ETI

ELECTRONICS TODAY INTERNATIONAL

Flash microcontroller programmer

Solar-powered plant watering system

Electronic guard dog

CMOS logic IC tester

JULY 1996 £ 2.25

PLUS

- Games headphone amplifier
- 8051 single board computer
- Valve radio restoration

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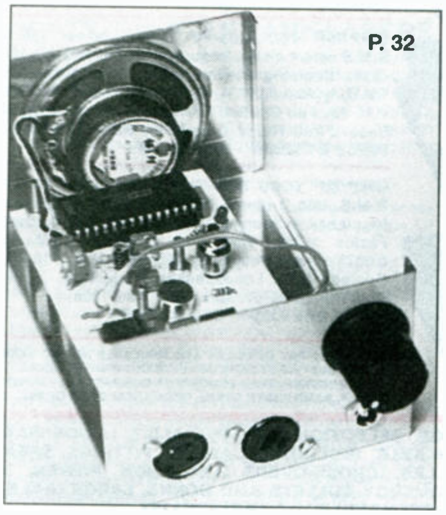

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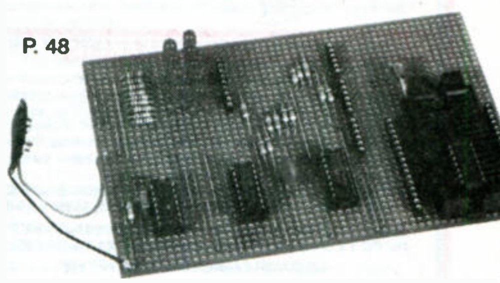


SURVEILLANCE TELESCOPE Superb Russian zoom telescope adjustable from 15x to 60x! complete with metal tripod (imposible to use without this on the higher settings) 66mm lense, leather carrying case £149 ref BAR69

RADIATION DETECTOR SYSTEM Designed to be wall mounted and connected into a PC, ideal for remote monitoring, whole building coverage etc. Complete with detector, cable and software. £19.95 ref BAR75.

WIRELESS VIDEO BUG KIT Transmits video and audio signals from a minature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter. Supplied with telescopic aerial but a piece of wire about 4" long will stil give a range of up to 100 metres. A single PP3 will probably give less than 1 hours use. £99 REF EP79. (probably not licensable!)

CCTV CAMERA MODULES 46X70X29mm, 30 grams, 12v 100mA. auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £79.95 ref EF137.

IR LAMP KIT Suitable for the above camera enables the camera to be used in total darkness! £5.99 ref EF138.

REMOTE CONTROLTANDATA TD1400 MODEM/ VIEWDATA Complete system comprising 1200/75 modem, auto dialler, infra red remote keyboard. (could be adapted for PC use?) psu. UHF and RGB output. phone lead. RS232 output. composite output. Absolute bargain for parts alone!!£9.95 ref BAR33.

9 WATT CHIEFTAN TANK LASERS

Double beam units designed to fit in the gun barrel of a tank, each unit has two semi conductor lasers and motor drive units for alignement. 7 mile range. full circuit diagrams, new price £50,000? us? £349. Each unit has two gallium Arsenide injection lasers, 1 x 9 watt, 1 x 3 watt, 900nm wavelength, 28vdc, 600hz pulse frequency. The units also contain an electronic receiver to detect reflected signals from targets. five or more units £299 ea. £349 for one. Ref LOT4.

TWO WAY MIRROR KIT Includes special adhesive film to make two way mirror(s) up to 60"x20". (glass not included) Includes full instructions. £12 ref TW1.

NEW HIGH POWER RF TRANSMITTERS AMPLIFIERS Assembled PCB transmitters, 4 types available,
12.6vdc 90 watt 1.5-30mhz 75 ohm in/out FM/AM £75 ref RF1
12.6vdc 40 watt 50-200mhz 50 ohm in/out FM/AM £65 ref RF2
28vdc 125 watt 1.5-30mhz 75 ohm in/out FM/AM £85 ref RF3
28vdc 100 watt 50-200mhz 50 ohm in/out FM/AM £75 ref RF4
A heat sink will be required, ring for price and availability.
If you intend using these as audio transmitters you will need a also need a preamp. Complex module available at £40 ref RF5.

COMPUTER/WORKSHOP/HI-FI RCB UNITS Complete protection from faulty equipment for everybody! Inline unit fits in standard IEC lead (extends it by 750mm), fitted in less than 10 seconds, reset/test button, 10A rating. £9 each Ref MM5.

RADIO CONTROLLED CARS FROM £6 EACH!!!! All returns from famous manufacturer, 3 types available, single channel (left,right,forwards,backwards) £6 ref LOT1. Two channel with more features £12 ref LOT2. Two channel proportional (plug in crystals etc) £35 ref LOT3.

THOUSANDS AVAILABLE RING/FAX FOR DETAILS!

MAGNETIC CARD READERS (Swipes) £9.95 Cased with flyleads, designed to read standard credit cards! they have 3 wires coming out of the head so they may write as well? complete with control elctronics PCB just £9.95 ref BAR31

WANT TO MAKE SOME MONEY? STUCK FOR AN IDEA? We have collated 140 business manuals that give you information on setting up different businesses, you peruse these at your leisure using the text editor on your PC. Also included is the certificate enabling you to reproduce (and sell) the manuals as much as you like! £14 ref EP74

PANORAMIC CAMERA OFFER Takes double width photographs using standard 35mm film. Use in horizontal or vertical mode. Complete with strap £7.99 ref BAR1

COIN OPERATED TIMER KIT Complete with coinslot mechanism, adjustable time delay, relay output, put a coinslot on anything you like! TV,s, videos, fridges, drinks cupboards, HIFI, takes 50p's and £1 coins. DC operated, price just £7.99 ref BAR27.

ZENITH 900 X MAGNIFICATION MICROSCOPE Zoom, metal construction, built in light, shrimp farm, group viewing screen, lots of accessories. £29 ref ANAYLT.

AA NICAD PACK Pack of 4 tagged AA nicads £2.99 ref BAR34

PLASMA SCREENS 222x310mm, no data hence £4.99 ref BAR67

NIGHTSIGHTS Model TZS4 with infra red illuminator, views up to 75 metres in full darkness in infrared mode, 150m range, 45mm lens, 13 deg angle of view, focussing range 1.5m to infinity. 2 AA batteries required. 950g weight. £199 ref BAR61. 1 years warranty

LIQUID CRYSTAL DISPLAYS Bargain prices,
16 character 2 line, 99x24mm £2.99 ref SM1623A
20 character 2 line, 83x19mm £3.99 ref SM2020A
16 character 4 line, 62x25mm £5.99 ref SMC1640A

TAL-1 110MM NEWTONIAN REFLECTOR TELESCOPE Russian. Superb astronomical 'scope, everything you need for some serious star gazing! up to 169x magnification. Send or fax for further details £249 ref TAL-1

GOT AN EXPENSIVE BIKE? You need one of our bottle alarms, they look like a standard water bottle, but open the top, insert a key to activate a motion sensor alarm built inside. Fits all standard bottle carriers, supplied with two keys. SALE PRICE £7.99 REF SA32.

GOT AN EXPENSIVE ANYTHING? You need one of our cased vibration alarms, keyswitch operated, fully cased just fit it to

WOLVERHAMPTON BRANCH NOW OPEN AT WORCESTER ST W'HAMPTON TEL 01902 22039

anything from videos to caravans, provides a years protection from 1 PP3 battery, UK made. SALE PRICE £4.99 REF SA33.

DAMAGED ANSWER PHONES These are probably beyond repair so just £4.99 each. BT response 200 machines. REF SA30.

COMPUTER DISC CLEAROUT We are left with a lot of software packs that need cleaning so we are selling at disc value only! 50 discs for £4, thats just 8p each!!(our choice of discs) £4 ref EP66

IBM PS2 MODEL 160Z CASE AND POWER SUPPLY Complete with fan etc and 200 watt power supply. £9.95 ref EP67

DELL PC POWER SUPPLIES 145 watt, +5,-5,+12,-12, 150x150x85mm complete with switch, flyleads and IEC socket. SALE PRICE £9.99 ref EP55

1.44 DISC DRIVES Standard PC 3.5" drives but returns so they will need attention SALE PRICE £4.99 ref EP68

1.2 DISC DRIVES Standard 5.25" drives but returns so they will need attention SALE PRICE NOW ONLY £3.50 ref EP69

PP3 NICADS Unused but some storage marks. £4.99 ref EP52

DELL PC POWER SUPPLIES (Customer returns) Standard PC psu's complete with fly leads, case and fan. +12v,-12v,+5v,-5v SALE PRICE £1.99 EACH worth it for the bits alone! ref DL1. TRADE PACK OF 20 £29.95 Ref DL2.

GAS HOBS AND OVENS Brand new gas appliances, perfect for small flats etc. Basic 3 burner hob SALE PRICE £24.99 ref EP72. Basic small built in oven SALE PRICE £79 ref EP73

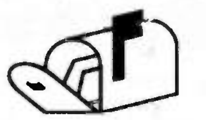
RED EYE SECURITY PROTECTOR 1,000 watt outdoor PIR switch SALE PRICE £6.99 ref EP57

ENERGY BANK KIT 100 6"x6" 6v 100mA panels, 100 diodes, connection details etc. £69.95 ref EF112.

PASTEL ACCOUNTS SOFTWARE, does everything for all sizes of businesses, includes wordprocessor, report writer, windowing, networkable up to 10 stations, multiple cash books etc. 200 page comprehensive manual. 90 days free technical support (0345-326009 try before you buy!) Current retail price is £129, SALE PRICE £9.95 ref SA12. SAVE £120!!!

COMPLETE PC 200 WATT UPS SYSTEM Top of the range UPS system providing protection for your computer system and valuable software against mains power fluctuations and cuts. New and boxed, UK made Provides up to 5 mins running time in the event of complete power failure to allow you to run your system down correctly. LAST FEW TO CLEAR AT £49 SAVE £30 ref LOT61

BIG BROTHER PSU Cased PSU, 6v 2A output, 2m o/p lead, 1.5m input lead, UK made, 220v. SALE PRICE £4.99 REF EP7



Check out our WEB SITE

http://www.pavilion.co.uk/bull-electrical

RACAL MODEM BONANZA! 1 Racal MPS1223 1200/75 modem, telephone lead, mains lead, manual and comms software, the cheapest way onto the net! all this for just £13 ref DEC13.

4.5mw LASER POINTER. BRAND NEW MODEL NOW IN STOCK!, supplied in fully built form (looks like a nice pen) complete with handy pocket clip (which also acts as the on/off switch.) About 50 metres range! Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. just £39.95 ref DEC49 TRADE PRICE £28 MIN 10 PIECES

BULL TENS UNIT Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN/1

RUSSIAN MONOCULARS Amazing 20 times magnification, coated lenses, carrying case and shoulder strap £29.95 REF BAR73

PC PAL VGA TO TV CONVERTER Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware.. Ideal for laptops or a cheap upgrade.Supplied in kit form for home assembly. SALE PRICE £25 REF SA34

EMERGENCY LIGHTING UNIT Complete unit with 2 double bulb floodlights, built in charger and auto switch. Fully cased. 6v 8AH lead acid req'd. (secondhand) £4 ref MAG4P11.

YUASHA SEALED LEAD ACID BATTERIES Two sizes currently available this month. 12v 15AH at £18 ref LOT8 and 6v 10AH (suitable for emergency lights above) at just £6 ref LOT7.

ELECTRIC CAR WINDOW DE-ICERS Complete with cable, plug etc SALE PRICE JUST £4.99 REF SA28

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. £8.99 REF SA25.

ECLATRON FLASH TUBE As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £8.99 REF SA15B.

*SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

BULL ELECTRICAL
250 PORTLAND ROAD, HOVE, SUSSEX.
BN3 5QT. (ESTABLISHED 50 YEARS).
MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3 P&P PLUS VAT.
PLEASE ALLOW 7-10 DAYS FOR DELIVERY PHONE ORDERS WELCOME (ACCESS, VISA, SWITCH, AMERICAN EXPRESS)
TEL: 01273 203500
FAX 01273 323077
E-mail bull@pavilion.co.uk

24v AC 96WATT Cased power supply. New. £9.99 REF SA40

MICRODRIVE STRIPPERS Small cased tape drives ideal for stripping, lots of useful goodies including a smart case, and lots of components. SALE PRICE JUST £4.99 FOR FIVE REF SA26

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor. Superb value kit SALE PRICE JUST £4.99 REF SA27

RGB/CGA/EGA/TTL COLOUR MONITORS 12" in good condition. Back anodised metal case. SALE PRICE £49 REF SA16B

PLUG IN ACORN PSU 19v AC 14w, £2.99 REF MAG3P10

13.8V 1.9A PSU cased with leads. Just £9.99 REF MAG10P3

UNIVERSAL SPEED CONTROLLER KIT Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 REF: MAG17

PHONE CABLE AND COMPUTER COMMUNICATIONS PACK Kit contains 100m of 6 core cable, 100 cable clips, 2 line drivers with RS232 interfaces and all connectors etc. Ideal low cost method of communicating between PC's over a long distance utilizing the serial ports. Complete kit £8.99. Ref comp1.

VIEWDATA SYSTEMS made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc. SALE PRICE £12.99 REF SA18

AIR RIFLES .22 As used by the Chinese army for training puposes, so there is a lot about! £39.95 Ref EF78. 500 pellets £4.50 ref EF80.

PLUG IN POWER SUPPLY SALE FROM £1.50 Plugs in to 13A socket with output lead. three types available, 9vdc 150mA £1.50 ref SA19, 9vdc 200mA £2.00 ref SA20, 6.5vdc 500mA £2 ref SA21.

VIDEO SENDER UNIT. Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £15 REF: MAG15 12v psu is £5 extra REF: MAG5P2

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range up to 2km in open country. Units measure 22x52x155mm. Including cases and earp'ces. 2xPP3 req'd. £30.00 pr. REF: MAG30

***FM TRANSMITTER KIT** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £15 REF: EF62 (kit) Transmits to any FM radio.

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

TALKING COINBOX STRIPPER COMPLETE WITH COINSLOT MECHANISMS originally made to retail at £79 each, these units are designed to convert an ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else?? SALE PRICE JUST £2.50 REF SA23

GAT AIR PISTOL PACK Complete with pistol, darts and pellets £12.95 Ref EF82B extra pellets (500) £4.50 ref EF80.

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. SALE PRICE £4.99 REF SA24.

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

MIXED GOODIES BOX OF MIXED COMPONENTS WEIGHING 2 KILOS YOURS FOR JUST £5.99

4X28 TELESCOPIC SIGHTS Suitable for all air rifles, ground lenses, good light gathering properties. £19.95 ref R/7.

RATTLE BACKS Interesting things these, small piece of solid perspex like material that if you try to spin it on the desk it only spins one way! In fact if you spin it the 'wrong' way it stops of its own accord and go's back the other way! £1.99 ref GI/J01.

GYROSCOPES Remember these? well we have found a company that still manufactures these popular scientific toys, perfect gift or for educational use etc. £6 ref EP70

HYPOTHERMIA SPACE BLANKET 215x150cm aluminised foil blanket, reflects more than 90% of body heat. Also suitable for the construction of two way mirrors! £3.99 each ref O/L041.

LENSTATIC RANGER COMPASS Oil filled capsule, strong metal case, large luminous points. Sight line with magnifying viewer. 50mm dia, 86gm. £10.99 ref O/K604.

RECHARGE ORDINARY BATTERIES UP TO 10 TIMES! With the Battery Wizard! Uses the latest pulse wave charge system to charge all popular brands of ordinary batteries AAA, AA, C, D, four at a time! Led system shows when batteries are charged, automatically rejects unsuitable cells, complete with mains adaptor. BS approved. Price is £21.95 ref EP31.

