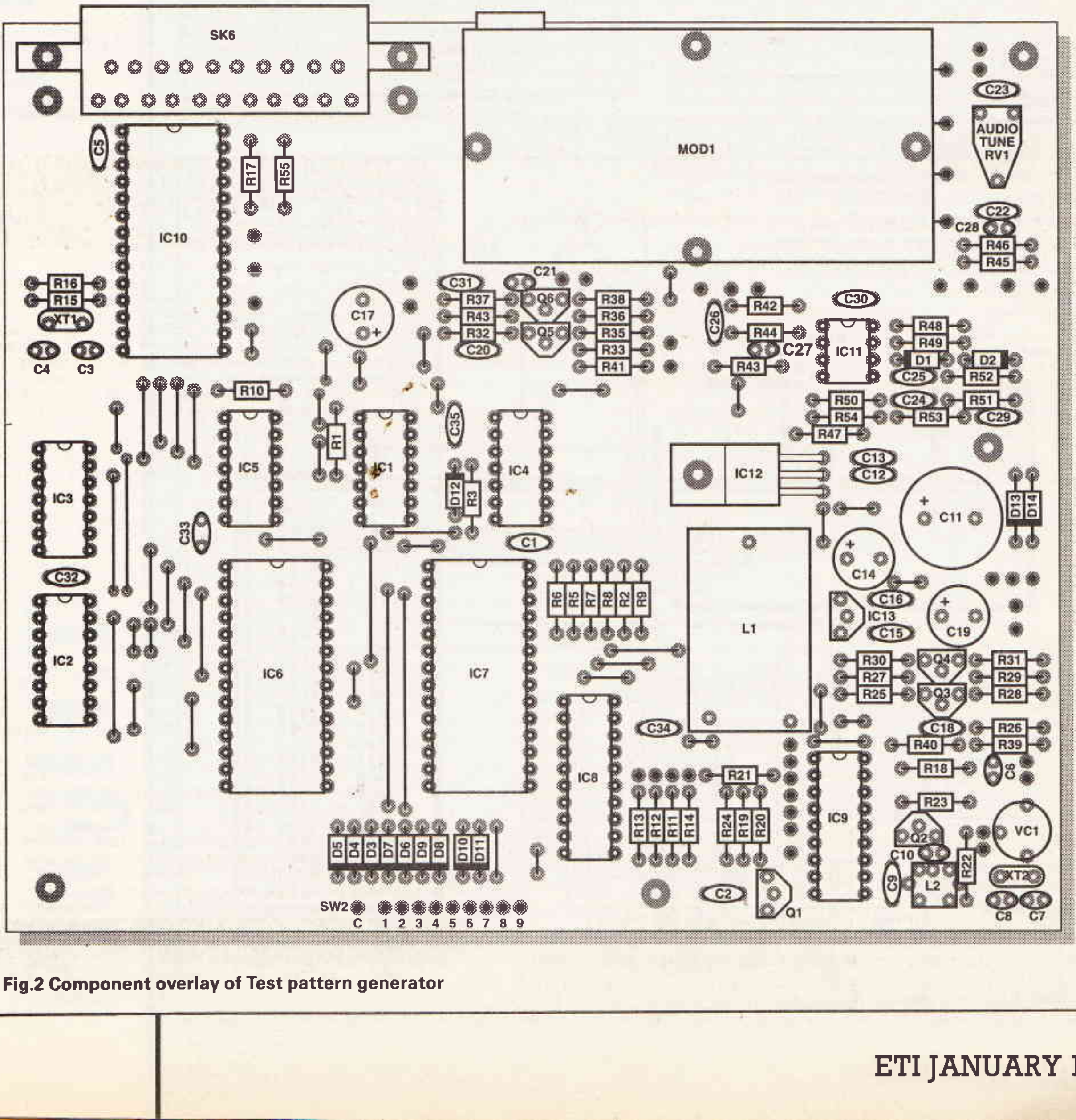


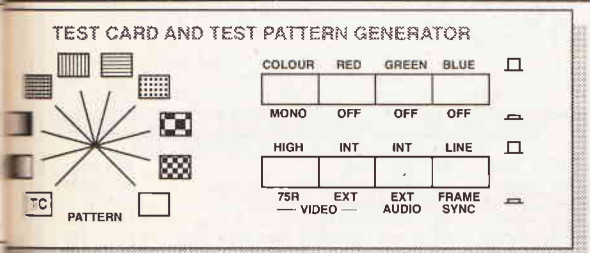
Fig.2 Component overlay of Test pattern generator

