ETI
ELECTRONICS TODAY INTERNATIONAL

TOMORROW'S TECHNOLOGY TODAY

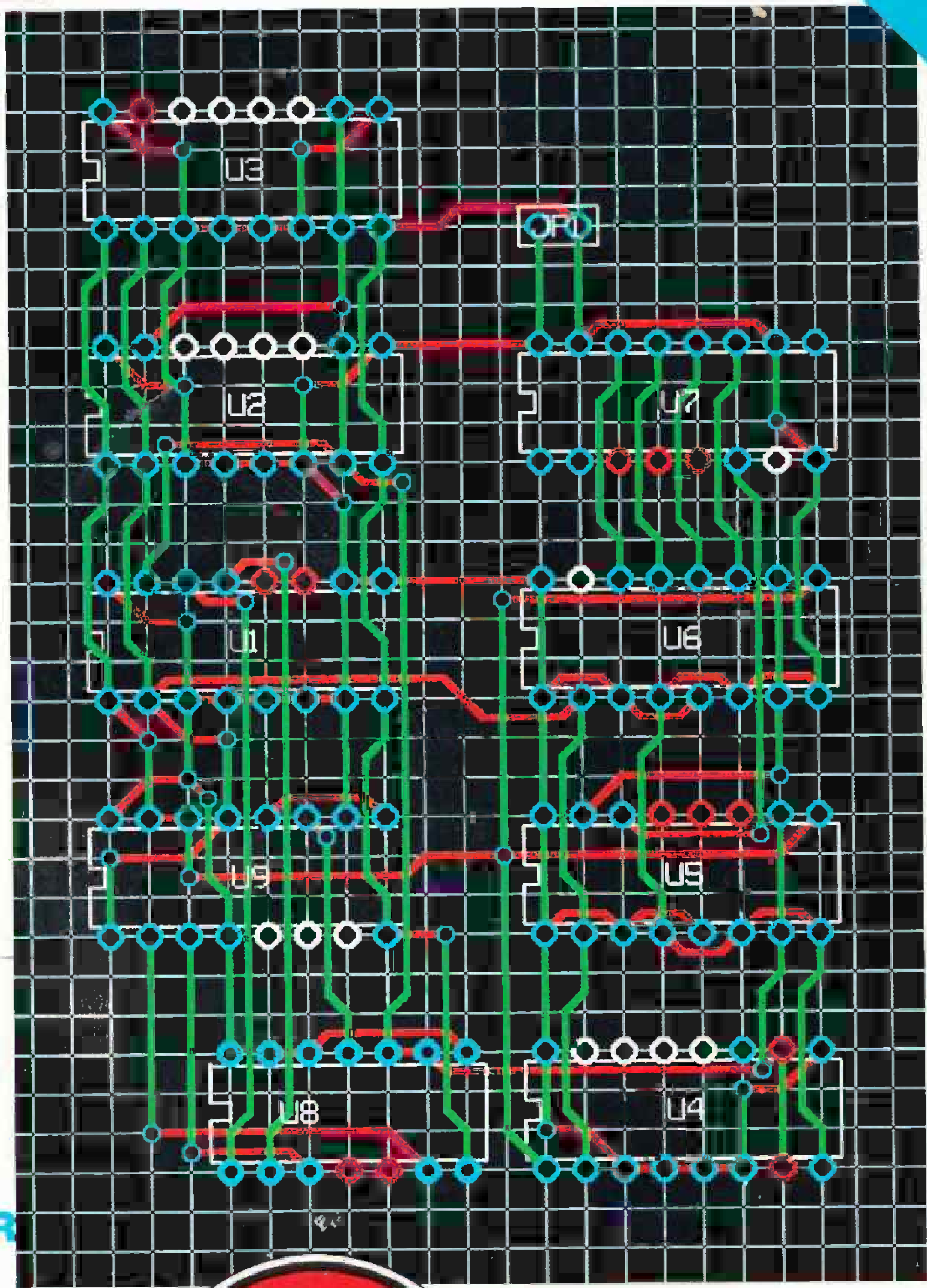
FREE PCB & SCHEMATICS DESIGN PACKAGE TO RUN ON YOUR PC

BUILD A Z-80 SINGLE BOARD COMPUTER

RECYCLING OLD PC's

MAKE A FREQUENCY METER ADAPTOR

BUILD AN INGENIOUS DISPLAY FOR YOUR PC



NO COVER DISK?

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(UK COPIES ONLY)

6 OUTSTANDING PROJECTS

February 1994 £2.25

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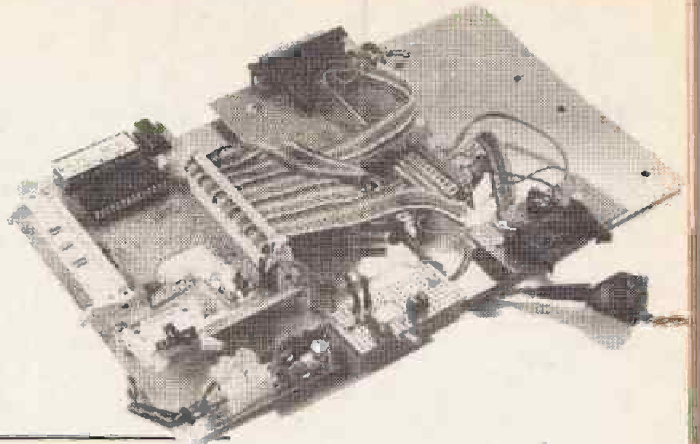
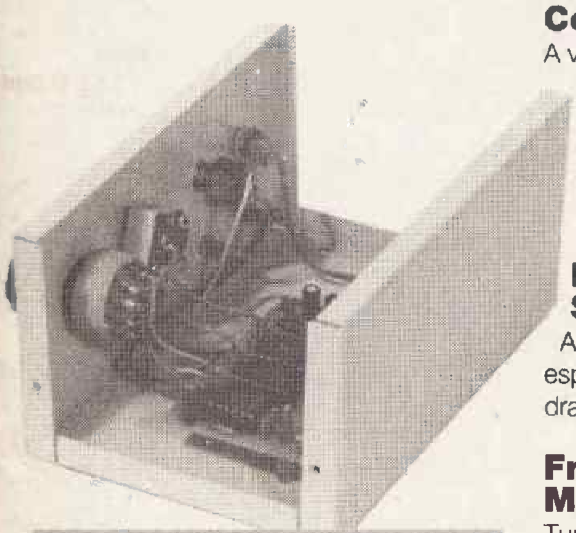
Contents

Volume 23 No.2
February 1994

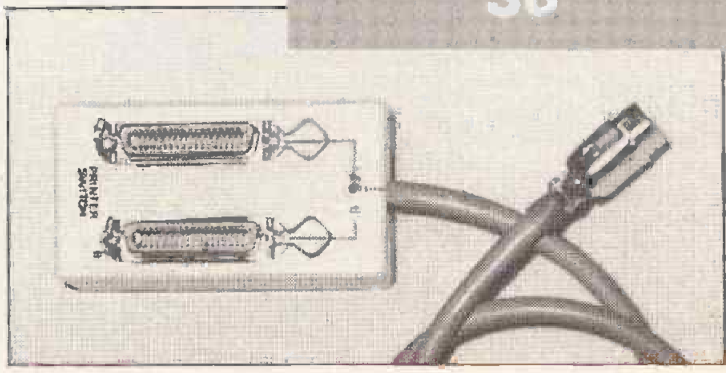


Features & Projects

Regulars



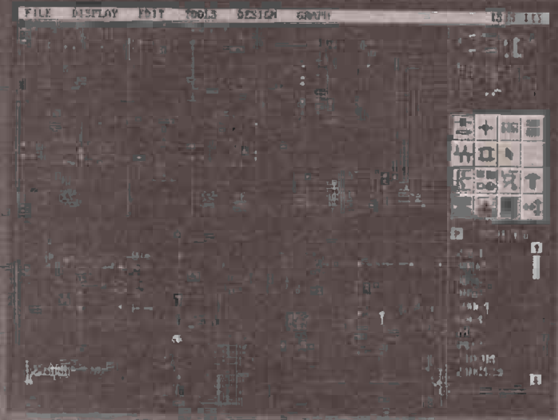
Project
Frequency Meter Adaptor
16



Project
PC Printer Switch Unit
36

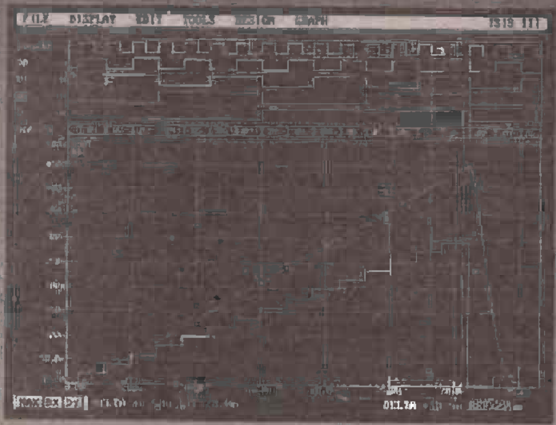
PROTEUS

The Complete Electronics Design System



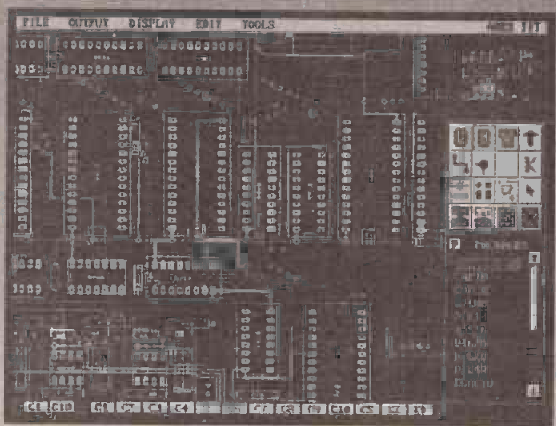
Schematic Capture

- Easy to Use Graphical Interface.
- Netlist, Parts List & ERC reports.
- Hierarchical Design.
- Extensive component/model libraries.
- Advanced Property Management.
- Seamless integration with simulation and PCB design.



Simulation

- Non-Linear & Linear Analogue Simulation.
- Event driven Digital Simulation with modelling language.
- Partitioned simulation of large designs with multiple analogue & digital sections.
- Graphs displayed directly on the schematic.



PCB Design

- Multi-Layer and SMT support.
- Unlimited Design Capacity.
- Full DRC and Connectivity Checking.
- Advanced Multi-Strategy Autorouting.
- Output to printers, plotters, Postscript, Gerber, DXF and DTP bitmaps.
- Gerber View and Import capability.

Labcenter Electronics

Write, phone or fax for your free demo disk, or ask about our full evaluation kit.
Tel: 0274 542868. Fax: 0274 481078.
14 Marriner's Drive, Bradford BD9 4JT.

Proteus software is for PC 386 compatibles and runs under MS-DOS. Prices start from £475 ex VAT; full system costs £1495. Call for information about our budget, educational & Windows products. All manufacturers' trademarks acknowledged.

ETI NEWS

Be Prepared - The Personal Attack Alarm

This is one "Rip-OFF" that you won't object to! The new personal Attack Alarm from Maplin electronics is triggered by pulling the rip cord, which pulls the plug from its socket. The Alarm can sound continuously for up to an hour and is reset by replacing the plug.

The Personal Security Alarm is a very compact personal alarm, in a tough black plastic case. Thanks to its slim size, it can be easily slipped into a pocket or handbag, carried by hand, or attached to a belt or key ring, using the supplied clip. The loud, piercing, 110dB alarm is activated by pulling the rip cord, which removes a plastic plug from its socket.

The Personal Protector costs £5.95 and can be obtained from any Maplin store or by mail order, tel 0702 554161.

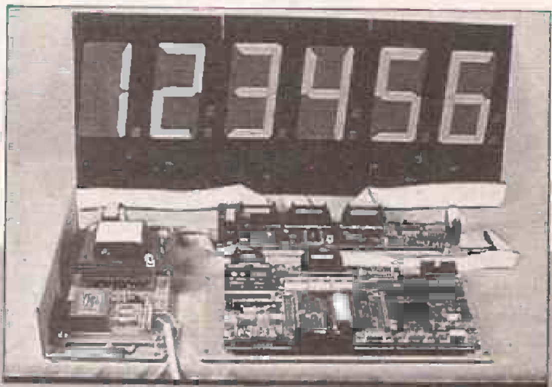
High Electronic Mobility Transistors

Although high-electron mobility transistors (HEMTs) are impressive performers in the laboratory they have found only limited applications in commercial systems. This situation could change, however, with a new Asynchronous Transfer Mode (ATM) chip, from Fujitsu Laboratories Ltd., of Atsugi, Japan, that uses more than 7,000 direct coupled FET logic (DCFL) gates, built with advanced transistors.

Compared with the few hundred MHz rates of current ATM switches, this new chip at 1.2GHz is an ideal candidate for broadband ISDN applications. Fujitsu researchers mounted 16 of these ATM switches onto a ceramic substrate and successfully switched video signals at 38.4 GBits/second.

Because current BiCMOS and ECL silicon technologies very quickly reach their limits in Gbit/s channel applications, the new chip could supply a critical link between world-wide telecommunications systems and local nodes. In addition to the advanced transistors, which require special epitaxial layers on gallium-arsenide substrates, the new ATM chip uses a novel event controlled logic design. With gate delays as short as 25ps, the Fujitsu researchers had to scrap static RAM based buffering in favour of asynchronous pipeline architecture.

ATM protocol requires a switch to route data packet to their destination based on address information held in a header. Instead of queuing, the incoming packets in a dual port RAM, the HEMT ATM operates a multistage FIFO that is triggered by the arrival of data, rather than timed with an external clock. Asynchronous operation results in higher parallelism, since data packets do not have to wait for a clock signal to begin their journey through the multi-stage pipeline. The one disadvantage of this new architecture, however, is higher total heat generation. This is because the chip is utilising the available gates more efficiently.



Breakthrough in LCD Technology

A technological breakthrough in the way that Liquid Crystal Displays are manufactured looks set to open up a whole new market for LCDs. The new product, called Visilight, will make it possible to produce large character high visibility LCDs for applications such as airport passenger information, at the moment the exclusive preserve of LED and electroluminescent displays.

The new technology - polymer dispersed large scale liquid crystal - has been developed by a U.S. based company and differs considerably from previous liquid crystal displays, which sandwich a liquid between two plates of glass. Visilight uses a dry film technique, which allows the production of light weight flexible displays.

Up to now, the practical maximum size of an LCD display has been 6in, but the manufacturers of Visilight, FP Displays, are offering seven segment display modules in sizes ranging from 2in to 18in high.

Visilight has an excellent visibility in all light conditions as well as a 160 degree viewing angle. Furthermore, its slimness and light weight means that support structures can be kept to a minimum.

For further information on Visilight, contact the manufacturers - FP-Displays AG in Bristol on 0272 251125.

High Quality Listening at a Low Price

The latest addition to the extensive range of headphones from Maplin Electronics is a pair of high quality headphones with a frequency range and sensitivity ideally suited to digitally reproduced music. The unit features gimbal mounted, leather cushioned, detachable earpads. The drivers are equipped with rare earth magnets for high sensitivity and a wide frequency range, making them suited for use with CDs and other digital equipment.

These headphones cost £14.95 and are available from all Maplin stores or by mail order, telephone 0702 554161

New DC-DC Converters from Gresham

Gresham Power Electronics has just introduced a new miniature 3W dc-dc converter which has a wide 2:1 input voltage range and requires no temperature derating in normal use.

This small device is intended for PCB and distributed power applications. The wide range of input voltages makes them useful for operation from 5V dc bus supplies, 12 and 24V batteries and 48V telecommunications systems.

Fully encapsulated and equivalent in size to a standard 24pin DIL package, the range of converters offer output voltages of 5, 12, and 15V. They offer input to output isolation of better than 500V dc. For further information contact Gresham Power Electronics of Salisbury on 0722 413060.

Prototype Filter Tank

A U.S. company, Superconductor Technologies Inc. of Santa Barbara, has constructed a prototype filter tank based on high- temperature superconductor technology integrated with fibre optics. The final product could be a very precise filter, operable over a wide range of frequencies, which will be used by the U.S. Air Force for anti-jamming applications.

The module is a four channel bank of individually switchable band reject filters, each tuned to a specific frequency, and controlled by signals from laser diodes, transmitted via optical fibre. The filters are made from the thallium-barium-calcium HTS.

STI covers the resonator of each filter with a layer of gallium arsenide. The GaAs film looks like an ordinary dielectric but illumination will generate carriers in the layer that will change the filter's resonant frequency.

One advantage of HTS filters is their lower insertion loss. The loss in traditional YIG (yttrium-iron-garnet) filters is at least 4 to 5dB each. A receiver might have a maximum of 3, which has proved inadequate in some situations.

The loss in an HTS filter is one-tenth that of most YIG filters, so STI believes it can combine up to 100 and still not exceed the same total loss of 12 to 15dB as a bank of three YIG filters.

The bank fits in a prototype cryocooler measuring 4 x 4 x 10in. To avoid forcing the cryocooler to chill the diodes as well, STI chose to place them outside the module, and channel light signals in through an optical fibre.

Pocket Sized Precision

Maplin Electronics has introduced a low-cost, high quality, pocket sized analogue multimeter. The unit is designed for electrical and electronic fault finding, domestic uses around the home, educational uses and for vehicle electronics.

The Precision Gold 108 Pocket Multimeter is a rugged, accurate, easy to use unit with a sensitivity of 2000 ohms per volt for both ac and dc ranges. The linear meter movement offers accurate readings of measurements on all ranges through a 90 degree arc mirrored scale. The functions included are ac and dc voltages, dc current, resistance, battery check, and decibels. The meter has an accuracy of 5% of full scale deflection on the ac voltage range and 4% on the dc voltage and current range.

This multimeter costs just £9.95 plus VAT and can be obtained from any branch of Maplins, or by mail order, telephone 0702 554161.

New Concept Energy Metering

A new concept in metering is available from Northern Design of Bradford. The PM 305 uses the latest micro-controller and unique waveform analysis techniques to accurately measure direct values of RMS voltage, current and power, lead and lag peak of waveforms and frequency. Calculated values include kVA, kW, PF, kWh, kVAh, +-3 phase kVar and inductive and capacitive kVarh.

The fully programmable low cost (£269) meter has a backlit wide viewing angle LCD display featuring two rows of 7 x 7 segment digits with custom energy management legends.

For more details contact Northern Design on 0274 729533.

Radio Waves Light Lamp

Intersource Technologies Inc. recently developed the long life E-lamp (electronic lamp) for commercial use. The E-lamp differs from conventional incandescent light bulbs in that it does not use a filament to emit light.

Radio signals are generated by a crystal controlled oscillator, then amplified and emitted into a phosphor coated bulb through an energy coupling antenna. Mercury vapour inside the glass assembly is ionised by the RF energy, forming a conductive ring and resonating at the ultra-violet wavelength of 254nm. As the ultraviolet radiation is emitted, it strikes the phosphor coating to produce visible light.

Diablo Research Corp. purchased the rights to continue E-lamp research from Dr. Donald C. Hollister. With funding from the Department of Energy, researchers began work on E-lamp technology but were unable to eliminate the RF interference. The problem has been rectified and the product is currently undergoing the patent process.

Developers claim that the lamp is more efficient than incandescent bulbs, which lose 95% of their energy in heat. The E-lamp requires 25W of ac power to produce as much light as a 100W incandescent bulb. The lamp operates as long as the phosphors and electronics are intact. At about 20,000 hours the phosphors degrade to a point where 30% of the lamp's intensity is lost, and this is considered the end of the bulb's life.

E-lamp bulbs will switch on or off in less than a second, work in cold temperatures and can be used with dimmer switches. Based on four hours of daily operation, the electronic lamp costs about $5 a year to operate. The price tag per bulb is estimated at $15. A 100W incandescent lamp costs $14 a year to operate and lasts from 180 to 250 days.

Precision industrial quality hobby tools

A precision tool kits designed for electronics and general hobby use has been introduced by ZED Group Inc. of Massachusetts, USA.

The Xuron Precision Hobby Tool Kits include a combination of three industrial grade tools and a convenient canvas carrying pouch. The kits feature a high precision shear for making clean cuts in restricted areas, Tweezernose pliers and special scissors with large finger loops that are comfortable to hold in either hand.

Designed for high durability and ease of use, these tools have precision ground steel blades, slip resistant handles and light touch return springs.

For more information contact ZED Group Inc., in the USA on 0101 617 889 2220.

Commercialising Virtual Reality the Kreuger Way

Myron Kreuger, the man credited with inventing virtual reality, says the time for research into the subject was over 20 years ago. There is "no excuse" for the absence of affordable VR from U.S. companies, he adds.

Kreuger says that U.S. researchers are over-engineering virtual reality gear, making it too cumbersome to be commercially successful - a mistake the Japanese are not making.

"People won't trouble themselves to use virtual reality in its present form with electronic goggles and gloves and tens of thousands of dollars in investment needed," he said.

"The real question is what kind of VR would people use every day if it was free? Once you answer that question, then you can engineer commercial versions that come as close as possible to that ideal.

"As our population ages, many people already wear glasses anyway, so they would probably use VR glasses or contact lenses if they were free," he said. Kreuger called current semiconductor techniques entirely adequate to fabricate transparent surface emitting lasers or diodes onto electronic contact lenses which directly inject photons into the eye.

"Contact lenses could also be fabricated very cheaply, since their size is very small. They would also be the best way to deploy HDTV."

So far, however, only Japanese manufacturers have shown real interest. "If I tell an American company that there is one good application for VR, they are only mildly interested"

£1 BARGAIN PACKS

In fact... cheaper than £1 because if you buy 10 you can choose one other and receive it free!

1 x 12v Stepper Motor. 7.5 degree Order Ref: 910

1 x 10 pack Screwdrivers. Order Ref: 909

2 x 5 amp Pull Cord Ceiling Switches. Brown. Order Ref: 921

5 x reels Insulation Tape. Order Ref: 911

4 x 14 Min Bull-races. Order Ref: 912

2 x Cord Grip Switch Lamp Holders. Order Ref: 913

1 x DC Voltage Reducer. 12v-6v. Order Ref: 916

1 x 10 amp 40v Bridge Rectifier. Order Ref: 8698

Lightweight Stereo Headphones. Moving coil so superior sound. Order REf: 896

2 x 25W Crossovers. For 4ohm loudspeakers. Order Ref: 22

2 x nicad Constant Current Chargers. Easily adapable to charge almost any nicad battery. Order Ref: 30

10m Twin Screened Flex. White pvc cover. Order Ref: 122

2 x White Plastic Boxes. With lids approx 3" cube. Lid has square hole through the centre so these are ideal for light operated switch. Order Ref: 132

2 x Reed Relay Kits. you get 8 reed switches and 2 coil sets with notes on making relays and other gadgets. Order Ref: 148

1 x Big Pull Solenoid. Mains operated. Has 1/2" pull. Order Ref: 871

1 x Big Push Solenoid. Mains operated. Has 1/2" push. Order Ref: 872

1 x Mini Mono Amp.3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 268

1 x Mini Stereo 1W Amp. Order Ref: 870

1 x In-Flight Stereo Unit is a stereo amp. Has two most useful mini moving coil speakers. Made for BOAC passengers. Order Ref: 29

1 x 10-1mA Panel Meter. Full vision fact 70mm square. Scaled 0-100. Order Ref: 756.

2 x Lithium Batteries. 2.5V penlight size. Order Ref:874

2 x 3m Telephone Leads. With BT flat plug. Ideal for phone extensions, fax, etc Order Ref: 552

1 x 12V Solenoid Has good 1/2" pull or could push if modified. Order Ref: 232

3 x In-Flex Switches. With neon on/off lights, saves leaving things switched on. Order Ref: 7

2 x 6V 1A Mains Transformers. Upright mounting with fixing clamps. Order Ref: 9

1 x Humidity Switches. As the air becomes damper, the membrane stretches and operates a micro switch. Order Ref: 32

5 x 13A Rocker Switch. Three tags so on/off, or changeover with centre off. Order Ref: 42

2 x Flat Solenoids. You could make your multi-tester read AC amps with this. Order Ref:79.

1 x Suck or Blow-Operated Pressure Switch. Or it can be operated by any low pressuire variation such as water level in tanks. Order ref: 67

1 x 6V 750mA Power Supply. Nicely cased with mains inputand 6V output lead. Order Ref: 103A

2 x Stripper Boards. Each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers. etc. Order ref: 120.

12 Very Fine Drills. For PCB boards etc. Normal cost about 80p each. Order Ref: 128

5 x Motors for Model Aeroplanes. Spin to start so needs no switch. Order Ref: 134

6 x Microphone Inserts. Magnetic 400 ohm, also act as speakers. Order Ref: 139

6 x Neon Indicators. In panel mounting holders with lens. Order Ref: 180

1 x In-Flex Simmerstat Keeps your soldering iron etc always at the ready. Order Ref: 196

1 x Mains Solenoid. Very powerful as 1/2" pull or could push if modified. Order Ref: 199

1 x Electric Clock. Mains operated. Put this in a box and you need never be late. Order Ref: 211

4 x 12V Alarms. Makes a noise about as loud as a car horn. All brand new. Order Ref: 221

2 x (6" x 4") Speakers. 16 ohm 5 watts, so can be joinedin parallel to make a high wattage column. Order Ref: 243

1 x Panostat. Controls output of boiling ring from simmer up to boil. Order Ref: 252

2 x Oblong Push Switches. For bell or chimes these can switch mains up to 5A so could be foot switch if fitted in patress. Order Ref: 263

50 x mixed Silicon Diodes. Order Ref: 293

1 x 6 Digit Mains Operated Counter. Standard size but counts in even numbers. Order Ref: 28

2 x 6V Operated Reed Relays. One normally on, other normally closed. Order Ref: 48

1 x Cabinet Lock. With two keys. Oreder Ref: 55.

1 x Magnetic Brake. For stopping a motor or rotating tool. Order Ref: 66.

1 x Shaded Pole Mains Motor. 3/4" stack, so quite powerful. Order Ref: 85.

2 x 5 Aluminiumk Fan Blades. Could be fitted to the above motor. Order Ref: 86

1 x Case. 3 1/2x 2 1/4 x 1 3/4with 13A socket pins. Order Ref: 845

2 x Cases 2 1/2 x 2 1/4 x 1 3/4 with 13A pins. Order Ref: 565

4 x Luminous Rocker Switches. 10A mains. Order Ref: 793

4 x Different Standard V3 Micro Switches. Order Ref: 340.

4 x Different Sub Min Micro Switches. Order Ref: 313

BARGAINS GALORE

Tangential Heaters. Standard replacement for many expensive blow heaters, these comprise a long quiet running blow heater beyond the element, which is thermally protected should the blower stop or air flow be impeded, 3 models available.

Free Standing Coal Effect heater. Curved iron legs, is a 2kw blow heater with switchable powerful full heat covered by coal effect fibreglass. Lights when switched on, looks very attractive, is very efficient and can be moved from room to room, £13, Order Ref 13p2.

Linear Heaters. Infra red elements encased in quartz glass tubes. Ideal for spot heating. 12" long, rated at 360W 110v. Uses 2 or more in series depending upon heat output required. 2 for £1, Order Ref. 907 or 20 for £9, Order ref. 5P11.

Water Proof Heating Wire. Ideal for wiring around pipes, stops them from freezing. 15m long, just right for 230v input, £5, Order ref. 5P109.

1000W Fire Spirals. For repairing old heaters. 4 for £1, Order Ref. 223

1000W Pencil Elements. Available in several lengths, specify the length you want and we will send the nearest we have, 2 for £1, Order Ref. 376.

Other Heaters. Elements available, see our current Newsletter which we will send with your order.

MS DOS 3.3. has 5' or 31/2" disk and comes complete with manual, £5, Order Ref. 5P208/5" or 5P208/31/2".

Medicine Cupboard Alarm. Or it could be used to warn when any cupboard door is opened. The light shining on the unit makes the bell ring. Completely built and neatly cased requires only a battery. £3. Order Ref: 3P155.

Don't Let it Overflow! Be it bath, sink, cellar, sump or any other thing that could flood. This device will tell you when the water has risen to the pre-set level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted. £3. Order ref: 3P156

Very Powerfulk Mains Motor. With extra long (2 1/2") shafts out each side. Makes it ideal for a reversing arrangement for, as you know, shaded pole motors are not reversible. £3. Oreder Ref: 3P157.

Solar Panel Bargain. Gives 3v at 200mA. Order Ref: 2P324.

£1 Super Bargain
12V axial fan for only £1. Ideal for equipment cooling, brand new, made by West German company. Brushless so virtually everlasting. Needs simple transistor drive circuit, we include diagram. Only £1, Order Ref: 919. When we supply this we will include a list of approximately 800 of our other £1 bargains.