TALKING WATCH Yes, it actually tells you the time at the press of a button. Also features a voice alarm that wakes you up and tells you what the time is! Lithium cell included. £7.99 ref EP26.

PHOTOGRAPHIC RADAR TRAPS CAN COST YOU YOUR LICENCE! The new multiband 2000 radar detector can prevent even the most responsible of drivers from losing their licence! Adjustable audible alarm with 8 flashing leds gives instant warning of radar zones. Detects X, K, and Ka bands, 3 mile range, 'over the hill' 'around bends' and 'rear trap facilities. micro size just 4.25"x2.5"x.75", Can pay for itself in just one day! £79.95 ref EP3.

SANYO NICAD PACKS 120mmx14mm 4.8v 270 maH suitable for cordless phones etc. Pack of 2 just £5 ref EP78.

3" DISCS As used on older Amstrad machines, Spectrum plus3's etc £3 each ref BAR400.

STEREO MICROSOPES BACK IN STOCK Russian, 200x complete with lenses, lights, filters etc etc very comprehensive microscope that would normally be around the £700 mark, our price is just £299 (full money back guarantee) full details in catalogue. Ref 95/300.

WE BUY SURPLUS STOCK FOR CASH
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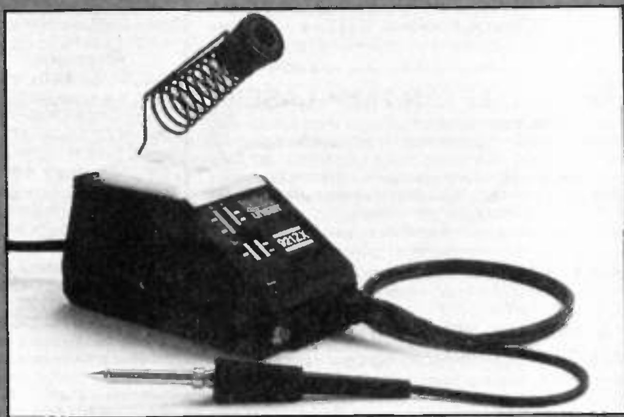
ETI ELECTRONICS TODAY INTERNATIONAL News...

High tech soldering station

The new Weller 921ZX benchtop soldering station from Cooper Tools brings high specifications professional soldering capabilities into the DIY and hobbyist price range. At £98.85 (list price excluding VAT) the new electronically controlled station provides adjustable soldering temperatures in the range 287-450C to suit a great variety of jobs around the home and workshop from electrical and electronic repairs to making jewellery. The value for money price of £98.85 (list excluding VAT) has been brought about by combining competitive features synonymous with the Ungar brand, acquired by Cooper in 1993, with the proven technology and reputation for quality of Weller. For instance, the station's soldering iron employs a 60 watt long-life ceramic heating element and the station is safe from the risks of electro-static discharge (ESD) and mains voltage spikes. A range of standard, high capacity and surface mount tips is available for use with the new station For further details contact: Cooper Tools, Tyne & Wear. Tel: 0191 416 6062



Miniature low-cost linear positioning tables

Daedal, a division of Parker Hannifin Corporation, has launched two new families of miniature low-cost linear positioning tables that measure just 60mm wide by 32mm high. Known as the 102000BN and 402000LN series, the tables offer a variety of high-performance bearing and leadscrew combinations, enabling designers to exactly match their application needs. The tables' combination of high positional accuracy, exceptionally small physical size and low cost makes them particularly suitable for precision positioning applications where access is restricted, or where conventional stages and motors are simply too large or expensive. They are ideal single and multi-axis positioners for applications involving relatively light payloads and short stroke lengths, such as optical alignment units, inspection systems, and gauging equipment.

Starting at less than £350, Daedal's 102000BN series tables incorporate a linear ball bearing system to provide low-cost, smooth and repeatable translation for loads of up to 20kg. The tables have a specified working life of up to 1,200km of travel, and there is a choice of two drive mechanisms. A low-cost rolled thread leadscrew version offers 12 micron repeatability for low speed X and X-Y positioning applications, and is available with pitches of 2, 5, 12 and 15mm.

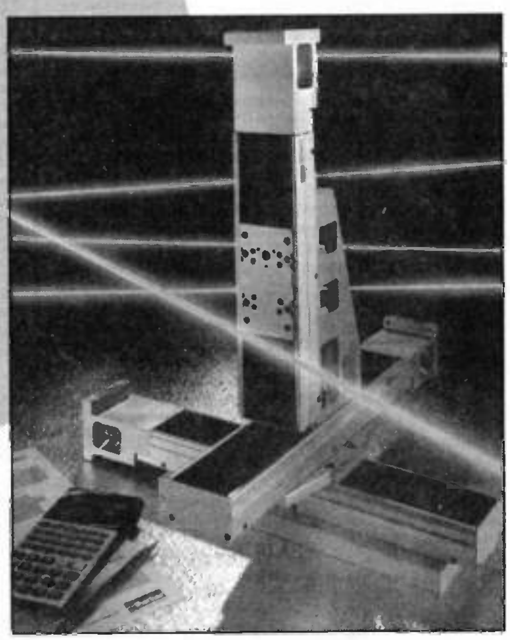
Alternatively, for applications that demand more precise positioning capabilities and faster speeds, a precision ground leadscrew version provides 2 micron repeatability, and is available with pitches of 1, 2 and 5mm.

The 402000LN series tables have the same small physical dimensions as Daedal's 102000I3N series, but employ a square rail bearing system instead of linear ball bearings, to increase the payload capacity to 70kg. Again, the tables have a specified working life of up to 1,200km of travel, and offer a choice of rolled thread or precision ground leadscrews with a variety of pitches, to facilitate easy matching of accuracy and speed. The precision ground leadscrew versions accommodate acceleration rates as high as 9,800mm/sec/sec.

All these new tables are fitted with way covers as standard, to protect the bearing and drive system against the ingress of contaminants and help ensure a long working life. Any table can be fitted with Hall effect home and end-of-travel limit switches, which are mounted externally to allow fine tuning adjustments to be made very easily; an internal optical sensor is also available, for applications that require minimum overall width.

Daedal 102000BN and 4020000LN tables accept NEMA size 17 and 23 stepper motors, as well as SM16 size servo motors. A complete range of motor mounting flanges is available, together with fully-machined X-Y adaptor plates and vertical brackets for multi-axis systems.

For further details please contact: Parker Hannifin plc. Digiplan Division, Poole. Tel: 01202 699000.



Recharge Your Notebook

New CE Approved PROwatt DC to AC power inverters convert battery power into 230v AC mains electricity to run and recharge Notebook computers in a vehicle. Also ideal for powering bubblejet printers and other peripherals in cars for completely mobile offices.

After a number of modifications, the PROwatt 150i and 250i now conform to EU directives 89/336/EEC as amended by Directive 93/68/EEC for EU-harmonised standards EN50081-1 and EN50082-1 for electrical interference, allowing the units to be confidently used in many more applications involving sensitive electronics.

The PROwatt 150i and 250i are compact enough for mobile applications, and will fit into notebook or briefcase. They weigh just 620 & 740 grammes respectively. The units are simply connected via a cigar lighter plug. 230v AC mains is accessible from the IEC 320 socket on its case.

A new, unique daughterboard arrangement helps regulate output current and improve surge capability to assist the running of difficult loads such as SVGA computer monitors. Due to improved current regulation, the life of the inverter is considerably extended.

Standard safety features include overheat and overload protection for complete peace of mind. The PROwatt 150i and 250i also sense low input battery voltage, should this reach a preset level, the unit will emit an audible warning allowing users to save their work and turn off to prevent damage to the vehicle's battery and allow the user to re-start the vehicle engine. The PROwatt 150i and 250i retail at £86-00 and £120-00 respectively, ex VAT and carriage and are available fiom UK importers Merlin Equipment.

FOr further information please contact; Merlin Equipment,Wallingford, Oxfordshire. Telephone: 01491 824333.

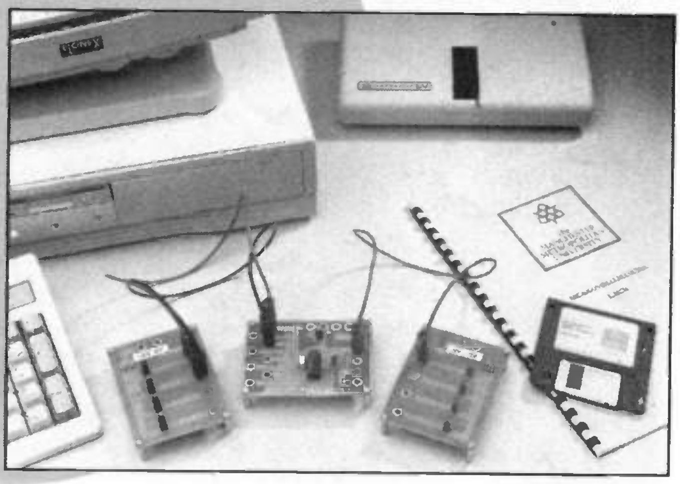
R.T.C.S. course update

For many years the R.T.C.S. has been conducting tutored and untutored correspondence courses for the City & Guilds of London Institute professional qualifications in Telecommunications and Electronics Engineering, Course No. 2710, which is now in the process of being updated to 2720. The course comprises three levels: the Technician Certificate, Technician Diploma and the Advanced Technician Diploma.

This course can be started at any time of the year and can be undertaken by anyone with a reasonable background of basic mathematics and science as taught at school. The School's correspondence course is designed especially for City & Guilds 2710/2720 and all students are under the general supervision of Mr. A.A. Goddard B.Sc(Eng), MIEE, who is a past member of the examining bodyof the City & Guilds.

Each subject is taught by a combination of standard approved textbooks, lesson and revision notes, worked examples and examination questions from past years' City & Guilds programmes.

The R.T.C.S. also conducts tutored or untutored correspondence courses for the Radio Amateurs' Examination held under the auspices of the Radio Society of Great Britain for the Radio-communications Agency, which is an Executive Agency of the Department of Trade and Industry. Again, these courses can be started at any time of the year and a student of, say, average ability and interest can successfully complete their studies in six to nine months. Courses covering Microelectronic Systems and Television Principles are also available. Full details and content of all the above courses can be obtained by applying for the relevant Prospectus from: R.T.C.S. at 12 Moor View Drive, Teignmouth, Devon. TQl4 9UN, Tel: 01626 779398.



Multimedia demo

Engineers can now evaluate Actel's FPGA design tools by exploring a free multimedia demonstration. An interactive CD-ROM explains Actel's FPGA architecture and devices, design entry options and provides a realistic emulation of the tools. It enables engineers to gain confidence that Actel's intuitive software tools will simplify the design of complex, high performance FPGAs, whilst maximising the performance. Also included is a step-by-step guide through every aspect of FPGA design process using the Designer Series 3.0 tools. The CD-ROM is available free from Actel in Windows 3.1 formats. For information contact: Actel Information Centre, Direct Mail Systems, 6 Woodbury Lane, Clifton, Bristol, BS8 2SD, United Kingdom

SKYNET 4 satellite

The UK Ministry of Defence (MoD) has awarded Matra Marconi Space UK a contract to supply a further SKYNET 4 satellite in order to extend the life of the current British military satellite communications system.

Valued at some £130 million, this "delivery-in-orbit" contract includes the launch of the satellite by Arianespace. The contract also provides for operational control and in-orbit testing of the satellite prior to handing over to the customer. The purchase will be in addition to the two spacecraft of the same design ordered two years ago and which are presently being manufactured at the company's Stevenage and Portsmouth plants. The new constellation will ensure that the UK can continue to rely on the vital global communications services already being provided by the proven SKYNET 4, Stage 1 system well into the 21st century. Satellite communications proved their worth in the Falklands Campaign and, even more dramatically, in the Gulf War. Today they are providing an essential link to the "Peace-Keepers" in Bosnia. They have become a vital part of military life both in peacetime and war and will play an ever more important role in the future. The new satellite, to be known as SKYNET 4F, together with SKYNET 4D and 4E ordered earlier will be built to the SKYNET 4, Stage 2 standard. The enhanced communications payload of the Stage 2 satellites incorporates steerable antennas to support SHF spot beam communications. Other improvements provide increased power and a superior anti-jamming capability whilst, at UHF, a fully tuneable system offers increased flexibility.

United Kingdom involvement in military satellite communications started in the 1960s with multiple-orbiting systems which led to the United Kingdom pioneering the introduction of a geostationary satellite, SKYNET 1. This was followed in 1974 by a more capable satellite - SKYNET 2 - designed and built in the UK. In 1981 the British MoD decided to proceed with a new generation of spacecraft - SKYNET 4. Three SKYNET 4 Stage 1 spacecraft were built and launched, and all are currently still in operational service with the British Armed Forces In 1987 the same industrial team, today totally within Matra Marconi Space, was selected to supply NATO with its new generation of military communications satellites. The two NATO IV satellites, virtually identical to the SKYNET 4 , Stage 1 satellites, were successfully launched in January 1991 and December 1993 and are currently providing strategic and tactical communications for the NATO Command structure and for Alliance members.

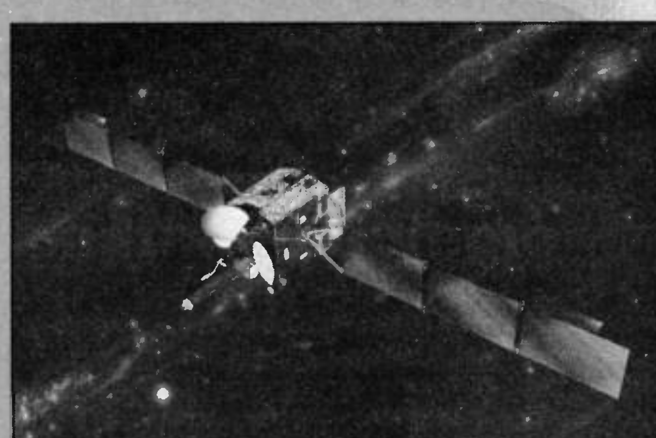
The SKYNET4 spacecraft is based on the highly successful three-axis stabilised platform developed by the now Matra Marconi Space for the European Space Agency's ECS and MARECS programmes which formed the foundations of the Eutelsat and Inmarsat communications networks.

The SKYNET 4 satellite is of modular construction comprising a service module, which provides general housekeeping and orbital control functions, and a payload module which carries the communications equipment. Two solar array wings, which rotate about their axis to follow the sun, provide electrical power for the operation of the satellite. The communications payload module is mounted below the service module and houses the transponders and the transmit and receive antennas which point permanently towards the Earth.

The entire spacecraft has a launch mass of 1500kg and its modular construction increases schedule flexibility by allowing parallel integration and test of the service module and communications payload at separate sites - Stevenage and Portsmouth respectively - prior to full system integration.

A wide variety of spot and global beams enables the SKYNET 4 satellite to serve an extensive inventory of Earth stations on land, sea and in the air, ranging from small manpack sets and aircraft terminals to those on widely dispersed naval vessels, including submarines, and large anchor stations on land. SKYNET 4 employs signal processing and anti-jamming features and its ability to survive in the harshest of electronic warfare environments is extremely important.