Q2,4,6	BC558
Q3,5	BF244
D1,2	2V7 400mW Zener
D3-12	1N4148
D13,14	1N4001

MISCELLANEOUS

MOD1	UM1286 UHF Modulator
SK1,2,3	Panel BNC Socket
SK4,5	Panel Phono Socket
SK6	R/A PCB SCART Socket
SW1,3-9	DPDT Latch Push Switch
SW2	1P/12W Rotary Switch
T1	240 to 12-0-12 6VA
XT1	5.000000 MHz
XT2	8.867238 MHz

IC sockets (1×8 way, 4×14 way, 1×16 way, 1×18 way, 1×20 way and 3×28 way), Knob for SW2, Buttons and brackets for SW1 & SW3-9 (Maplin FH61R & FH78K), PCB, case 170x70x190mm (WxWxD) or larger, coaxial cable, interconnection wire, tinned copper wire (about 24 SWG), 3 core 3 Amp mains flex, 13A mains plug with 3A fuse, phono plug to Co-ax aerial plug lead (Maplin FV90X), other leads as required, grommet, nuts, screws and spacers.



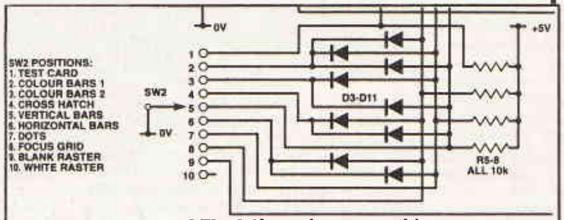
Front panel design

Part 1 corrections

Fig.1 The bottom left pin of SW7 should not be connectd to anything.

Fig.3 The junction at the bottom of R11-14 also joined to SW3-SW6 should be labelled 0V. The connections to SW2 pins 3 and 4 have become jumbled. See correct diagram below.

How It Works. The end of the fourth sentence in the second paragraph should read . . . so lines A0 to A7 count up from 0 to 255 (00h to FFh) and then to 0 and 1 (00h and 01h) again.



Corrected part of Fig.3 (from last month)

BUYLINES

All Components except IC6,IC7, & IC8 can be obtained from Maplin Electronic Supplies Ltd, the majority can probably also be obtained from your usual supplier. The Maplin Order Codes for the more obscure components are given in the parts list. The 74HC574 (IC6) & 27C128-15 (IC7/8) are listed by RS/Electromail and several other suppliers. The PCB is available from ETI PCB Service, see page 15.

EPROMs for this project can be programmed by the author at the following address: Paul Stenning, 1 Chisel Close, Hereford, HR4 9XF. Please enclose £5 to cover erasing if required, programming and return UK postage. Don't forget to enclose your own name & address and 2 EPROMs! If you prefer to program your own EPROMs, send an SAE for a HEX listing, or a blank PC formatted floppy disk (3.5" or 5.25") and return postage for an ASCII Hex Dump on your disk.

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MONITORS

MONOCHROME MONITORS

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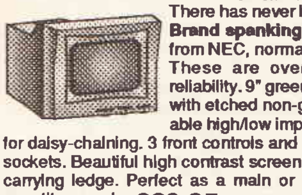

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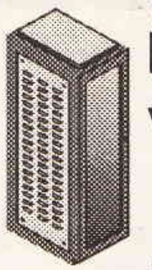
ADDS 2020 VDU terminals - **brand new**	**£ 225**
Sekonic SD 150H 18 channel Hybrid recorder	**£2000**
Trend 1-9-1 Data transmission test set	**£ 525**
Kenwood DA-3501 CD tester, laser pickup simulator	**£ 350**



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10 inch	As above but 230 volts	£24.95(B)
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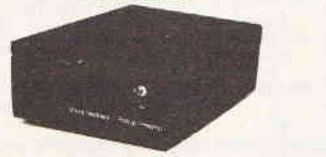