PC Operating Systems. Fully user documented and including software. MS-DOS 3.20, with 5" disk. **£5** Order Ref: 5P2076: MS-DOS 3.3 with 3 1/2" disk. **£5** , Order Ref:5P208: MS-DOS 4.01, with 3 1/2" disk **£10** Order Ref: 10P99

45A Double Pole Mains Switch. Mounted on a 6x3 1/2brass plate, beautifully finished in gold, with pilot light. Top quality made by MEM, **£2.** Order Ref: 2P316.

Amstrad 3" Disk Drive. Brand new and standard replacement for many Amstrad and other machines. **£20** Order Ref: 20P28.

Movement Alarm. Goes off with the slightest touch. Ideal to protect car, cycle, doorway, window, stairway, etc. Complete with Piezo, shrieker, ready to use only **£2**(PP3 battery not supplied), Order Ref: 2P282.

AM-FM Radio Chassis. With separate LCD module to display date and time. This complete with loudspeaker, **£3.50** Order Ref: 3.5P5

2m 3-Core Lead. Terminating with flat pin instrument socket. **£1.** Order Ref: 879. Ditto but with plug on the other end so that you could use this to extend an instrument lead. **£1.50.** Order Ref: 1.5P10.

20W 5" 4 Ohm Speaker mounted on baffle with front grille, £3. Order Ref: 3P145. Matching 4 ohm 20W tweeter on seperate baffle, **£1.50,** Order Ref: 1.5P9.

LCD 3 1/2 Digit Panel Meter
This is a multi range voltmeter/ammeter using the A-D converter chip 7106 to provide 5 ranges each of volts and amps. Supplied with full data sheet. Special snip price of **£12.** Order Ref. 12P19.

Solar Energy Educational Kit. It shows how to make solar circuits and electrical circuits, how to increase voltage or current, to work a radio, calculator, cassette player and to charge nicad batteries. The kit comprises 8 solar cells, one solar motor, fan blades to fit motor and metal frame to hold it complete a free-standing electric fan. A really well written instruction manual. Price: **£8.00** Order REf: 8P42B.

High Power Switch Mode PSU Normal mains input, 3 outputs: +12V at 4A, +5V at 16A and -12V at 1/2A. Completely enclosesd in plated steel case. Brand new. Our special offer price of £9.50. Order Ref: 9.5P1.

Ultra Thin Drills. actually 0,3mm. To buy these regular costa a fortune. However, these are packed in half dozzens and the price to you is £1 per pack. Order Ref: 797B.

Ultra Sonic Transducers. Two metal cased units, one transmits, one receives. Built to operate around 40kHz. Price **£1.50** the pair. Order Ref: 1.5P/4.

1 RPM MOTOR. This is only 2W so will not cost much to run. Speed is ideal for revolving mirrors or lights. **£2,**Order Ref: 2P328.

12 SOLAR CELL. Could keep a battery charged even when no mains available. £17.50, /rder Ref: 17.5P1.

Battery Quick Charger Into a flat battery to about 5A the charging rate would be 8-10A, this would fall away as the battery charges up or it can be switched to a lower rate. Complete kit includes mains transformer, rectifier, capacitor, switch and metal case. £7.50, OOrder REf: 7.5P20

15V PSU. Mains operated nicely cased, adequately smooth dc output. **£1** Order Ref. 942.

Unusual Solenoid Solenoids normally have to be energised to pull in and hold the core, this is a disadvantage where the appliance is left on for most of the time. We now have magnetic solenoids which hold the core until a voltage is applied to release it. **£2** Order Ref: 2P327.

BARGAINS GALORE

You can Stand On It! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools in, internal size approx, 10 1/2"x4 1/2"x 6" high. Complete with carrying strap, price **£2,** Order Ref: 2P283B

200VA Mains Transformer. Secondary voltages 8v-0-8v. So you could have 16v at 12A. Could be ideal for car starter charger, soil heating, spot welding, carbon rod welding or driving high powered amplifiers etc. **£15,** Order Ref: 15P51.

Mains Filter. Resin impregnated, nicely cased, pcb mounting. **£2** Order Ref: 2P315.

Safety Leads. Curly coil so they contract but don't hang down. Could easily save a child from being scalded, 2 core, 13A, extends to 3m, **£1** Order Ref: 846, 3 core, 13A, extends to 3m **£2** each, Order Ref: 2P290

Power Supply with Extras. Mains input is fused and filtered and the 12V DC output is voltage regulated. Intended for high class equipment, this is mounted on a PCB and also mounted on the board buteasily removed, are two 12V relays and Piezo sounder, **£3** Order Ref: 3P80B.

100W Mains Transformers. Normal primaries 20-0-20 at 2.5A, or 30V at 3.5A, **£4** , Order Ref: 4P24, 40V at 2.5A, **£4** Order Ref: 4P59, 50V at 2A **£4** Order Ref: 4P60.

Phillips 9" High Resolution Monitor. Black and White in metal frame for easy mounting. Brand new, still in maker's packing, offered at less than price of tube alone, only **£15,** Order Ref: 15P1.

Insulation Tester with Multimeter. Internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges , AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. These instruments are ex-British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50, yours for only **£7.50** with leads, carrying case **£2** extra, Order Ref: 7.5P/4.

Mains 230V Fan. Best make "PAPST", 4 1/2" square, metal blades, **£8** Order Ref: 8P8

2MW Laser. Helium neon by Phillips, full spec. **£30,** Order Ref: 30P1. Power supply for this is in kit form with case is **£15,**Order Ref: 15P16, or in larger case to house tube as well **£18** Order Ref: 18P2. The larger unit, made up, tested and ready to use, completet with laser tube **£69,** Order Ref: 69P1

1/3hp 12V Motor- The Famous Sinclair C5. Brand new, **£15** Order Ref: 15P8

Solar Charger. Holds 4AA nicads and recharges these in 8 hours, in very neat plastic case **£6** Order Ref:6P3.

Ferrite Aerial Rod. 8" long x 3/8" diameter, made by Mullard. Complete with two coils. 2 for **£1.** Order Ref: 832P

Air Spaced Trimmer Caps. 2.20pf, ideal for precision tuning UHF circuits, 4 for **£1.** Order Ref: 818B.

Mains Isolation Transformer. Stops you getting "to earth" shocks. 230V in and 230V out. 150 watt, **£7.50,** Order Ref: 7 5P/5 and a 250W version is **£10,** Order Ref: 10P97

5 RPM Mains Driven. This is a shaded pole motor, **£5,** Order Ref: 5P54

Amstrad Power Unit. 13 5V at 1.9A or 12V at 2A encased and with leads and output plug, normal mains output plug, normal mains input **£6,** Order Ref: 6P23.

80W Mains Transformer. Two available good quality both with normal primaries and upright mounting, one is 20V 4A, Order Ref: 3P106, the other 40V 2A, Order Ref: 3P107. Only **£3 each.**

Project Box. Size approx. 8"x4"x4 1/2" metal, sprayed grey, louvered ends for ventilation otherwise undrilled. Madee for GPO so best quality, only **£3** each. Order Ref: 3P74.

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ETI's Cover Disk - Layo1 PCB design and schematics package.

This month's free cover disk gives readers the software to design their own computerised PCB layouts

As readers in the UK will notice, this issue includes ETI's first ever cover mounted disk. It contains free software that should run on any IBM PC or 100% compatible, with mouse, EGA graphics and running DOS 3.1 or later. This is the first of two disks and contains a versatile PCB design and schematics package, called Layo1.

This disk contains a shareware version of the program limited to 1000 commands, which in practice means designs with about 200 pads and 800 tracks. Sufficient capacity to design almost any of the PCBs used in ETI projects.

Let's take a brief look at what Layo1 can do.

What Is a PCB Design Program?

A PCB design program, such as Layo1, is really a specialised form of CAD drawing package, concerned with manipulation of two-dimensional graphic objects. Although the copper pattern on a PCB would seem to be a very complex graphic shape, it can be broken down into an arrangement of many small, simple basic objects, which are linked together in a unique pattern to form the PCB. These objects fall into four distinct categories and are referred to as pads, tracks, text and components.

Pads are small areas of copper, usually drilled with a hole, where a component lead is soldered to the board, a tracks being a thin line of copper which joins two or more pads. A special form of pad is the via, which is used to connect tracks on opposite sides of a double-sided board.

A text object is, as its name implies, simply a single character or a string of text characters which are put on the board to provide information to users. A component is a 'ready-made' combination of pads, a component outline and sometimes text, showing the component reference and value. Thus, a component might be the pad outline for a DIL chip or a transistor.

The PCB design program is used to place these objects onto a board. The maximum board size for Layo1 is 650 x 650mm, more than sufficient for any design of an ETI type project. This board size must be defined before starting.

With Layo1, the PCB can normally have from one to seven copper layers and one to eight text or silk-screen layers. Again, this is more than adequate, most boards being fabricated with one or two layers as single sided or double sided boards. The silk-screen layers hold the information that would be printed over the top or bottom copper layers, typically showing component outlines and references.

Objects can be placed on any of the layers, although normally text and component outlines are placed on the silk screen layers and pads and tracks on the copper layers. When a component is placed on the board, the outline automatically appears on the silk-screen layer whilst the pads appear on all the copper layers.

Laying Out a PCB

Having looked at some of the basics, lets now turn to how a simple board can be laid out using Layo1. A line at the top of the screen area is taken up by the display of status information. The various options can be selected by activating a menu bar and then selecting a drop-down menu. The desired function can then be selected from this menu. Everything is under mouse control and very easy to use.

A mouse controlled cursor is also used to move and manipulate objects, and to select options from the menus.

Unless the desired board is very small, the screen will only show a small part of the overall layout, but the board layout view can be altered by pan and zoom functions. The pan function allows one to move the field of view to any part of the board. whilst the zoom function allows one to look at a section of the board in greater detail, or to see more of the board in the viewing field. Layo1 has nine levels of zoom.

Objects on the different layers are normally shown in different colours, in order to clarify the display. In addition, each layer may be by turned on or off individually.

Selecting and Laying Out the Components

The first step in manually designing a PCB (the design can be generated automatically, more about that later) is to select components from a library of devices supplied with the program. Each component will have a name, such as R50, which might be a resistor with 0.5in pad spacing. Once selected, a component is placed on the board by moving the cursor to roughly the required position and pressing a mouse button.

Components selected from the library will come complete with pads. Additional pads are added by selecting the size and shape from a menu of options and placing them in position on the selected layer, in a similar manner to the components. The size and shape of pads available from the menu can be configured by the user.

Laying Out the Tracks

The next step is to run the tracks. With the cursor at the starting point, one of the mouse buttons is pressed. The cursor is then moved to the next pad or point where a bend is required and the mouse button pressed again. When the last pad is reached the other mouse button is pressed, to finish the track. The procedure is very similar to taping by hand. The width of tracks can be selected in a similar way to the size of pads.

Adding Text

Text may be added to the PCB in a selection of sizes and thicknesses. Once the text has been typed in at the keyboard it is treated as a single object and may be placed anywhere on the board. The main use of the text facilities is for adding references (IC1, R1, etc.) to components. For special characters, logos, etc., Layo1 includes a versatile text editor.

Design Aids

One of the most useful design aids is a grid which is superimposed on the design to aid accurate positioning of objects. Its size can be set by the user in multiples and fractions of a tenth of an inch or the metric equivalents. It is also possible to switch on a 'snap' mode, whereby when an object is released it is automatically aligned on the nearest grid point or points. This is a great help in positioning objects quickly and accurately.

The scale function gives a read out on the screen of the x and y co-ordinates of the current position of the cursor in either metric or imperial units. The position is measured relative to the absolute origin, which is at the bottom left of the maximum viewing area, or relative to a user defined origin. As an example, the distance between two pads is easily checked by making the first pad the origin of the scale and then pointing to the second pad.

Editing for Errors

The program provides editing functions to allow correction of the inevitable mistakes that will occur when designing a layout. The method involves selecting an object by positioning the cursor close to it and pressing the mouse or return button. The object is highlighted and can be rotated, reversed, deleted or simply moved by repositioning the cursor. When the mouse button is pressed again, the object is redrawn in the new position or orientation.

To make doubly sure that errors are not made, Layo1 includes a design rule check. This can be used to ensure that tracks and pads are not placed too close to each other.

When editing a component to which tracks have already been connected, each track remains connected to the pads and is stretched as a 'rat's nest' to the new position. Tracks will have to be adjusted but at least the connections are retained.

Editing tracks is a little more complicated. The track route is usually stored as a list of node co-ordinates. A node is a point where the track starts, finishes or changes direction. The nodes are stored in the order in which they were entered. Each node can be selected individually and deleted or moved. If a node is deleted then it is removed from the list and the track is now routed from the previous node in the list directly to the node following the deleted node. If the nodes have been entered in a straightforward manner the result is what is expected. However if the track was laid down with overlapping sections strange things can occur.

Working With Blocks

Block functions form the next higher level of editing facilities. A rectangular area of the PCB is selected and the contents can then be moved, deleted, copied or rotated. As when moving a component, tracks crossing the block boundaries can be left behind or stretched to reach their new position.

Creating Components

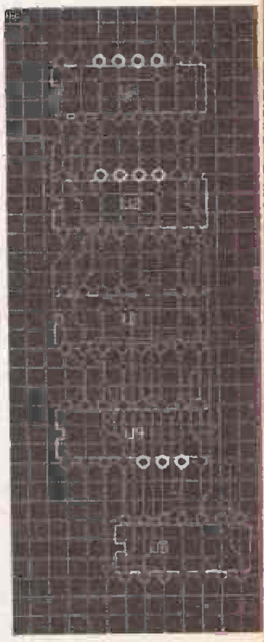
Although Layo1 is supplied with an extensive component library, there are facilities to create or modify components. The procedure is to lay down the pattern of pads required together with an outline and any text in a blank area of the screen. Special graphic functions are available for drawing rectangular and circular outlines. The completed component is stored in the library under a suitable name.

What About Schematics?

So far we have just looked at the basic manual PCB layout facility of Layo1, but the program is capable of a lot more than this. Layo1 comes complete with a schematic drawing facility. This not only allows one to create nice looking diagrams to accompany your PCB design but it also provides a means of automating PCB layout, using what is known as autorouting.

Schematic Capture

Integration of schematic drawing and PCB layout design is a very powerful feature of Layo1. It involves a two stage process. First a schematic drawing of the circuit is produced and from the information provided by this drawing, the system automatically produces two files, a component list and a netlist. The component list is a list of all the component types and their circuit references. The netlist specifies the connections between them as a list of nets, which specify the component pins that are to be connected together by tracks. The format of each net is typically a unique reference number followed by a series of component pin designations such as IC3/2.



The great advantage of schematic capture is that the preliminary stages of PCB design are unnecessary, as the program can use the component list and netlist to automatically select components from the libraries, place them on the board and display all connections as a rat's nest, ready for routing. There is also less chance of mistakes as, once the schematic has been defined, the rest of the process is computerised.

A PCB at the Push of a Button

With the aid of schematic capture, Layo1 can automatically generate a PCB. This is done by the autorouter. The results may not be the optimum layout, but it is certainly a very quick way of producing a reasonable quality board. Any board produced by the autorouter can always be altered manually if necessary.

Putting It On Paper

Layo1 supports a range of output devices consisting of 9 and 24 pin dot-matrix printers, HP Laserjet compatible laser or inkjet printers, HPGL compatible pen plotters and PostScript compatible printers. Files can also be produced in Gerber and Excellon format for controlling photo-plotters and NC drills respectively. These latter options are useful if you intend to have a board produced commercially. The layers to be printed are selected individually and output can be produced at various scales, rotated to fit on the paper or mirror-imaged. A draft mode may also be available for producing check plots more rapidly.

Installing Layo1

To install Layo1 on your computer there is a special Install program to simplify the procedure. All you need to do is insert the disk into the appropriate disk drive and access that drive, then simply type:

INSTALL

The program will ask you a few questions about your system and where you want to install the program. In most cases, the default answer will be given by simply pressing Return. After these questions, the install program will expand the files stored on the disk and copy them onto the designated target drive (drive C: is the default drive for installation of Layo1). This takes a few minutes, after which Layo1 is installed and can be run by typing LAYO1 in the root directory.

There is a copy of the manual on disk and this can be printed out either from Layo1 or by loading it into Word for Windows. Also included in Layo1 and its documentation are details of how to order versions of the program with a larger capacity.

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Next month

In next month's issue of ETI we will be giving away another disk which includes the remaining part of Layo1. The programs will include the Schematic output driver and the PCB output driver, the PCB design rule check and tutorial software. To make sure you do not miss your copy, place an order with your newsagent now.

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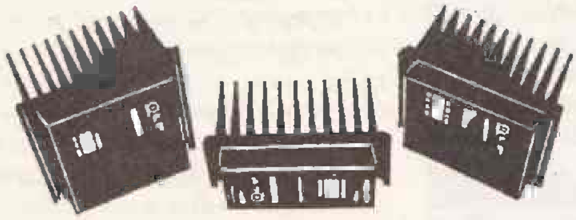

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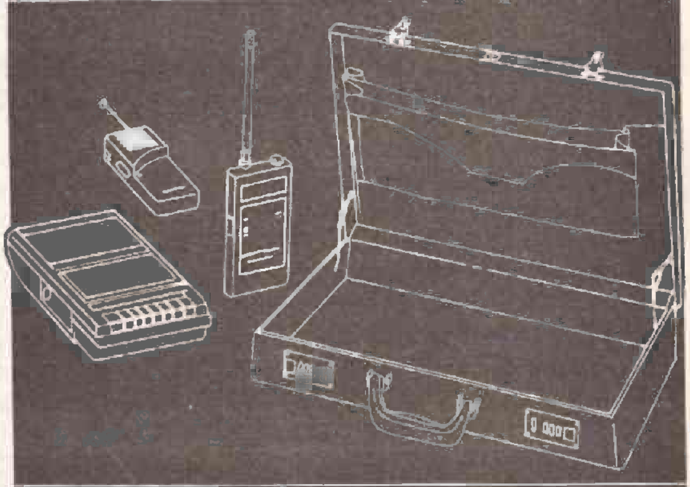

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Recycling PCs

Discarded personal computers are an ideal source of cheap equipment for the home experimenter

The personal computer revolution began in earnest about fifteen years ago, and since then the number of personal computers of all sorts which have been produced around the world must be well into the hundreds of millions. I doubt if anyone really knows, but an awful lot of machines have been made and sold. It is an industry which has been driven by a relentless drive to produce better and faster machines.

The life of a personal computer is not dictated by it's starting to break down, but by its obsolescence in this relentless drive for the better and the faster. A machine is now considered old just three or four years after it has been bought. At five or six years old it becomes very difficult to obtain parts and software and thus it is no longer worth keeping. Indeed, it is probably true to say that the majority of PCs which are scrapped are still in working condition and could probably go on working for another ten years or more before suffering serious faults. The personal computer is in many ways the ultimate consumer product.

So what has happened to all these machines, to the ZX81s, to the VIC20s, the Dragons, Orics, TRS80s, PETs, Spectrums and Apple IIs, not to mention the hoards of different makes of IBM PCs. Some, of course, are still in use, but the majority have been scrapped or lie unused in cupboards, attics and draws. Few are recycled and even fewer are refurbished and put to new uses.

It is a terrible waste and one which looks set to increase. Indeed, a recent report by the Carnegie-Mellon University of Pennsylvania predicted that between 1992 and 2005 over 150 million PCs and work stations will have been discarded in the US alone. To this we must add, at the very least. an equal number of peripherals such as printers, plotters, monitors, etc., plus probably five or six times as many consumer/games computers.

So what will happen to all these machines, indeed what has happened to the ones which have already been scrapped? I have already said that some are recycled. Companies like IBM and ICL run recycling projects, but according to reports these are not exactly profitable, and there is an actual loss of over £7 per recycled machine. They are largely PR exercises.

More constructively, a few machines are refurbished and shipped to the third world, but the majority are destined for attics or dumped into landfill sites with the rest of the rubbish we all generate.

It is amazing to think that, according to that Carnegie-Mellon report, the cost of burying those 150 million PCs and work stations discarded in the US over the next decade, will be in the region of $1 billion. Surely a lot of them could be put to some better use, thereby saving some of this massive expenditure?

Scrap PCs and the Experimenter

All these scrap computers and their peripherals are, in a way, a godsend to the experimenter. Probably eighty or more percent of these systems either still work or could easily be repaired. They are in most cases being thrown out because users think them too slow, perhaps they have too little memory, too little disk space, or too low a resolution display, or maybe the company simply has a policy of replacing all electronic equipment after a certain time.

If these old machines still work, then they can be used as the basis for all sorts of devices and experiments which require in-built intelligence. If they don't work, then they make a great source of spare parts for repairing other machines, or of useful bits and pieces that can be incorporated into other projects. They all contain nice 5V and 12V power supplies, ideal for the experimenter and laser printers also incorporate nice EHT units. They are a good source of memory and processor chips. They are also a good source of various units like disk drives, LCD displays, stepper motors, monitors, etc. Even old cases can prove a useful source of sheet metal.

Where Can You Get an Old PC?

Old computers and computer peripherals now seem to crop up in the most unlikely places. I recently saw a whole pile in a builders skip! But rubbish dumps and skips are not the best place to start looking, machines are usually well smashed up by the time they reach such places.

Probably the best places to start looking, besides your own attic, are some of the companies who advertise in magazines like ETI. If you skim through this issue, you will probably find at least half a dozen companies which can sell you old computers, often in guaranteed working condition, at very low prices.

Another good place to look is at the company you work for, or a local large company. Very often companies offer old computers to their employees at knock down prices and in some cases are prepared to give old equipment to local schools or clubs.

Then, of course, there are the small ads in local papers and in computer magazines although, unfortunately, many individuals who advertise old equipment for sale have a very inflated idea of what it is worth. Computer auctions are another very good source, as are local jumble sales and car boot sales.

Refurbishing Old Machines

You will find that a great many old computers and peripherals still work, while many others just need a simple bit of repair and refurbishment to bring them back to working condition. The most likely components to fail are purely mechanical units like printers and disk drives and there is often little that can be done about these, it is just a case of them wearing out. Switches and keyboards fall into the same category. If the unit can be disassembled and, more importantly, reassembled, it may be worth giving the more critical parts of it a very good clean, using a suitable non-water based solvent of the type sold for cleaning PCBs, etc., then reassembling and very carefully lubricating any bearings.

Dirt is also a major cause of failure in the electronics. I remember once looking inside an old PET computer and finding it full of cigarette ash where the user had let it drop through the keyboard. Again, careful cleaning with a small paint brush and then application of a non-water based PCB cleaner is an essential first step. The next step is to check the power supply, it is surprising how many systems are scrapped simply because a fuse has blown or a voltage regulator has cut out.

Having checked the power supply, any socket mounted chips should then be eased out of their sockets one at a time, pins lightly scraped of any oxide build up (not forgetting to take precautions to protect the device from static damage) and then reinserted in the correct orientation. All edge connectors should also be eased off and back a couple of times to remove any oxide or dirt stopping proper connections being made.

Next, it is a good idea a to make a manual check of the board for dry joints (use a low power hand lens for this). These are a not uncommon cause of failure, especially around sockets and socket mounted chips, where the board may have been exposed to local mechanical deformation, or where chips get very hot and there is a continuing cycle of board expansion and contraction. These factors can help turn a weak but conducting solder joint into a dry, non-conducting one. Any suspect joints should be very carefully resoldered.

Seven times out of ten, you will find that the above procedures will bring a seemingly dead machine back to life. I personally have found chip failures to be fairly rare, indeed the commonest of such failures is likely to be that of a RAM chip, which in most cases will not stop the system from running, just reduce the amount of memory available. If you have spares available, then disk drive controller boards, I/O boards and video boards can be checked out by a bit of board swapping. Again all the above procedures should be applied to these boards.

If none of the above procedures bring the system back to life, then I personally would give up and cannibalise it for parts. Attempting more complex repairs will require access to circuit diagrams and fairly good test equipment. On old systems, the manufacturer may very well have gone out of business, so circuit diagrams are often virtually unobtainable.

Some Intelligent Controller Applications

Old computer systems which can be brought back to life can, of course, continue to be used as conventional computers, but there is always the problem that suitable software becomes very difficult to locate (try small ads in some computer magazines). Alternatively the ingenious experimenter can turn an old computer into the intelligent component of an instrument or a control system.

For example, a simple home computer such as an old Spectrum or C64 could be used as the basis for a home monitoring and alarm system, that could turn lights off and on when you are away on holiday, that would check the integrity of doors and windows, check smoke alarms, etc. The I/O port on the system could be used to poll a collection of different sensors and the program, which could be written in BASIC, would take the appropriate action.

I have heard of people using old computers as the basis of an intelligent weather station, to control a machine tool, to act as a data logger and chart recorder and to act as the basis for an intelligent virtual test equipment set up. In fact, virtual test equipment is becoming very much the in thing amongst professionals, since it offers the user a far greater range of functions than would be possible using conventional test equipment. On top of which it allows the user to log all data for later analysis.

All a virtual test equipment set up consists of is a computer interfaced to, for example, an analogue to digital converter. With suitable software, the computer can then emulate an oscilloscope, a digital voltmeter, or any other piece of test equipment which has as its input a variable voltage. Similarly, with suitable hardware interfaced to the computer, it could be used to measure frequencies, test and analyse logic and test and analyse ICs (we will be looking at implementing different types of virtual instrument in future issues of ETI).

Not Forgetting the Environmental Aspect

Recycling old PCs and peripherals is a great idea for the experimenter and a good way for students to learn about such systems, but we must not forget that recycling machines has a positive environmental aspect. According to a recent issue of New Scientist, it takes £200 worth of electricity and 12 tonnes of water to make the average PC/work station. By recycling old systems, particularly by putting them to new uses we can ensure that this utilisation of scarce resources is not wasted by being buried in a waste tip.

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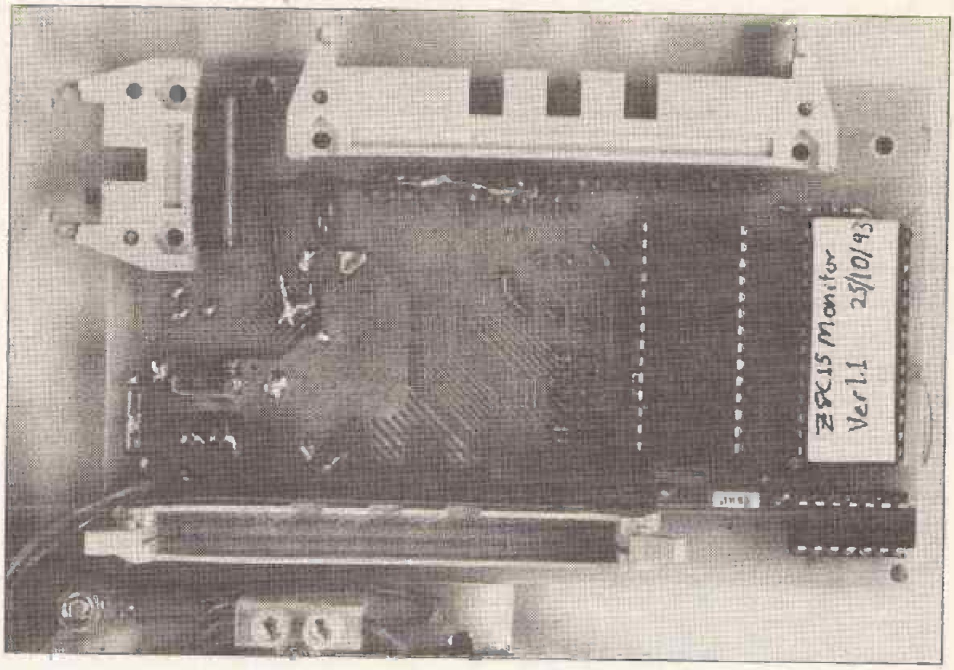
PROJECT

Z-80 Single Board Computer



Jason Sharpe describes how to build a simple, low cost, Z-80 based computer which can be used as the basis for a great many fascinating and useful projects

In recent years there has been an explosion in the use of single chip micros in electronic products. Small size, falling price, low power consumption and increased functionality, are all contributing factors.

Most of the better known microprocessor families, which can be found in anything from telephones to navigation systems, are single chip devices. No external support ICs are required, as they have small amounts of RAM/EEPROM/EPROM/PROM, clock generators, I/O ports, ADCs, etc., on board.

For most amateurs however, the single chip project is out of reach. Device programmers and development boards often cost several hundred pounds, rising to several thousand pounds if an ICE (In Circuit Emulator), is required.

This project is a low cost development board for the Z84C15. All that is required to use it is a Z80 assembler or cross assembler and a computer with a serial port and simple terminal emulation software.

The Z84C15 Microcontroller

The Z84C15 microcontroller, or IPC (Intelligent Peripheral Controller) as Zilog calls it, consists of a standard Z80 CPU core, standard Z80 peripherals and some custom devices, all integrated onto a single chip, as shown in Figure 1.