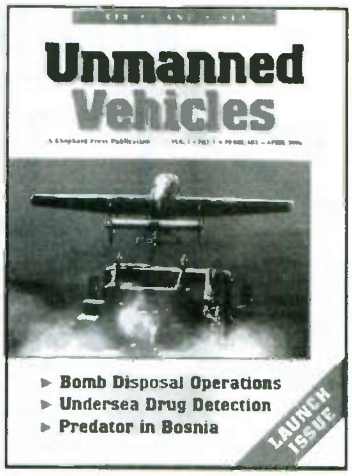
For further information contact: Matra Marconi Space Stevenage, Herts. Tel: 01438 736698



Unmanned Vehicles

A new magazine, Unmanned Vehicles, has been launched to highlight the many capabilities of aerial, ground and water ROV systems to the military and civil reader. The quarterly publication will document stories with a worldwide perspective and carry in-depth features covering the technology, news, procurement requirements, political and funding issues and the views of leading miltary and industrial personnel.

Further information: The Shephard Press, 111 High Street, Burnham, Bucks SL1 7JZ. Tel: +44 1628 604311, Fax: +44 1628 664334.



Open EMC test platform

Schaffner has released an open-architecture system platform to meet the fast-growing and changing requirements for EMC testing of electronic and electrical products. Known as ProfLine, the platform is constructed around flexible standards-based hardware and Windows control software, to allow users to automate the test and documentation process, yet re-configure and adapt the system to meet the evolving nature of EMC compliance. The approach empowers a user community which has learnt a lot about EMC in the panic to comply with the January 1996 CE deadline, by providing simple, high-level test tools capable of verifying current and future EMC standards .

Automated test systems can reduce the time and effort involved in EMC compliance validation by as much as 50%, while simultaneously optimizing the quality and repeatability of the process. By building a system on an open platform, Schaffner is also enabling users to configure more powerful and cost-effective test configurations compared with today's dedicated and proprietary instrumentation. Such a platform not only allows test systems to be configured for any EMC standard, but can also be used to extend the test process, to incorporate instrumentation to verify equipment functionality or safety, for example.

It allows systems to be configured using any instrument or resource with a standard VXI, IEEE488 or RS232 interface. Its Windows-based control and operator interface environment, POWERSTAR, allows sophisticated EMC compliance or pre-compliance test programs to be created in minutes, using drag-and-drop techniques to sequence library-based routines and custom fill-in-the-blanks screens. This software provides a basis for management of the entire test process, with a layered structure for drivers, control mechanisms, task management, test applications, administration and operator interfacing.

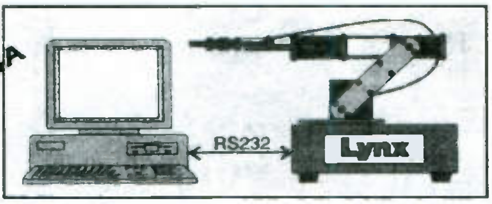
A further important aspect of this platform lies in the development of accessories to allow test systems to provide a universal solution to EMC requirements. This includes a rack- mounting interface for conducted immunity and conducted emissions testing which provides a common equipment-under-test (EUT) powerline coupling capable of routing any type of interference - such as burst, surge or flicker - for single- or three-phase equipment. Versions capable of handling power levels up to 500A provide immense flexibility for busy test departments. ProfLinc's software-controlled instruments and universal EUT interfacing speeds the test process dramatically, allowing changeover to test a new product in minutes - regardless of whether the equipment is a household appliance or an item of three-phase industrial control gear. Users can buy systems now to provide a turnkey solution for a particular set of standards - such as IEC 1000-3 (EN h1000-3) for conducted emissions - but add new instruments and applets to extend capability as needs change. ProlLine systems boost the integrity and repeatability of the test by controlling all aspects of the process, making them immune to the kind of errors and uncertainties which are possible with manual instrument and EU.I. interconnection. Programs can be made more rigorous through the ability to run multiple tests in sequence without disconnecting and reconnecting instruments. And test programs can be modified and saved easily, allowing users to develop and apply in-house EMC criteria in addition to minimum legal standards. Finally, test results are documented automatically, providing a clear and unambiguous record of compliance. ProfLine's basis on Windows helps to enhance this aspect even further by allowing test results and images from scopes or cameras to be exported to report generation packages to Provide more meaningful documentation,

Two further accessories offer an important growth path for the future. These are IOkV scanner and relay modules which provide the isolation resources to allow systems to be employed for EMC test and as conventional functional and/or safety ATE (automatic test equipment).

Schaffner' s ProfLine family supports a wide range of instruments and systems solutions for conducted immunity and emissions testing including burst, surge, powerline quality and electrostatic discharge guns. These instruments support compliance verification to the IEC 1000-4-2, -4,-5,-6,-8,-9,-11 and -13, and IEC 1000-3-2 standards. All Schaffner instruments are supplied with Windows applets for integration in PC-controlled test systems under POWERSTAR. ProfLine's open interface approach also provides the basis for systems to be configured with instrumentation to handle RF field measurements such as EMC measuring receivers, I-IF generators, amplifiers, etc.

For further information please contact: Schaffner EMC Ltd, Wokingham, Tel: 01734 770070

ROBOTICS!



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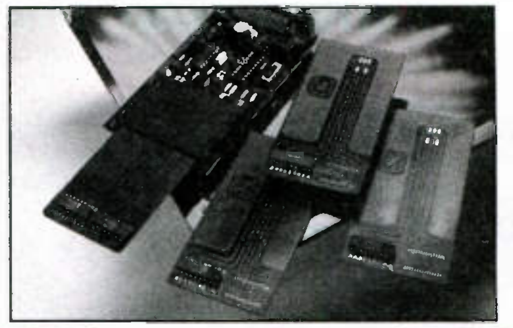

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DIY RADIO

Fancy running your own radio station? Thousands of people already have. Bill Shaw explains how

Current legislation allows low powered, local radio stations to go on air for up to four weeks at a time. They're known as restricted service licences, or RSLs, and such stations are usually set up to cover a "special event", such as Cowes week or the Brighton Festival. But RSLs can be set up for any reason - the biggest RSL project was in 1991, when almost a hundred "Radio Cracker" stations went on air across the country to raise money for the Third World.

Over 250 RSL licences were issued by the Radio Authority in 1994. Licences are available on AM or FM - most stations seem to choose FM - although the licence is more expensive, the quality of the signal is much better.

"Hope FM" was an RSL broadcasting to Bournemouth in the weeks leading up to Christmas last year. It was set up by Bournemouth YMCA, who hope to get a permanent licence for the area. The programming was music based (mostly Gospel music), and included interviews with guests. The station had a 25 watt FM transmitter on 105.4 MHz. They operated from one "on-air" studio, with presenters "hot-seating" between programmes.

So, how do you build a radio station? The simplest radio is a microphone connected to a transmitter; it's the basis of amateur radio, and there was a time, back in the 1920s, when the BBC (then the British Broadcasting Company), was broadcasting with little else. However sophisticated your radio station, microphones will always be at the heart of it, so it's worth looking at them in more detail.

Microphones are described in two ways - the principle on which they operate, (which gives some idea of the quality available), and where they pick up sound from.

A microphone can be as simple as a collection of carbon granules, which are compressed by sound waves, so that their resistance changes.

This is the sort of microphone found in telephones; they're cheap, but the quality is poor.

Dynamic microphones operate like speakers in reverse - sound hits a diaphragm, which moves a coil placed in a magnetic field. The resulting induced current is the output from the microphone.

The construction is fairly simple, so dynamic microphones can be inexpensive, and yet they're capable of high quality (the standard reporter's microphone, the AKG 130, is dynamic). They tend to be insensitive to "handling noise", so they're good for hand-held use (important if they're going to be used as a reporter's microphone). Another advantage of dynamic microphones is that they can handle loud volumes, or "Sound Pressure Levels" (SPL's).

Another type of microphone is made by inducing an electric field between two metal plates. One of the plates is free to move; as it does so, the distance between the plates, and hence the capacitance between them, changes. The current flow is detected and amplified.

Polar Response

This is the principle of operation of electret or condenser microphones, which are capable of high quality, but can get very expensive.

The "polar response" of a microphone is an indication of where it will pick up sound from. Microphones can be made to be omni-directional (picking up sound from all round them, such as the AKG 130), or uni-directional, (sometimes abbreviated to "directional"), which respond to sound in front of them. Depending on how directional a microphone is, it's described as cardioid, (which will still pick up some sound from the side), or hyper-cardioid.

The standard microphone used in BBC local radio stations, and by Hope FM, is the hyper-cardioid condenser microphone, the Beyer 201. Being hyper-cardioid, it will reject "off-axis" sounds, so it's useful in noisy environments; but the disadvantage is that it's easy, if the presenter moves slightly, for them to sound as if they're "off-mic". A good source for reasonably priced microphones is Audio-Technica.

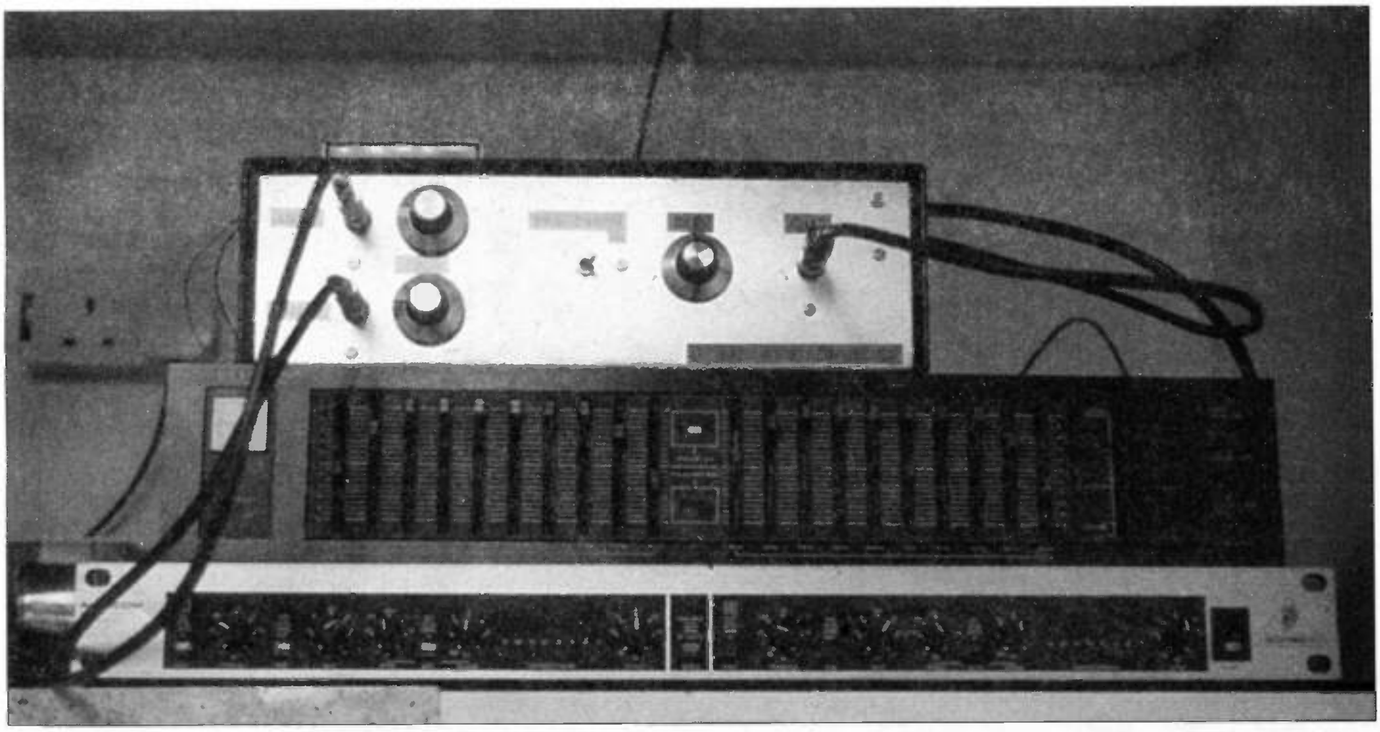
So much for getting the presenter's voice heard (and you may regret that...). But you'll want to include other sources in your radio programmes, such as CDs and jingles - and at the heart of all this will be the mixer.

Broadcast mixers differ from PA mixers in two main ways. First, they have what is known as a "prefade" channel - a way of listening to a source before it is faded up "on-air". This means that while, for instance, a CD is playing, the next item to be broadcast (for example, another CD), can be listened to, its levels checked, and it can be cued so that it'll start where you want it to start. It's important to get presenters to "prefade" every source before it goes on air. There are several reasons for this - levels must be set so that everything is broadcast at the right volume - you don't want the listener to be deafened one minute, and then not be able to hear anything the next. It must be listened to to make sure it's not distorted - for instance, if you're playing off a vinyl disc, (remember them?), there may be fluff on the needle. You'll also need to set the levels at the loudest point of the track - it's no good playing the first few seconds of a track and setting the levels there -tracks tend to start quietly - you must listen for the loudest part of the track, and set the levels on that. Finally, it's a way of making sure you're about to play the correct item - it's no good introducing "Eternal", and then finding you're playing Demis Roussos when you put the track on air.

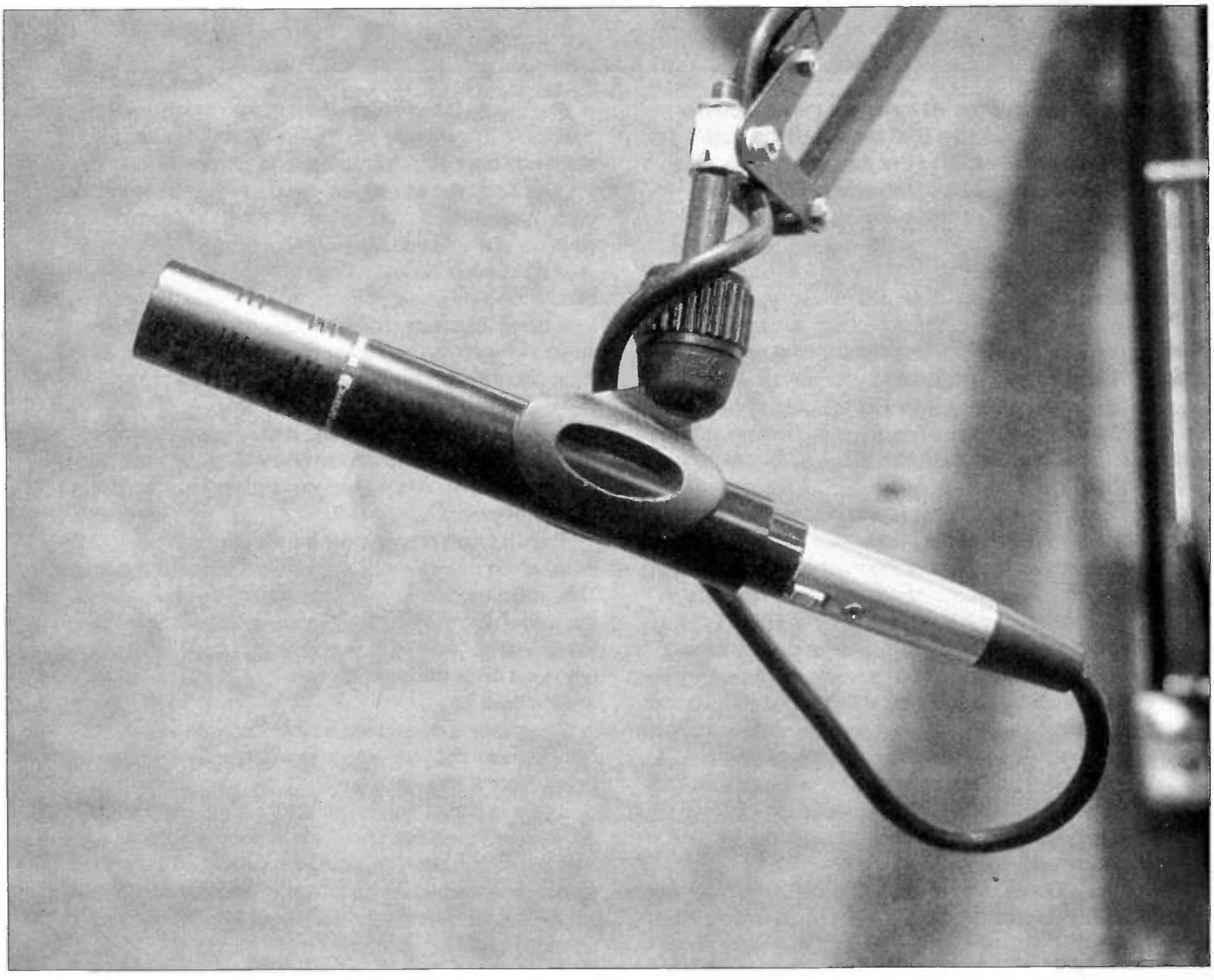
More importantly, if you're playing commercials, it's important to broadcast the right ones - advertisers will not be pleased if you don't play their commercials at the time they've booked them.