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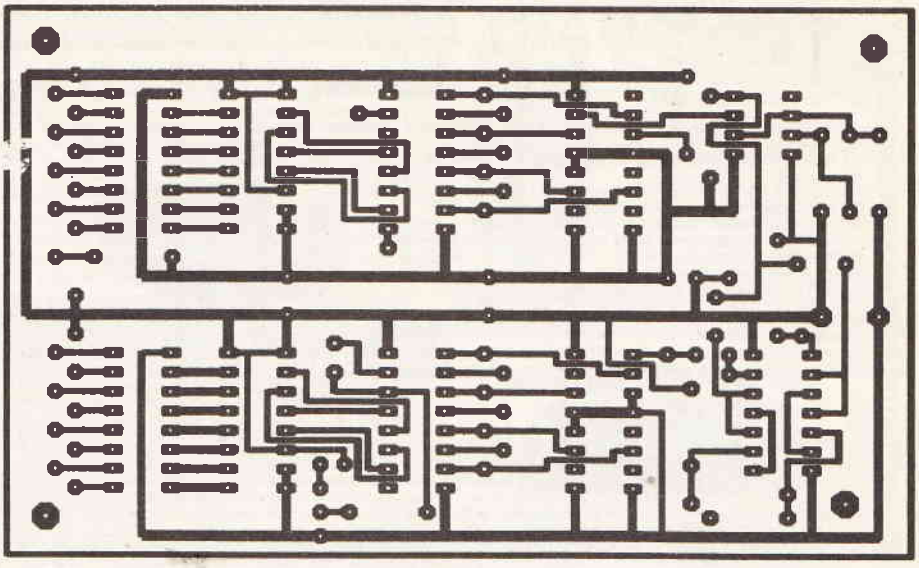
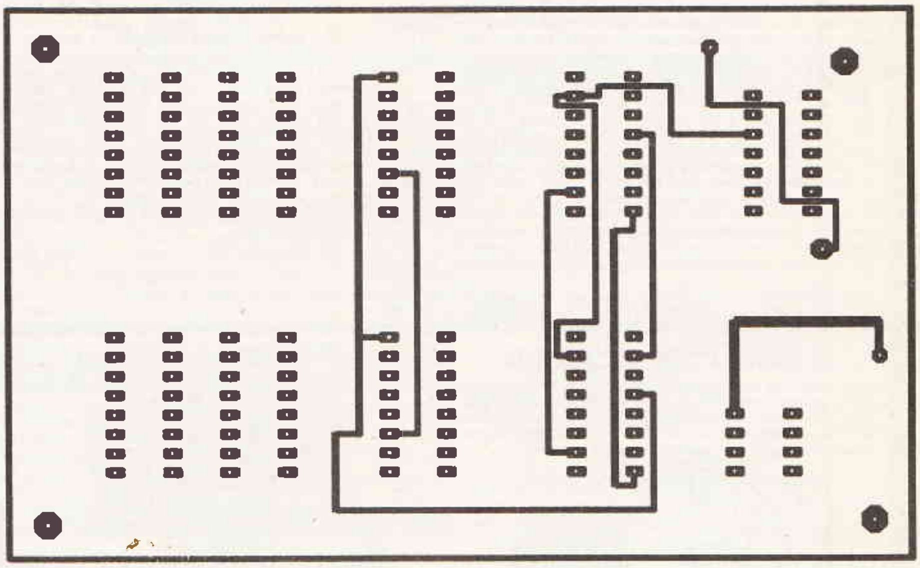
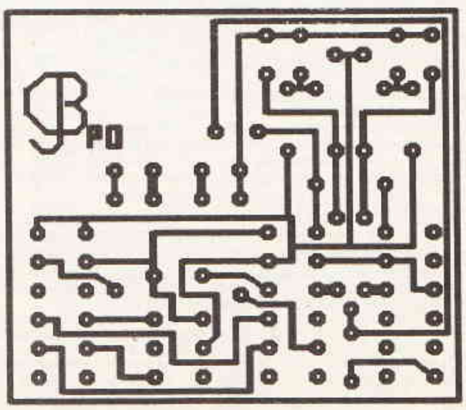