Its main features are

- Standard Z80 CPU core and bus
- TTL/CMOS compatible
- Two channel 8 bit parallel I/O port (PIO)
- Two channel serial I/O ports (SIO)
- Four channel counter time controller (CTC)
- Watch dog timer (WDT)
- Built in clock generator controller (GCG)
- Built in wait state generator
- Built in power on reset (POR) circuit
- Up to 10Mhz clock
- Small surface mount package
- Power saving 'Idle' modes (50µA supply current in STOP mode)
- No demultiplexing of outputs required

Internal memory on microcontrollers is often too small for all but simple applications. The IPC has no internal memory, instead a standard Z80 bus is available from the chip, allowing 64kB to be accessed. Using the two built-in programmable chip select pins only two OR gates are required to access two external

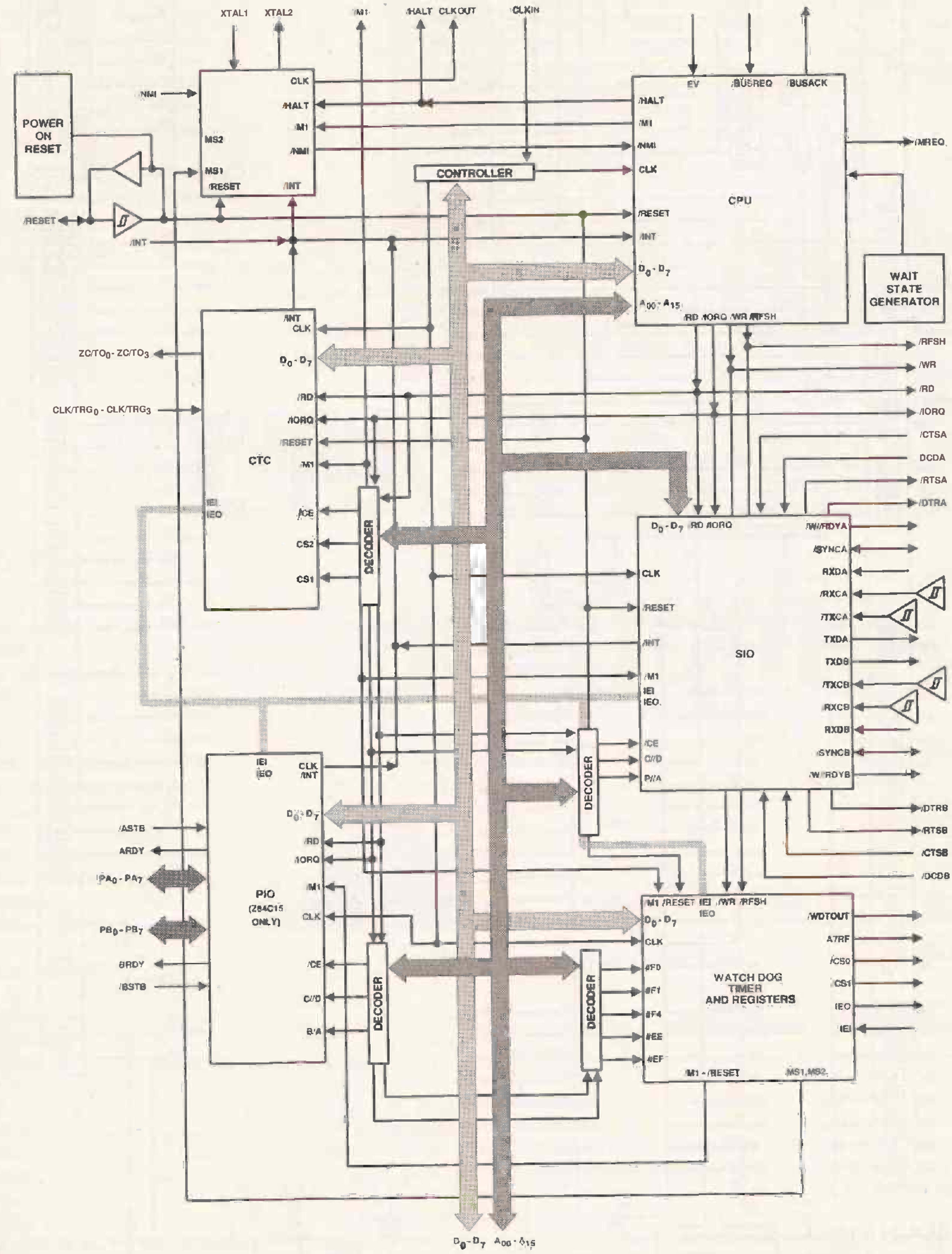


Fig. 1A Block diagram of Z84C15 Microcontroller

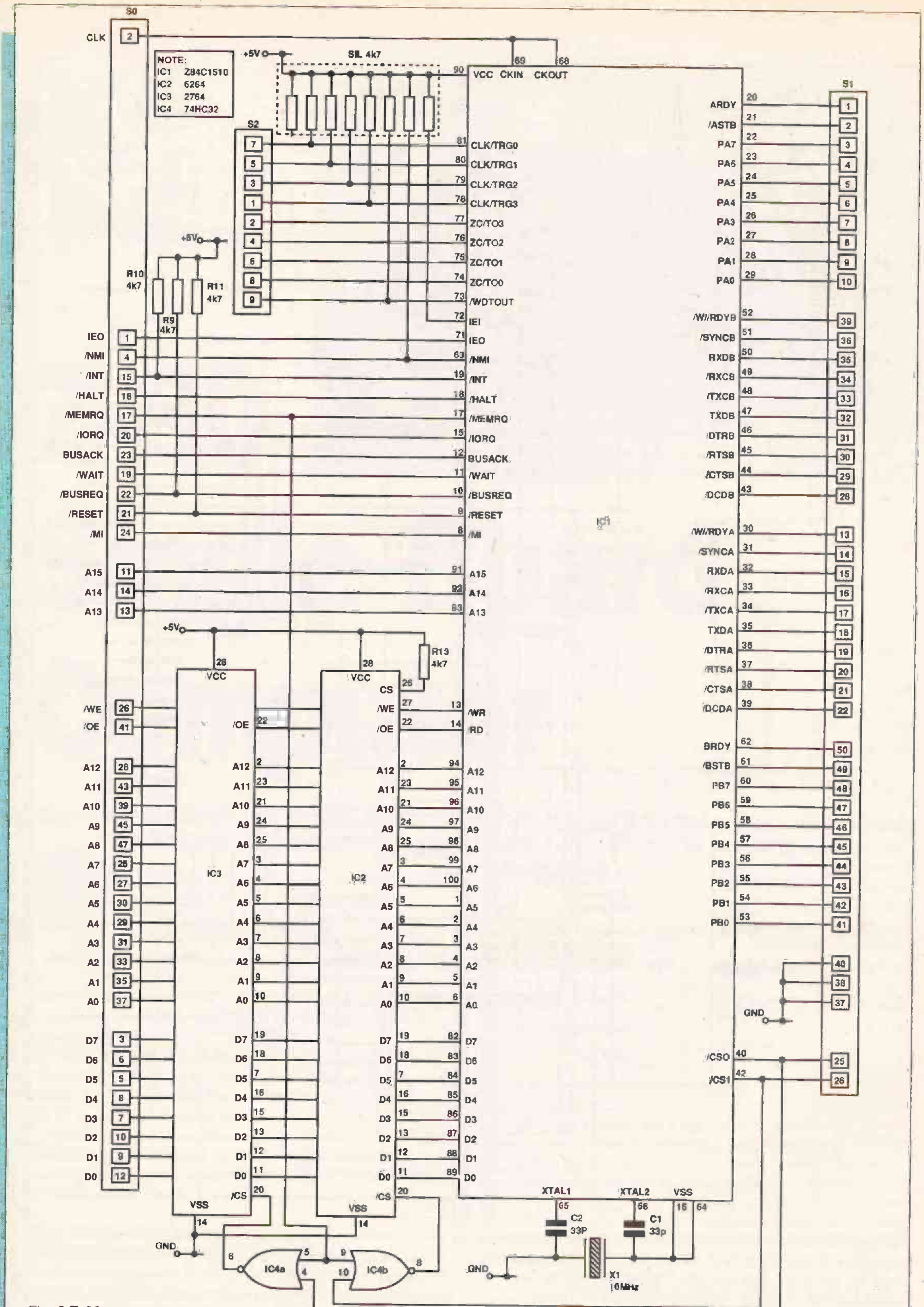


Fig. 2 Z-80 computer circuit

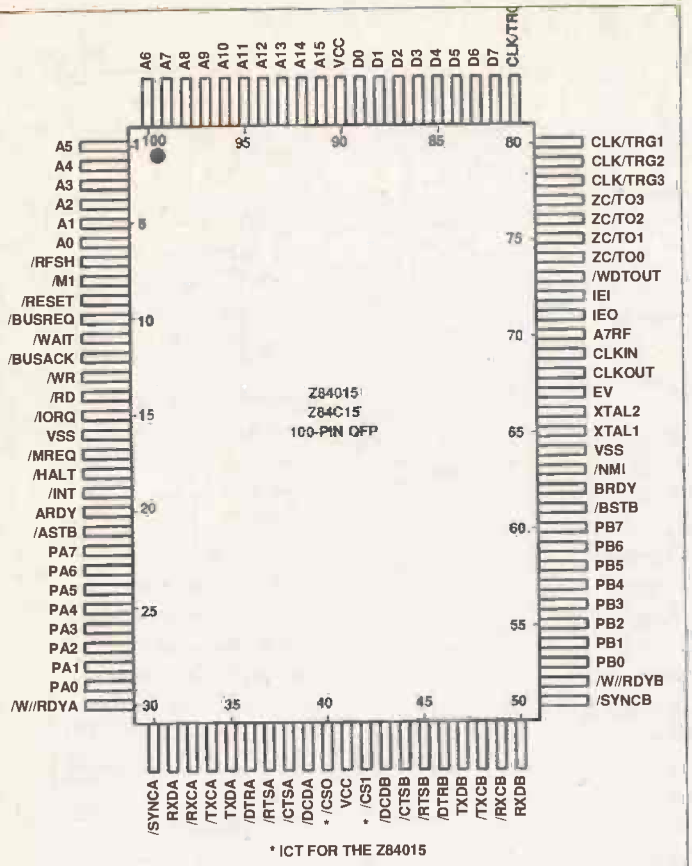


Fig. 1B Pinout for Z84C15

memory devices.

As the IPC contains standard Z80 peripherals, those of you familiar with the devices will have no problem programming it, and may even have some software already developed.

Many pins are required to make the above functions available. Often, microcontrollers multiplex several signals onto one pin, which must be demultiplexed with external logic. Zilog decided to have a pin for every function - the IPC comes in a 100 pin Quad Flat Pack (QFP)!. This is a surface mount device with a ~.65mm pin spacing, and overall package size of ~18 x 24mm.

The Circuit

As the circuit diagram, Figure 2, shows, few components are required to make a working system. It was originally designed for evaluation of the IPC and development, so most pins are available on external connectors. Unused inputs are tied high with 4k7 resistors to prevent spurious operation. A 10Mhz crystal is connected to the CGC inputs. The CGC output (pin 68) is connected to the system clock input (pin 69). Chip select lines /CS0 and /CS1 are OR'ed with the /MEMRQ line. When a memory access is attempted, /MEMRQ will go low, as will the appropriate CS line, causing the OR output to go low, selecting one of the two memory devices. The circuit board is wired for two 8kB memories, which should be enough for most applications. /CS0 must select a ROM, /CS1 can select a RAM or ROM.

Construction

Due to the IPC package, this circuit must be constructed on the double sided circuit board shown in Figure 3.

The IPC is mounted on the under side of the board. Mount this first, so the board lies flat. Wear an earth strap and try not to touch the pins as it is a CMOS device. Without special equipment, soldering is a slow process. I used a 15W Antex soldering iron with a 1mm bit, grounded via a 10M resistor, and solder paste. Solder paste is a low melting point solder that does not leach as easily as normal solder.

Position the device on the board. A vacuum pen is the best way to handle the device, though sticking a blob of Blu-Tak to the top will suffice and is considerably cheaper! Check the orientation is correct, as it won't be easy to remove once soldering is started. While still holding the device in place, apply a little solder paste to a couple of pins and solder them. This should hold the device in place. Apply the paste to one pin at a time, using a sewing pin, and solder as you go. A couple of applications may be required for each joint. The first application may just tin the pin and track.

Be careful not to get the IC too hot. Although the paste will melt when the soldering iron comes close, the (IC) pin and track should be touched, to get a good joint. Figure 4 shows the process. Check each joint carefully for solder bridges and a little solderwick can be used to clear these up. This process may take around an hour (or two with coffee breaks!), but trying to rush is a recipe for disaster.

The board is not through hole plated, so track pins must be used to join tracks on one side to the other, Figure 5. Crossed circles on the overlay show where they should be placed. Turned pin sockets must be used for the ICs, so the pins marked with dots can be soldered to both sides. The case of xtal1 should be soldered to the ground plane. Add the IDC connectors last.

When constructed, check the board carefully for solder bridges, etc. Then place the ICs in their sockets.

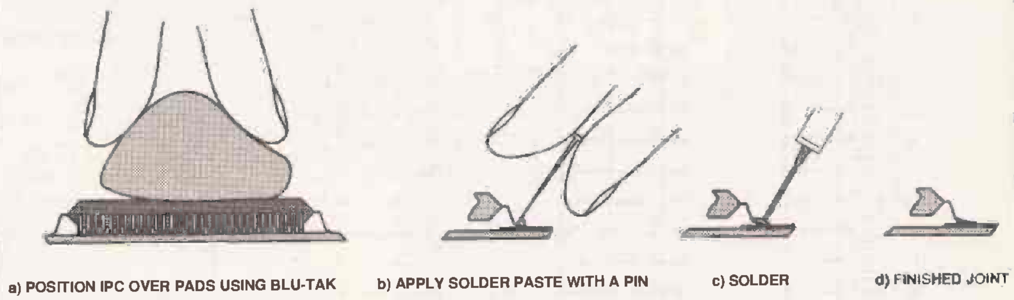


Fig. 4 Soldering the QFP

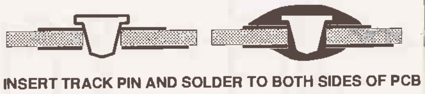


Fig. 5 Soldering track pins

Testing

It is possible to test the circuit without using the monitor ROM by hardwiring certain instructions (e.g. NOP), into a socket, and monitoring the bus with an oscilloscope. It will be assumed that the reader has the monitor ROM, described later.

Figure 6 shows a couple of circuits that can be used to connect the IPC board to a standard RS232 port. One requires a +12V supply, the other operates from a +5V supply. The circuits change the voltage level of the signals from TTL to RS232 and vice versa. When one of these circuits has been connected to the

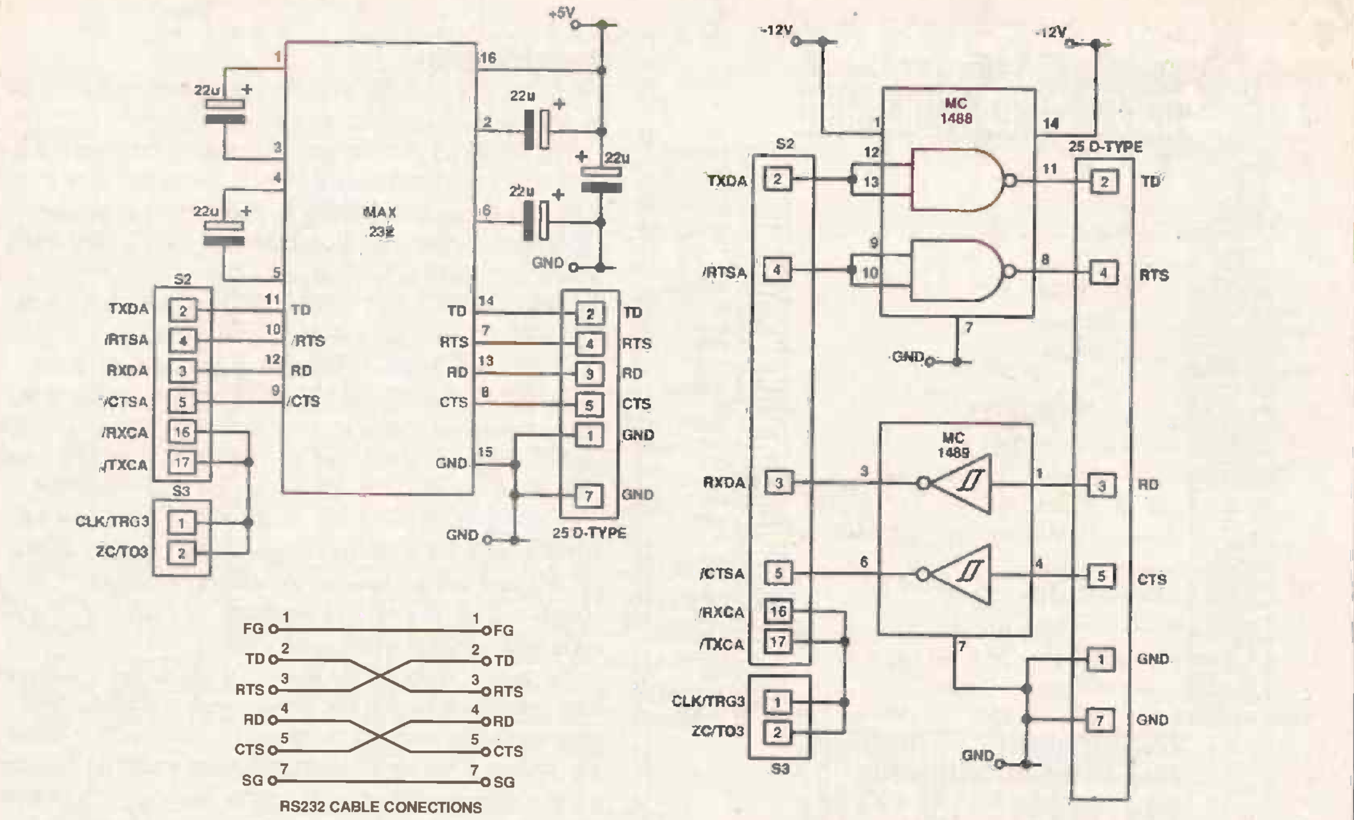


Fig. 6 RS232 buffer circuits and connection lead

IPC board, it should be connected to the PC using the lead shown in Figure 6.

If you have a PC and Windows, you can use the terminal emulation program to set up a communications link between the board and the PC. One should set the following options on the terminal program,

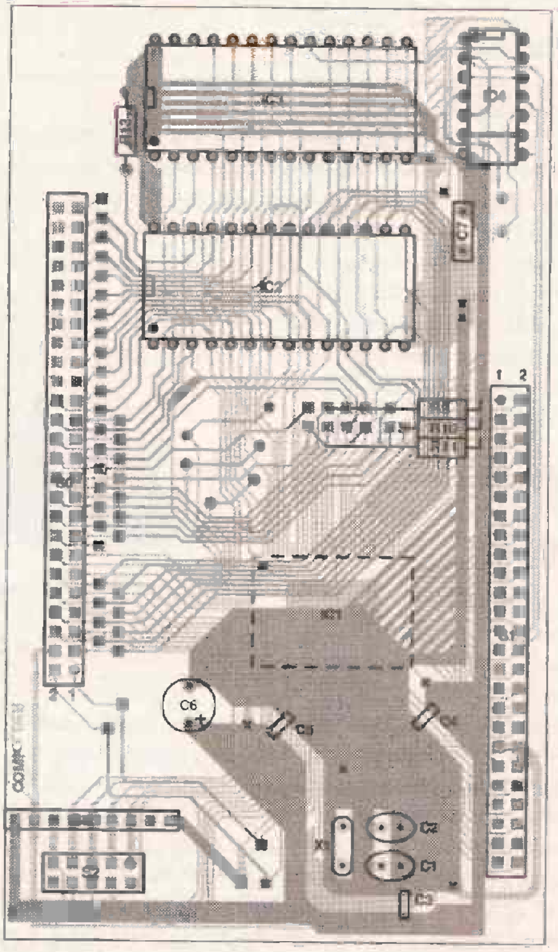
```
Terminal Emulation     - DEC-VT100 (ANSI)
Text Transfer          - Standard Flow
                       Control
Communications         - Baud rate   4800
                       - Data bits   8
                       - Stop bits   1
                       - Connector   COM2 -
                       or whichever port you
are using
                       - Flow control   None
                       - Parity      None

                       - Carrier detect and

                       Parity check, off
Modem Commands         - Modem defaults None
```

You may also wish to change the font size. Save this information. Connect the PC, and turn on the IPC's power supply. If all is well, a message should appear on the terminal window. If it appears garbled, check the settings, or reload the settings and remove and re-apply the IPC power. Pressing keys (except space) should cause the characters pressed to appear in the terminal window.

If nothing happens, disconnect the RS232 line. Check the CLKOUT pin of the board is oscillating. If it is OK and there is activity on the bus lines, check the connections in the RS232 circuit, especially that the lead is constructed correctly. Otherwise, check the boards for bad connections, shorts, etc.



NOTE: IC1 IS MOUNTED TO SOLDER SIDE OF BOARD.

Fig. 3 Component layout on double sided PCB

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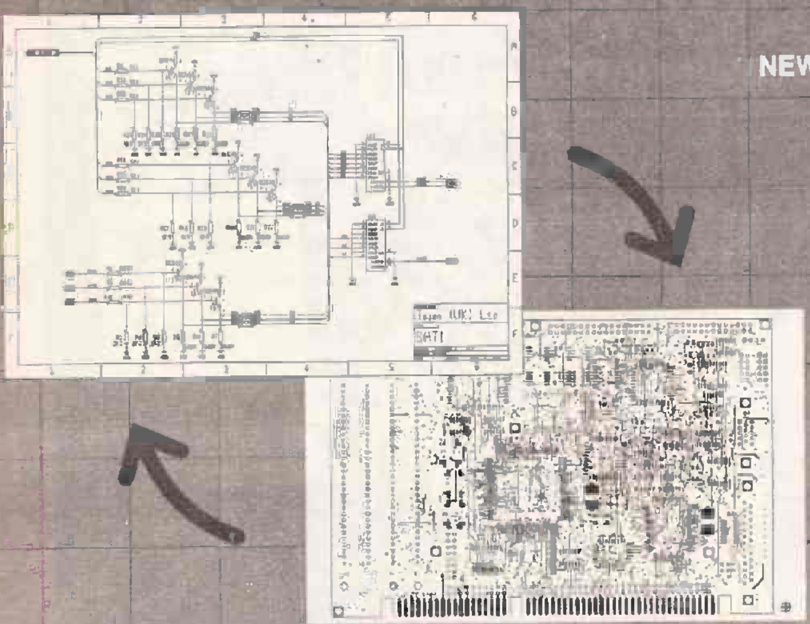

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PROJECT

Bob Noyes designed this programmable stroboscope project to provide those special effects for a local school drama department.

Programmable Stage Stroboscope.

Recently, the head of Drama at the local secondary school approached me as to the possibility of producing a stroboscope, but one with a couple of extra features.

It had to be able to operate as a normal strobe, i.e. work over a wide speed range in its own right with the controls built in. It also had to be controlled from the lighting control consul and so be directly under the control of the lighting engineer. It had to be able to be fired on pressing a button and be capable of being synchronised, if more than one strobe was used. These remote control signals had to be 5V compatible and capable of being operated from the computer interface on the lighting control, or a simple manual control for more simple productions.

Because of the possible side effects for those students susceptible to epileptic fits, the strobe should have two power levels. There had to be a low level, in a medium sized hall, so the speed and effect could be seen but would not be as powerful as the level needed for an actual performance. It was estimated that the particular sequence that the strobe would be required for, although only lasting for under a minute on the final performance, might well take a total of several hours in rehearsal - hence exposing the students to the effects during this time, albeit in short bursts. Full power would normally only be used in the final stage production, but must be powerful enough for the medium sized stage used in school productions.

For those of you who are not familiar with strobes, a strobe is based around a xenon tube (flash gun tube). This produces a very fast intense flash, unlike a tungsten light bulb that has to warm up to get the filament white hot before light is given off. The xenon tube relies on a gas breaking down under a high voltage and hence is almost instantaneous.

Normally, a flash gun, once fired, has to charge up before it can be fired again - this is due to it being battery driven and the high voltage produced by a small invertor. A strobe is normally mains powered and so can be fired as quickly as required - power being no limitation. Although each flash is of the same duration, the gap between flashes can be altered on the speed control and, depending upon the setting, normal movement can be made to appear as a series of still frames taken from a movie film.

Unlike a film, where the still frames are shot very close together to get continuous movement, the strobe effect makes it seem as if only every tenth still is used, to produce a very jerky movement that has "certain dynamic qualities" (to quote the teacher). The slower the strobe runs, the more jerky the movements, because the subjects on stage have moved further between flashes when the stage is in darkness and are only illuminated when the strobe flashes. Strobes have been more commonly found in discos but because of the possible side effects, their use has been limited over the past few years.

The Principles of Firing a Xenon Tube.