Some stations try to get away with using PA mixers which do have a prefade channel - they then find out about the other difference between broadcast and PA mixers when they put something on air. PA mixers have an extra 10dB or so of gain on each channel - if you fade it up fully, the signal will be at 10dB above the level you set on prefade.

This is to give a sound engineer a bit of flexibility when mixing a live band - but it's annoying for a broadcaster. The moral of the story - get a proper broadcast mixer.



Most mixers will have VU (Volume Units) meters on them. These are an American idea, and respond to the average signal level, in the same way that the ear does. The circuitry is fairly straightforward - a rectifier and smoothing circuit - so they're cheap, and simple to make. The problem with them is that, while the human ear may respond to average signal levels, electronic circuitry does not - it responds to peaks, and, if it sees a peak it doesn't like, it'll let you know in no uncertain terms!



It's for this reason that the VU meter got the reputation of being Virtually Useless, and the BBC developed the Peak Programme Meter, or PPM, which, as the name implies, gives a reading of the peaks of a signal. The circuitry is a lot more sophisticated, so they're not cheap, but it's worth using PPMs if at all possible.

It's important to use the best equipment for monitoring - you want to be certain, if you think you're hearing a problem somewhere, that there is a genuine problem, and not something spurious caused by using cheap and nasty amplifiers and/or speakers to listen to your output. Most good domestic equipment will be fine for RSLs; but it will be worth investing in good headphones. The standard headphones for broadcast use are the Beyer DT 100s - again, they're not cheap, but they will last a lifetime.

Most good domestic CD players and disc players will be fine for RSLs. If you want to put phone calls on air, to do phone interviews (and try to avoid them - the quality's lousy - those carbon granule microphones again) , or to have phone ins, you'll need a Telephone Balancing Unit, or TBU. For understandable reasons, BT are not keen for people to plug their own equipment into the phone system; a TBU will provide the interface between your station and the phone lines.

For jingles and commercials, you'll need a cartridge system of some sort. These are traditionally just loops of tape in a plastic container, with the tape exposed on one side so it can be recorded on and played.

They're used for short items (20 or 30 seconds) such as jingles and commercials, though they are available in lengths of several minutes. Digital carts are now becoming more popular - Hope FM used the discart system, which records sound as digital information.

The quality is better, and the carts are much quicker at re-cueing. All this will give you the basics you need to get "on-air", to do basic music programming, interviews, and phone-ins. But if you want to do some more ambitious programming, such as discussion programmes, drama, or recording bands, you'll need a separate production studio.

A production studio can be as simple as a room which has been acoustically treated in some way to cut the reverberation time down. Depending on the room, this treatment can be as straightforward as hanging heavy curtains around it. A few microphones and headphones in there, plugged into your mixer, and you have a production studio.

Professionally, there's a large double-glazed window between the production studio and the "on-air" studio (or control room, where the producer and engineer are supposed to control things).

There's a gap between the panels of glass several inches wide, which provides acoustic isolation between the studios. This would be difficult to arrange for an RSL, but you may find that some sort of video link (borrow a couple of camcorders) will do just as well. Some sort of talkback will be needed - but any good mixer will have this built-in. A cue light system would also be useful.

Programmes done using a production studio can become quite complex; so, rather than doing them live, it may be better to pre-record, and edit later.

If your station is not "on-air" all the time (for instance, if you do your own breakfast show and evening programmes, but take a sustaining service during the day), you'll be able to record programmes during the day. Otherwise, you'll need another control room, with a separate mixer, monitoring, CD players etc.

This will increase costs (or make more demands on your ability to scrounge equipment) but will have the advantage that it can also be used to make commercials when your station is on air. The traditional way of editing is to record on 1/4" tape, and then take a (specially made) razor blade to it. But with the increasing popularity of DAT machines, it would be worth experimenting with mastering on DAT, and then just dubbing what you want to another DAT machine.

So much for all these wonderful programmes you're going to make - how do you get your signal to the transmitter? You could have the transmitter "in house", and run a bit of wire to it. There are a couple of disadvantages to this. First, there's a danger that some of the RF might feed back into your studio (a particular problem with AM transmitters). Second, the Radio Authority allows the antenna for RSLs to be at 10 metres above ground level, so you'll want to site it at the highest piece of ground locally.

Hope FM have used BT landlines to get their signal from their studios to the transmitter - but these are not cheap. They now use an RF link; an 800 mw transmitter on 199.7 MHz which costs £27 a week.

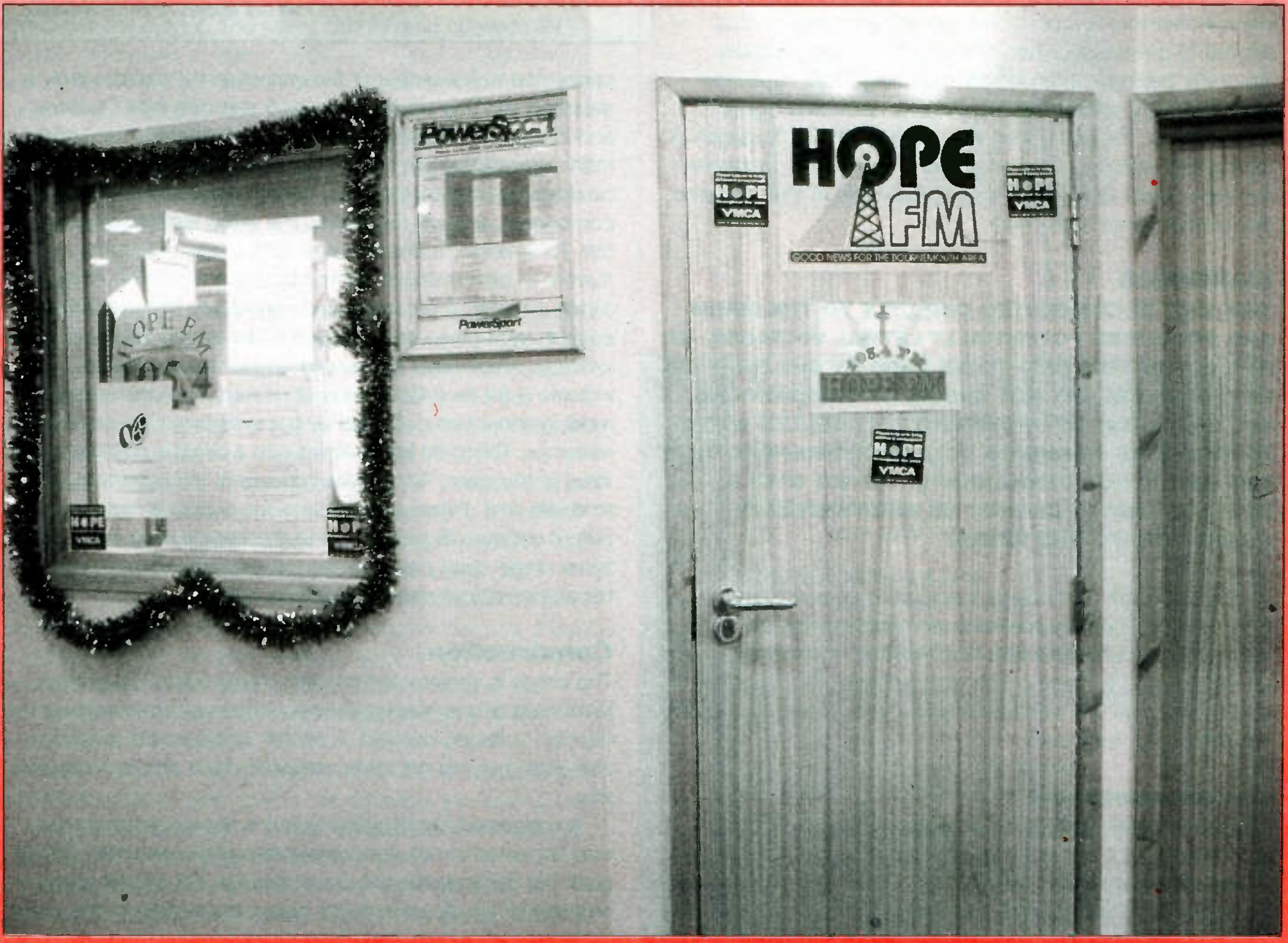
There are some legal restrictions on RSLs. For a start, you'll need a licence. An FM licence for 28 days can cost £2,200. You'll need to pay copyright fees, depending on how much music you'll be playing, and the type of licence you have. And you'll also have to be careful about broadcasting offensive material - the Radio Authority can't listen to every RSL, but they do respond to listeners' complaints. You'll have to log all your material, and keep it for six weeks. The standard way to do this is to use long-play VHS cassettes, which will record eight hours of your output at a time.

So much for the theory - what about the practice? Hope FM say their latest broadcast went fairly smoothly. The main problems they faced this year were slight interference from the London station Melody FM, which was on the same frequency as them, and a problem with the stereo encoder in their transmitter, which meant they had to transmit in mono. They say the biggest problem they've ever faced in the two years they've been running RSLs has been getting their signal to the transmitter; but the RF link has now solved that.

Hope FM have been able to buy most of the equipment they use, which is worth their while doing as they hope to get a permanent licence. Places to contact for equipment for a temporary station would include PA hire shops, and the chief engineer of your local TV or radio station - they should be able to tell you who will supply broadcast equipment locally. See if these companies will sponsor you by lending you equipment in return for namechecks on air and in your publicity, or cheaper advertising.

Contact BT or Mercury about TBUs. For the legal aspects, get in touch with the Radio Authority - they produce some helpful leaflets about getting a licence and copyright payments. An application for an RSL should be made at least three months in advance.

RSLs are hard work - you'll need almost all the facilities that a permanent radio station has. But RSLs can get a lot of local people listening (to use the jargon, they can have a very high "reach"); partly because they have novelty value, and also because they will have very local interest (normally covering a city, as opposed to the county or counties that other radio stations cover). It will be great experience - so do yourself and local people a favour, and set up an RSL.



HIGH VOLTAGE ELECTROLYTIC CAPACITOR REFORMER

Another handy project from Paul Stenning to help with restoration of old valve based electronics

This unit was designed to accompany the valve radio repair and restoration series in ETI. The high voltage electrolytic capacitors in valve equipment tend to deteriorate if the equipment is not used for an extended period. This deterioration takes the form of reduced capacitance and greatly increased leakage current. In some cases the capacitor will become virtually short circuit. If an item of equipment with capacitors in this state was used, the high current drawn could cause the capacitors to overheat and possibly explode. This can also cause damage to the mains transformer and rectifier valve. This unit is designed to pass a controlled low current through the capacitor, allowing the internal chemical composition to reform gradually without the risk of overheating. Two output voltages are available. The 240V setting is intended for reforming 275V capacitors, while the 320V setting may be used for 350V and higher components. The unit is also very useful in the early stages of testing and repairing valve equipment. This use is detailed in the Valve Radio Restoration series elsewhere in this magazine, and will not be repeated here.

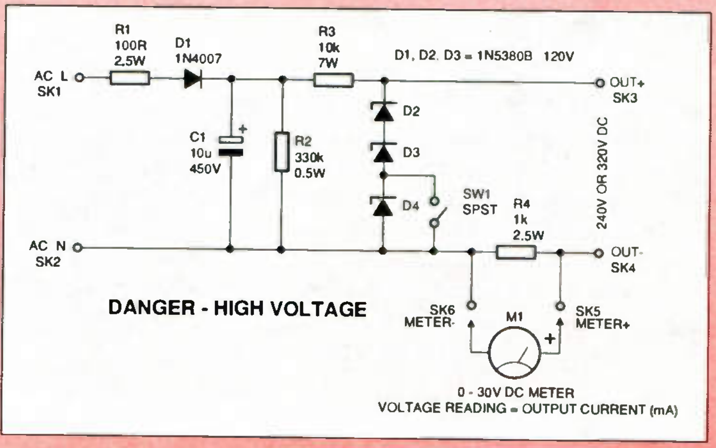
WARNINGS

THIS UNIT IS CONNECTED DIRECTLY TO THE MAINS AND PRODUCES POTENTIALLY LETHAL VOLTAGES. DO NOT ALLOW THIS UNIT TO BE USED BY CHILDREN OR PERSONS WHO ARE NOT AWARE OF THE DANGERS. THE UNIT MUST BE PROMINENTLY LABELLED WITH APPROPRIATE WARNINGS. IT IS RECOMMENDED THAT THE UNIT IS NOT PERMANENTLY FITTED WITH A PLUG, SO THAT IT CANNOT BE INADVERTENTLY CONNECTED TO THE MAINS.

The Capacitor Reformer is intended to be used in a workshop situation, by someone who knows what he/she is doing. Anyone who is familiar with working on valve equipment should be used to dealing with high voltages, and therefore able to treat this unit with due respect. This project is definitely not suitable for beginners.

Circuit operation

The mains supply voltage is half-wave rectified by D1 and smoothed by C1. R1 is a surge limiting component, intended to limit the initial inrush current to C1. R1 must be a wirewound component. R2 will gradually discharge C1 and any capacitors



connected to the output of the unit when the mains supply is switched off. This will take about 15 seconds with C1 alone, and longer with additional capacitors connected. The voltage is then regulated by D2, D3 and D4. Note that D4 is short-circuited by SW1 on the 240V setting. R3 is the current limiting component, and will run warm. The zener diodes are rated at 5W. R4 is added in the negative output rail to allow the output current to be monitored without breaking the circuit. This allows a meter to be connected periodically to monitor the current, rather than committing a meter for the whole reforming process. A voltmeter connected across this resistor will indicate 0-3V for 0-30mA output current. Thus the voltage reading should be multiplied by ten to obtain the current in milliamps. R4 could be replaced with a suitable milliamp meter fitted to the case. R3 will limit the current through the capacitor to a safe limit. If the capacitor leakage current is high the output voltage will be low due to the voltage drop in R3. The zener diode chain prevents the voltage rising above the rated capacitor voltage when the leakage is lower.

Construction

The circuit is constructed on plain matrix board. Do not use Veroboard as the spacing between the tracks is insufficient for the high voltages involved. A printed circuit board could be designed, but it is not really necessary for a simple design like this.

A suggested circuit board layout is shown, although this may be varied to suit the components and case used. Do not pack the components too close together. R3 will get warm, and should be mounted a little above the surface of the circuit board. Alternatively, the circuit could be constructed on tag strip or tag board, in true valve tradition! The unit must be mounted in a suitable enclosure for safety. I would suggest a metal case, because some of the components run warm. A low-cost diecast box would be ideal, and is sufficiently durable to survive workshop use. The case must be earthed. A mains indication neon should be fitted to the case and connected to the mains input to provide a warning that the unit is live. Make sure the mains polarity is connected as shown, with the neutral connection to the negative terminal of C1. As mains neutral is at a similar potential to earth, the negative output terminal and test meter terminals should be at a safe potential. Do NOT rely on this however. The output may be brought to a pair of 4mm sockets or some other connector that has no exposed live parts. Use red for positive and black for negative. A pair of test leads should be made, having 4mm plugs on one end and insulated crocodile clips on the other.