Enlarger Timer Selector Foil solder side

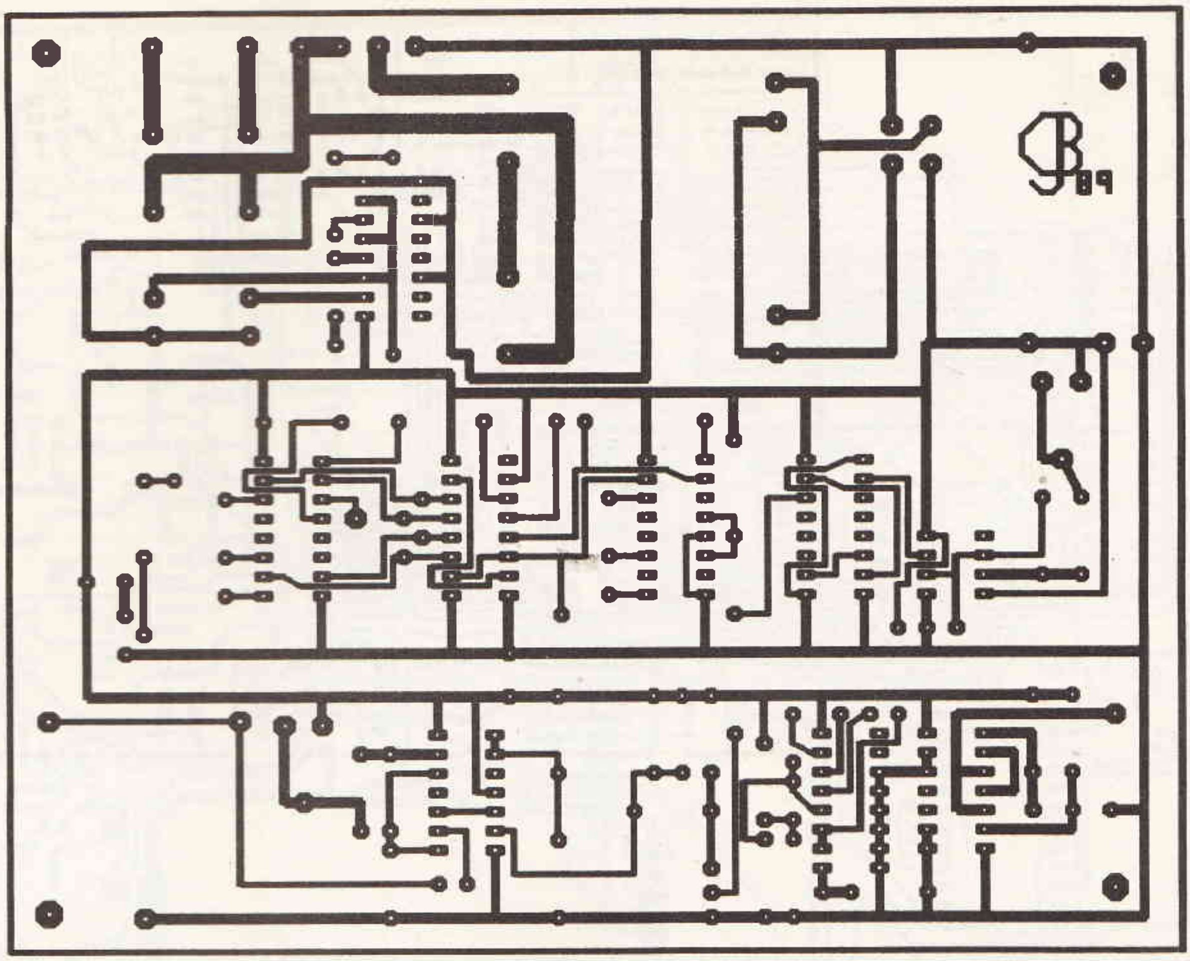


Enlarger Timer Selector Foil top side

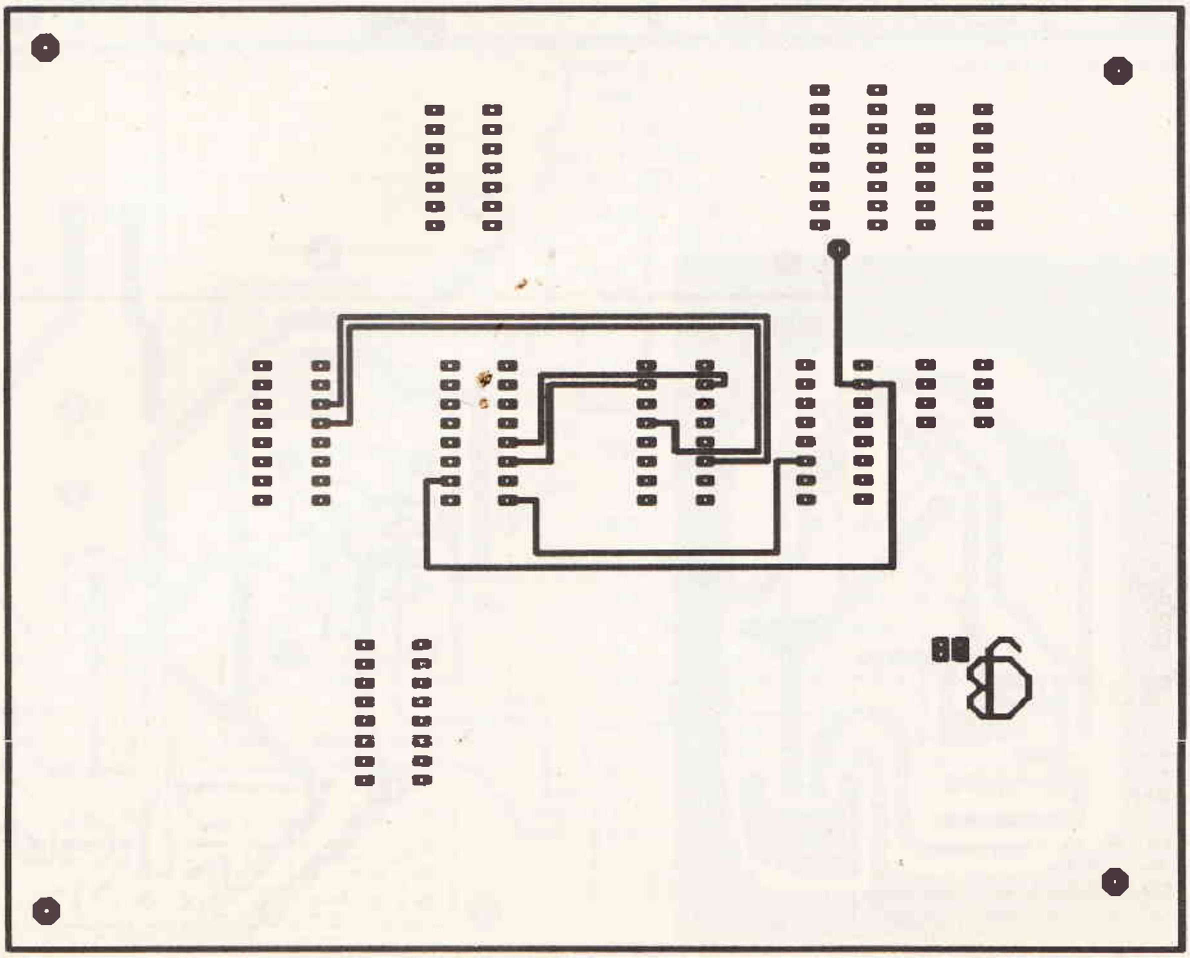
The Nightfighter December 91
We forgot to mention that programmed EPROMs for the Nightfighter are available from the author. Please send either a blank EPROM and £6 or £12 for the combined programming and chip to us here at ETI (address on page 66). We will pass it on to the author (any cheques made payable to M. Meechan).