The most commonly available xenon tubes come in two forms, a short straight tube up to a couple of inches long and the U shaped tube. The straight tube types are usually found in small flash guns and the U shape in strobes and professional flash units. The advantage of the U tube is that the flash is concentrated in a smaller, more compact area and hence the flash produced seems brighter, having effectively two straight tubes next to each other. These tubes are filled with xenon, an inert gas but when a high voltage of 300-500V dc is applied across its anode and cathode, the gas directly around the electrodes ionises. Still next to no current flows and the tube shows no visible signs of glowing. When a high voltage of 6KV or so is applied to the grid (middle pin), the xenon gas breaks down and conducts. When the tube does fire, it becomes a virtual short

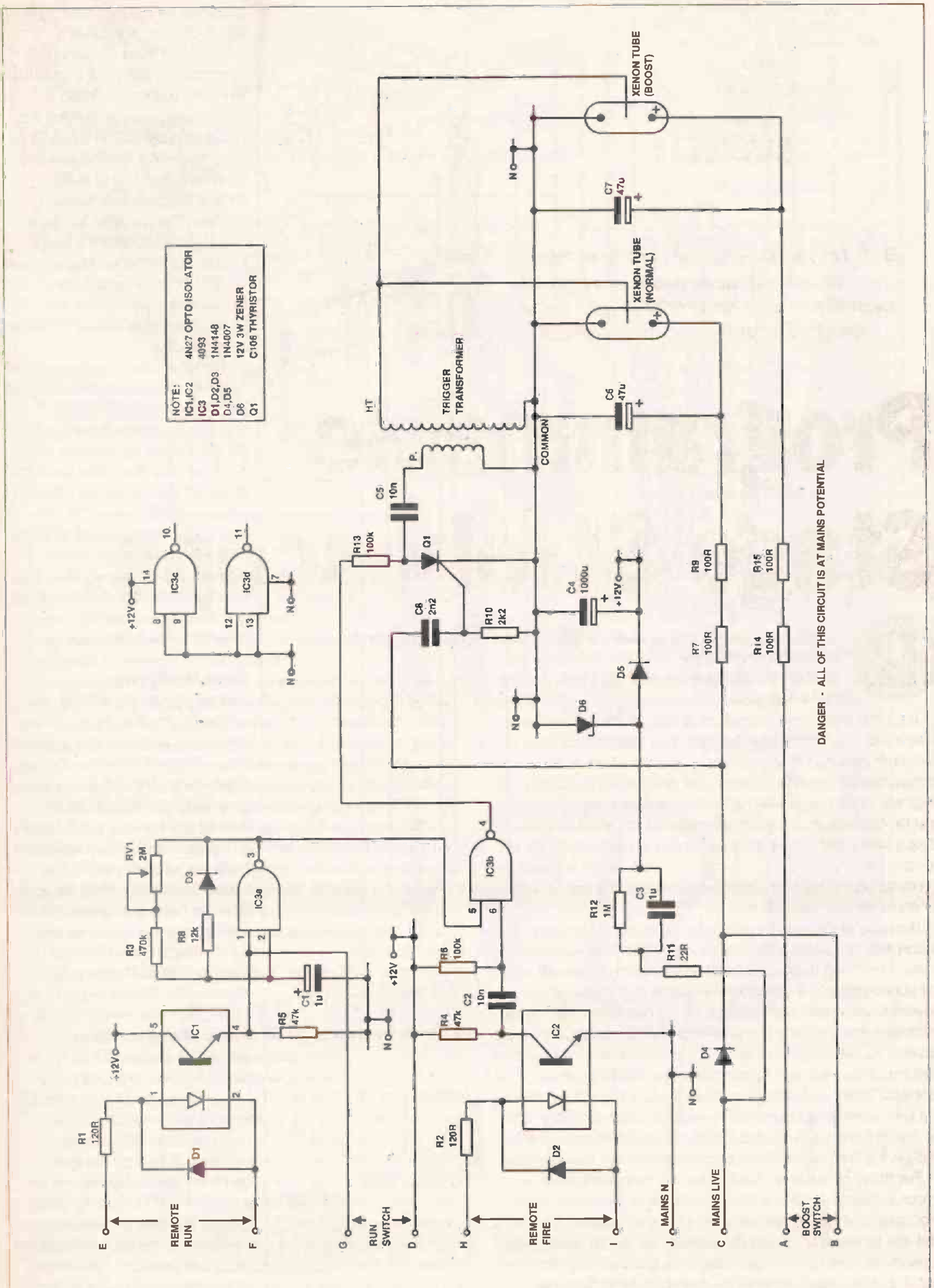

Fig. 1 Main Circuit

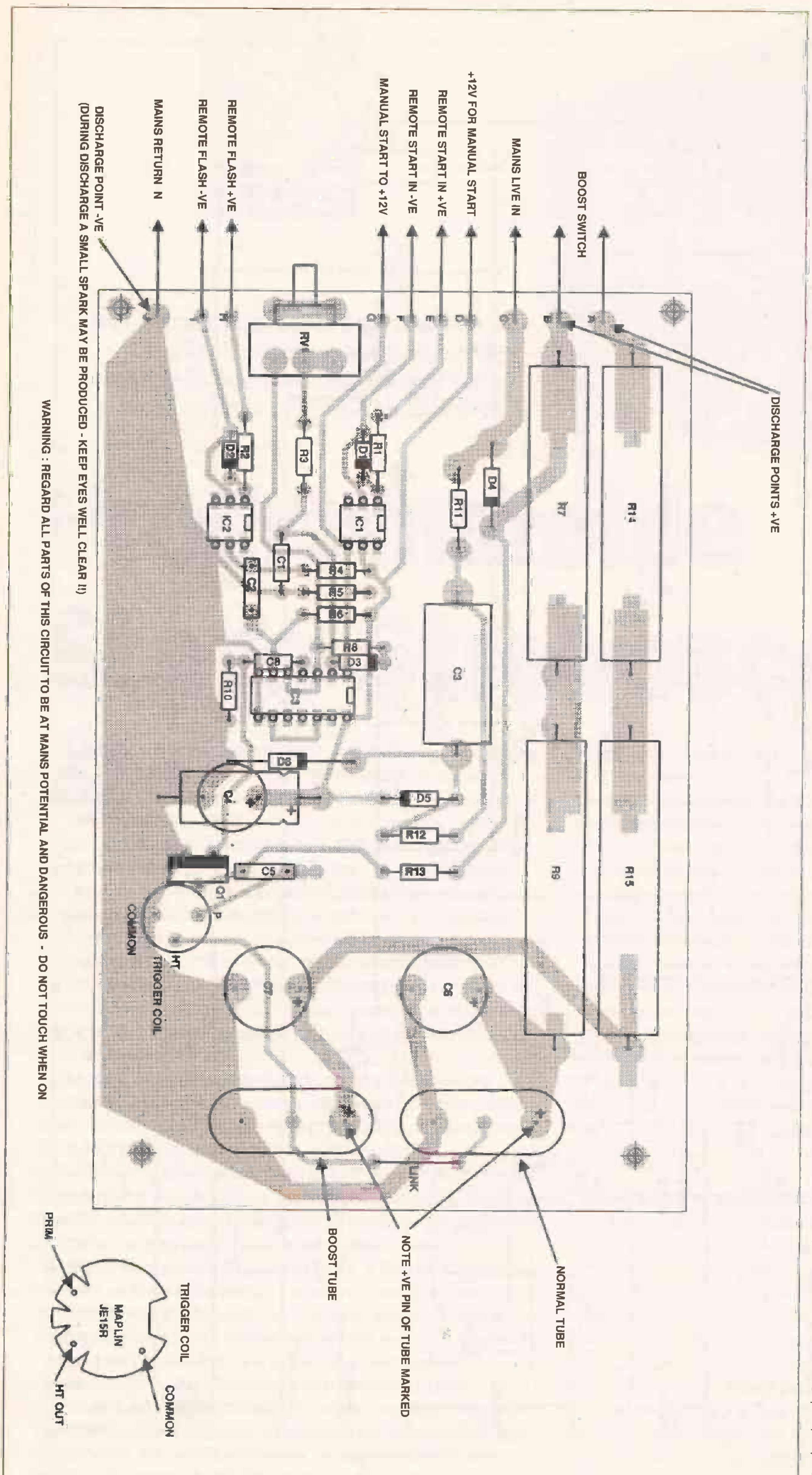

Fig. 2. PCB Component overlay

circuit, so the voltage across it causes a very high current to flow, albeit for a tiny fraction of a second. Because of these high currents, the flash rate should be limited in order to maintain a much lower average current. It is not practicable to use this type of tube for normal lights where its firing rate would need to be several hundred flashes per second. The spec. for the tube used here is around 100 flashes per minute on continuous use, but strobe effects on stage are of limited time duration and this speed can be exceeded for these short periods.

Now the basic principles of the 'flashing' are known, the full circuit can be explained. All of the following circuit is at mains potential and cannot be touched when on. Even after the mains has been removed, the capacitors C6, C7 and, to a lesser extent C5, can maintain a charge of over 300V dc so great care must be taken, especially when getting the circuit working on the bench. This circuit is not recommended for newcomers to electronics.

How It Works

Basically, the strobe has two modes of operation. Firstly, there is continuous flash at a variable speed set on its speed control on the back of the strobe. This function operates around IC3, a standard NAND Schmitt oscillator but with the addition of R8, D3. These two components discharge C1 via the 12K resistor and without these the oscillator gives a square wave at IC3 pin 3, with equal mark to space ratio, but in order to fire the thyristor TR1 and turn it back off again quickly, only a narrow pulse is required, so the square wave oscillator has its output modified to produce low spikes. The charge path for C1 is via R3, VR1 but to discharge it a 12K resistor is added in parallel. D3 prevents R8 from charging C1.

The output of IC3 pin 3 is normally high pulsing low (see Figure 4) when the oscillator is on and high when the oscillator is off. This oscillator can be turned on by the switch on the back of the strobe for manual operation. This is done by switching a high +12V on to IC3 pin 1, normally held low by R5.

To facilitate the remote control

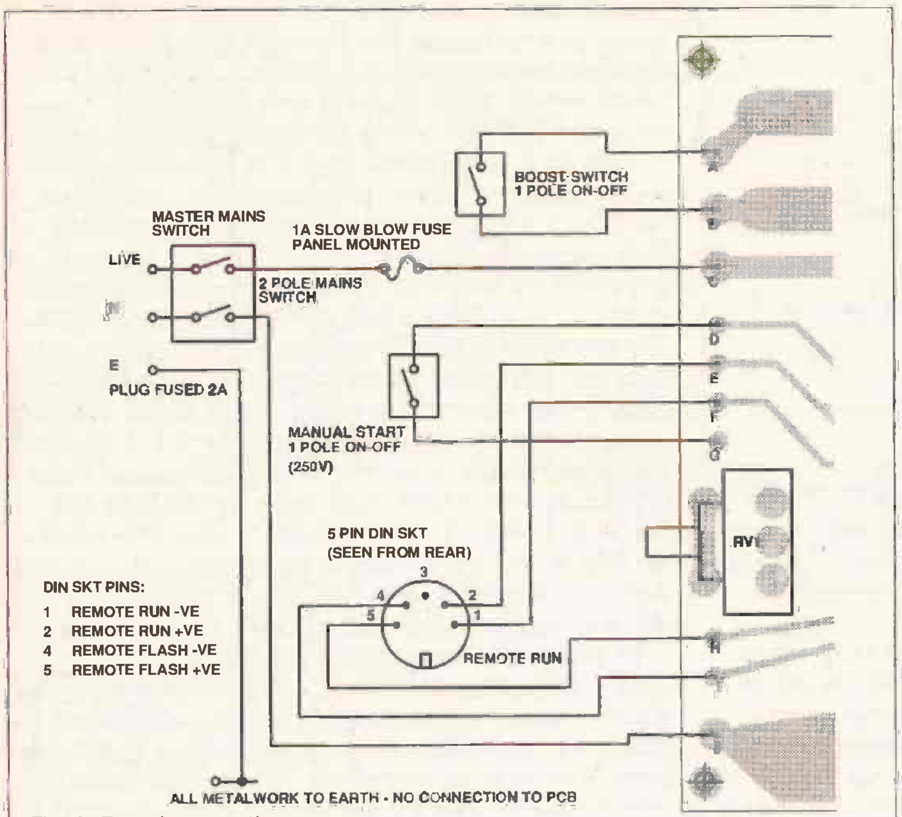

Fig. 3. Board connections

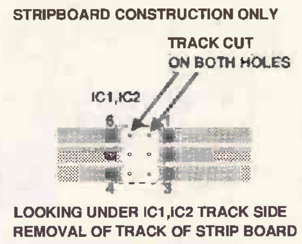

Fig. 5. Precautions when using stripboard

of the strobe, the switch can be bypassed by IC1, an opto isolator. When 5V are applied across the remote run pins of the DIN socket pins 1 and 2, the output transistor in the opto isolator turns on, pulling IC3 pin high, must be off or this feature is bypassed by the internal run switch.

An opto isolator must be used, as the circuit of which IC3a is a part is at full mains potential and any direct connection would also be connected directly to the mains. IC1 then totally electrically isolates the remote start pins on the DIN socket from the rest of the live circuit. If the PCB is not being used for this circuit and it is being built on strip board, all the track under IC1, IC2 should be removed because a track cutting tool leaves the edges of the cut track perilously close and the mains could easily track across such a small gap (see Figure 5). Making this circuit on strip board is possible, but not recommended because of the problem of mains tracking to adjacent tracks.

The choice of R1 at 120n enables the 'remote' to be run from a 5V supply compatible with interfaces from computers. If the 'remote' is to be run from higher voltages, the value of R1, R2 will need to be increased to allow about 30Ma through the LED of the opto. This might well mean increasing its power rating as well.

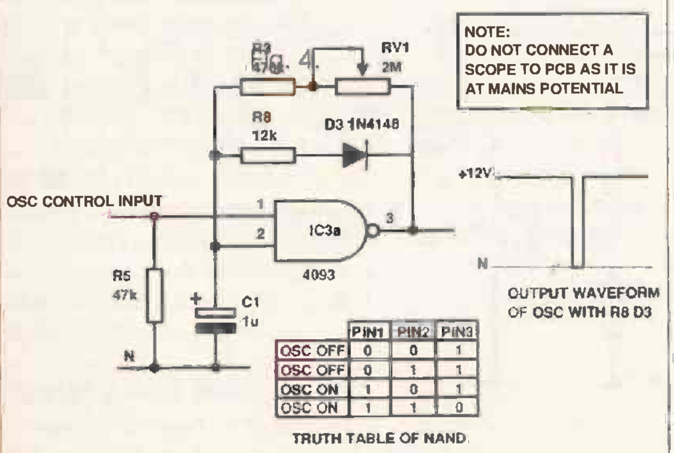

Fig. 4. Basic oscillator

The second way the strobe can be used is to cause it to flash on demand, say to compliment the flash of a gun. This input is also used as the synchroniser input, because if two or more of these strobes are used, a signal on this input on both of them will cause them to fire at the same time. This can be a single flash or pulsed to form a conventional strobe but with the speed set from the external source.

For this mode, IC3b is used because the internal oscillator would be switched off or, more technically, not turned on. This would cause a high on the output of the oscillator IC3 pin 3 and hence on IC3 pin 5. Normally, R6 pulls up IC3 pin 6, causing a low on the output of the 'NAND' gate pin 4. To produce a flash pulse, a 5V pulse is required on the remote fire pins of the DIN socket pins and 4 and 5. This is in turn taken to IC2 - another opto isolator where the pulse appears on pin 5 as a low pulse. This low pulse is taken to IC3 pin pulse delivered to IC3 pin 6 is fast and not held low for as long as a normal pulse delivered on to the remote fire pins. Although a fast pulse can be generated by the computer interface, this input can also be driven by a press switch too, for example, synchronised with a gun shot. If the switch were to be pressed and held it would turn on the thyristor and keep it on until the switch was released. Capacitive coupling removes this possibility.

The output of IC3 pin 4 is capacitively coupled and taken to the gate on the thyristor, TR1. R10 also prevents the thyristor from false triggering when high currents are flowing around the PCB, both in firing the xenon tube, hence discharging and also in the recharging of the main reservoir capacitors.

At first sight, the operation of the thyristor looks a bit of a mystery but it works in the following fashion. Normally the thyristor is off, i.e. C5 can charge up via R13 as the trigger transformer's primary winding is only a couple of ohms. 300V or so appear across C5 when the thyristor is turned on by a high pulse from IC3 pin 4. C5 is discharged and a negative pulse of 300V appears on the primary of the trigger transformer. This is stepped up by the transformer to produce around 6000V on its HT output pin, the pulse that causes the xenon tube to breakdown, hence fire. As there is no direct loading on this HT pulse it can be used to fire more than one tube. This property is used in the boost mode where the HT pulse is used to fire both tubes. Theoretically, tubes could be fired by this HT pulse if they have their own power supply and care is taken that the HT is kept well clear of anything it could possibly track to.

The xenon tubes, when they fire, almost go short circuit and if they were connected directly across the rectified mains, would

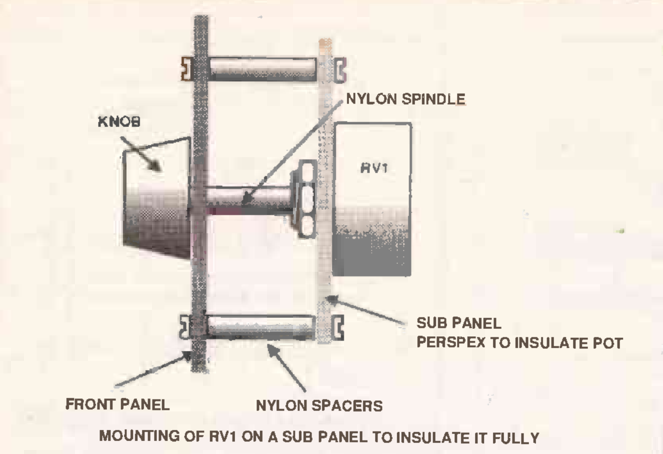

Fig. 6. Potentiometer mounting off PCB

blow the fuse or explode - dramatic but not cost effective. So they must have a reservoir of power that they can discharge but not be placed directly across the mains - hence the need for R7, R9, C6.

The capacitor C6 charges up via D4, R7, R9. Large power resistors are required because at the point of firing the full half wave rectified mains can appear across them, albeit for a fraction of a second. Two 10W resistors were chosen rather than one 20/25W, in order to disperse the heat given off. If one resistor of 220n was used, heatsinks or forced air cooling would be required increasing the cost and complexity. Even with using two resistors the same amount of heat is given off but more widely dispersed. If the strobe is going to be used in fast flash mode a great deal of heat will be given off especially in full power or boost mode when R14, R15 double the amount of heat generated. As stated earlier, this strobe is not designed for continuous fast flash operation but to be used as an effect for limited time periods, be it for stage or disco operation. This as well as the heat generated also reduces the possible risk of inducing epileptic fits.

Ventilation is required in the case and great care must be taken that enough heat can get out, but that fingers or anything else for that matter, cannot get in. To this end a grill is used but common sense must be exercised as to the mounting and mesh size. When in rehearsal, only one tube is used so the boost switch remains off, but during a performance both tubes are used.

The brightness of the flash is determined by the amount of energy the tube uses during its 'on time'. So, to reduce the power, reducing the value of the reservoir capacitor was tried. Although this worked, the flash was pretty feeble in the hall and so the use of two tubes was found necessary for the performance, with just one for rehearsals. For smaller halls or classrooms, the value of C6 could well be reduced to, say, 22µF 450V. Only trial and error can be used to obtain the optimum value, but remember when touching these capacitors they can still hold a charge, well after the strobe has been switched off.

The +12V used to power IC3 is derived directly from the mains supply via C3 1µF X rated capacitor (this means the capacitor can be directly connected across the mains). Only capacitors marked in this fashion should be used. A normal 1µF will not work for long and could cause damage to the circuit if it went short circuit. R11, D6, D5, C4 complete the +12V supply.

Normally, this type of supply is not used to power projects because it is not isolated from the mains. There is no earth or 0V safe on this type of supply and a severe, if not fatal, shock can be received by touching any part of it (as it is not uncommon to find live and neutral reversed in a mains socket).

Because so much of the circuit is at full mains potential, it seems pointless to have a mains transformer producing a 'safe' +12V supply and then having to explain where the 'safe' areas of circuit were, then using an opto isolator to connect to the dangerous areas. It is far easier and cheaper to use this type of supply and say all the circuit is dangerous. The speed control pot VR1 must have a nylon spindle, not a metal one and the pot should be mounted on the PCB. In no circumstance should it be mounted directly on the rear panel as the connections to it are at mains potential and they could track to the chassis of the pot. Although the chassis of the strobe is earthed, it is not worth taking the risk. If for one reason or another it is not practicable to mount the pot on the PCB, it must be mounted on an insulated sub panel as in diagram 6. A gap of at least 1/2in should be maintained between the pot and any spacer or part of the rear panel.

All the switches, Mains, On/Off, Run and Boost, must be capable of handling mains voltages and rated at an appropriate current. The base chassis should be a metal one because a plastic one might melt near to the power resistors. Special care needs to be taken with the earthing. A nut and bolt should be used to secure a solder tag, star washers should be used to prevent the nut from becoming loose through vibration. If a metal lid is used this should be earthed in the same way.

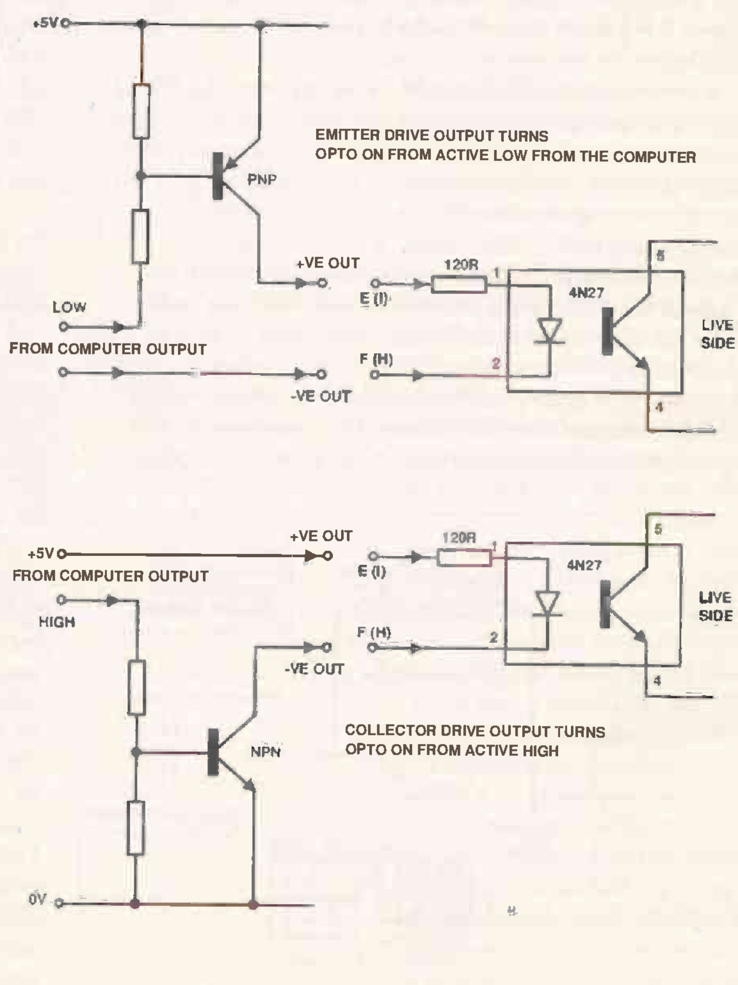

Fig. 7. Computer interface

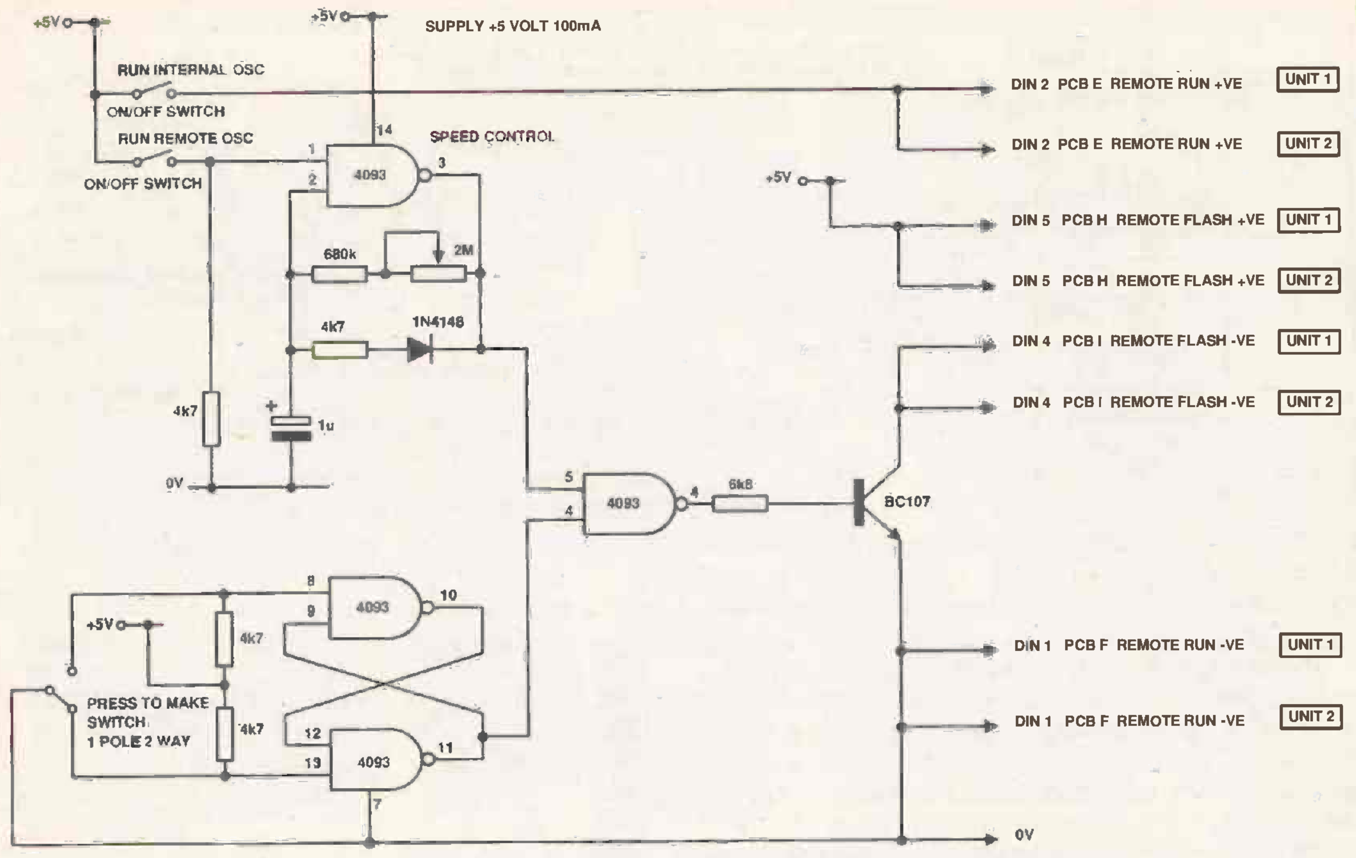

Fig. 8. Remote control for two units

Operating from the External DIN Connections

As can be seen from Figure 7, the two sets of commands that are brought in to the DIN socket are:

a) Remote Run pins 1 - 2
b) Remote Flash pins 4 - 5

Both are independent signals and do not have a shared common. This is to allow either open collector or emitter drivers. Both of these can be found on interfaces.

Because 30Ma or so is required to drive the opto isolators, some kind of amplifier is used to take the TTL compatible signal from the computer and amplify it. Figure 7 shows how to wire each type of output, while Figure 8 shows how a simple external fire button and external oscillator may be used to control the strobe where a computer is not available. Both of these methods have been employed to great effect (excuse the pun). If 12V CMOS logic is used as the external controller, either R1, R2 of the strobe will need to be increased to 390n 1/2W or a 270n resistor is added in series with the output signal of the control - this then keeps the strobe compatible with 5V controls. When operating from external control try to limit the speed of flash to a maximum of 5 flashes per second. This, as well as limiting the heat build up, keeps it outside the accepted possible danger speed of 8-15 flashes per second for inducement of epileptic fits.

Testing and Setting Up

The circuit should be made and checked and double checked, things like the polarity of all the electrolytics, especially C6, C7, as well as the xenon tubes and diodes, etc. The board should have all component leads cropped and the PCB cleaned to remove the flux. The PCB should be connected up to the switches and socket but not plugged into the mains yet. The opto isolators' input pins should be checked with a multimeter to see that there is no circuit to the live side of the board, i.e. there should be no reading at all on the highest resistance range, indicating complete electrical isolation. The earth should be checked back to the plug to ensure a good electrical contact and this should show complete isolation to the PCB. The internal fuse on the back panel should be 1A slow blow and a 2A fuse fitted in the mains plug. All this is common sense, but you can't be too careful with mains projects. While testing, remember that just unplugging the mains does not render the strobe safe as the capacitors C6, C7 may well be fully charged. To remove this charge the mains should be unplugged, not just turned off. Using an insulated piece of wire with bare ends, the mains side of R14 should be shorted to mains return on the PCB. This is shown as the discharge points on the PCB layout drawing. The same should be done to the mains side of R7 and, if the capacitors are fully charged, a small spark may be produced so keep your eyes well clear. The two parts of the circuit that may warrant modification are the value of C6, C7 to reduce the low power brilliance and R3, to adjust the speed range of the internal oscillator. Remember if you are in any doubt, do not take chances - contact a qualified engineer.

Casing the Strobe

No specific ready made box has been recommended for the strobe. The one shown in this article was made out of thin sheet aluminium (1.2mm) off cuts from a local engineering works. Even if the lid is not made of aluminium, the base should be, so that it can be earthed safely. As mentioned before, plastic boxes are not recommended because they can distort or even

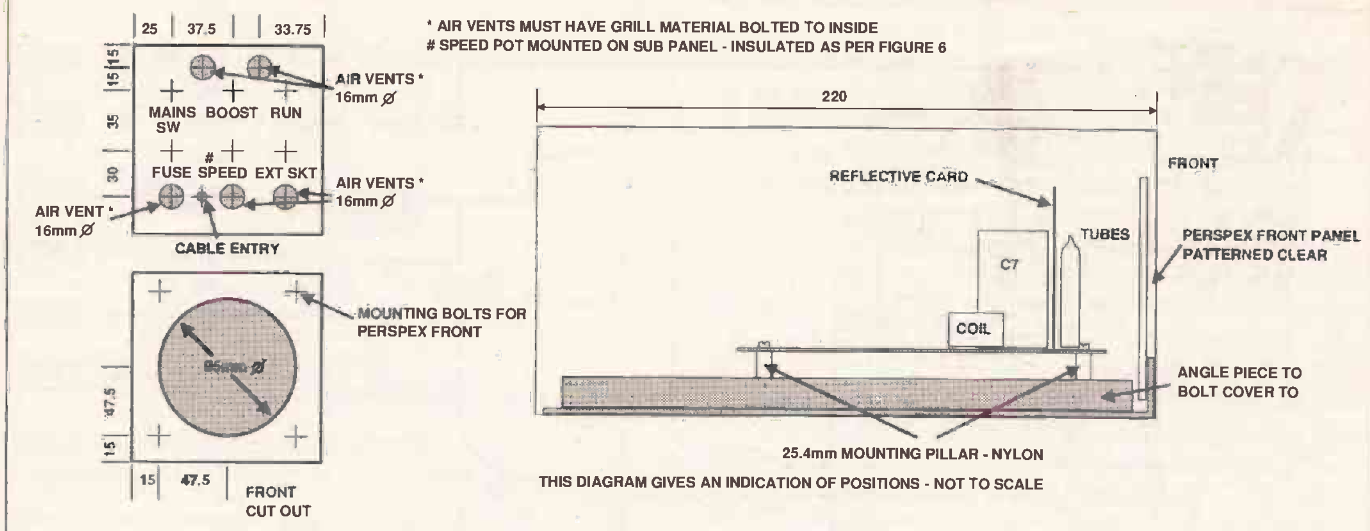

Fig. 9. Mounting details

melt when exposed to the heat of power resistors.

To bend the front and back of aluminium is easy enough and can be done using two angle iron steel pieces clamped in a Workmate and pressure put on the aluminium to bend. The lid, however, requires bending over a greater distance and hence much more pressure is required. An MDF lid is far easier and can be constructed as shown in Figure 10.