Testing

Using a test meter on a low resistance range, check that the metal case in connected to the earth pin of the mains plug. Using a high resistance range, check that there is no connection between the metal case and any of the input and output connections. Set the meter to a high DC voltage range (400V or greater) and connect it to the output terminals. Set SW1 to the 240V position and switch the mains on. The meter should read between 220V and 260V. Switch to 320V range, and it should read between 300V and 340V. Switch the mains off, and the meter should gradually drop to zero over about 15 seconds. Set the meter to the 10V DC range and connect it between SK5 and SK6 (across R4). Switch the mains on and the meter should read zero. Using a piece of INSULATED wire, short-circuit the output. The meter should read between 3V and 3.5V (equivalent to 30mA to 35mA). R3 will be dissipating about 11W and will get hot, so do not leave the output shorted for long. The unit would not normally be left connected to a short circuit for any time, so the 7W rating of R3 is fine for normal use. If the unit passes these tests it can be put into use. Make a point of labelling SW1 with the voltage settings, and also label the unit with a suitable high voltage warning.

In use

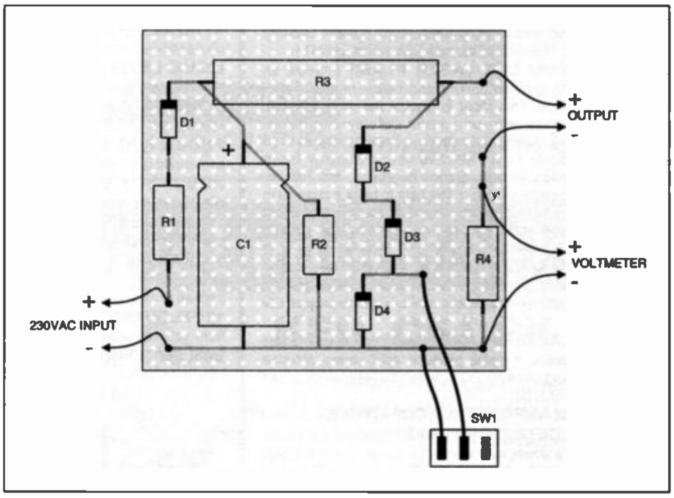
The use of this unit for testing valve equipment is described in the Valve Radio Servicing article, and will not be repeated here. The subject of capacitor reforming has also been mentioned, but a little more information is given here. Make sure the capacitor is rated at 275V or higher. Set the switch on the unit to a suitable setting for the capacitor - 240V for 275V components and 320V for 350V components. Connect the unit to the capacitor, making sure you have the polarity correct. If there is more than one capacitor in a single can, they should be tested one at a time. You will need to use a capacitor mounting clip or something similar to connect the unit to the case of the capacitor if this is the only negative terminal. Place the capacitor on an insulated surface, and do not allow it to come into contact with anything including the case of the reformer. Connect a voltmeter between SK5 and SK6 to monitor the output current.

DO NOT TOUCH THE CAPACITOR OR OUTPUT LEADS WHEN THE UNIT IS SWITCHED ON. Observe the reading on the meter. If the capacitor is good, the reading will steadily fall to almost zero within about 30 seconds or so.

If the capacitor is not so healthy the meter will show a higher reading and fall very slowly. Check the reading every 15 minutes or so; it should be a bit lower each time you look. If the reading is above about 5mA (0.5V), switch off and feel the temperature of the capacitor when you check the reading. If it is warm, leave the unit off to let the capacitor cool down before continuing. If the capacitor gets too warm the leakage current will increase. With luck, the meter should read almost zero after a couple of hours, but leave it for up to about ten hours before giving up. Some sources give the maximum acceptable leakage for a high voltage electrolytic as 1mA for each 10uF, but I feel that this is excessive. I would aim for about 1mA for each 30uF. When the capacitor is done, switch the unit off at the mains and wait for the meter to read zero. This could take a minute or more, depending on the value of the capacitor. If you have a dud capacitor that cannot be reformed, don't throw it away. The tidy solution is to fit it back onto the chassis so it looks right, but don't connect it. Fit a modern electrolytic tidily below the chassis, and no-one will ever know! If you're really enthusiastic, you could dig out the innards of the old capacitor and fit the modern replacement inside the can - I don't have this much patience!

Safety

I strongly recommend the use of an earth leakage circuit breaker or RCD with this unit. While it will not prevent a lethal electric shock, it will trip out if there is a short circuit or current leakage between either of the output connections and earth.



PARTS LIST

Resistors (all 0.25W 5% or better)

R1,R4 100R 2.5W wirewound resistor
R2 330K 0.5W resistor
R3 10K 7W wirewound ceramic resistor

Capacitors

C1 10uF 450V axial electrolytic capacitor

Semiconductors

D1 1N4007 rectifier diode
D2,D3 1N5380B 120V 5W zener diode
D4 1N5374B 75V 5W zener diode

SW1 SPST min toggle switch (rated for mains use)

SK3,SK5 Red 4mm socket
SK4,SK6 Black 4mm socket

Miscellaneous

Plain matrix board
Diecast box
3 core mains flex.

200 WATT INVERTERS Nicely cased units 12v input 240v output 150watt continuous, 200 max. £49 ref LOT62.

6.8MW HELIUM NEON LASERS New units. £65 ref LOT33

COINSLOT TOKENS You may have a use for these? mixed bag of 100 tokens £10 ref LOT20.

PORTABLE X RAY MACHINE PLANS Easy to construct plans on a simple and cheap way to build a home X-ray machine! Effective device, X-ray sealed assemblies, can be used for expenmental purposes. Not a toy or for minors! £6/set. Ref F/XP1.

TELEKINETIC ENHANCER PLANS Mystify and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing phychic phenomenon. £4/set Ref F/TKE1.

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GRAVITY GENERATOR PLANS This unique plan demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship out of simple materials and without any visible means- cause it to levitate. £10/set Ref F/GRA1.

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VOICE SCRAMBLER PLANS Minature solid state system turns speech sound into indecipherable noise that cannot be understood without a second matching unit. Use on telephone to prevent third party listening and bugging. £6/set Ref F/VS9.

PULSED TV JOKER PLANS Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound! works on FM too! DISCRETION ADVISED. £8/set Ref F/TJ5.

BODYHEAT TELESCOPE PLANS Highly directional long range device uses recent technology to detect the presence of living bodies, warm and hot spots, heat leaks etc. Intended for security, law enforcement, research and development, etc. Excellent security device or very interesting science project. £8/set Ref F/BHT1.

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MYSTERY ANTI GRAVITY DEVICE PLANS Uses simple concept. Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or science project. £6/ set Ref F/ANT1K.

ULTRASONIC BLASTER PLANS Laboratory source of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquides. Many cleaning uses for PC boards, jewllery, coins, small parts etc. £6/set Ref F/ULB1.

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PHASOR BLAST WAVE PISTOL SERIES PLANS Handheld, has large transducer and battery capacity with external controls. £6/set Ref F/PSP4

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VIDEO PROCESSOR UNITS?/6v 10AH BATTS/12V 8A TX Not too sure what the function of these units is but they certainly make good strippers! Measures 390X320X120mm, on the front are controls for scan speed, scan delay, scan mode, loads of connections on the rear. Inside 2 x 6v 10AH sealed lead acid batts, pcb's and a 8A? 12v torroidial transformer (mains in). Condition not known, may have one or two broken knobs due to poor storage. £17.50 ref VP2

RETRON NIGHT SIGHT Recognition of a standing man at 300m in 1/4 moonlight, hermatically sealed, runs on 2 AA batteries. 80mm F1.5 lens, 20mw infrared laser included. £325 ref RETRON.

MINI FM TRANSMITTER KIT Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but easily changed to cover 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £7 Ref 1001.

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FM/AM SCANNER KIT Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160mhz on both AM and FM. Built in 5 watt amplifier, inc speaker. £15 ref 1013.

3 CHANNEL SOUND TO LIGHT KIT Wireless system, mains operated, separate sensitivity adjustment for each channel, 1,200 w power handling, microphone included. £14 Ref 1014.

4 WATT FM TRANSMITTER KIT Small but powerful FM transmitter, 3 RF stages, microphone and audio preamp included. £20 Ref 1028.

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COMBINATION LOCK KIT 9 key, programmable, complete with keypad, will switch 2A mains. 9v dc operation. £10 ref 1114.

PHONE BUG DETECTOR KIT This device will warn you if somebody is eavesdropping on your line. £6 ref 1130.

ROBOT VOICE KIT Interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

TELEPHONE BUG KIT Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £8 Ref 1135.

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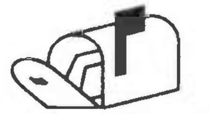

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PC TIMER KIT Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configeration is 286, VGA, 4.1,640k, serial

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MAGNETIC MARBLES They have been around for a number of years but still give rise to curiosity and amazement. A pack of 12 is just £3.99 ref GI/R20

STETHOSCOPES A fully functioning stethoscope for all those intricate projects. Enables you to listen to motors, pipes, heartbeats, walls, insects etc. £6 ref MAR6P6.

NICKEL PLATING KIT Proffesional electroplating kit that will transform rusting parts into showpieces in 3 hours! Will plate onto steel, iron, bronze, gunmetal, copper, welded, silver soldered or brazed joints. Kit includes enough to plate 1,000 sq inches. You will also need a 12v supply, a container and 2 12v light bulbs. £39.99 ref NIK39.

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3' by 1' AMORPHOUS SOLAR PANELS 14.5v, 700mA 10 watts, aluminium frame, screw terminals, £44.95 ref MAG45.

ELECTRONIC ACCUPUNCTURE KIT Builds into an electronic version instead of needles! good to experiment with. £7 ref 7P30

SHOCKING COIL KIT Build this little battery operated device into all sorts of things, also gets worms out of the ground! £7 ref 7P36.

FLYING PARROTS Easily assembled kit that builds a parrot that actually flaps its wings and flies! 50 m range £6 ref EF2.

HIGH POWER CATAPULTS Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 miles per hour! Range of over 200 metres! £7.99 ref R/9.

BALLON MANUFACTURING KIT British made, small blob blows into a large, longlasting balloon, hours of fun! £3.99 ref GI/E99R

9-0-9V 4A TRANSFORMERS, chassis mount. £7 ref LOT19A

2.5 KILOWATT INVERTERS, Packed with batteries etc but as they weigh about 100kg CALLERS ONLY! £120.

MEGA LED DISPLAYS Build your self a clock or something with these mega 7 seg displays 55mm high, 38mm wide. 5 on a pcb for just £4.99 ref LOT16 or a bumper pack of 50 displays for just £29 ref LOT17.

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SOLAR-POWERED PLANT WATERING SYSTEM

Colin Meikle describes a novel way to look after plants

The most common problem encountered in looking after plants is under/over watering, particularly so for plants in awkward places e.g. window boxes, hanging baskets etc. The obvious solution is to devise some sort of automatic system, that will water the plants when needed. Most commercial systems work by either drip watering or watering at fixed periods via a programmable timer. Neither of these solutions are suitable if you wish to leave the plants unattended for long periods of time, as the watering needs of the plants will vary. In addition, electrically operated systems require a mains power source, which is not always available.

The system described here is a totally self-contained unit; it is solar powered and therefore requires no external power source. The circuit works by detecting when the moisture level in the soil falls below a predefined level. When this happens water can either be pumped from a reservoir or released from a header tank via a control valve. Because this system is self-contained it can be used in remote and unusual places (the circuit was designed to water tomato plants in an attic, below a large sky light). The circuit has some built-in safety features to ensure the plants cannot be drowned or starved of water should a fault occur in the system. This is particularly important if the system is to be used in inaccessible places and may be left unattended for some time. A LED gives a warning when the water supply is running low, so that it can be filled up before it runs dry. Should a fault occur, such as a faulty probe in the soil, an error LED will be illuminated and the system will go into a default watering cycle, watering the plant every two days, until the fault is rectified. The watering system only waters the plants when it is dark (normally dusk). This prevents scorching the plants during strong sun and also minimises water loss due to evaporation.

The circuit has two controls for altering the soil 'wetness' and the amount of water delivered to the plants during each watering session. These controls can either be mounted on the PCB or on the case.

How it works

Although the circuit is solar powered, the solar panel does not drive the pump - this would require a VERY large solar panel. Instead the solar panel charges a 12V nicad battery pack. These batteries power the circuit when it is dark and also power the pump. In normal operation the circuit consumes very little current, about 1-2mA. The pump consumes 1-2A but is only on for a few minutes every day or so. The batteries can keep the circuit powered for some time if there is insufficient sunlight, therefore only a small solar panel is required to keep