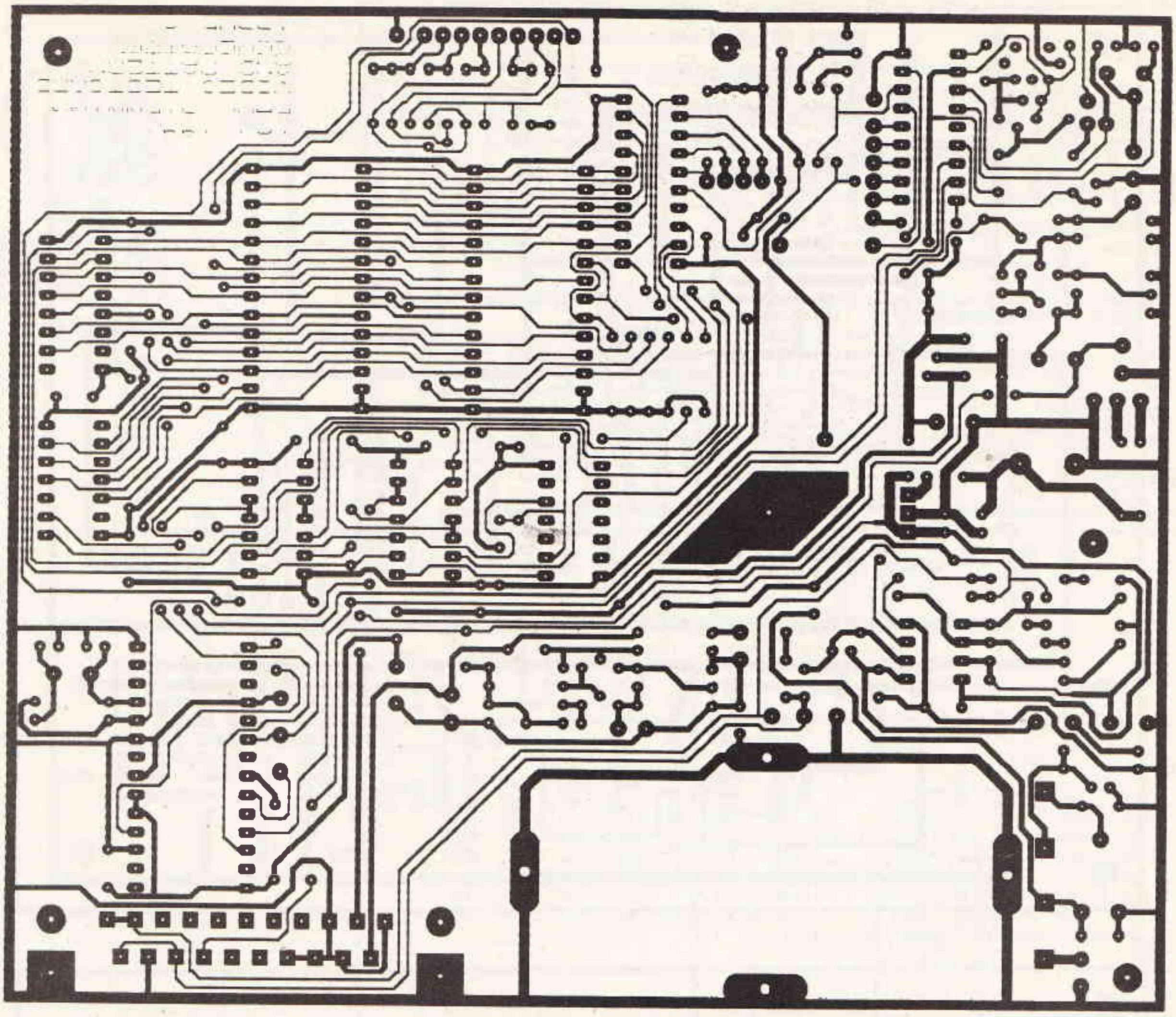
Enlarger Timer Switch Foil



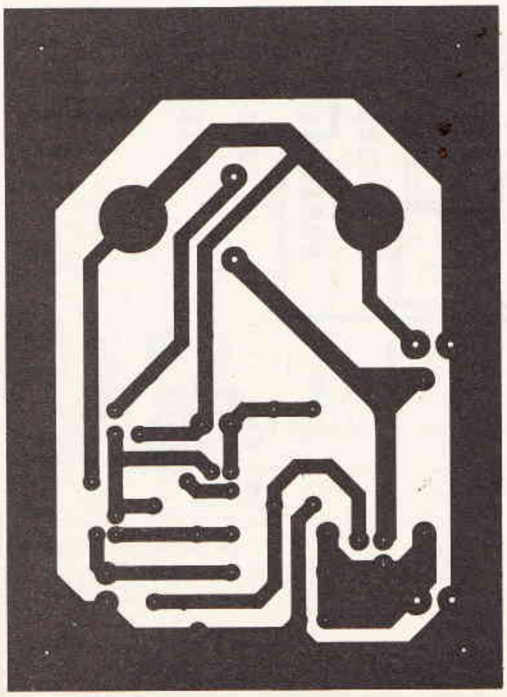
Enlarger Timer Main Board solder side



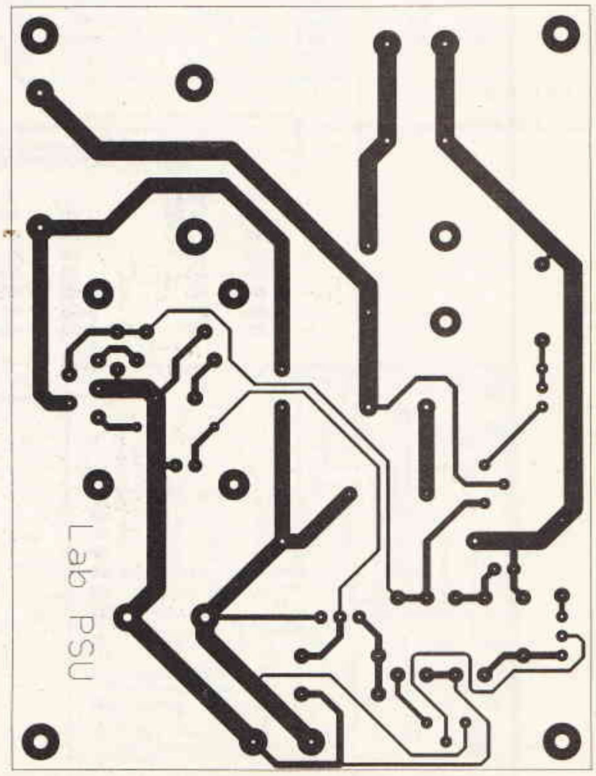
Enlarger Timer Main Board top side



Test Card Generator Foil

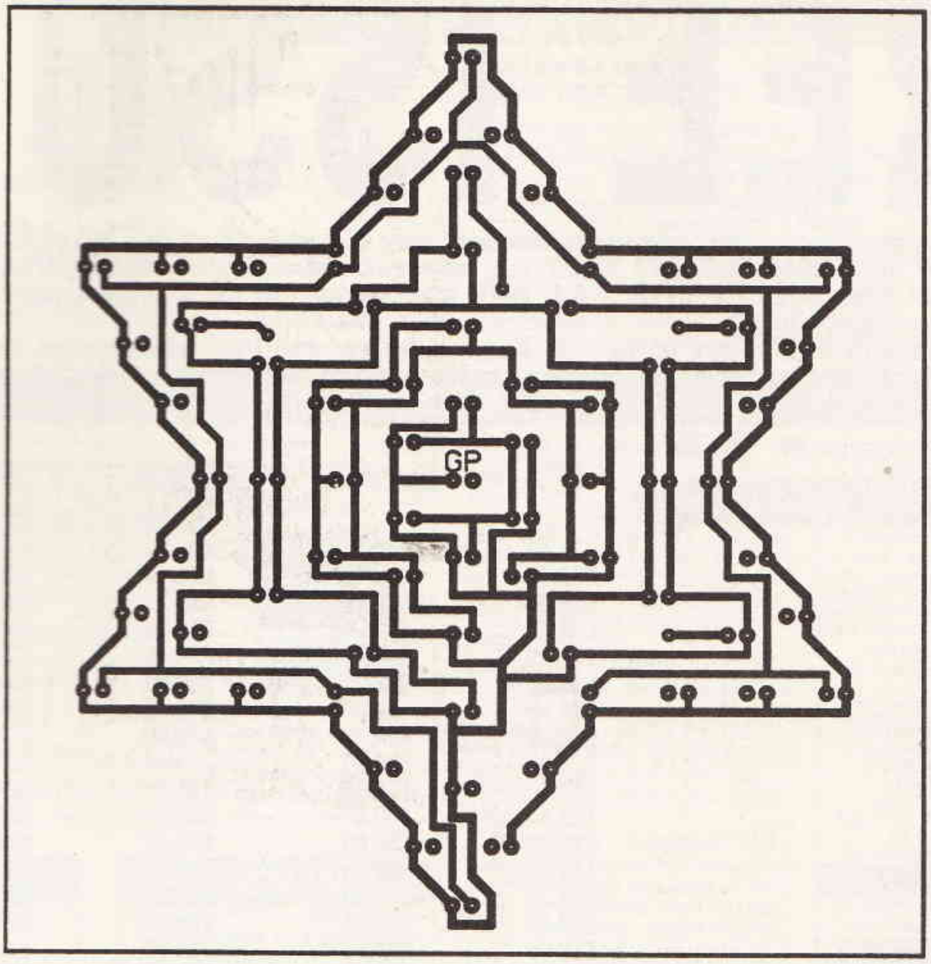


Correct side to Power On and Overload from last month

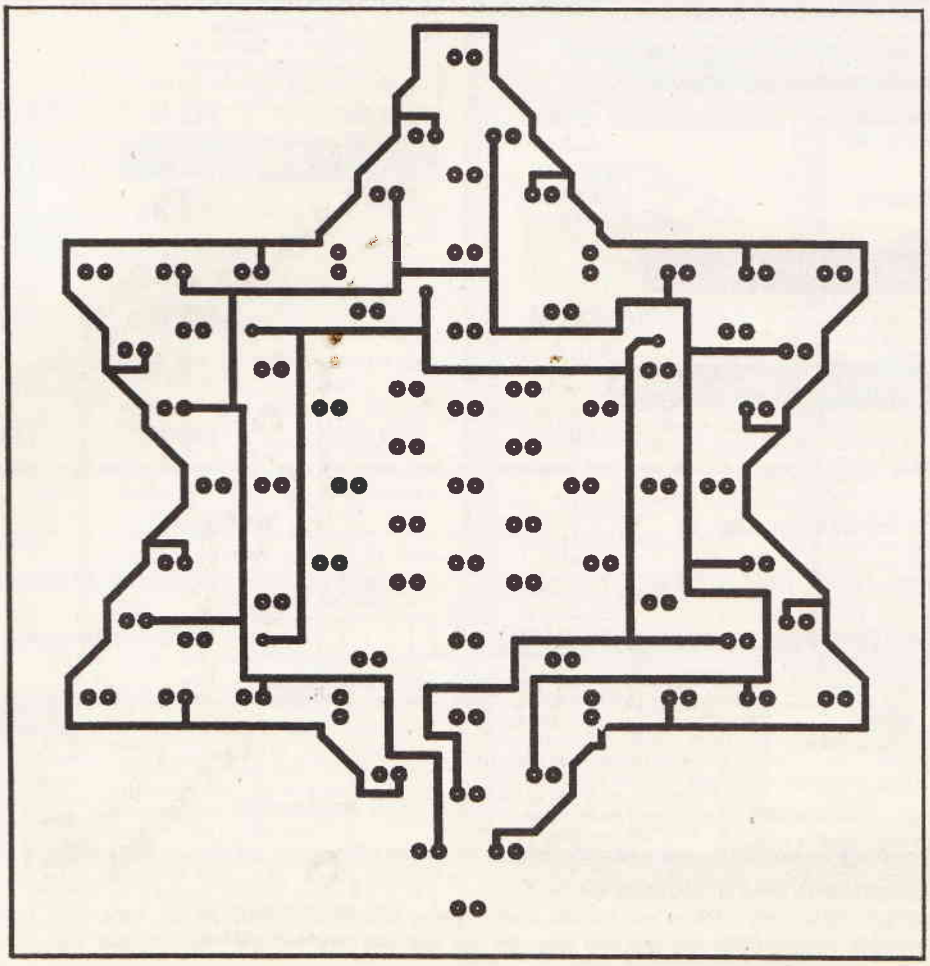


Switched Mode Laboratory Power Supply

LED Star
solder side



LED Star
top side



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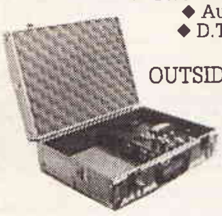

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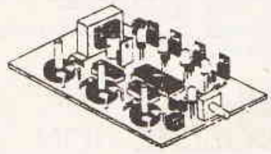