The PCB should be mounted on nylon pillars at least 15mm long, off the bottom of the box - the ones used in my unit are 25mm. Great care should be taken with all aspects of mounting. Check that none of the wires are trapped when bolting the PCB down and fitting the lid. A piece of reflective coated cardboard was used as a reflector mounted behind the tubes and in front of the main capacitors - this increases the output brilliance considerably so all the light is focused forward.

A round hole was cut in the front of the box and a piece of clear but patterned Perspex placed inside and bolted to the front. This keeps fingers out and adds a professional touch as the patterned effect on the Perspex prevents any of the internal workings from being seen.

It also helps diffuse the light to give a more even distribution, although do not look at this from close range.

The precise details of construction are left to the constructor, as the unit may be required for floor standing, in which case feet can be mounted on the bottom, or fixture mounted, in which case a metal bracket is mounted over the top of the box in order that the strobe can be tilted to the correct angle and swivel.

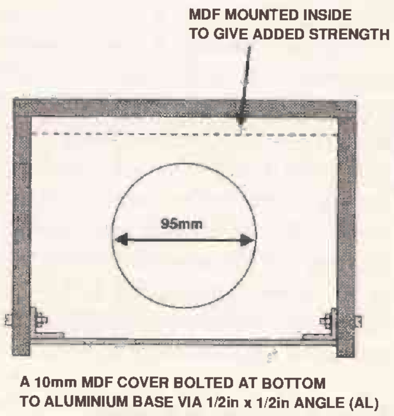

Fig. 10. Mounting details

After all's said and done, this project has proved to be relatively easy to construct and should present no problem to the seasoned constructor. The school is over the moon with it and has since used it in several productions to great effect - so much so that they may well get round to paying for it soon!

PARTS LIST

RESISTORS

R1,2	120n
R3	470Kn
R4,5	47K
R6	100Kn
R7,9,14,15	100n 10W
R8	12K
R10	2K2
R11	22n 1/2W
R12	1M 1/2W
R13	100K 1/2W

CAPACITORS

C1	1µF Radial 25V
C2	0.01µF 25V
C3	1µF X (rated full mains) 250 VAC
C4	1000µF 16V Axial
C5	0.01µF 400V DC
C6,7	47µF 450V Radial
C8	2n2pF

SEMICONDUCTORS

IC1,2	4N27 opto isolator
IC3	4093 CMOS

DIODES

D1,2,3	IN4148
D4,5	IN4007
D6	Zener 12V 3W
TR1	C106 D thyristor

MISCELLANEOUS

VR1	2 Meg pot PCB mounted
Xenon 1,2	Xenon beacon tube, Maplin FS 79L
Trigger transformer	6KV, Maplin JE 15R
Mains switch	2 pole, on/off
Mains switch	boost on, on/off
Mains switch	manual start, on/off

5 pin DIN 270 degree socket
IC sockets if required.

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❒ MODEL RAILWAYS	£40.80	£58 80	£62.00	$102 00
❒ R/C MODEL CARS	£38.40	£56 40	£59.40	$96.00
❒ RCM&E	£40.80	£60.00	£63 20	$86.00
❒ RADIO MODELLER	£38.40	£53.20	£59 80	$80.00
❒ SCALE MODELS	£40 80	£53.20	£55.20	$84.00
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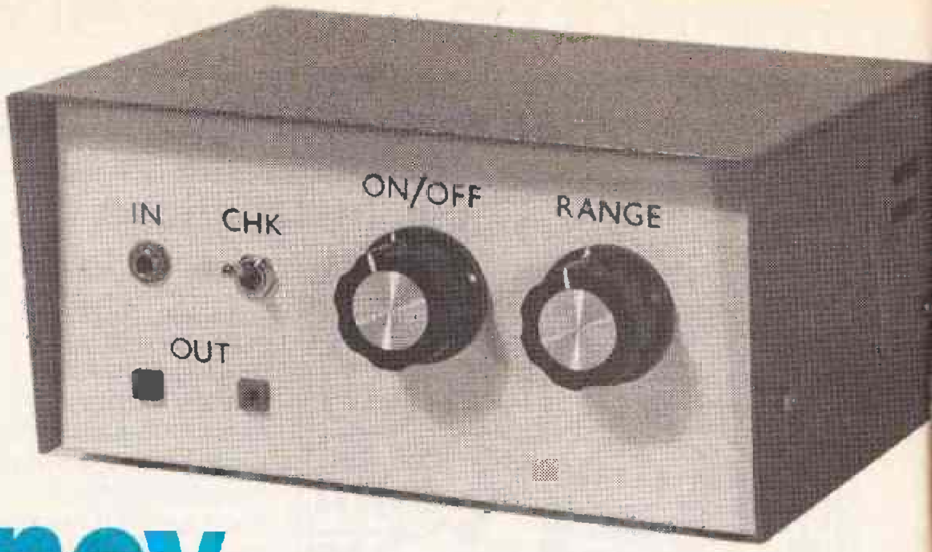


Frequency Meter Adaptor

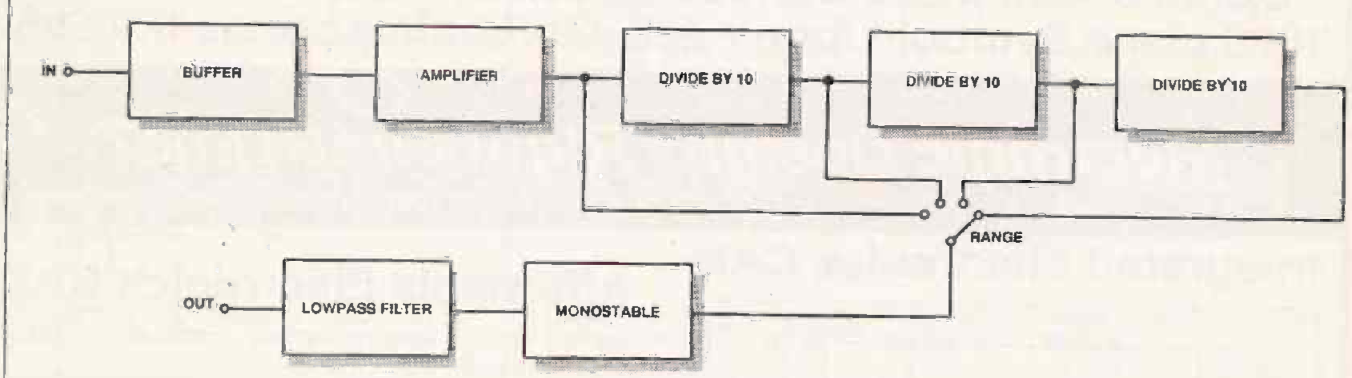


Fig. 1 Block diagram

Make better use of your digital multimeter with this simple add-on device from Robert Penfold

The range of facilities offered by modern digital multimeters seems to become greater year by year. In addition to the usual voltage, current, and resistance ranges, many now sport temperature and capacitance ranges.

The latest addition to digital multimeters is frequency measurement. Although the maximum frequency that can be read is usually far lower than the maximum frequency for a d.f.m. (digital frequency meter), the ability to measure frequencies up to (typically) a couple of megahertz is extremely useful. Checks on audio frequency oscillators can be made, as can checks on some crystal clock oscillators, b.f.o.s, etc. This project allows one to add such a feature to your multimeter.

Frequency To Voltage Conversion

A normal digital frequency meter operates using a pulse counting process. The basic scheme of things is to have the input signal applied to a pulse counting circuit for a gate period of one second. The final value in the counter is then equal to the input frequency in hertz. In a practical d.f.m., the gate period is controlled by a high precision quartz oscillator so that a high degree of accuracy is obtained.

The frequency ranges of digital multimeters seem to operate using a different process. These devices work on the basis of having a voltmeter with a full scale value of 1.999 or 0.1999V. Every range of the unit, whatever is being measured, has to produce a suitable input voltage to the voltmeter circuit. In the case of frequency measuring ranges, a frequency to voltage converter circuit is obviously all that is needed.

Although this method should give highly accurate results in theory, in practice it is difficult to produce a system that will give the sort of accuracy that can be achieved using a pulse counting d.f.m. The same degree of accuracy is not possible anyway, since the 3 1/2 digit display of a digital multimeter can obviously not give the same sort of resolution as the seven digits of a typical d.f.m. display. For many purposes a d.f.m. provides substantial overkill, and a set up of more modest capabilities is still perfectly adequate for much general testing.

Of course, it is possible to add frequency ranges to a digital multimeter using an external frequency to voltage converter. This is the function of the project featured here. It can be used with any digital multimeter which has a 1.999V range, and provides full scale values of 1.999kHz, 19.99kHz, 199.9kHz, and 1.999MHz. Obviously the decimal point of the display will be in the wrong place on the middle two ranges, but there is no difficulty in mentally adjusting the position of the decimal point.

System Operation

The block diagram of Figure 1 helps to explain the way in which the unit functions. A buffer stage at the input provides the unit with a high input impedance of one megohm. This ensures that minimal loading is placed on the circuit under test. An amplifier stage then boosts the signal to a level that enables the following stages to be driven properly. The voltage gain of this amplifier is not very high, but it enables the unit to function with input signals down to about 50mV r.m.s.

The amplifier is followed by a chain of three divide by ten circuits. These provide the unit with its four ranges. The frequency to voltage converter operates over an input frequency range of 0 to 1.999kHz. Switching in one divider gives an effective frequency range of 0 to 19.99kHz, two gives a range of 0 - 199.9kHz, and three give a range of 0 - 1.999MHz.

It would be possible to obtain the ranges by simply altering the timing component values of the frequency to voltage converter, but this would give inferior accuracy. The frequency to voltage converter works best at low frequencies. The divider stages ensure that the frequency to voltage converter never has to deal with frequencies of more than 2kHz, even if the input frequency is as high as one to two megahertz. This considerably improves accuracy on the higher ranges.

The frequency to voltage converter is composed of a non-retriggerable monostable, followed by a simple lowpass filter. The monostable is triggered on each input cycle, and it produces an output pulse having a duration that is independent of the input frequency. The pulse duration is controlled by a C - R timing circuit. Suppose that an input frequency of 1kHz produces the monostable output waveform of Figure 2(a). This has a mark-space ratio of 1:9, so the average output voltage is one tenth of the supply voltage.

If the input frequency is doubled, the output pulses remain the same length, but there are twice as many in a given period of time. This gives the monostable output waveform of Figure 2(b). The mark-space ratio is 1:4, and the average output

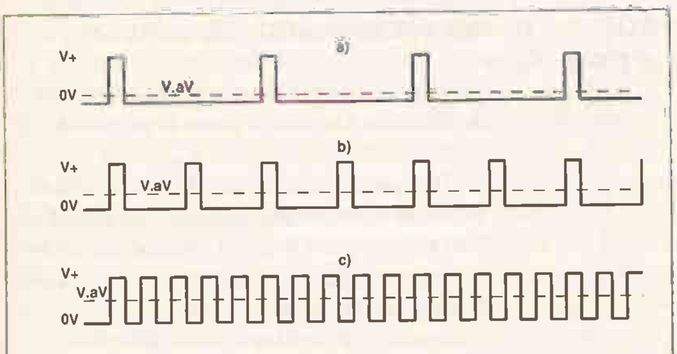


Fig. 2 Monostable output waveforms

voltage is one fifth of the supply voltage. In other words, doubling the input frequency has doubled the average output voltage. Increasing the input frequency to 5kHz gives a 1:1 mark-space ratio, as in Figure 2(c). The average output voltage is now half the supply voltage. Like the input frequency, the output voltage is now five times its original figure.

In the present application it is just a matter of selecting C - R timing values that give an output voltage of one volt per kilohertz. The lowpass filter at the output of the unit smoothes the pulsed signal to produce a reasonably ripple-free dc. output signal that can be read properly by the digital multimeter. A

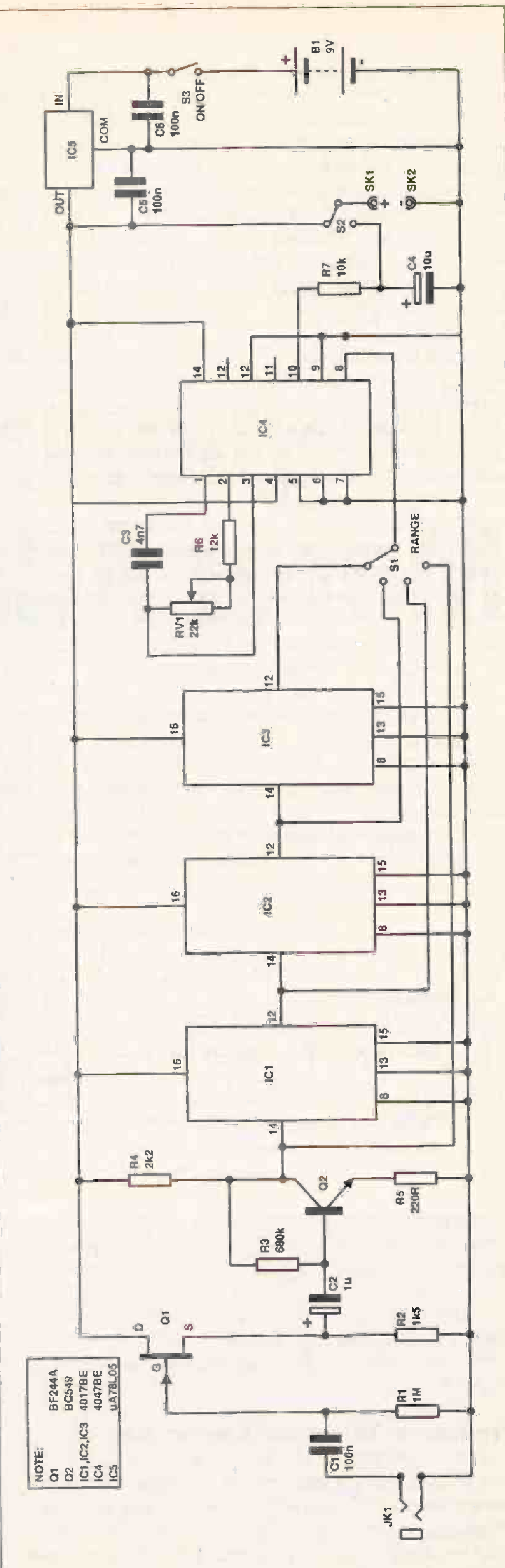


Fig. 3 Circuit diagram

basic 6dB per octave passive filter is perfectly adequate.

Although a monostable is a very crude method of frequency to voltage conversion, it actually gives very good linearity at low frequencies. At high frequencies the output waveform tends to deteriorate, and this is reflected in reduced linearity In this case the maximum frequency handled by the monostable is just under 2kHz, and this is low enough to give extremely good linearity from the CMOS monostable used in the actual unit.

Circuit Operation

Figure 3 shows the full circuit diagram for the frequency meter adaptor. The input buffer stage uses Jfet TR1 in a simple source follower stage R1 provides gate biasing for TR1 and sets the input impedance at 1 megohm. Of course, at high frequencies the input capacitance of TR1 reduces the input impedance significantly, but this is not a major problem as the input capacitance is only a few picofarads. The voltage amplification is provided by TR2. It is used as a common emitter amplifier having a substantial amount of local negative feedback provided by R5. The voltage gain is about 10 times (20dB) and this is maintained well over the frequency range covered by the circuit.

IC1 to IC3 are the divide by ten circuits, and these are all CMOS 4017BE one of ten decoders. In this application it is only the 'carry out' output at pin 12 of each device that is of interest, and the other ten outputs of each 4017BE are simply left unused. The reset and inhibit inputs are not needed either, and are simply wired to the 0V supply rail.

The monostable is based on IC4, which is a CMOS 4047BE. This can be used in a variety of astable and monostable configurations, but it is used here as a positive edge triggered monostable. It is acting as a pulse shortener, so it must be used in the non- retriggerable mode. C3, VR1, and R6 are the timing components, and the output pulse duration is nominally 2.48 C R seconds. VR1 enables the unit to be calibrated against a known input frequency.

The components R7 and C4 form the lowpass filter. S2 enables the multimeter to read either the output voltage from the adaptor, or the supply voltage. A well stabilised supply is essential for this application, since any variations in the supply potential will produce proportional changes in readings. Monolithic voltage regulator IC5 provides a well regulated 5V from the 9V battery supply. The regulated supply voltage should be checked with a new battery fitted, and the reading obtained should be noted. The supply voltage must be rechecked each time the unit is used, and a new battery should be fitted when a significant reduction in the supply voltage is noticed. The current consumption is only about 5mA and a PP3 battery is adequate.

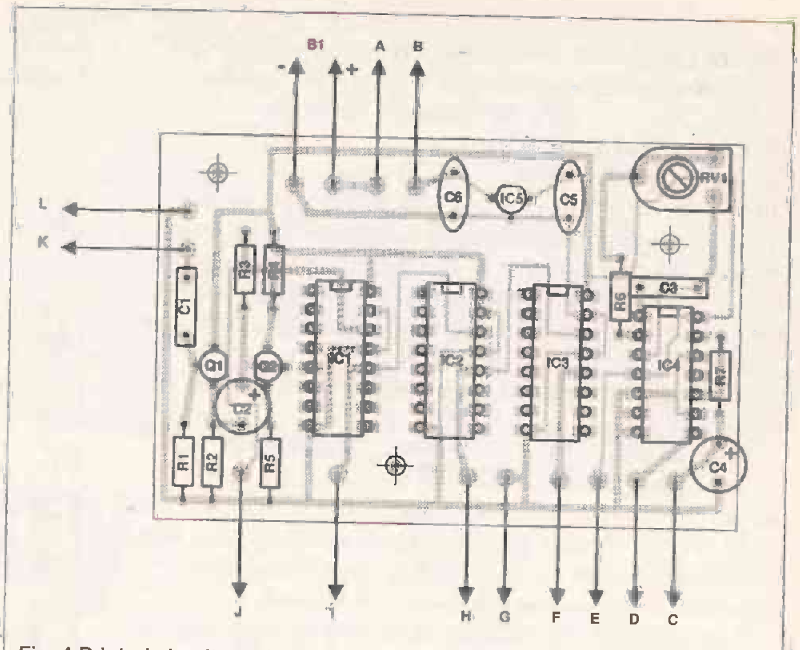


Fig. 4 Printed circuit overlay

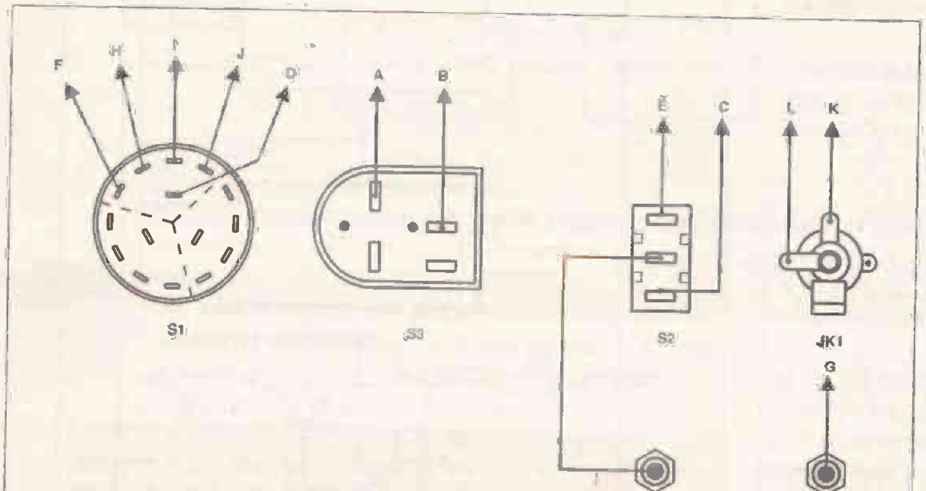


Fig. 5 Details of the point-to-point wiring

Construction

Figure 4 shows the overlay for the printed circuit board. All four of the d.i.l. integrated circuits are CMOS types, and they should therefore be fitted in holders. The other normal anti-static handling precautions should also be observed when dealing with these components. TR1 is a Jfet device not a MOSFET type, and it does not require anti-static handling precautions. Ideally VR1 should be a multi-turn trimpot, but it is possible to adjust an ordinary type for accurate results if great care is taken. C1 and C3 must be miniature printed circuit mounting types having 7 5mm (0.3in) lead spacing if they are to fit onto the board properly. Fit single-sided solder pins to the board at the positions where connections to the off-board components will be made.

The prototype is housed in an aluminium instrument case which measures about 150 x 100 x 75mm, but this is somewhat larger than is really necessary. In particular, a much lower profile case can be used if preferred. The general layout of the unit is not critical, and any sensible layout will do. Try not to have the output sockets too close to the controls, or the test prods might get in the way when adjusting the controls. You might prefer to relegate SK1 and SK2 to the rear panel. Most multimeter test prods will fit 2mm sockets, but it will be necessary to use a different type of connector if your multimeter has non-standard prods.

Details of the hard wiring are shown in Figure 5. This should be used in conjunction with Figure 4 (e.g. point A in Figure 4 connects to point A in Figure 5). It is not necessary to use a screened lead to carry the connection from JK1 to the printed circuit board, provided that this lead is kept reasonably short. S1 is a standard 3 pole 4 way rotary switch, but in this case only one pole is used. It should be a break before make type, not a make before break switch.

Adjustment and Use

As an initial check of the unit, switch the multimeter to the 20V (19.99V) dc. range and set S2 to the battery check position. With S3 set to the 'on' position a reading within a few per cent of 5V should be obtained. With VR1 set at a roughly middle setting, S2 set for normal operation and the multimeter set to the 2V (1.999V) dc. range, the system should function properly, but probably with rather poor accuracy.

In order to calibrate the unit, an accurate reference frequency is

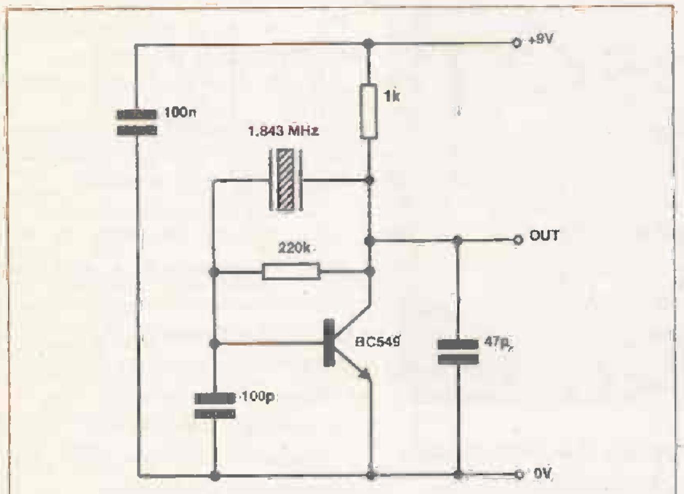


Fig. 6 Circuit of a crystal oscillator used calibration purposes

needed. Ideally, this frequency should be close to the full scale value of one range, but it does not matter which range is used. The accuracy of the adaptor is the same on all ranges. I breadboarded the simple calibration oscillator circuit of Figure 6. This can be built quite cheaply even if all the components (including the crystal) have to be bought specially for this circuit. If you have a crystal calibrator with a 1MHz output frequency, this will also suffice, as will practically any source of an accurately known frequency in the range 1kHz to 1.999MHz.

Calibration is just a matter of setting the adaptor to the appropriate range, connecting the calibration signal to the input, and carefully adjusting VR1 for the correct reading on the multimeter. Very precise adjustment of VR1 is needed, but even using an ordinary preset resistor it is possible to obtain good accuracy if due care is taken.

In use, the ideal test lead is a screened type as used with oscilloscopes, etc. Simple non-screened leads will suffice however, provided they are reasonably short, and the equipment is not used to make checks on signals having high source impedances. As with any frequency measuring equipment, bear in mind that there will be a certain amount of capacitance in the test leads, plus the input capacitance of the adaptor to contend with. This can have a slight detuning effect on some high frequency sources.

Note that the adaptor does not have input overload protection circuitry, and that it should not be used with very strong input signals. The prototype suffered no damage when used with input levels of up to 12V peak-to-peak, but it would probably be advisable not to use the adaptor with input levels much greater than this, unless it is used with an oscilloscope type X10 probe. This will attenuate the input signal by a factor of ten, permitting input levels of up to 120V peak-to-peak to be handled safely.

The unit can be used with an analogue multimeter having a sensitivity of 20k per volt or better. However, it is likely that readings will be less precise than those obtained using a digital multimeter. Bear in mind that the adaptor is only reliable when providing output voltages of under 2.5V. With output voltages of 2.5V or more, it is possible that the monostable is not triggering on every input pulse and that the output voltage produced is misleading.

PARTS LIST

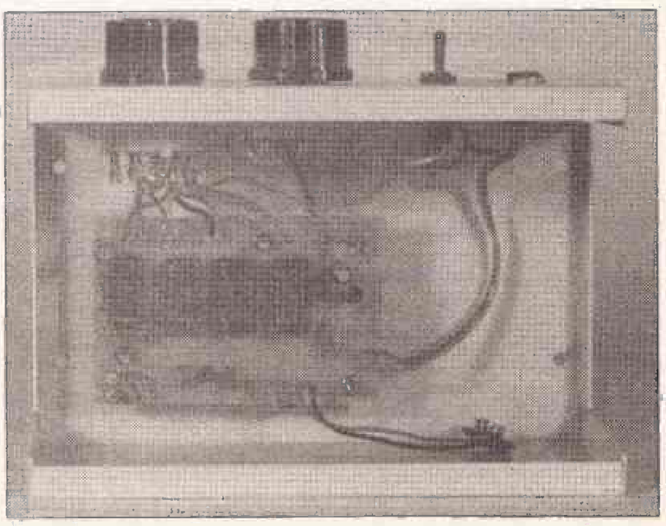
RESISTORS (All 0.25W, 5% tolerance)
R1 1M
R2 1k5
R3 680k
R4 2k2
R5 12k
R6 10k

POTENTIOMETER
VR1 22k sub-min hor preset

CAPACITORS
C1 100n polyester
C2 1µ 63V radial elect
C3 4n7 polyester
C4 10µ 25V radial elect
C5 100n ceramic
C6 100n ceramic

SEMICONDUCTORS
IC1 4017BE
IC2 4017BE
IC3 4017BE
IC4 4047BE
IC5 uA78L05 (5V 100mA positive regulator)
TR1 BF244A
TR2 BC549

MISCELLANEOUS
JK1 3.5mm jack socket
SK1 Red 2mm socket
SK2 Black 2mm socket
S1 4 way 3 pole rotary (only one pole used)
S2 s.p.d.t. min toggle
S3 Rotary on/off switch
B1 9V (PP3 size)
Small instrument case, two control knobs, PP3 battery clip, 14 pin IC. holder, three 16 pin IC. holders, wire, solder, etc.



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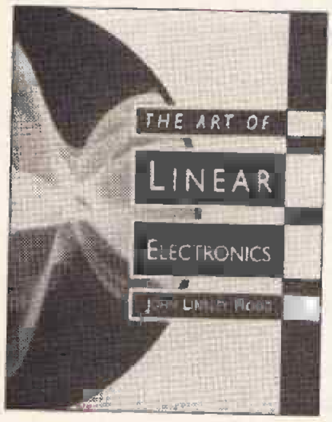


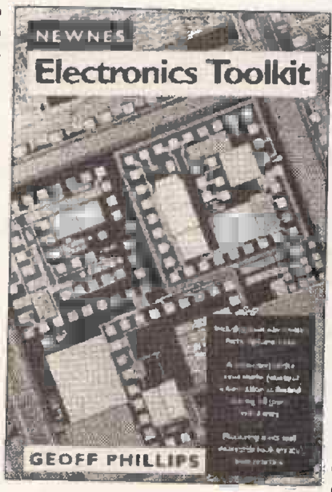
The Art of Linear Electronics, by John Linsley Hood.

Linear electronics covers that part of the art concerned with the handling of real life signals of variable size, shape and frequency, such as are found in things like audio amplifiers and radio receivers. This handbook covers the principle aspects of the subject in a way that will not only introduce the reader to the basics of linear circuit design but will also allow them to begin to do some designing themselves.

Drawing on the considerable practical expertise of the author (John Linsley Hood is a professional electronics engineer and consultant, author or many books and, as of next month, author of a new series of articles in ETI - Ed), this book offers a hands on approach to the how, what and why of the components and circuitry used in this field, from thermionic valves to MOSFET transistors, and from quartz crystal oscillators to silver oxide button cells. Useful information is also given on topics such as material properties or the conventions used in component labelling and theoretical circuit drawing.

The open approach offers the student an entry to the world of real life analogue electronics. The guidance on practical matters also lays bare a lifetime of experience and helpful advice for the more skilled electronics engineer.