Fig. 1

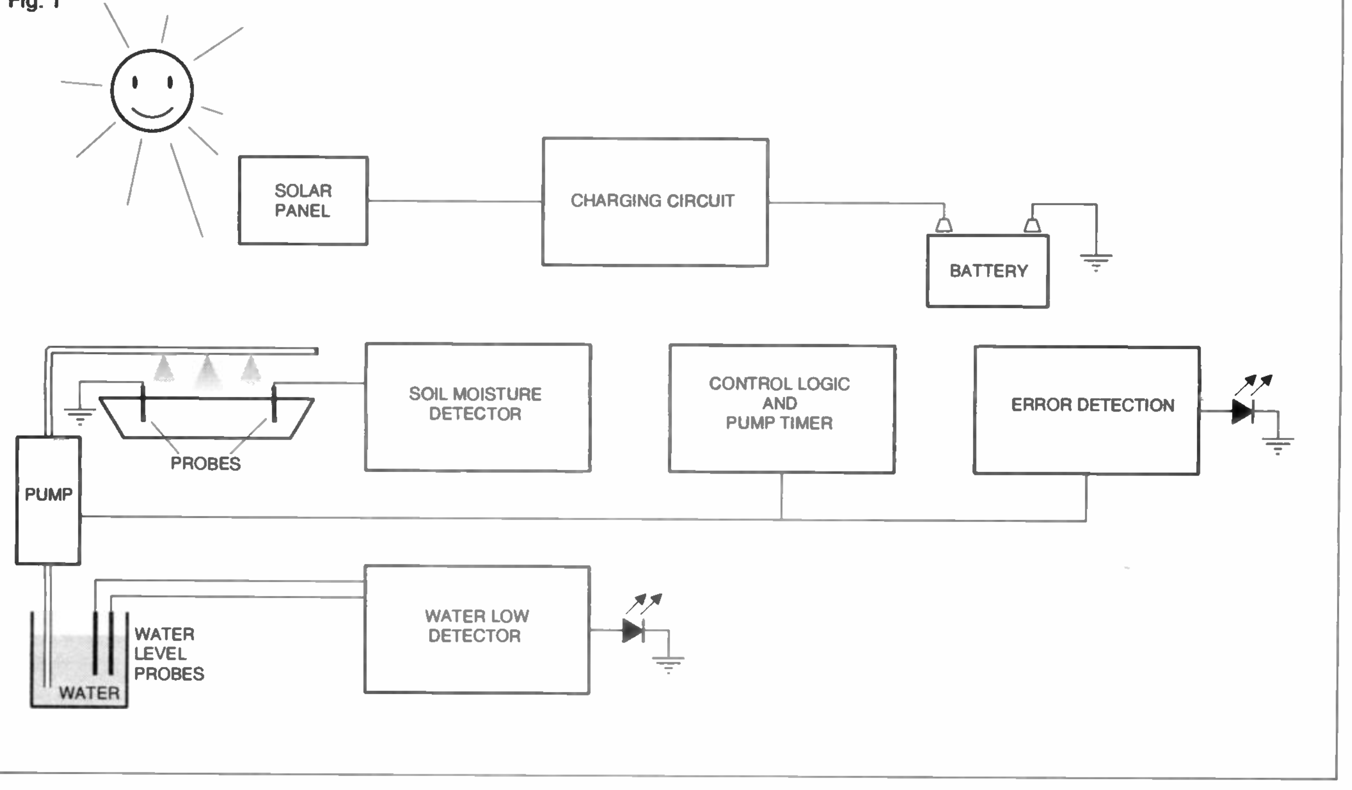


Fig. 2a

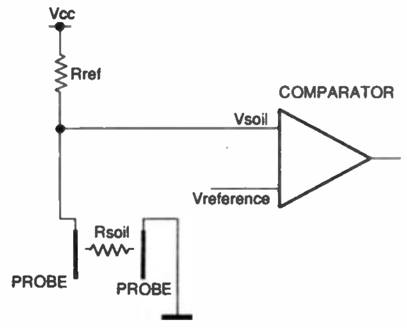


Fig. 2b

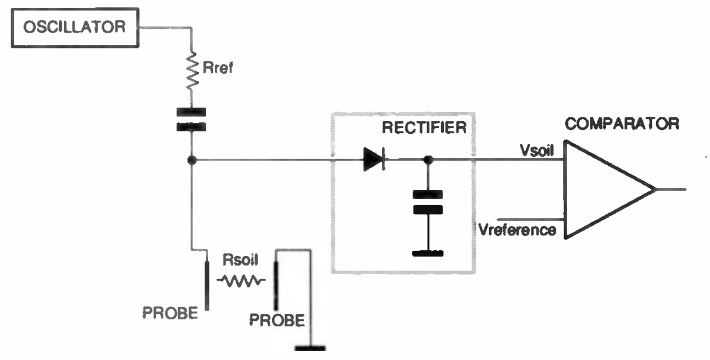


Fig. 3a

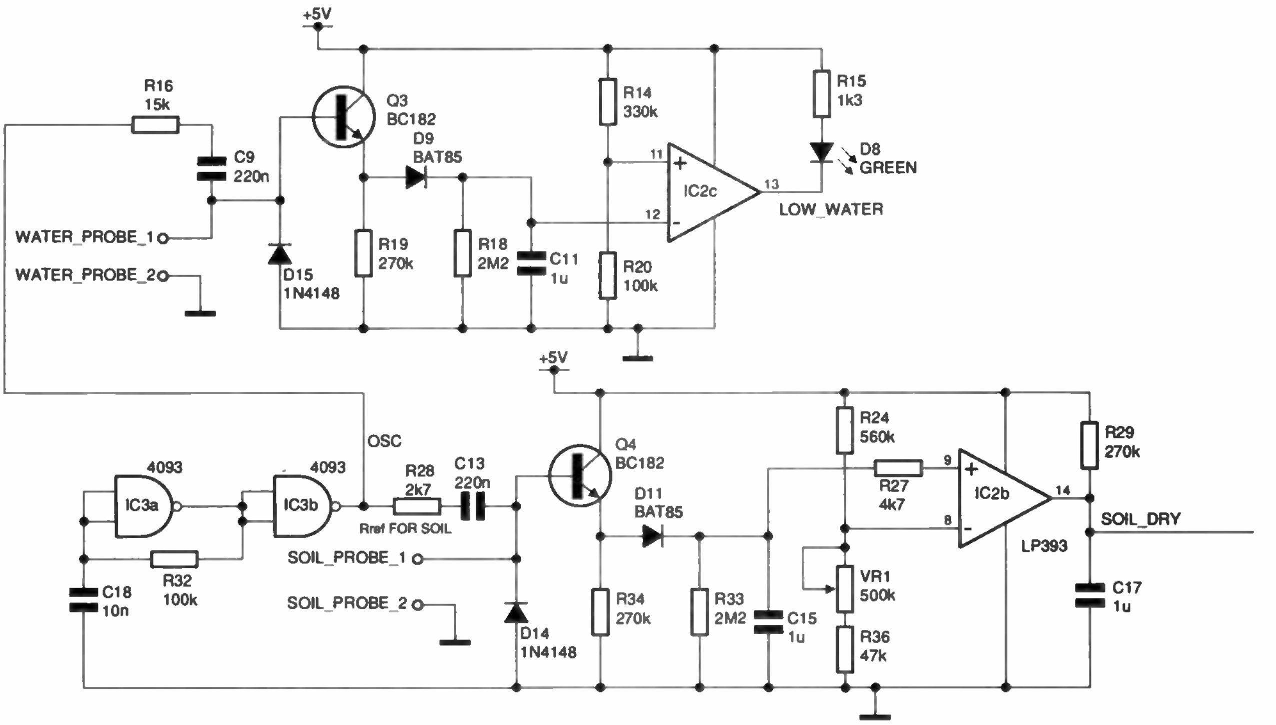
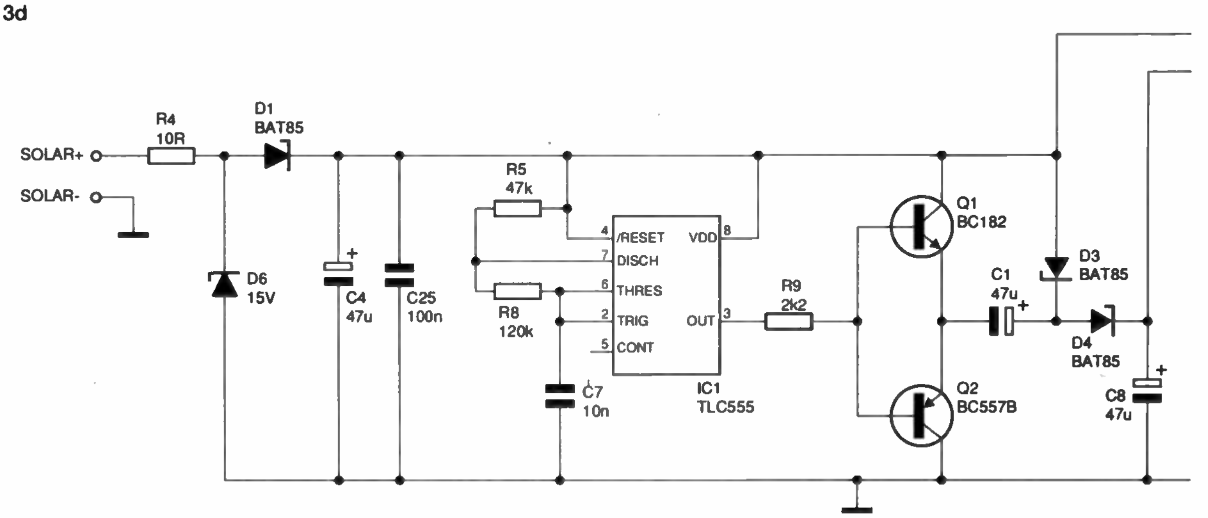


Fig. 3d



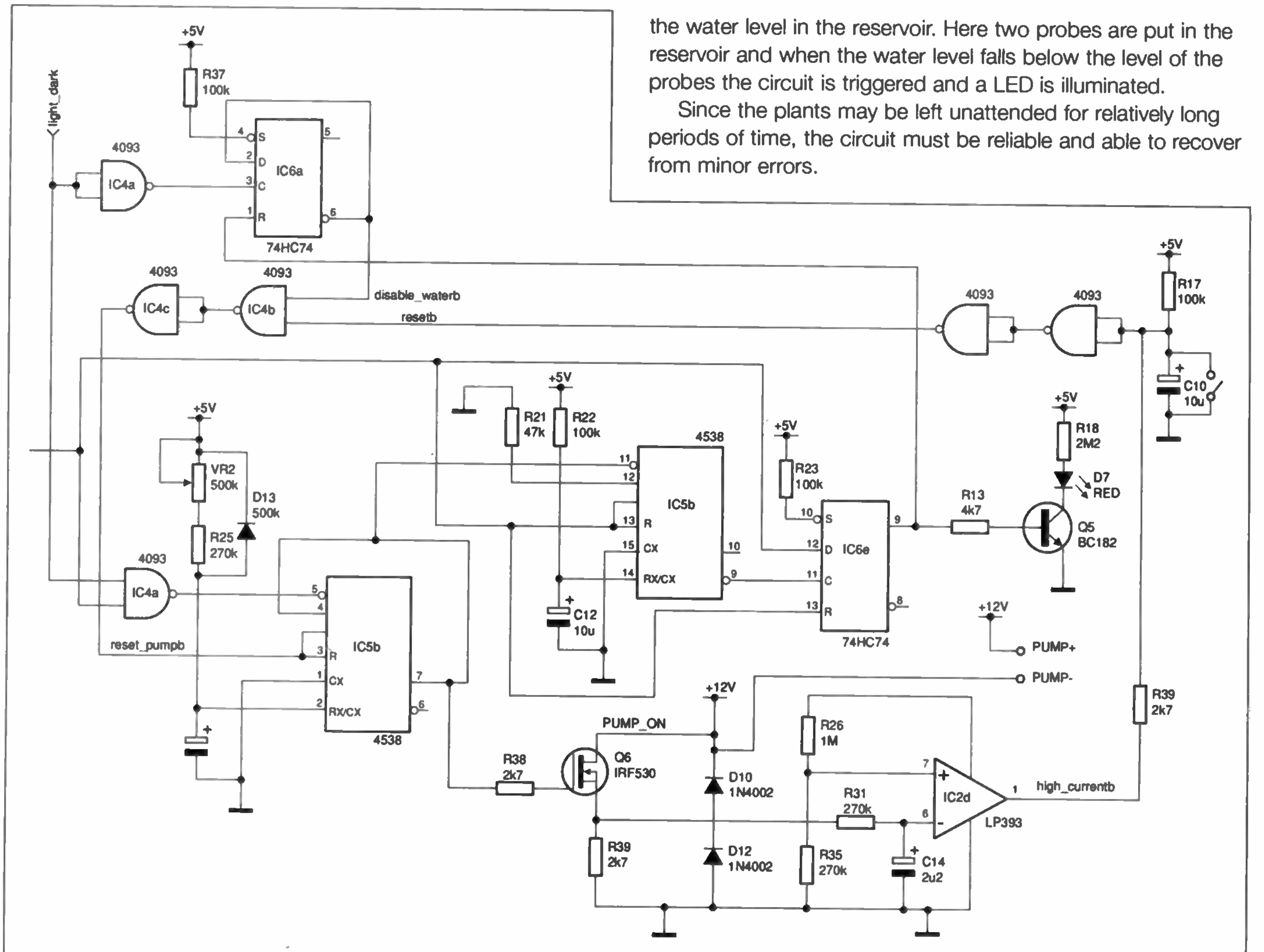


Fig. 3b

the batteries 'topped up'. Diagram 1 shows how the circuit functions.

The output voltage from the solar panel varies greatly with the brightness of the sun; normally 10 to 12V in bright conditions. This voltage is insufficient to charge a 12V nicad battery, as a voltage in excess of 14V is required. To overcome this problem the voltage from the solar panel is doubled. This allows the batteries to be charged even if the voltage drops quite low, i.e. in dull weather.

The soil moisture is measured by testing the soil's resistance. If the soil is wet the resistance will be low, (a few hundred ohms), if the soil is dry it will be much higher (10s of kilo-ohms). A simple method for measuring this resistance would be to create a potential divider with the soil in one arm, (two metal plates put in the soil) and a fixed reference in the other, as shown in diagram 2a. The resultant voltage from the potential divider would simply be compared against a reference voltage. When the soil dries out the voltage exceeds that of the reference and the output of the comparator changes.

The above method is OK for point measurements, but it cannot be used in a permanent set-up. This is because the polarisation of the probes in the soil causes one probe to slowly disintegrate and the other to become plated. To overcome this problem the circuit uses an AC current; therefore there is no polarisation. The principle for measuring the resistance is the same, although the circuit is slightly more complex (see diagram 2b). The same circuit is used to detect the water level in the reservoir. Here two probes are put in the reservoir and when the water level falls below the level of the probes the circuit is triggered and a LED is illuminated.

Since the plants may be left unattended for relatively long periods of time, the circuit must be reliable and able to recover from minor errors.

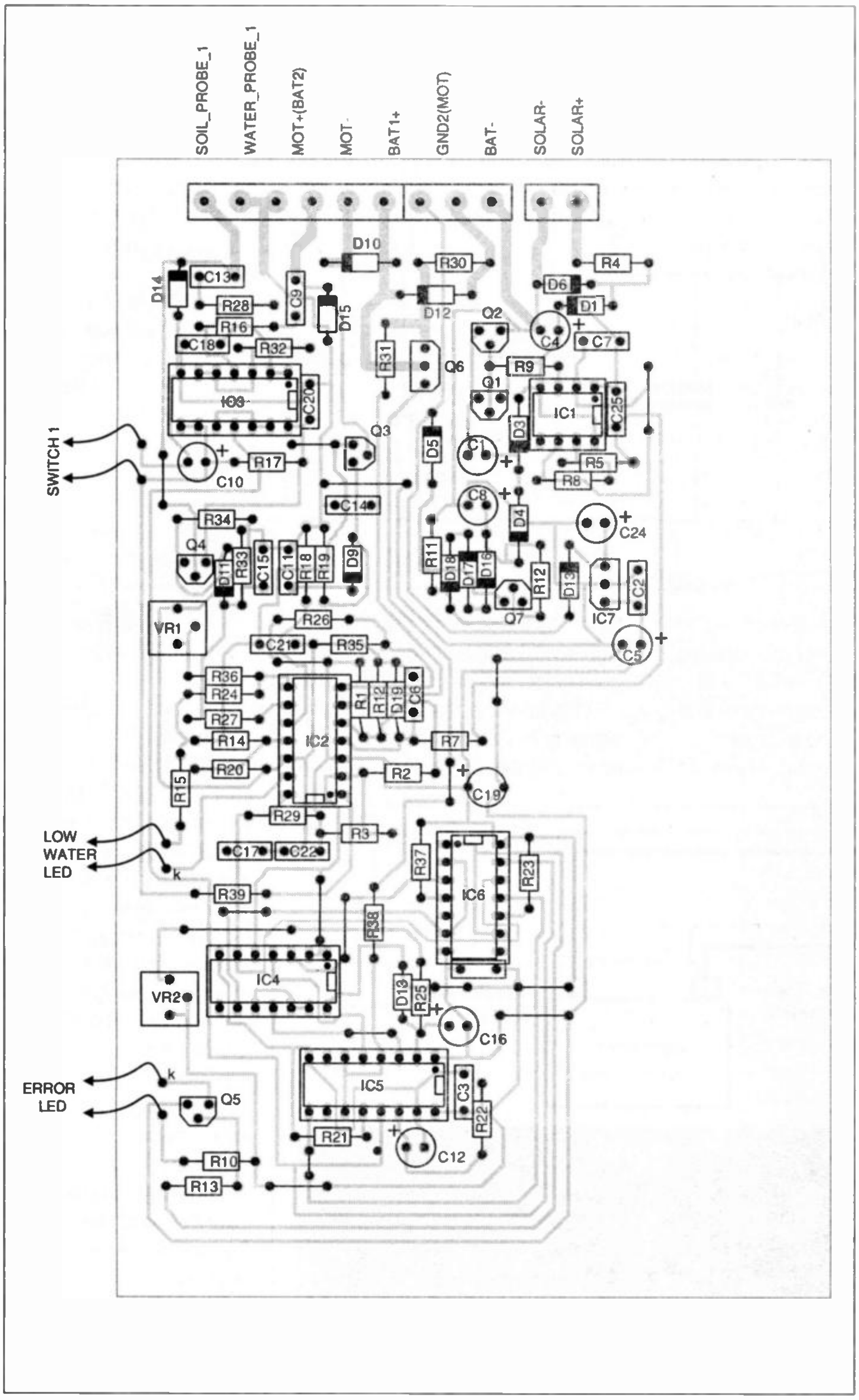
An unreliable system is worse than not having it at all. The circuit therefore has some basic error checking and recovery built-in, which will stop the plants being drowned or drying out, under the most common fault conditions, (disturbance of the soil probes can be troublesome). If a fault condition is detected, the circuit turns on a LED to indicate an error and goes into a default watering cycle. During this cycle the plants are watered every second day, until the fault is corrected or the reset button is pressed. The circuit tests for error conditions by testing the soil moisture a short time after the plants have been watered. If the soil is still dry, an error condition is assumed. Either the plants have not been watered e.g. faulty pump, or the circuit can not correctly determine the moisture, e.g. a probe may have been accidentally removed.