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NEXT MONTH

Continuing very much on the audio scene, we feature a 20 watt amplifier for you to build and Mike Meechan continues to delve into the content of digital professional mixing desks and their computerised control.

We have a mains switched timer for your constructional delight through the cold winter months to use perhaps with the washing machine on off-peak electricity.

Feature articles next month include Maximum power transfer a case for matching 'source to sink', bootstrapping (lifting yourself up by your bootstraps!) and Mike Barwise is back with a new series on Intuitive Electronics, where he encourages you to get the feel for the subject.

ETI, the all important guide for the electronics professional and amateur alike is on sale in your newsagents from January 3rd.

The above articles are in preparation but circumstances may prevent publication

LAST MONTH

In the December issue we featured:

The Nightfighter Part 4
Test-card generator Part 1
Laboratory Power Supply Part 1
Op-amp parameter display chart
Making PCBs at home
Electromagnetism and man
Negative feedback

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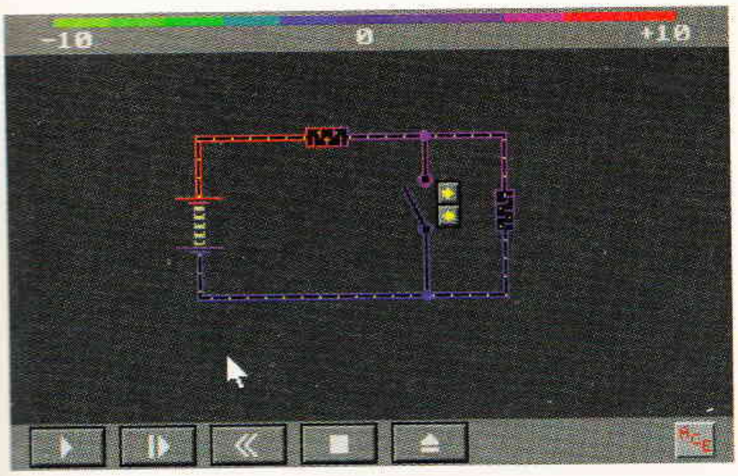

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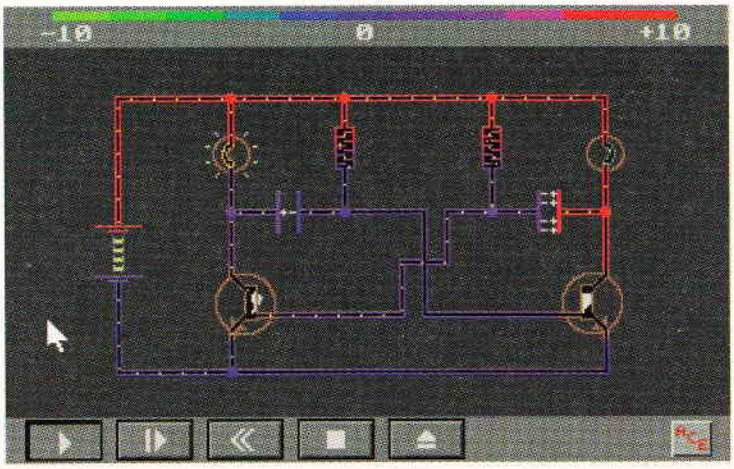

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