Published by Butterworth-Heinemann.
ISBN 0 7506 0868 4
Price £16.95

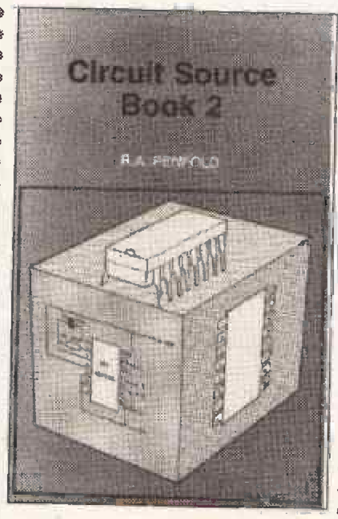


Newnes Electronic Toolkit, by Geoff Phillips.

The author has used his 30 years experience in the electronics industry to draw together the basic information that is constantly in demand by everyone involved. Facts, formulae, data and charts are presented to help the engineer when designing, developing, evaluating, fault finding and repairing electronic circuits. The result is this handy reference source which is recommended to all electronics engineers, students and technicians.

This is the kind of book that is best kept within reach at all times. It is a concise and comprehensive guide to electronics concepts and rules of thumb. It makes it easier for the reader to source a component, or choose between two alternatives for a particular application, and it will save the reader a lot of time and effort searching through manufacturers' specifications.

Published by Butterworth-Heinemann
ISBN 0 7506 0929 X
Price £12.95



Circuit Source Book 2, by R.A.Penfold.

Mr Penfold is well known to readers of ETI as the designer of a great many useful projects. He is also well known as the author of a number of successful books. This is the latest in that series and consists of a collection of 170 useful circuits.

The book has been designed to help the reader create and experiment with his/her own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.

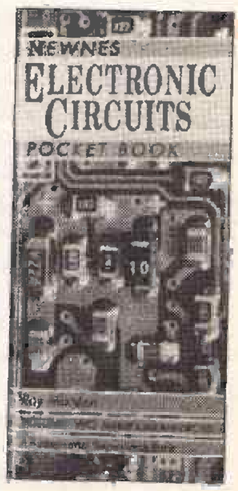
The circuits covered are mainly concerned with signal generation, power supplies and digital electronics and as such is meant to complement the range of circuits provided in Circuit Source Book 1 (which covered filters, amplifiers, voltage comparators, etc.).

Published by Bernard Babani
ISBN 0 85934 322 7
Price £4.95

Electronic Circuits Pocketbook, by Ray Marston.

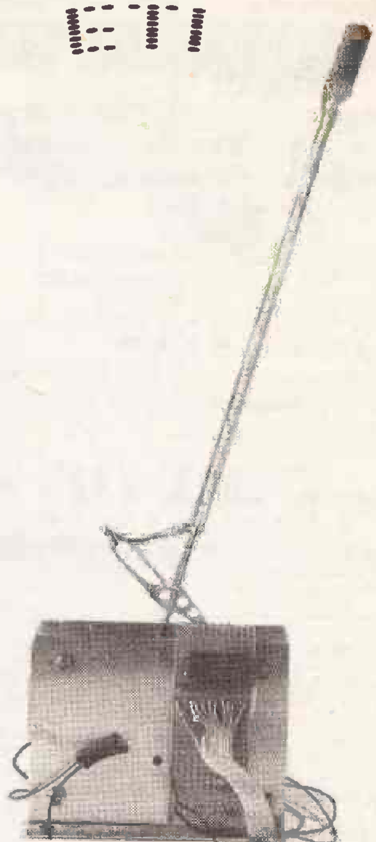
Passive components and discrete devices form the bed rock on which all modern electronic circuits are built. This book is a single volume applications guide to the most popular and useful of these devices. It contains 670 diagrams, tables and carefully selected practical circuits. Throughout the pocketbook, great emphasis is placed on practical user information and circuitry, and all of the active devices used are modestly priced and readily available.

The book is split into twenty chapters. The first three explain important practical features of the ranges of modern passive electrical components, including relays, meters, motors, sensors, and transducers. The next two chapters deal with the practical design of attenuators, filters and bridge circuits. The remaining fourteen chapters are devoted to specific types of discrete semiconductor devices, including various types of diode, transistor, JFETs, MOSFETS, VMOS devices, UJTs, SCRs, TRIACs, and various optoelectronic devices.



The easy to read, concise, highly practical and largely non mathematical volume is aimed directly at engineers, technicians, students and competent experimenters who can build a design directly from a circuit diagram and, if necessary, modify it to suit individual needs.

Published by Butterworth-Heinemann
ISBN 0 7506 0857 9
Price £12.95



A Latent Image Display

To start our quest for inventive ideas we look at the development of a simple little device which creates a novel form of computer display.

A year or so ago an acquaintance, the manager of a local shop, came to me with a problem which he thought I might be able to solve. It concerned a window display. What he wanted was a display which would attract people and which, when the shop was closed, would inform passers by about the products on display.

I suggested that he use one of the moving signboard systems that are commercially available. But apparently he had already thought about using such a system. Although it was on the right track he had dismissed the idea, the reason being that he did not want to have a large black box stuck in the middle of his shop window display.

He said that what he really wanted was some means whereby the changing text display would seemingly hang in the middle of the window with people being able to see through it to the products displayed behind. Not so easy.

The Solution

This request started me thinking about ways in which one could generate an image which would appear to seemingly hang in mid air. Some form of projection system using mirrors was an obvious solution, the old stage technique for creating theatrical ghosts. But it was a solution which would not necessarily work very well in the wide range of lighting conditions experienced by a shop window, and the low light intensity generated by a computer monitor, or moving signboard display. Use of a projection TV was out of the question on

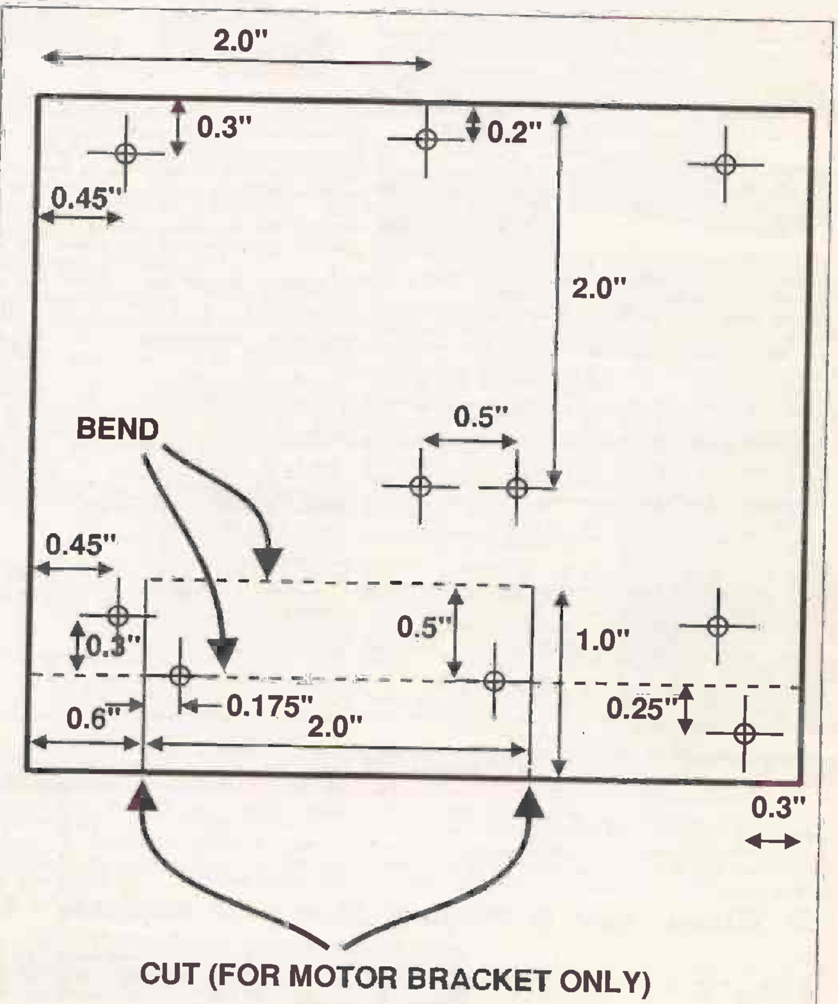


Fig. 1. Side plate cutting and drilling

Calling All Inventors

The unique thing about us humans is our creativity and inventiveness. All around us are products of our species' creativity, things which have been designed by people who perceived a problem, or a need, and then sat down and used their brains and knowledge to invent something which solved that problem or those needs.

Britain has long had a reputation as a land of inventive people. Without a doubt we have a history of inventiveness of which we can truly be proud, but being inventive depends as much upon the way that we look at life as it does upon the knowledge and resources available to the prospective inventor.

Success in innovation is largely an attitude of mind, which allows us to perceive problems and needs. An attitude which then forces us to solve those problems rather than simply shrugging our shoulders and accepting the situation, or waiting for someone else to solve them.

It is the importance of this attitude which makes it so hard to create an innovative society where one does not already exist. It is the reason why it is so dangerous to discourage innovative ideas and an innovative culture. If you look at the backgrounds of well known inventors you will discover that most had fathers, grandfathers, and great-grandfathers who were also inventors to a greater or lesser degree.

As editor of ETI, I want to encourage readers to become inventors, not necessarily inventors in a commercial sense, but to be inventive. Not to sit back and blindly follow a project in every detail, but to think of ways of improving it, or of entirely new ways of solving the same problem.

We do not need well equipped workshops and laboratories to be inventors, neither do we need large financial resources. What we do need is the ability to work out ways of solving a problem and, for that, a pencil and paper are often resource enough.

To show that innovation is not difficult and is something that any reader of ETI can do, I am, over the next few months, going to describe a number of unusual, and I hope innovative, ideas. They may be original, as far as I know they have not been described before, but the inventor can never be sure of complete originality.

All these inventions have been built with the hand tools that most hobbyists and DIY people will already have. They have been built on the proverbial kitchen table and they have been built at less cost that a take away Chinese!

So lets be inventive, and lets hear about it in ETI!

Nick Hampshire

grounds of both size and cost.

The problem was a lot harder than I initially thought!

This difficulty made it all the more intriguing. As so often happens the solution came in a rather oblique manner. During a discussion about movie making someone mentioned the phenomenon of the retention of a latent image by the eye. This was the solution, to build up an image in the viewer's eye by rapidly sweeping a line of LEDs across the field of view. In this way the viewer would just see a computer generated image built up from dots that would appear to hang in the air. If painted black, the cable to the LEDs and any mechanical support would just appear as a blur in all but the brightest light conditions.

To try out the concept I mounted a line of eight LEDs on the end of a rod and with the aid of an octal Darlington driver chip connected the LEDs to a parallel I/O port on a PC. A small program written in Basic was used to output a simple dot pattern. When I ran the program, the line of LEDs lit up as I expected they would with a barely perceptible flickering. But when I waved the rod around, lo and behold a rather jumbled dot pattern appeared to hang in mid air. The concept worked, it now needed to be refined so that it would display a proper image.

The first thing that was needed was a mechanical system for moving the LEDs back and forth over a set path. The line of LEDs would have to move very rapidly and would have to retrace the same visual path at least five times per second. The retracing of the path would have to be accurate, otherwise the resulting image would have an unacceptable jitter.

The problem is that the LEDs have to be connected to the computer. This ruled out mounting them on the outer radius of a transparent rotating disk, or a transparent rotating belt. Building a reliable commentator to connect between the fixed cable from the computer and the rotating component would be too difficult.

The solution had to be a reciprocating system and the most obvious was a metronome type oscillating rod with the LEDs mounted on the far end. To swing it back and forth - a small geared dc motor with a crankshaft. A means of detecting when the oscillating rod had reached the end of its swing was also needed, so that the computer could have a fixed reference point from which to start its display output. For this, an optical sensor on the crankshaft would be ideal.

The Prototype

In order to keep costs down and make construction easier, the

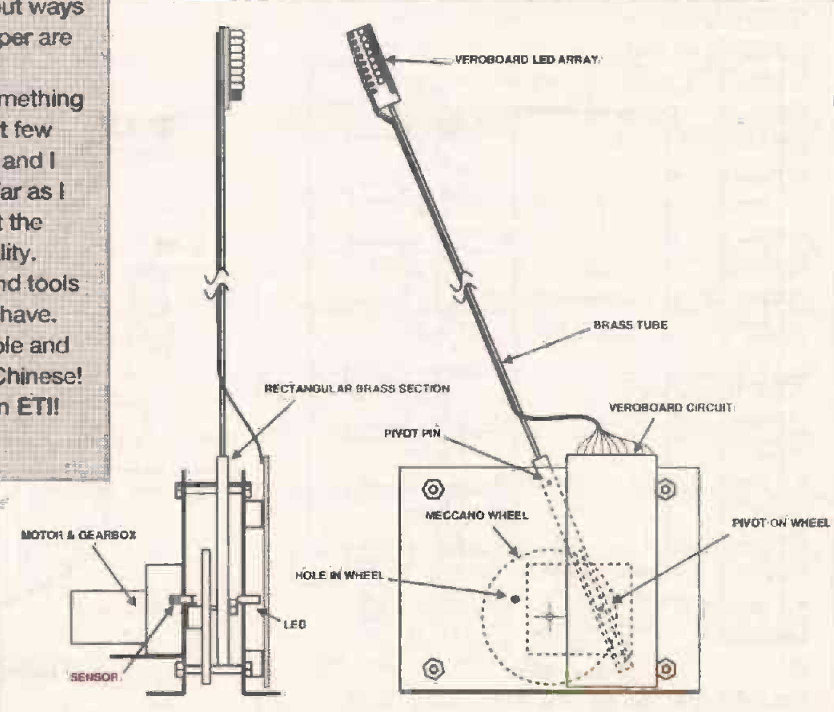


Fig. 2. Arm assembly

prototype was kept quite small, probably about half size. But even so, the sweep of the oscillating arm produced an image area of about twelve inches long and just under one inch high.

All the various bits needed to build the mechanical part of the design were obtained from a local model shop, and it was built with just a few DIY tools.

A small geared motor from Como Drills, outputting 230rpm, provided the motive power. This was mounted on a simple case made from thin (.032in) sheet aluminium. This was cut using a small hacksaw to give two pieces 3.5 x 4in square. The two sheets were then taped together, the site for each hole marked with a punch (a nail lightly hit with a hammer) and then drilled with an electric drill fitted with a 1/16in bit. The four holes in each corner, the two mounting holes at the bottom and the two in the centre were then redrilled to 5/32in diameter (see Figure 1 for cutting and drilling positions).

One of the two plates was then further cut and drilled to provide the motor mounting bracket. Once all the drilling and cutting was done the two plates were folded over a block of wood using hand pressure, and another piece of wood as mallet/former. The two plates were fixed together using 2in 4BA bolts and nuts.

The actual reciprocating arm was made from a 12in long 1/16in brass rod, at one end of which was soldered a wider piece of brass with a 2in slot cut in it, wide enough to take a 6BA bolt. At right angles to the rod was soldered another piece of 1/16in brass rod, about 2 in long and positioned about 3/4in above the end of the slot (see Figure 2).

The camshaft was constructed from a standard 2in Meccano pulley, attached to the shaft from the motor gearbox. A 1/2in long 6BA bolt was put through one of the outer holes in the pulley and attached with a screw. On the other, the motor side of this pulley, a disk of black painted cardboard was glued, in which a small 1/8in hole was cut at a position 180 degrees from the bolt. This was for the optical sensor.

The line of LEDs was assembled on a small piece of Veroboard (see Figure 3) together with a SIL resistor pack. The sides of each LED had to be carefully filed down so that they fitted side by side on a 0.1in spacing. The wiring proved a problem. Since nine wires were needed, even the finest plastic covered wires were quite bulky, and it was important to keep the reciprocating rod as thin as possible. The best solution was to use thin enamel coated wire that was taped onto the rod with masking tape. To allow the rod ease of movement the bottom 4in of wire, between the rod and the board containing the electronics, were left free and untaped - this can best be seen in the accompanying photograph.

The actual display output electronics are shown in Figure 4 and consisted of a ULN2 octal Darlington driver IC, connected to Port A of an 8255 based PC I/O card (in this case the PC I/O board produced by Maplin), and driving the eight LEDs. The system also used an optical sensor to detect the rotating hole in the cardboard disk. This sensor consisted of an infra red source and a sensor, the sensor being connected to line 1 of Port B on the 8255. Note that the 1M resistor on the photosensor can be lowered in value to reduce sensitivity, or raised to increase sensitivity. The circuit was built on a small piece of Veroboard as shown in Figure 5.

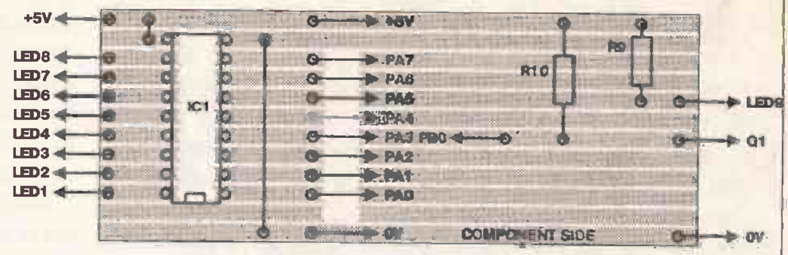


Fig. 5. Veroboard Layout

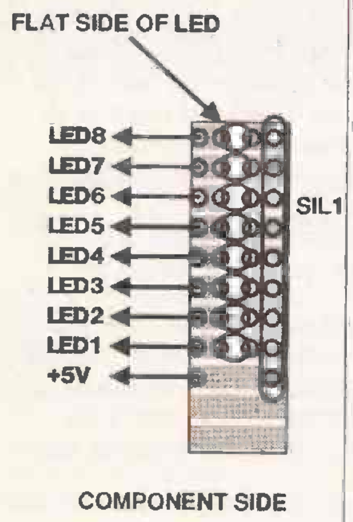


Fig. 3. LED Veroboard

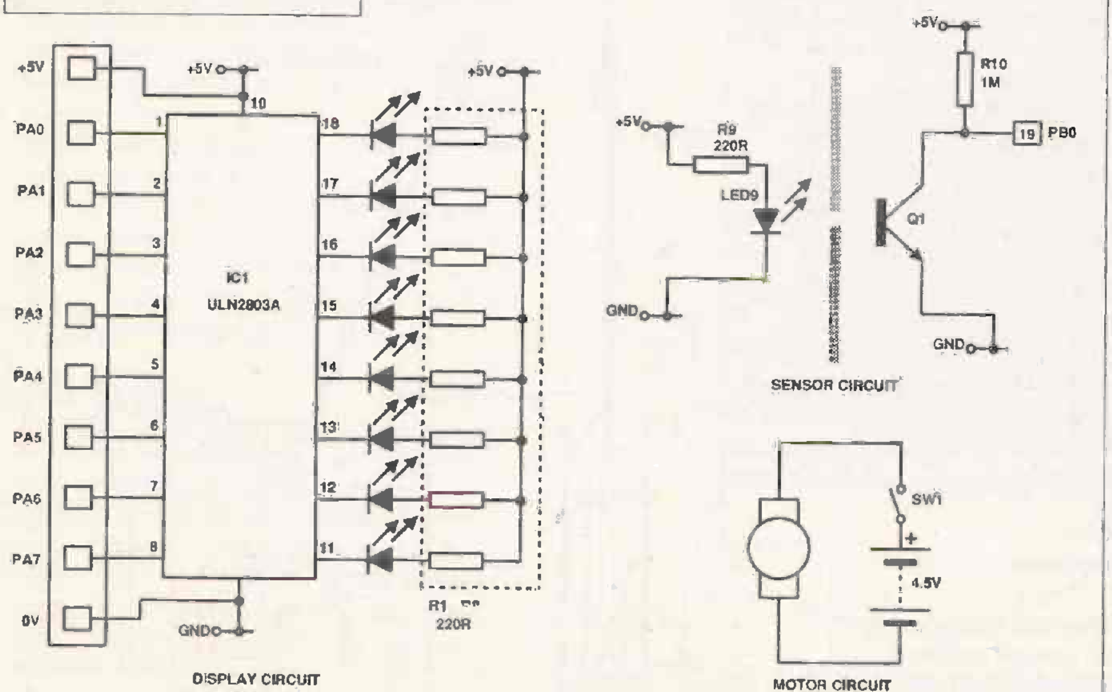
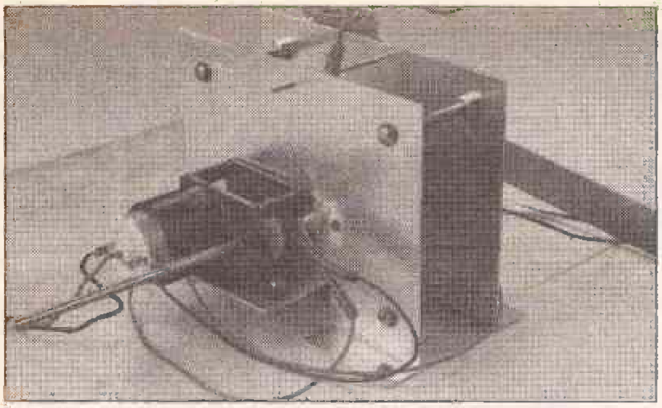


Fig. 4. Circuit diagrams

The Control Program

The control program was written in Basic and is very simple. It consists of three parts. The first part defines the starting location of the 8522 registers, sets up the I/O control register, initialises an array where the dot pattern will be stored and then loads the dot pattern from a data statement into the array. Note that the data statements store decimal values, the binary equivalents of which indicate the dot pattern at each position in the sweep. Always



set the first few values to zero since the beginning of a sweep tends to be rather jittery.

The second part of the program is a small loop which tests for a negative, or zero, pulse coming in from the photo-sensor on line 1 of Port B. The occurrence of this pulse indicates that arm is at the beginning of its sweep and that the program can jump to the third part. This third part is another loop which simply scans through the data array displaying each byte in turn. A small FOR...NEXT loop is used to generate a delay between each dot display and thus ensure that the pattern is properly spread.

Final Assembly and Testing

Once all the various bits have been located, assembly is fairly easy. The mechanical components are rather noisy and application of a small quantity of light grease should help, as will fastening the unit to a good solid base.

As far as the electronics are concerned, testing the LEDs is simply a matter of connecting the circuitry to the computer and running a little test program which will turn the LEDs off and on. A similar technique can be used to test the IR source and sensor, but be warned that the IR sensor will also react to daylight and artificial light. This means that the system will only work when enclosed in a reasonably light proof box, the inside of which, together with the mechanism, should be painted matt black to stop unwanted reflection.

Depending on the PC being used, the processor speed, the motor voltage, motor gearing ratio, etc.,. it may be necessary to alter the timing delay in the code in order to ensure generation of a suitable display.

PARTS LIST

RESISTORS

R1-8	220R SIL
R9	220R 1/4W
R10	1M 1/4W

SEMICONDUCTORS

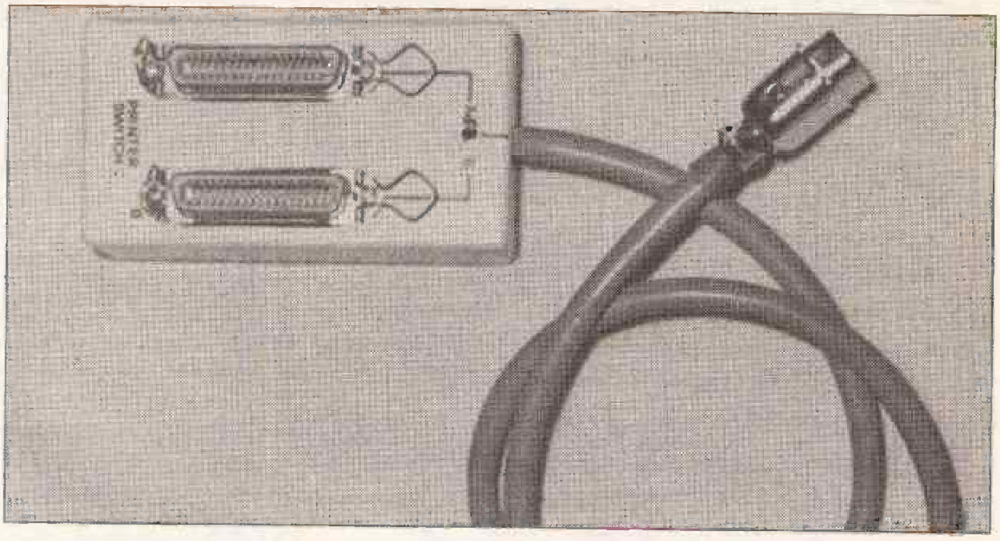
IC1	ULN2803A
LED1-8	submin red
LED10	IR LED
OT1	IR Phototransistor

MISCELLANEOUS

Geared motor	430G from Como Drills, Deal, Kent. CT14 0PA. Tel. 0304 612734 - price £4.85
Veroboard	12 tracks x 2.5in
Aluminium sheet	0.032 x 4 x 10in - K&S Engineering, from model shops - £1.00
Brass rod	1/16in diameter, 12in long - K&S - 50p
Brass tube	5/32in diameter, 12 in long - K&S - 70p
Bolts	4BA x 2in 4off plus 12 x 4BA nuts
Bolts	6BA x 1/2in 3off plus 4 x 6BA nuts
Meccano	2in pulley
	3ft 11way ribbon cable
	37 way D type connector (only needed if used with the Maplin PC Parallel I/O Board)
	Approx. 20ft of .236mm enamel coated wire.

Program Listing for Latent Image Display

```
1 REM Program to display a simple line of text using
2 REM the latent image display hardware and circuitry.
3 REM The program has been designed to run on a system
4 REM equipped with a Maplin 8255 PPI based parallel PC
5 REM I/O port. Port A is configured as an output and
6 REM port B as an input.
7 REM *****************************************************
8 REM set up data array and initialise I/O ports
10 BASEADD%=&H300
20 DIM A(50)
30 OUT BASEADD%+3,130
  40 FOR Q = 0 TO 25
  50 READ A(Q)
  60 NEXT Q
  64 REM
  65 LOOP TO CHECK OPTICAL SENSOR INPUT
  66 REM
  70 SENSE%= INP(BASEADD%+1)
  80 IF SENSE%=0 GOTO 100
  90 GOTO 70
  94 REM
  95 REM loop to display image - note delay in lines 101 and
  102
  96 REM
  100 FOR Q = 1 TO 25
  101 FOR X = 1 TO 4
  102 NEXT X
  110 OUT BASEADD%,A(Q)
  120 NEXT Q
  199 GOTO 70
  400 REM
  401 REM Data array to generate image. Note that the first
  402 REM six characters are 0, to allow the arm to stabilise.
  403 REM This data array displays the three characters ETI.
  404 REM The first line of dots is the upright part of the E,
  405 REM for this all eight LEDs are lit by outputting a
  value
  406 REM of 255, or binary 11111111. The next two lines of
  dots
  407 REM are the horizontal parts of the E, a value of 137,
  or
  408 REM binary 10001001, repeated twice. The other two
  409 REM characters are built up in a similar way.
  410 REM
  500 DATA 0,0,0,0,0,0,255,137,137,0,0,128,255,128,0,0,255
  510 DATA 0,0,0,0,0,0,0,0,0
```



Printer Switch

Have you ever wanted to connect two PCs to a single printer and be able to switch between them easily? Keith Wardill shows how

This bi-directional switch was originally built to save the expense of buying a second printer. It allows two computers to use one printer, or one computer to connect to two printers.

The Circuit

Most computers use the Centronics Interface to a printer. This uses eight parallel data lines and a number of 'handshake' lines. The switch uses four bi-directional, three state bus driver ICs, type 74LS245, to switch these lines from one of two ports to a common port. Figures 1a and 1b show the data and handshake lines used, and the possible data flow directions.

IC1 and IC2 switch the eight data lines. If the DIR signal on pin 1 is high (LK1 not fitted), then data flow is as shown in Figure 1a. If LK1 is fitted, then the direction is as shown in Figure 1b. Port selection is with SW1. When the signal on pin 19 is low, then data through that IC is enabled. If it is high, then the output from the IC is 'tri-stated', effectively disconnecting the data path.

IC3 and IC4 operate in a similar way on the handshake signals. A couple of points to note here are that the Strobe handshake direction is from computer to printer, and that all the others are from printer to computer. If you do not use the PCB layout I use, ensure that this is connected in the correct direction. Also, the Star printer has a 5V supply available for external use on pin 18 of its connector, which I have used to provide power to the switch box. Other Star printers also have this supply available. I was unable to check other makes, but if this supply is not available on your printer, then it is possible to use a small external power supply, the circuit for which is shown in Figure 3.