This circuit also monitors the current drawn by the pump (or solenoid). If excess current is detected the circuit is reset and the pump turned off, the error LED is not illuminated. This functionality is here to protect the system under fault conditions, such as a frozen pump.

Circuit description

Referring to the circuit diagram, the circuit can be divided into 4 main blocks: the power supply and charging circuit, the soil moisture (and water level) detector, control logic and pump driver.

Power supply



The power supply consists of a constant current supply of 25mA to charge the 12V nicad batteries (nicads must be charged via a constant current). The supply from the batteries is used directly to power the pump. However, all of the other circuitry is powered via a 5V regulator.

The input voltage from the solar panel may rise to a level where it could damage the circuit. To prevent this, it is limited by R4 and D6. D1 prevents damage to the circuit should the input voltage become reversed. In order to provide a constant current to the batteries, a voltage in excess of 14V is required. To get this voltage, a voltage doubling circuit is used. The doubling circuit uses a 555, U1, as an oscillator which drives a charge pump circuit consisting of Q1, Q2, C1, C8, D3 and D4. The resultant output voltage is a bit less than double.

However, it does allow the charging circuit to work with input voltages as low as 8V. The constant current circuit which charges the battery is very simple (accuracy is not required). The three diodes, D16-D18, keep the base of Q7 at approximately 2.1V below the supply; as a result the voltage across Rcharge (R6) is 2.1-Vbe=1.4V. The charging current to the batteries is approximately the same current as that through the resistor R! charge. The charge current is simply 1.4/Rcharge.

Moisture detector

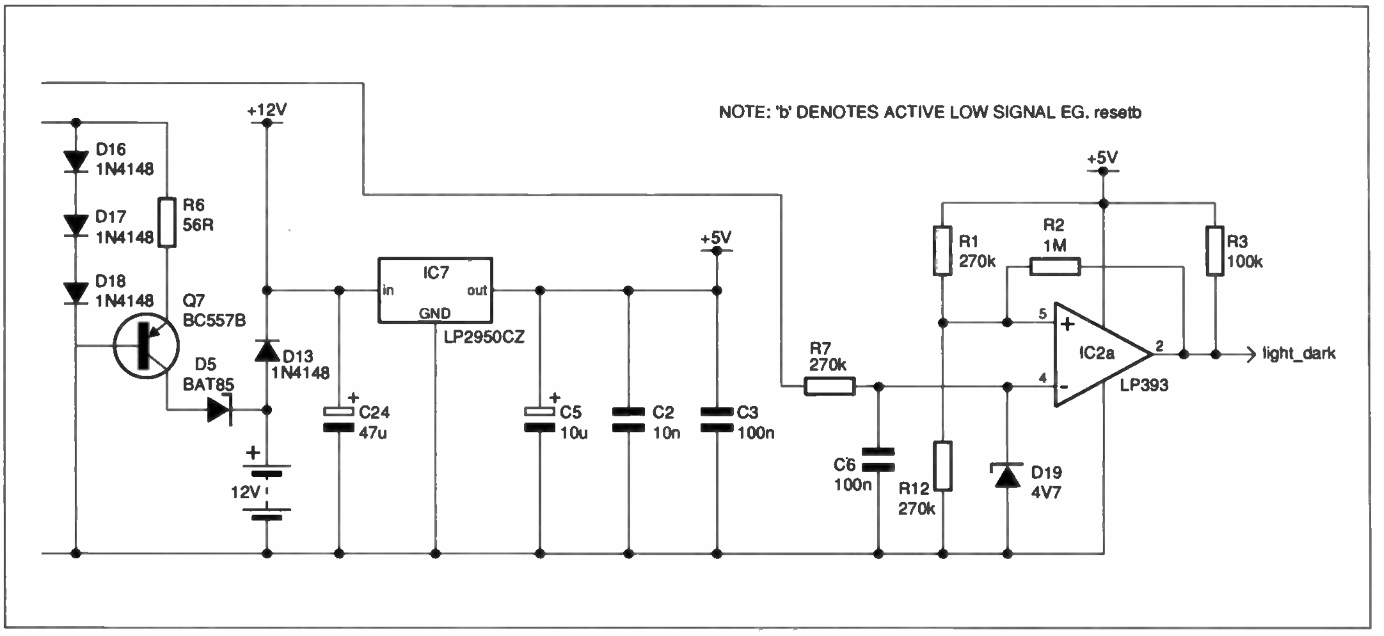
The water level detector and soil moisture circuits are identical, only the soil moisture detector will be described.

U3a, R32 and C18 form the oscillator which drives the circuit. U3b buffers this signal, before going to the probes. R28 is the reference resistance which forms a potential divider with the soil's resistance, (via two probes placed in the soil). The resultant voltage, form the potential divider, is buffered by Q4, before being smoothed by C15. D14 clips the negative part of the input signal. U2b compares the rectified voltage, (i.e. the voltage across C15) with a reference voltage set by VR1. When the soil is wet the resistance will be low compared to R28. As a result the input voltage and hence the voltage across C15 will be low. The output voltage comparator U2b will therefore be low . When the soil starts to dry out, its resistance will increase. When the voltage across C15 exceeds that of the reference voltage the output of U2b will be high.

Control logic

The control logic determines the timing of the pump i.e. when it should be turned on and for how long. It also performs error checking to ensure watering has actually taken place; if not it controls the default error watering cycle. Watering is only triggered during darkness. To determine when it is dark U2a and associated components compare the solar voltage with a reference voltage. When the solar voltage drops below the reference, the 'light-dark' signal will go high and darkness will be assumed. This 'light-dark' signal is NANDed together with the 'soil-dry' signal from U2b. When both of these signals are high (i.e. it is dark and the soil is dry), the input to monostable U5a will be triggered. The output of the monostable drives the MOSFET transistor which in turn drives the pump. The pulse width of the output from the monostable (hence the length of time the pump is on for) is determined by C16, R25 and VR2.

Error checking is done by 'sampling' the soil moisture a short time after the pump has been deactivated, after a watering cycle. If the soil is still dry an error is assumed and a



LED is illuminated. When monostable U5a is turning off, i.e. on the falling edge of the watering pulse, the second monostable, U5b, is triggered. The output of this monostable clocks a flip-flop, U6a. The D input of this flip-flop is connected to the 'soil-dry' signal. When monostable U5b times out the level of the soil-dry signal is clocked through to the ERROR signal.

Normally the soil-dry signal will be low, therefore the ERROR signal will be low. If soil-dry is still high, the ERROR signal will go high an the error LED will be on.

U6a controls the default watering cycle. When the ERROR signal is low i.e. in normal circumstances, this flip-flop is held in reset and this piece of circuitry has no effect. When the ERROR signal is high, i.e. there is an error, the circuit is enabled. U6a is clocked by the 'light-dark' signal (via a Schmitt inverter), the output from U6a therefore changes every second day. The /Q signal from U6a is connected to the reset of the pump monostable, U5a. As a result, the pump monostable is disabled every second day. If the soil dry signal remains high (i.e. the fault persists) the plants will be watered every second day. The error cycle is exited either by pressing S1, i.e. causing a reset, or by the fault being fixed.

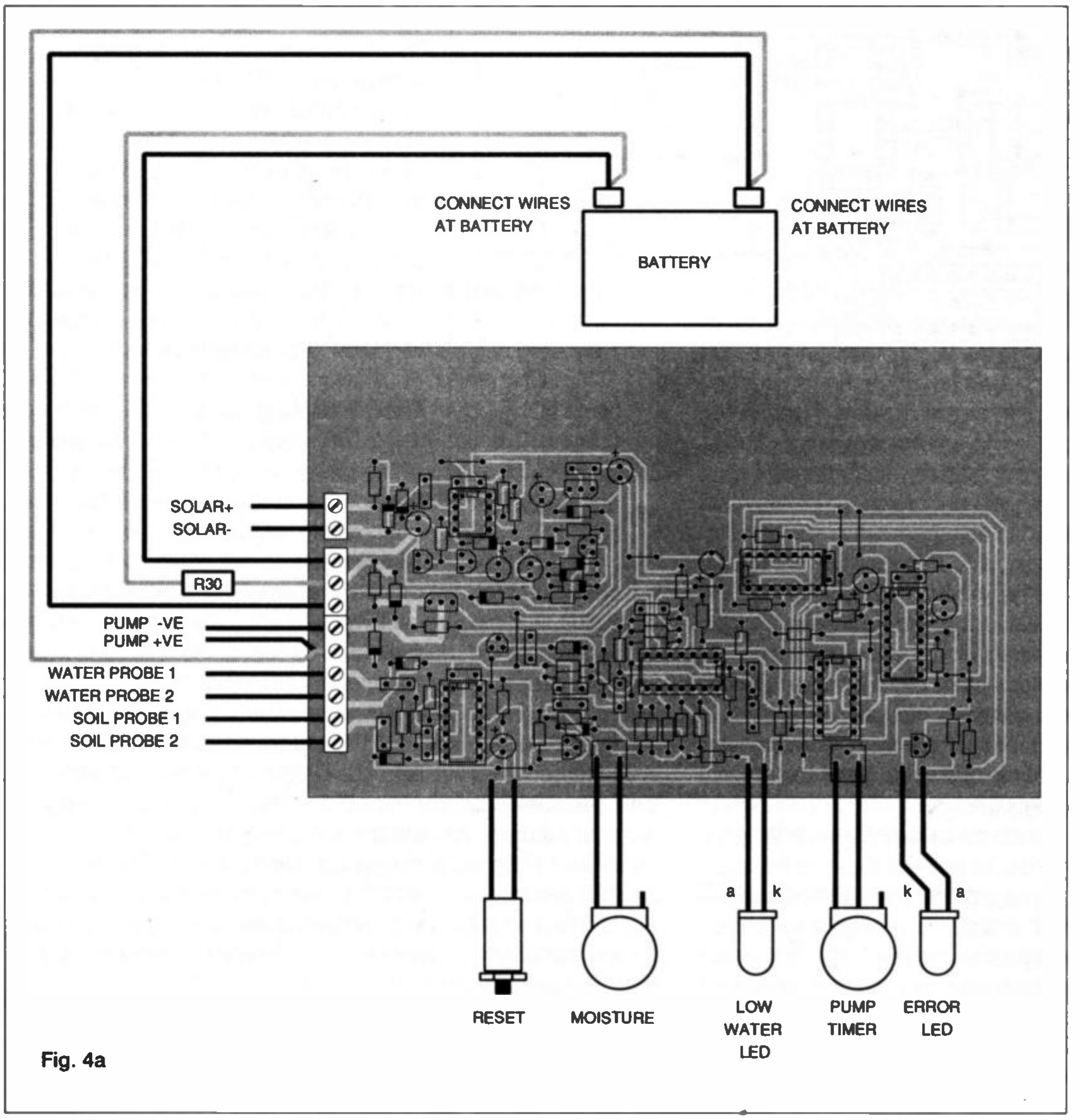


Fig. 4a

Output circuitry

The pump is driven by the MOSFET transistor Q6. D10 and D12 protect the MOSFET (and the reset of the circuit) from voltage spikes produced by the pump. The MOSFET and pump are also protected from excess current; this may happen if the pump freezes. This is done by placing a small resistance, R30, in series with the ground to the MOSFET. The current flowing through R30 produces a small volt drop. This voltage is compared to a reference set by R26 and R35 (0.45V). If the voltage across R30 exceeds this limit the output of comparator U2d changes and the reset line is pulled low, resetting the whole circuit. R31 and C14 stop the circuit from being reset by small peak current, e.g. when the pump is starting up.

Components

Since this circuit relies totally on solar power, careful component selection is required, to ensure that the normal operating current is as low as possible. Otherwise large solar panels and batteries would be required, which would be unacceptable. Before selection of the pump, batteries and solar panel can be made, the operating conditions must be considered, e.g. can a sunny location be found for the solar panel, how much watering is required, is the system to work all year round or just in the summer months (when there is more sunlight)?

The system I have built (using the default components) waters two large window boxes, pumping up to two gallons a week. The solar panel is mounted on my windowsill and only gets a few hours of strong sun. This system works well and can be used as a reference when selecting components.

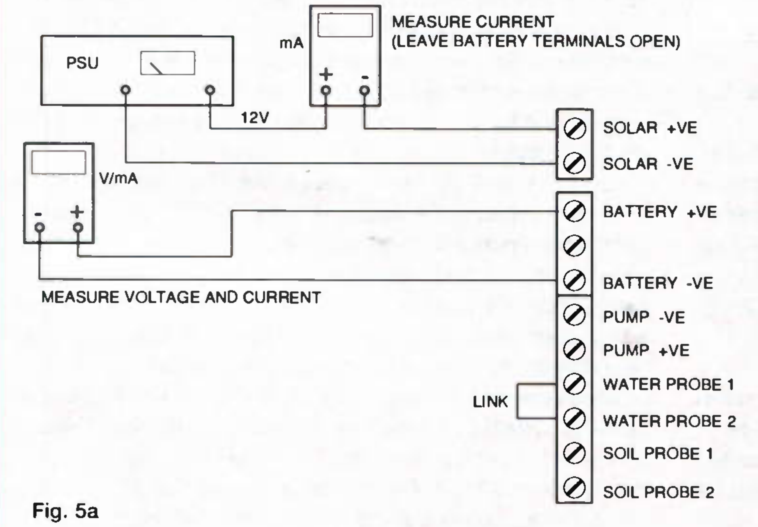


Fig. 5a

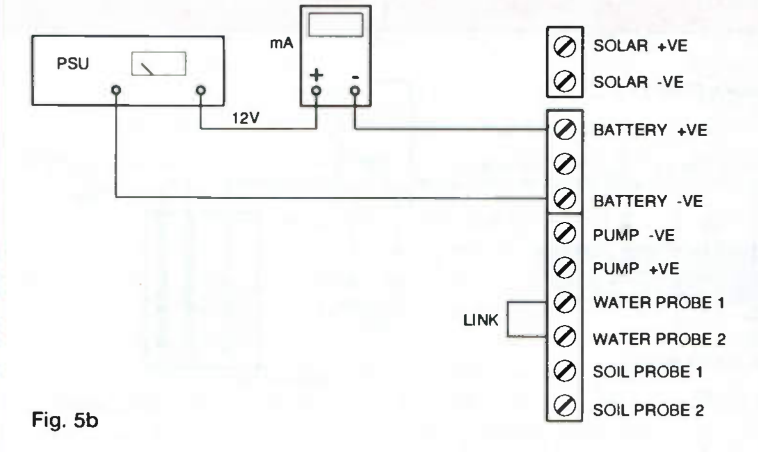


Fig. 5b

Solar panel

There are various types of solar panel available, the type used here is an amorphous silicon panel. This panel is a plate glass with the silicon deposited on strips on one side of the glass. These cells give a good output for their size (e.g. 12x6 inches) and can be bought cheaply from surplus retailers. When choosing your panel remember the output you will get from it will be considerably lower than the stated output, with typical British weather. The panel I used was a 12V 300mA panel this should be sufficient for most applications.