Construction

The switch can be built using the PCB shown in Figure 5, or, as in the case of the original, built on a piece of matrix

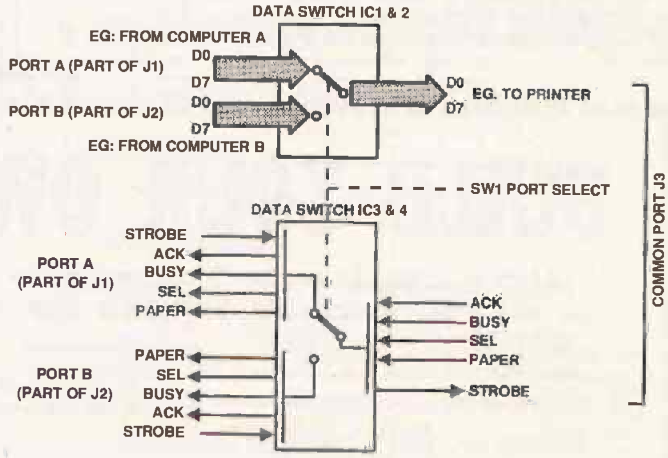


Fig. 1a. Data flow with LK 'A' omitted

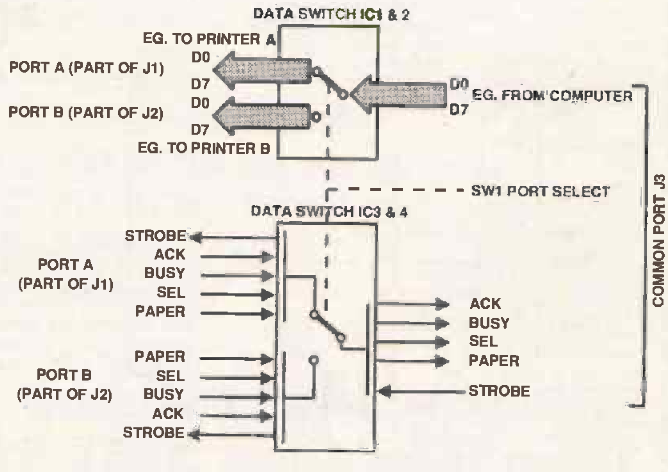


Fig. 1b. Data flow with LK 'A' fitted

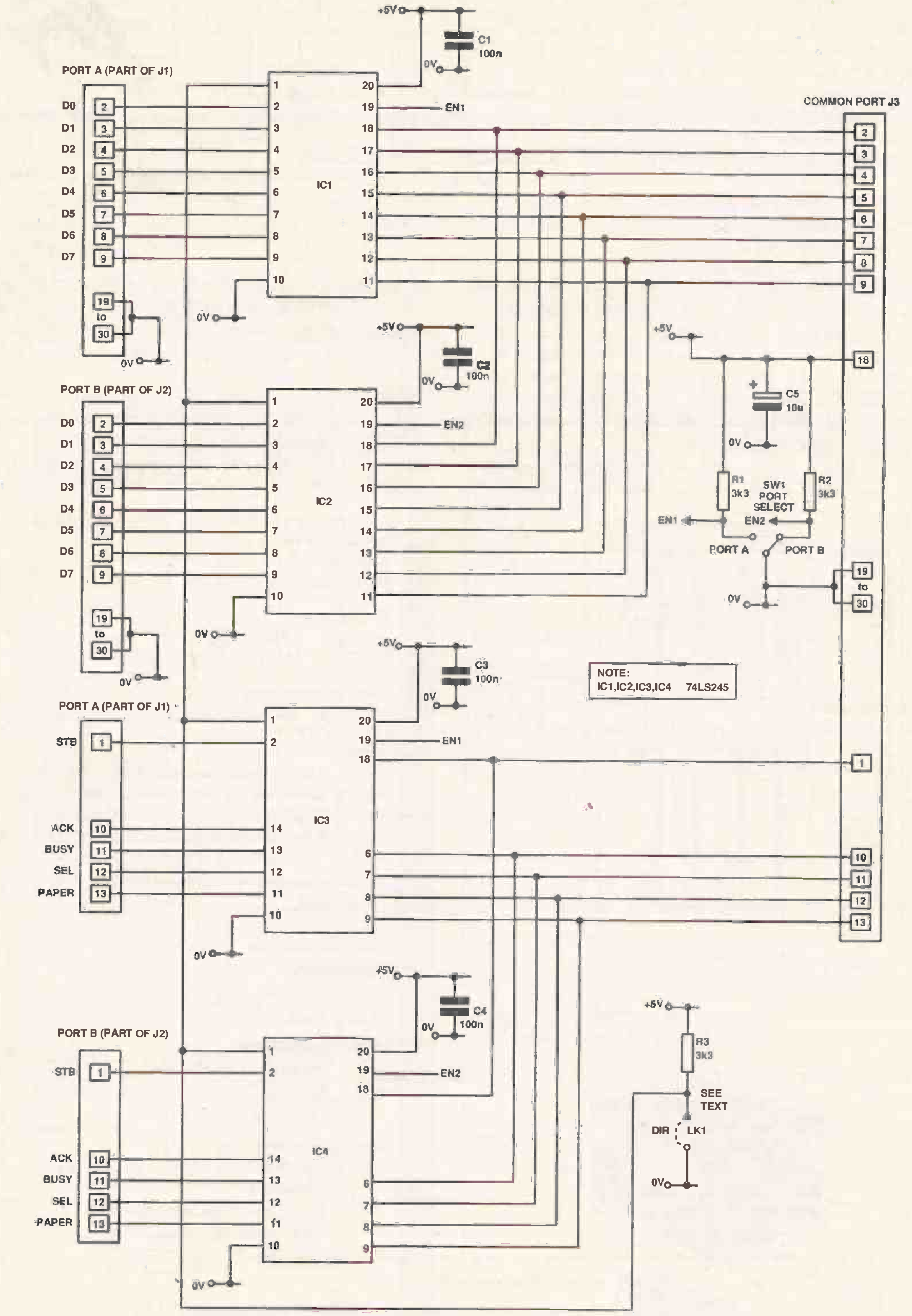


Fig. 2. Printer switch

board using a Vero wiring pen. To keep the PCB simple and single-sided, four wire links, indicated in Figure 4, the Component Layout, were used. These should be fitted first, because they are under other components. Use insulated wire.

It is not essential that sockets are used for the integrated circuits, but they are recommended. Note the polarity of C5 when fitting it.

For clarity, the individual connections from the integrated circuits to J1, J2 and J3 are not shown in Figure 4, so study the circuit diagram when making these connections

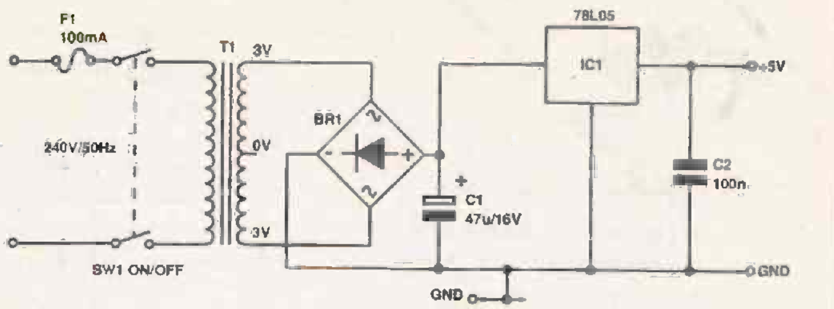


Fig.3. 5v DC Power supply

The board is mounted in the base of a small plastic box, with the two connectors for Ports A and B mounted on top of the box, and connected to the PCB with short pieces of wire. The connection to the common port is a length of cable about 1m long, with 16 cores. It should not be much longer than this to keep noise and consequent signal corruption to a minimum. A suggested layout is shown in Figure 6. SW1 can be mounted on top of the box for easy access.

I used a link, LK1, on the PCB, to select the direction of data flow, because normally I use the box in the Figure 1a configuration. This avoids accidentally switching the data direction, with consequent possible damage. If you wish, this link could be replaced with a switch, allowing quick change-over, but bear in mind the risk of damage.

Finally, I used Centronics 36-pin chassis mounted sockets for J1 and J2, and a 36 pin plug on the end of the common connector. These are the standard connectors used for Centronics, and will allow the box to be plugged straight into the printer and your normal printer lead to be plugged into the box.

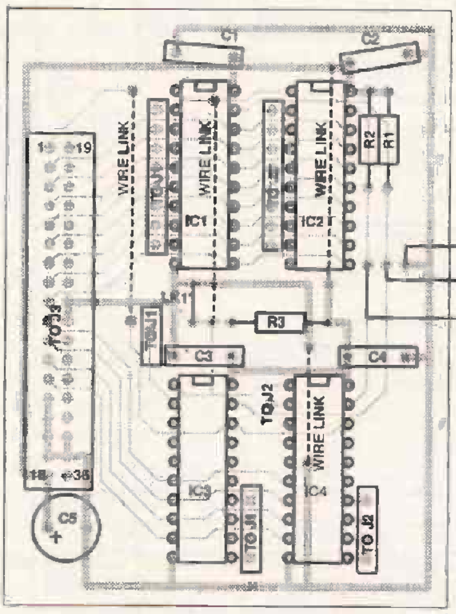


Fig.4. Component layout

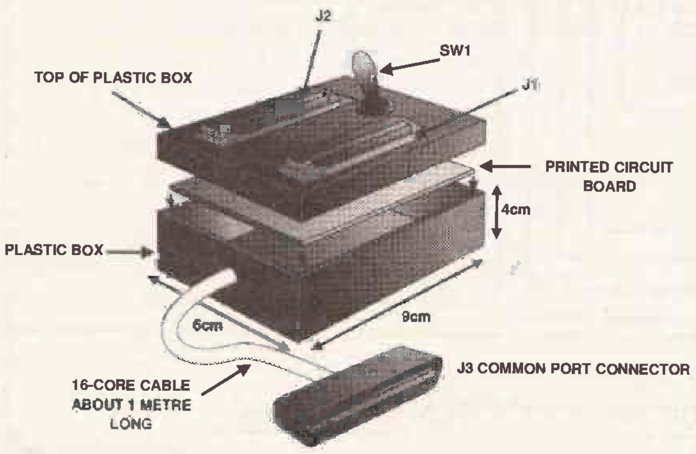


Fig.5. Unit assembly

PARTS LIST

SWITCH BOX

Resistors

R1,R2,R3 3K3

Capacitors

C1,2,3,4 0.1µF
C5 10µF/10V Electrolytic

Semiconductors

IC1,2,3,4 74LS245 8-bit bi-directional bus driver

Miscellaneous

SW1 1 pole/2 way miniature toggle switch
J1,2 36 pin Centronics socket, chassis mount
J3 36 pin Centronics plug, with housing.
Plastic Box - Internal dimensions about 9 x 6 x 4cm
16 core cable about 1m (printer connection)
M3 nuts, screws and spacers for mounting PCB and connectors.

POWER SUPPLY

Capacitors

C1 47µF/16V Electrolytic
C2 0.1µF

Semiconductors

IC1 78L05 5V regulator IC
BR1 miniature full-wave bridge rectifier W01 (1A/100V)

Miscellaneous

TR1 Miniature Transformer: 230V ac:6V ac/100mA
SW1 2 pole on-off switch 250V ac
F1 Fuse holder and Fuse 50mA
Connecting wire

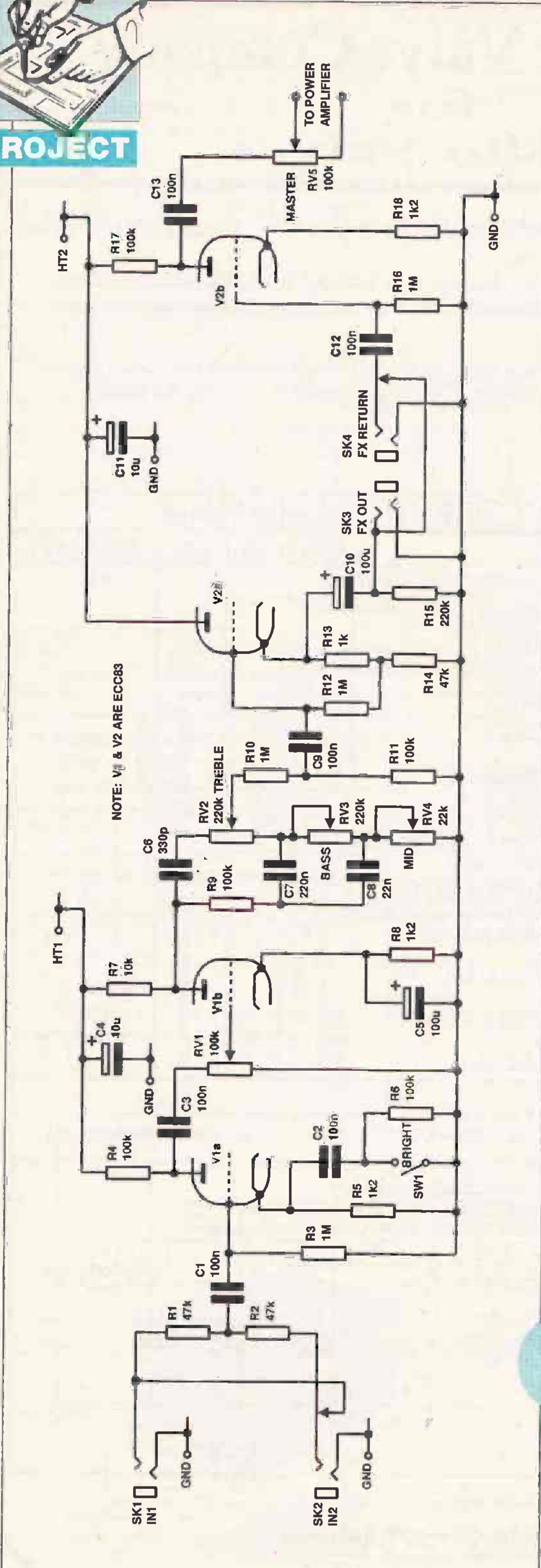


Fig. 1 The preamplifier circuit.

Paleface Minor Guitar Amp

Part 2

For bedroom blues fiends and garage thrashers, Dave Bradshaw presents the 15W Paleface Minor valve combo unit for lead guitar

Last month, we looked at some of the principles involved in designing a valve amplifier, this month we will look at a practical circuit, a guitar amplifier. When designing a guitar amplifier, you turn most hi-fi design principles on their head. The circuit of the amplifier is very similar to the classic valve amps of the '60s and '70s from likes of Fender, Marshall and Vox. Starting in the pre-amp (Figure 1), the signal is amplified by the two halves of V1, an ECC83 (also known as 12AX7 and, in the USA, 7025) which is a high-gain dual triode valve.

V1a and b are both wired as cathode-coupled amplifiers with a volume control between them. For most guitar pick-

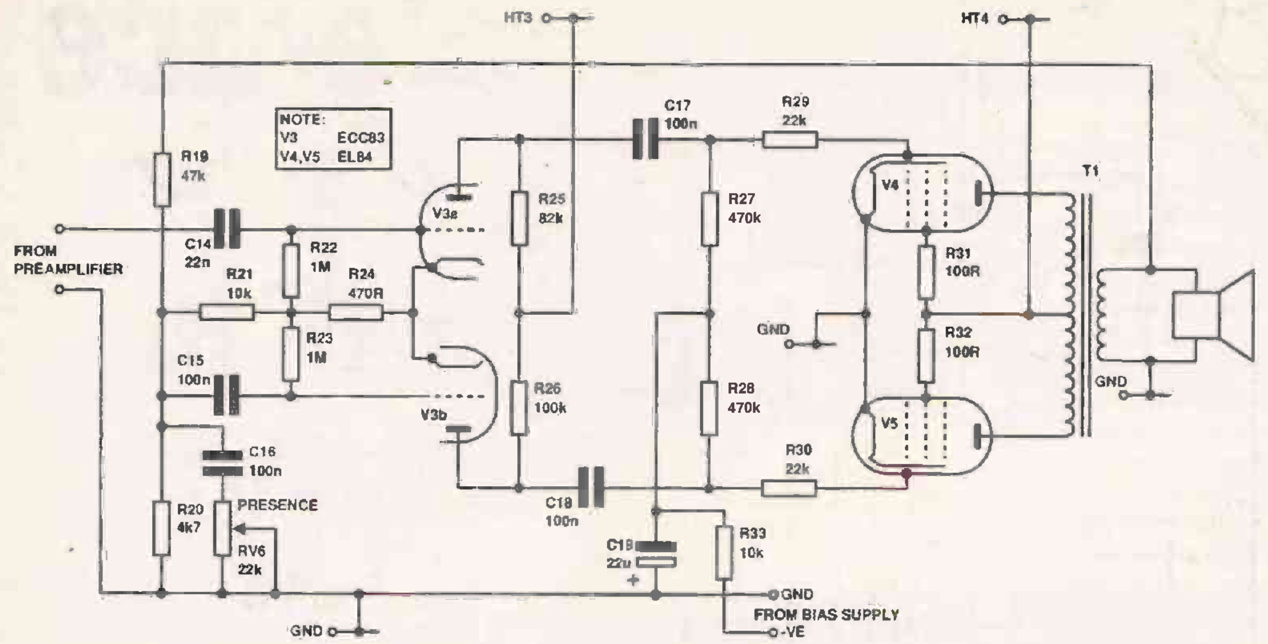


Fig. 2 The power amplifier

ups, there is more than enough gain for the second stage to overdrive (i.e. overload). With good quality valves, there is so much gain that a suggested modification is to insert some switchable attenuation - see 'Designer Approved' below.

The output from V1b goes to the passive tone control. Again, this is the classic format used on virtually all the older amplifiers, with the values slightly tweaked to take account of E12 and E6 component values (in the good old days, 250k pots were common).

The output from the tone control goes to an attenuator that feeds a self-biasing cathode follower, V2a. The cathode follower sends the signal out to the effects (FX) loop. The attenuation is necessary because the signal level can easily be 10V peak-to-peak, after the tone control. This is more than enough to overload any solid state circuitry in the FX loop.

The FX loop allows you to use an external reverberation effects unit. I really wanted to include a traditional spring line reverberation unit, but could not find a source despite a lot of asking around.

V2b amplifies the Return signal back up to the level needed for the power amplifier. Again, there's the option of adding a capacitor in the cathode circuit, either for more gain (unlikely to be necessary) or as a 'bight' option. The output from V2b goes to the master volume control, and thence to the power amplifier.

Power Amp

The power amplifier (Figure 2) is again classic in design, with a long-tailed pair phase splitter. Actually, the tail is rather short and there are several fiddles applied to this phase splitter to get it to balance more evenly. There are more accurate phase splitter circuits, but they can give problems under overload. Getting round these problem requires an extra valve and other

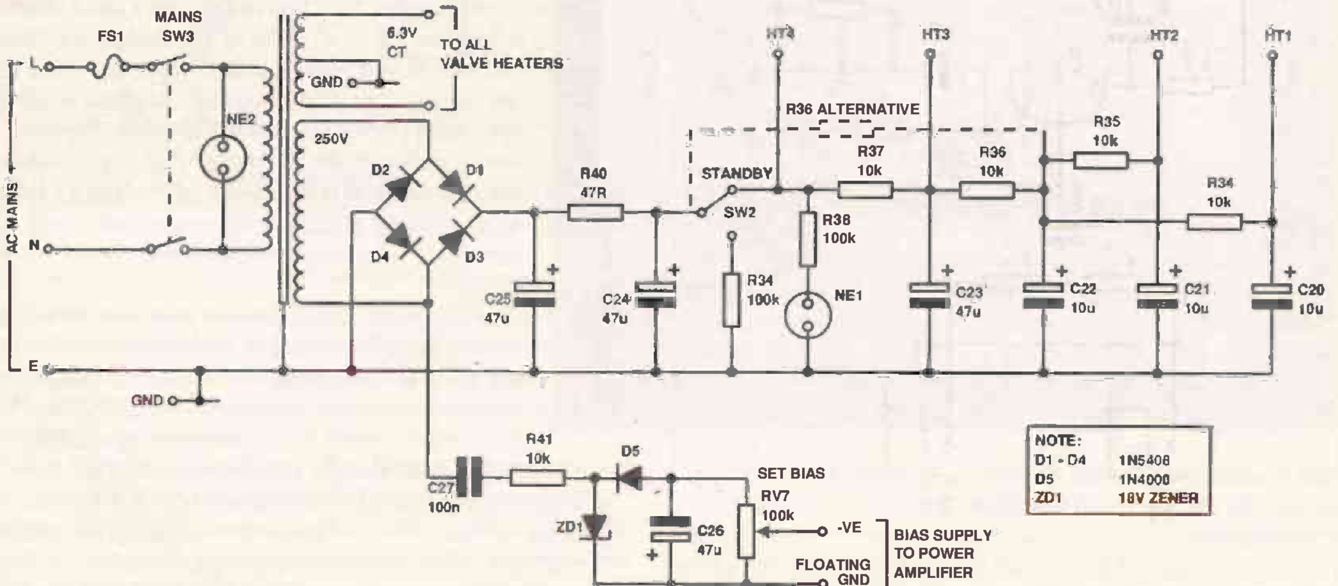


Fig. 3 The power supply

complications, so we go back to the tried and tested fiddles.

The output stage is a text-book application of the EL84 with one exception - the use of fixed bias on the output values. EL84s normally use self-biasing, i.e. a common resistor between the cathodes and ground (and the control grids at zero volts) so that the grid bias floats according to the demands made on the valves. Moreover, purists will further point out that the Vox AC30, perhaps the best known 'vintage' amp based on EL84s, used self-biasing. If you'd like to follow the purists, there's a mod below.

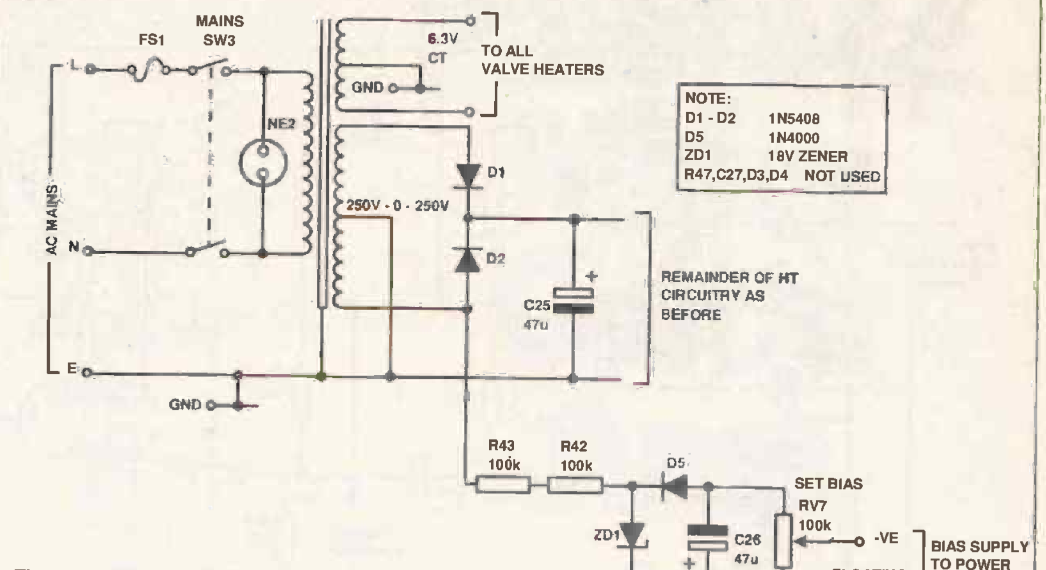
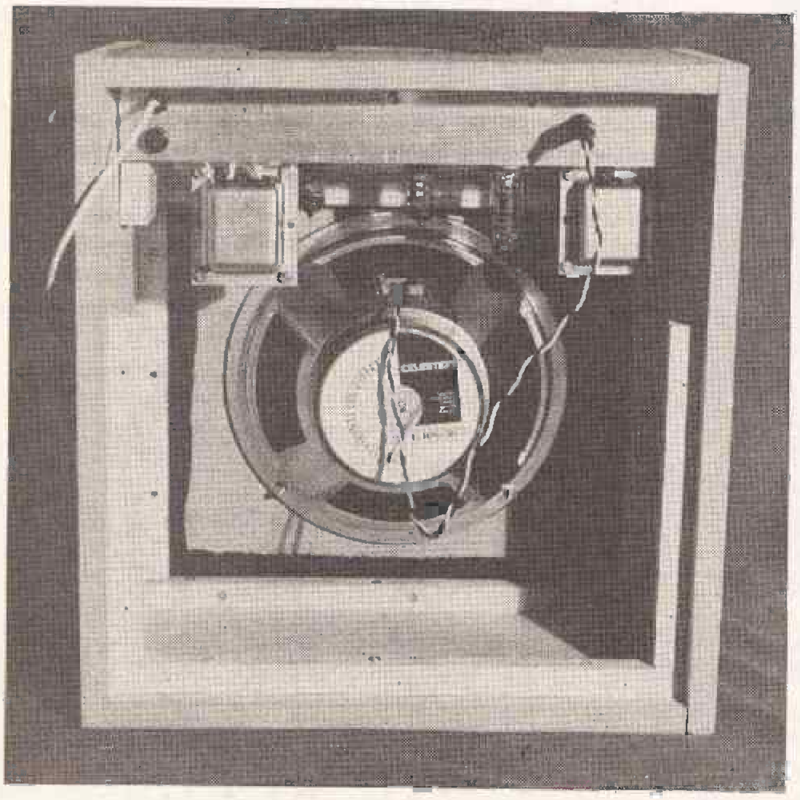


Fig. 4 Modification of the power supply to accommodate a 250-0-250V mains transformer.

However, I chose fixed bias because this allows more current flow at signal peaks, giving the amp a lot more punch than most other amps of a similar rating. This little amp sounds more like a 'big' amp than a small one.

In theory both valves may need to be biased individually, but this has not caused problems with the recommended matched pair from Chelmer Valves. Another advantage with fixed bias is slightly lower power dissipation when quiescent,



but the difference is only marginal. The heaters dissipate quite a lot of power in stand-by anyway.

Powering

The power supply (Figure 3) will be familiar territory for ETI readers, except for the voltages involved. With a full wave rectifier, it uses a mains transformers with the single 250V secondary. Figure 4 shows the arrangement for use with a 250-0-250V secondary winding, common in the valve gear of yesteryear that you may be plundering.

The stand-by switch has two uses. It should always be off (i.e. the amplifier on stand-by) when the mains is first turned on - this allows the power amplifier valves to warm up before they are asked to pass current. Secondly, the stand-by mode should be selected when the amp is not needed, or when changing input or output connections. This prolongs the life of the power amp valves, and prevents 'thumps' coming through to the loudspeaker while changing inputs or the FX loop.

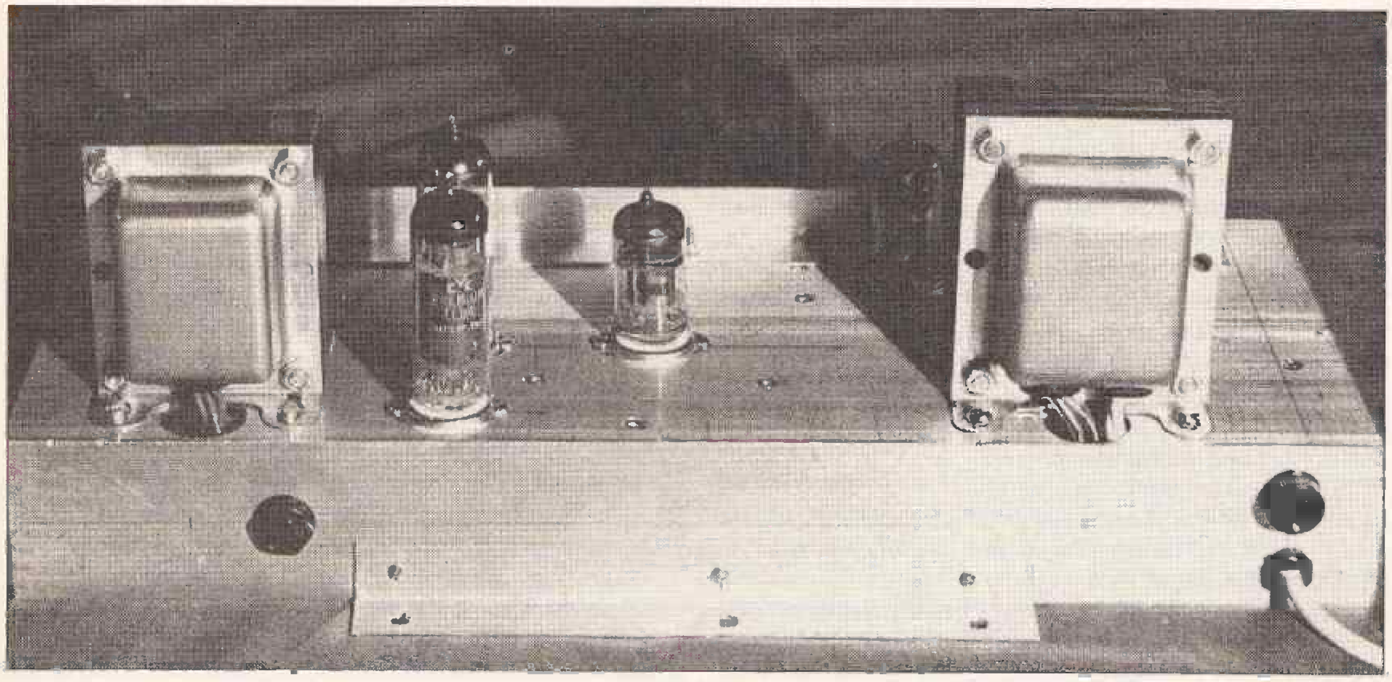
Do not be tempted to put a smoothing capacitor directly on the power amplifier side of the stand-by switch, as you will eventually destroy both capacitor and switch. Note also the option for powering the pre-amp even when the power amp is held off by the stand-by switch.

Designer Approved

These are the main mods I have tried myself and found to be potentially useful. There are quite a number of circuit options in this design and there is no harm in you trying most of the possibilities yourself. In fact, one of the nice things about working with valves is how easy it is to try out different ideas. However, do remember that many parts of the circuit are at dangerously high voltages and that capacitor voltage ratings have to be high enough to take these voltages, with some margin to spare.

No FX loop: To save some costs, you can leave out V2 and all its circuitry and feed the output from the tone control straight to the master volume control. However, I recommend keeping the effects loop option, unless you are certain you will never want to use the amplifier with any external effects.

Gain increase: You can increase the gain of V1a by changing C2 to a 100µ 10V electrolytic capacitor in parallel with cathode resistors. In the same way, the gain of V2b can be increased by adding a similar electrolytic in parallel with R18. The most flexible option is to include a switch, similar



to SW1, and a resistor like R6, so that gain can be adjusted without a soldering iron. The PCB is laid out to accommodate an electrolytic for C2 and the extra capacitor, resistor and switch in parallel with R18. This mod is probably useful only with old or low-quality valves.

Gain switching: Far from having too little gain, the valves from Chelmer gave an embarrassing wealth of gain! Using a dual pole switch to move the gain around adds some extra flexibility, as shown in Figure 6. The 470k resistor in series with the 'hot' end of RV1 reduces the signal going into the tone control, so that the amplifier sound remains clean up to the maximum setting of RV1. A section of the switch shorts this out to restore the gain. The other section of the switch adds a 10k or 22k resistor in parallel with R11, reducing the distorted signal level reaching the FX line and reducing the chance of unwanted (solid state) distortion from here.

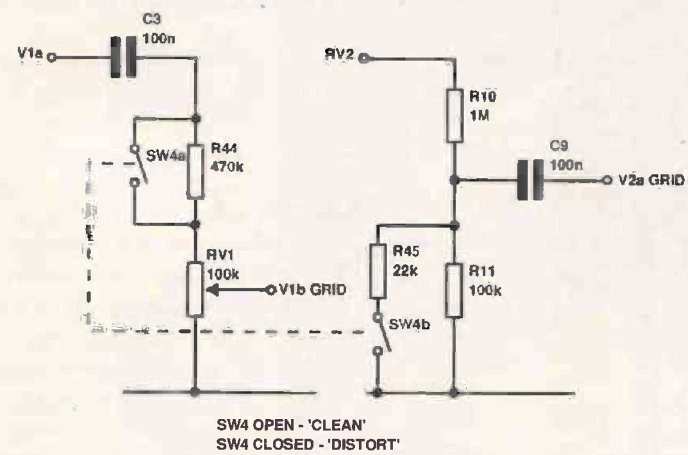


Fig. 5 Arrangements for gain switching, to give a 'clean' and 'distorted' setting.

Bright switches: there are two ways of adding 'bright' switches. The first is to use a 100n or 220n capacitor in parallel with R5 or R18, with a switch to take it out of circuit if required (as with the gain increase mod). The other way is to add a low value capacitor (220 or 330p) in series with a switch between the top and the wiper of RV1. Personally, I didn't find this particularly useful, as the 'presence' control has a very much stronger effect, but there's no harm in seeing if it suits your needs.

More inputs: The most radical and flexible option is one or more extra input channels. Not only does this allow different inputs, but you can have different set-ups on the channels and switch between them or even 'jumper' (parallel) two channels together, to get a blend. The Paleface Major amplifier will have this option built in, so rather than going into detail I suggest you wait a couple of months until that project is published.

Tone controls: Do play around with the capacitors and resistors in the tone control, but note that the 'hot' side of the capacitors can be at 300V. Not only do you need to use high-voltage capacitors, but you should take care that the power is off and supply capacitors are disconnected. My favourite tweak is to make C6 1n0, not 330p.

Floating power amp bias: Purists trying to reproduce the sound of Vox AC30s can set up the power amp for floating bias. To do this, remove the negative grid bias supply to the power amp, earth the junction of R25 and R26, and add a 180R 5W resistor between the commoned EL84 cathodes and earth, as shown in Figure 8. If you have a scope and signal generator, it may be worth experimenting with different values of cathode resistor to see which give the best cross-over distortion.

Full constructional details will be given next month.

How It Works - Pre-amplifier

The signal passes through R1 and R2, through C1, to the gird of valve V1a, which is wired as a common-cathode amplifier. The cathode is not by-passed so the gain of this stage is around 20.

V1b is a second common-cathode amplifier, but cathode resistor C5 gives it higher gain so that it can be driven into overload fairly easily. Following V1b, are the passive tone controls around RV2-4. If a 'mid' control is not required, RV4 can be replaced with a 10k resistor (there's a place for this resistor on the PCB). Note that capacitors C6 to C8 must withstand at least 300V dc.

The tone control is followed by an 11:1 attenuator (R10 and 11), then V2a wired as a cathode-follower. This circuit supplies any external effects with a signal of around 1V peak-to-peak at low enough impedance to drive semiconductor circuits. When no input is plugged into the return socket, the switch on the socket connects the FX Out to Return. If you have trouble getting the amplifier to play 'clean', it may be either because the external effects are overloading, or V2b may be distorting due to the high signal level. Try lower values for R11, e.g. 47k or 33k.

The returned signal is amplified by common-cathode amplifier V2b to the level needed to drive the power amplifier. As with the first stage, the gain can be increased by adding a cathode capacitor, although this is unlikely to be necessary. Gain can be reduced by increasing the value of R18, say to 2k7. The signal goes to the power supply via a master volume control, RV5. Note that RV5 gets its earth from the power amplifier, which removes some potential hum noise.

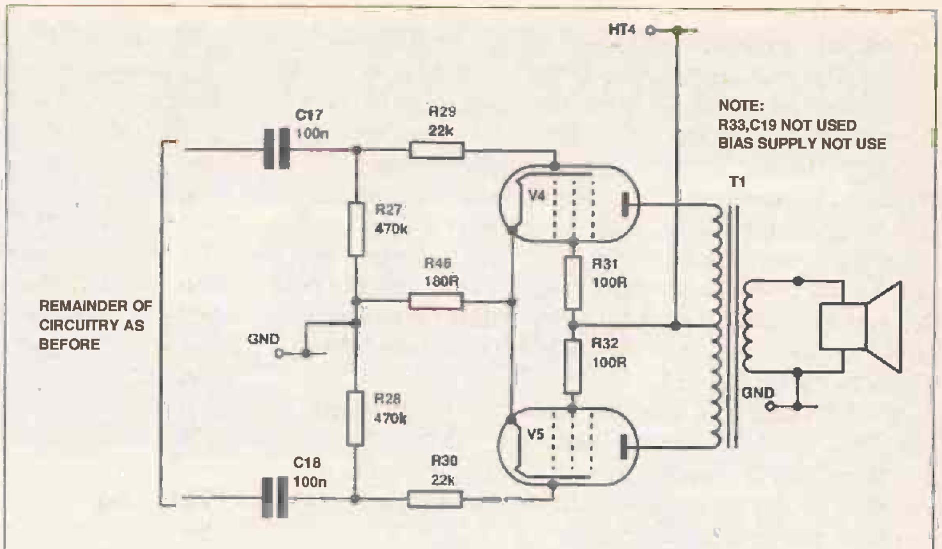
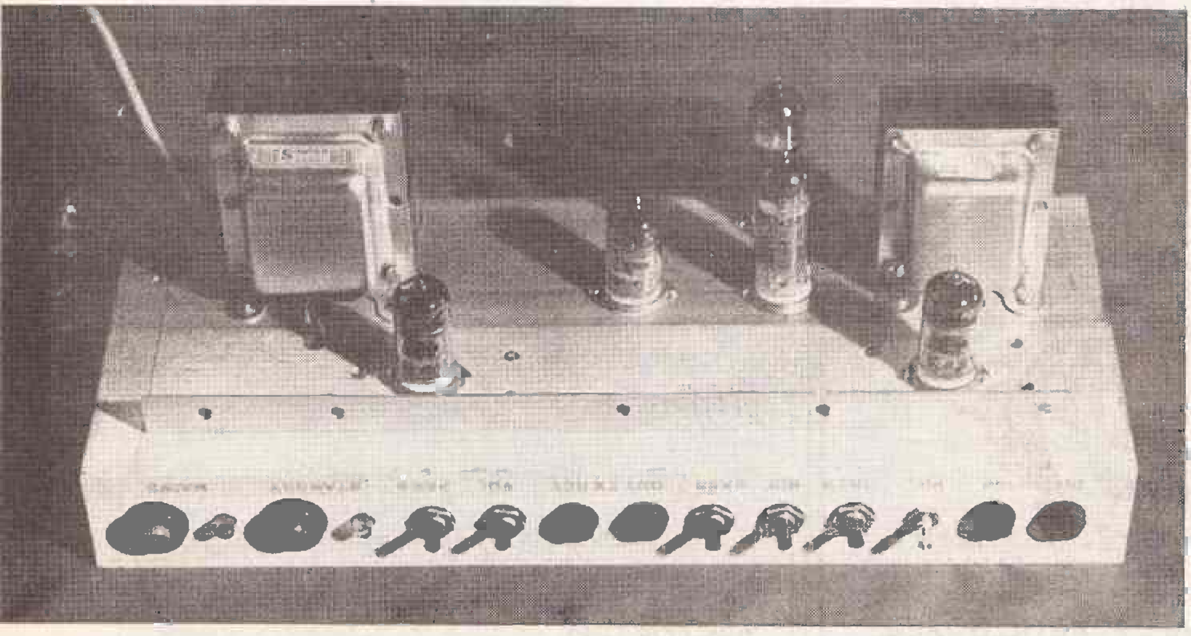


Fig. 6 Modifying the biasing arrangement on the output valves..

How It Works - Power Amplifier

The driver/phase splitter, V3a and b, is wired as a long-tailed pair amplifier, which takes the input signal from C14 and provides amplified complementary signals to the output valves. However, this circuit is a relatively inaccurate splitter, for a variety of reasons. One of them is that valves generally have fairly high cathode resistances (the cathode resistance is the resistance in series with the 'perfect' cathode in valve equivalent circuits). Also, the 'tail' (R21 and R24) is only around 15k long



(i.e., around 30 to 50V).

With an ideal valve and a nice long tail, the two anode resistors (R25 and R26) would have the same value, but here R25 is lower in value than R26, reducing the gain of V3a. Also, the feedback from the output is applied part way along the tail, via R17, reducing the gain in V3a and increasing the effect of the feedback. These compensate for imperfections and give reasonably well matched driving signals to the output valves.

The power output valves V4 and V5 are power pentodes, wired according to the standard format. (Note that the cathodes and third grids are connected internally.) They operate in class B with a fixed grid bias voltage supplied from the small negative supply. The screen grids are connected to the HT line via resistors R30 and R31, which helps reduce screen current flow at quiescent.

Note the addition of two resistors R29 and R30 in the control grid circuits. This is standard practice in most high power amplifiers. If the signal form the driver stage to the output valve is large enough, it will drive the grid positive with respect to the cathode and some current will flow from the grid. R29 and R30 restrict this current flow. This grid current flow is another reason for choosing the type of splitter/driver employed here - other designs rely on feedback from one valve to the other, and any grid current flow could seriously upset them.

The current from V4 and V5 goes to the output transformer T1, which transforms the signal impedances and also isolates the loudspeaker from the high voltages in the primary. Some of the output is fed back to the input via R19. Do not try to reduce R19 too much, as this can make the amplifier oscillate. C16 and RV6 provide a 'presence' control - they reduce feedback at higher frequencies.

Note that the power amplifier should never be operated without a load, and preferably always with a load of the correct impedance. Disconnecting the load under signal can lead to a not-so-nice fireworks display inside the output valves, due to high voltages being generated in the output transformer secondaries.

How It Works - Power Supply

The power supply (Figure 3) will be familiar territory. D1 to D4 form a bridge rectifier. I have used high-current 1N5408 diodes, not for the standing current but for the high switch-on current. This is probably a bit over the top, but they cost only a few pence more than 1N4008s. The output from the bridge is smoothed by C25 and C24, with R40 between them.

Directly following C24 is the standby switch which removes HT power from the rest of the amplifier. Actually, if desired, the pre-amplifier can be powered while in standby mode by an alternative positioning of R36. There is provision for this option on the PCB, but R36 should be 22k not 10k with this option. Leaving the pre-amplifier powered while the power amp is off allows other equipment to be driven by the FX Out jack.

The PCB has room for either 10µ or 47µ for capacitors C22-25, and 47µ or 100µ for capacitors C26 and 27. The prototype used the lower values, with no significant hum problems. In former years, resistors R37 and possibly R40 would be chokes of around 10H.

The negative supply uses a capacitor, C27, tied to one end of the high voltage transformer. This point oscillates between 0V and 400V (although for much of the time, when diodes D1 to D4 are not conducting, this point is actually floating). This is conveyed and dropped by C27 to voltage clamp ZD1 and rectifier D5. Transients tend to come through the capacitor at low impedance and R41 dissipates these. The bias supply is smoothed by C26 and set by RV7. Note that the bias supply gets its earth from the power amplifier.

A curious feature of the bias voltage generator is that it tends to act as a rather inefficient charge pump, pumping up the voltage on capacitors C24 and C25 to over their rated voltages at no load. R39 removes this effect by soaking up a little current (can you work out how the charge pump works?). Neon NE2 needs a dropper resistor, R38, as it is operating at a steady dc voltage above its intended average normal voltage.

If you are using an old transformer, you may well find it has a 250-0-250V winding. To accommodate this, the modifications shown in Figure 4 are needed. Whatever you do, make sure that you do not have diodes D3 and D4 in circuit, or your amplifier will eat main fuses and possibly other components too. Also, R40 becomes 100k, C28 is replaced by R41 and resistor R38 is not needed since the charge-pumping effect no longer takes place.

No mains filter was used on the prototype - this is an obvious extra that could be added if the amp is to be used in electrically noisy conditions.

Warning

This is an advanced project. Not only does it involve working with the mains, but it involves circuits using high voltages. We advise readers with little experienced to wait until they have more experience before building this design. Special notice: the author retains all rights of commercial exploitation to this design.

The author would like to thank Chelmer Valves, Sowter Transformers and Wilmslow Audio, for all their help during the design and construction of this project.

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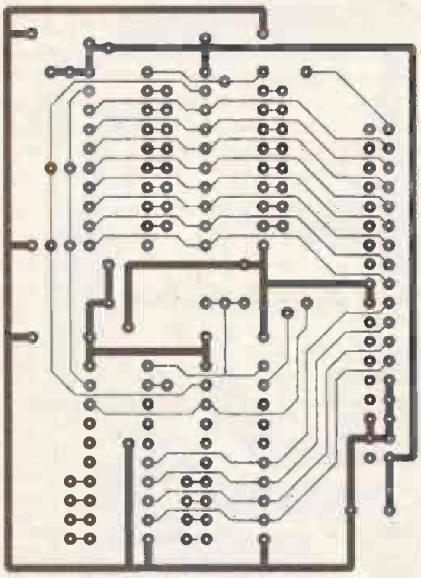

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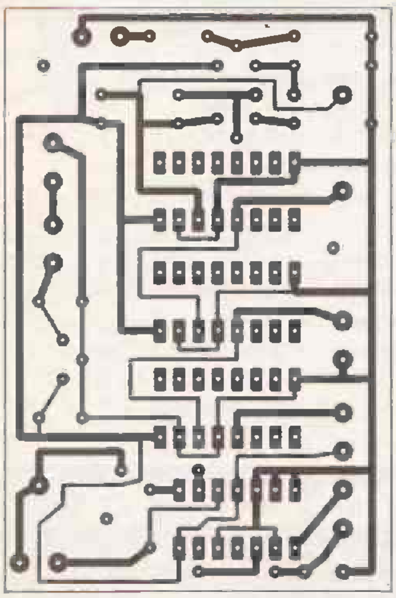

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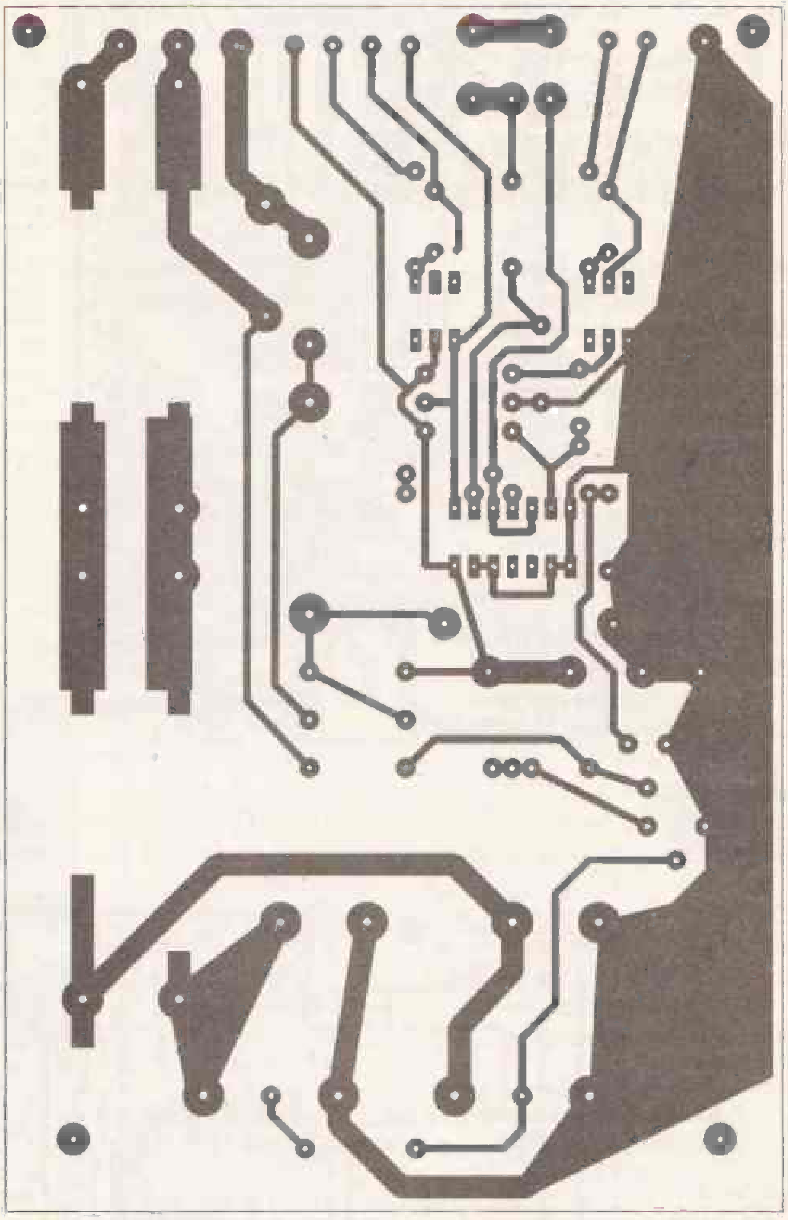

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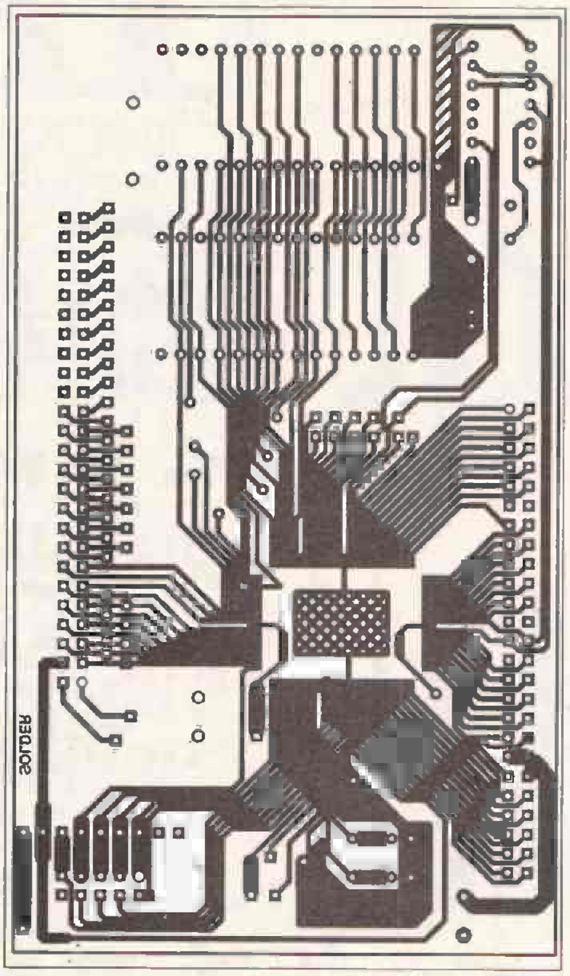

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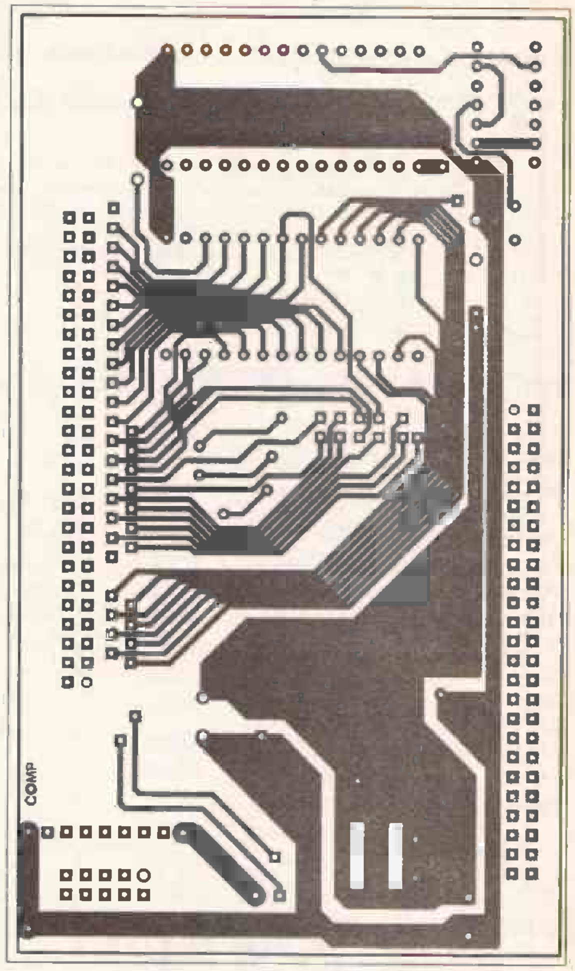

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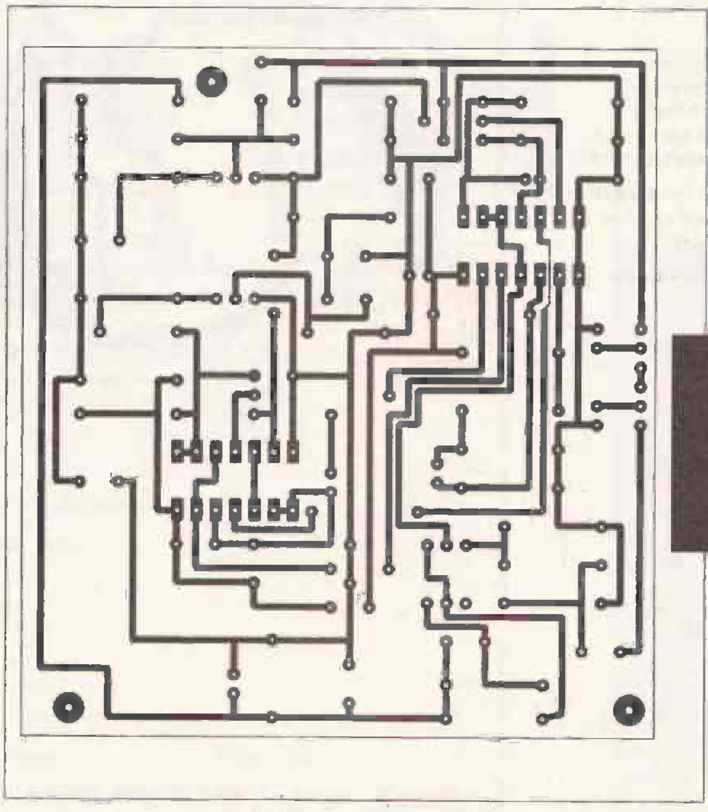

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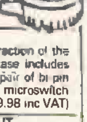

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Open Forum

Future historians will probably rate the development of the microprocessor during the early 1970s as one of the most significant technological developments in the history of mankind. There must be hardly a single consumer product which does not contain one, or owe its design to equipment which does.

The microprocessor has also meant that electronics engineering as a profession, and also as a hobby, has changed. The electronics engineer is now, by and large, an integrator of systems composed of standard building blocks. Systems in which software performs the functions rather than discrete components.

In electronics, a knowledge of programming is now as essential as a knowledge of the theories of circuit design. Indeed, it is probably more important, since in many cases the building blocks can be slotted together without much knowledge of electronics, but will fail dismally without any knowledge of programming.

For the amateur this can be a blessing in disguise. It is now possible to embark on building quite complex projects without being a 'professional' in the area of circuit design.

The use of standard building blocks even extends to the software . Whole libraries of standard routines are available in the public domain for us to use . Not to mention all the programming tools that allow us to do most of the development work on an ordinary PC.

We can even use the PC to help us design the hardware. The free PCB and schematics design program included with this issue is a perfect example. How many of us have, in the past, struggled with designing a PCB using tape and rub down pads.

Now if our schematics are right our PCB will be right. Maybe not as optimised a design as one done by a professional, but a design done in a fraction of the time. The necessary skill level has been reduced, for the professional an unfortunate side effect, but for the amateur a Godsend.

The amateur can now do what five years ago only a professional could do. In consequence we should see an increase in the sophistication of projects published in magazines like ETI.

Gentlemen and Players

The advent of the microprocessor is also narrowing the gap between the professional and the amateur in other areas. Specialised programs can help with design and education - there are already a number of very good computer based electronics education packages.

We are also seeing a de-specialisation in instrumentation. Whilst on the one hand the number of different parameters to be measured is proliferating, on the other hand we are witnessing a decline in the range of hardware.

In the past, there might have been need for a large range of different instruments there is now only need for a few. The PC and the workstation are taking the place of many instrumentation displays, with small front end boxes to perform the actual data input function. The rise of the virtual instrument.

The concept of virtual instruments will put powerful instrumentation into the hands of the amateur electronics engineer. Computerised design tools and the increasing modularity of electronic components will make it easier for him to create sophisticated designs.

For the amateur, the microprocessor has made life much more interesting and challenging, and the scope which it offers us must be seized with both hands.

Next month...

Next month in ETI we will be continuing two major construction projects, Jason Sharpe's Z-80 single board computer and Dave Bradshaw's valve guitar amplifier. We will also be starting a two part piece on an improved power supply design by John Linsley Hood. There will be another useful test equipment design from Robert Penfold and an interesting radio project from Raymond Haigh. For computer experimenters, the editor will be looking at a simple robotic vision system.

In addition, there will be a look at virtual instrumentation, reviews of some commercial EPROM programmers, and our continuing series on microprocessor fundamentals.

Don't forget that the next issue will have the second free disk on the cover, containing the remaining part of the Layo1 PCB design and schematics package. Make sure you don't miss it - order your copy of ETI from your newsagents today.

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ABC CONSUMER PRESS
ISSN 0142-7229

Subscription rates-UK £23.40 Europe £30.30 Sterling Overseas £31.50 US Dollars Overseas $52.00

Published by Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead HP2 7ST. Telephone (0442) 66551. UK newstrade distribution by SM Distribution Ltd, 6 Leigham Court Road, London SW16 2PG. Telephone 081-667 8111. Overseas and non-newstrade sales by Magazine Sales Department, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST. Telephone (0442) 66551. Subscriptions by Argus Subscription Services, ETI, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. Telephone (0737) 768611.
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