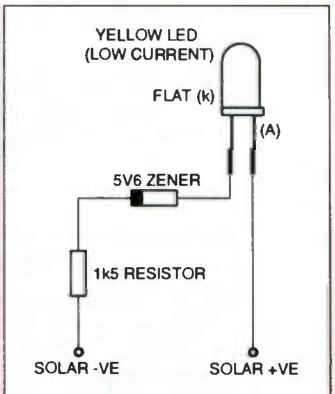


Fig. 4b

Pump and batteries

The pump I used is from a car windscreen washer. These are reasonably powerful and normally have standard fitting for 5mm tubing. You can buy these pumps from car accessory shops. Try and find a pump which consumes less than 2A (when loaded i.e. pumping water). Nicad batteries are used to drive the pump and power the circuit when it is dark. Nicad batteries can easily supply the large current (2A) required by the pump. Since this peak current is only required for a minute or so every few days, batteries with a capacity of 0.5AH are all that is required. A 12V battery pack can be bought reasonably cheaply. Try and find a pack which is made up 1/2 size cells rather than the more common AA cells as these are considerably smaller. Alternatively you can use 10 AA cells connected in series.

Low power components

The circuit has been designed so that it consumes as little current as possible during normal operation. This is required so that the batteries are not run down during prolonged dull spells, where the output of the solar panel may be too low to change the batteries. To achieve this low power consumption, low power ICs have been used. The regulator is a low power 5V regulator which has a very low quiescent current. The comparator is a low power version of the more common LM339. These components are more expensive than the standard parts. Standard parts may be used if the circuit will only be operated during the summer months (and the panel is in a sunny location), as there should be enough sun to keep the batteries charged despite the higher current drain. If in doubt use the low power components.

Construction

Construction of the PCB is fairly straightforward. The component overlay is shown in Diagram 3.The PCB contains a number of links; put these in first. Next put in the diodes, noting the polarity, don't mix up the Schottky and 1N4148 diodes as they both look the same. Follow this with the resistors, ICs,

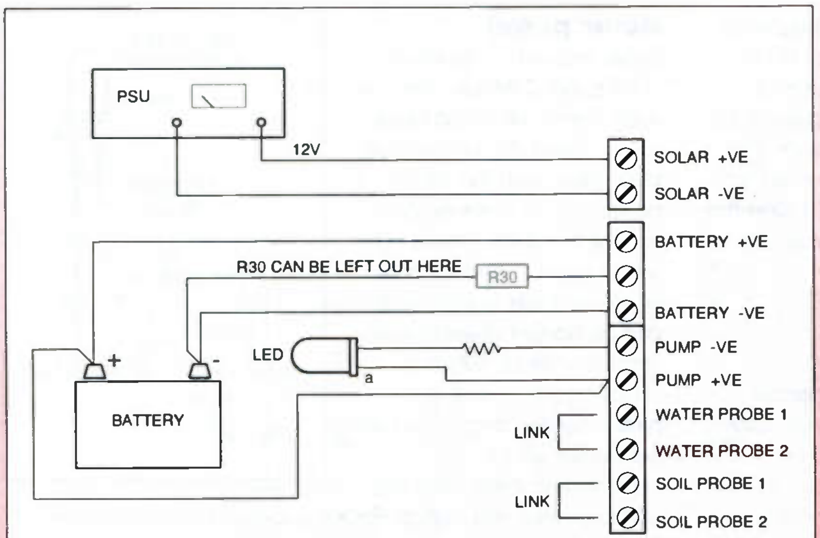


Fig. 5c

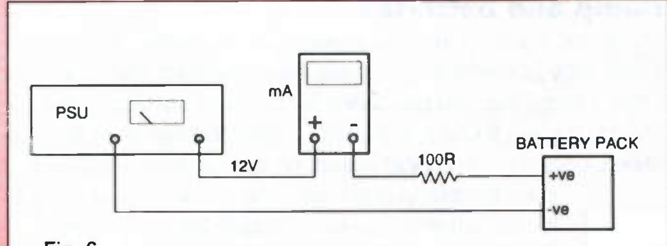


Fig. 6

First double check all the component polarities (diodes, caps and ICs). Next check for solder shorts, dry joints etc. When the PCB has been visually checked, connect a PSU to the Solar Panel inputs. Set it at 12V, short out the water probe connections and leave the soil ones open, as shown in diagram 5A, (do not connect the meter across the battery terminals yet). Turn on the PSU and press the reset button. Measure the current drawn from the PSU; this current should be around 2-4mA. Measure the voltage at the cathode of D4; this should be around 18-20V. If these values are correct the voltage doubler is working correctly. If you have excessive current, remove D5 (this will isolate the voltage doubler). If the current is still high, check the polarities of Q1 and Q2 (check you have the correct devices e.g. a BC182 not BC182L). If the current dropped when D5 was removed, the mistake is elsewhere in the circuit. Recheck for solder shorts. If the voltage was not around 18V or higher, again check U1, Q1 and Q2 and the polarities of D1-6.

Now connect a meter to the battery in terminals. First check the voltage is approximately 15-20V, then set it to measure current (hundreds of mA). The current drawn will be the charge current which will be around 25mA, with R6 set at 56R. If value is not correct, check Q7 and D5. Next remove the PSU and connect it to the battery inputs. Check the regulator output, (use the supply pins of U3 Pins 7 and 14); this should be 5V.

It is now safe to connect the battery to the battery in terminals. If the batteries are unchanged you will need to give them an initial charge (diagram 6 shows a simple circuit), or connect the PSU to the solar in terminals and leave the circuit for a few hours.

Connect the PSU to the 'solar-in' terminals and the charged or semi charged batteries to the 'battery in' terminals (do not connect the pump supply). Note, if you are going to leave the circuit for some time either disconnect the batteries or leave the PSU on, otherwise the batteries will start to drain. Connect a LED and 1K resistor between the battery + and the pump -ve terminal. With the circuit powered on remove the link between the water probe terminals. The Low water LED should come on. Replace the link and it should go off. Now adjust VR1 until U2 pin 8 (VREF) goes to 1V. Measure the voltage at the output of U2, pin 14; this should be 5V. Put a link in across the soil probe terminals; the voltage should drop to 0V.

If all is OK the soil and water level detector circuits work. Put a link in the soil probe terminals and press the reset button. Turn the PSU off (this simulates darkness). The LED

capacitors, transistors then finally the connectors. R30 can be mounted on the board, although it may be easier to mount it off the board (you may find it difficult getting it on the PCB due to its size). If mounting it externally, put a link in its place on the PCB. The resistor should now be put in series with the motor ground wire.(Note, you may have to change the value of R30, see the 'setting-up' section). If the solar panel you are using contains a blocking diode, replace D1 with a link; if in doubt leave it in.

Rcharge sets the charge current for the batteries, the charge current is approximately 1.4/Rcharge(R6). For R6 =56R the charge current will be 25mA. You should set the charge current to be 1/20th of the capacity (500mAH= 25mA charge current). If, however, you do not use low power devices you will have to take account of this current and increase the charge current accordingly.VR1 and VR2 can either be mounted on the PCB (using min presets) or externally on the case using standard potentiometers. The choice depends upon whether you wish easy access to change the settings or not.

Connect up the external connections to the LEDs, Switch and Potentiometers (if using), as shown in diagram 4. At this point DO NOT CONNECT the batteries or pump. The circuit must be tested first.

Testing and setting up

Nicads can supply very large peak currents (hundreds of amps), therefore before connecting them in to your circuit you must ensure there are no mistakes.

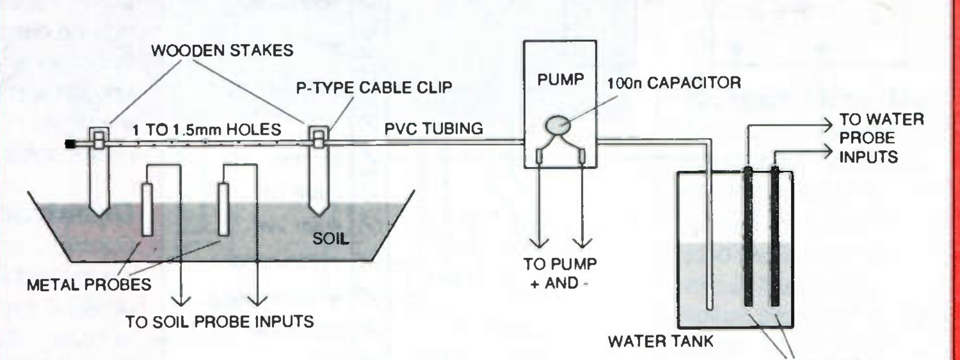


Fig. 7

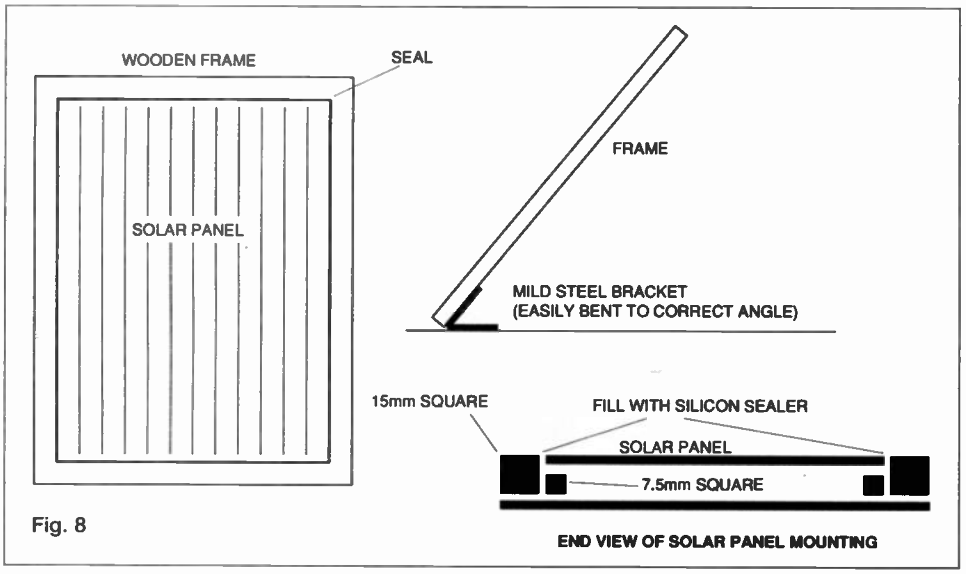


Fig. 8

across the pump terminals should remain off. Now remove the soil link. The LED should come on and then, after a minute or so, go off (time depending on the setting of VR2). After a few seconds the error LED should come on. Press the reset button and replace the link. Repeat removing the link, however while the pump LED is on replace the link. This time the error LED should remain off. If all is OK so far, connect up the pump as shown in figure 4 (use heavy wire to connect pump). A 100nF capacitor should be connected across the pump terminals. Do not connect it at the PCB; it must be connected at the pump. In place of the solar panel use the PSU and in place of the probes use a link as before. At this point we need to check the value of R30, this resistor determines the maximum current that can be drawn by the pump before the circuit is reset. Short out R30 (if in place), repeat the procedure above and measure the current drawn by the pump; if possible have the pump pumping water. You should set the trip current 1-2A above the normal running current. The value is then used to set R30 which should be R30= 0.88/I_trip. i.e. for a trip current of 4A , R30 =0.88/4= 0.22R. It is important that the GND wire between the battery and R30 is kept short and is of heavy gauge, otherwise its resistance may affect the trip current. Once all of the above tests are complete you can mount the PCB in its box. Coat the underside of the PCB with lacquer to protect it from moisture.

Setting up the complete system will depend upon your particular application. However, diagram 7 shows a basic configuration. A simple spray can be made to deliver the water evenly over the desired area, by drilling 1-1.2 mm holes in a length of PVC tubing, (with one end blocked). Some experimentation will be required to find the exact spacing and hole size. Small wooden stakes with cable clips can be used to position the tubing and spray.

When positioning the reservoir, try and keep it at the same level as the area being watered. If the reservoir is below this level the pump will have to work harder to pump the water. If the reservoir is above this level take care that you do not have a siphoning effect (this will depend upon the type of pump). If you use a control value instead of a pump the reservoir will need to be significantly higher than the watering level. In addition the tube will require to be inserted at the bottom of the tank (do not rely on a siphon).

Most solar panels come unboxed (the cheap ones anyway) and may not have any wires attached. Attaching wires to the panel is not as simple as it seems. You cannot solder onto the panel (you can cold solder the wires on). The best way I found was to use copper tape with conductive adhesive; this tape is often used in EMC screening. Here the wires can be soldered onto the tape and then the tape firmly attached to the solar panel. A protective frame should be made to house the panel, see diagram 8; this will also assist in mounting the panel. Silicon sealer, (the type used for sealing baths, sinks, etc.) is useful for sealing the glass panel into the frame.

The water probes can be any type of metal as long as it does not corrode. I made the soil probes from brass plates but any type of metal will do, (do not use different metals for each probe.). The probes should initially be spaced a few inches apart.

Final settings

Once you have your system set up and the control PCB wired correctly, you will need to set the soil moisture and pump timer. However, first ensure the solar panel is working correctly. In good sunlight the voltage across the solar panel inputs should be greater than 10V, if this is the case the batteries will be receiving their full change current. If the voltage is around 8-9V the batteries will only be partially charging; this may be the case in dull weather. If the voltage is less than 8V the batteries will not be charging and you will have to investigate. Diagram 4b shows a test circuit for the solar panel. The LED will start to light when the voltage exceeds 9V.

Ensure the batteries are fully charged before you use them .If you use the circuit diagram 6, adjust the PSU until you have approx. 50mA and leave for 12 hours; you may have to readjust the PSU if the batteries are dead. Alternatively keep the plants watered for a few days until the batteries are charged by the circuit (this assumes you have good sunlight for this period). To set the soil moisture first put the probes in soil which is just drying out (i.e. at the point where you wish the soil to be watered). Measure the voltage at U2 pin 9. Adjust the distance between the probes until the voltage is around 1V. If this cannot be achieved (to within +/- 0.5V) you will have to adjust R28 (Rref). If the voltage is too high, increase R28; if it is too low, lower R28. This should be unnecessary, as most adjustments can be made by moving the probes. Now monitor U2 pin 8, adjust VR1 until you have the same voltage (as pin 9); the moisture setting is now set. Once in operation, if you find the soil moisture is not correct, adjustments can be made by altering VR1. The amount of water delivered in each watering session is controlled by VR2. This can only be set by experimentation. If the maximum time given by the circuit is not enough C16 can be increased to give a longer watering time

If the system is in a very sunny position and a very efficient solar panel is used, the output from the solar panel may rise above 15V. R4 and D6 protect the circuit from damage but if the voltage is excessive these components could overheat. If you find this is happening simply upgrade these components to a higher wattage

Possible problems

Once operational, you will have to make regular checks on the system until you are confident that the settings are correct. If you find the ERROR LED on there are a few possible causes. Firstly check the water supply and pump e.g. a tube has not become detached. Check the probes are in place with the wires attached. Ensure the water spray covers the probes. Other possible problems could be that the controls on the control unit are set incorrectly (the timer is not on long enough or the moisture setting is too high).If you find the pump is never turned on, even when the soil is dry and the previous checks show the circuit is functioning correctly, the current limiting circuit could be resetting the circuit. Check the connections between R30 and the PCB/battery, ensure heavy wire is used to make all connections. If you are sure the connections are correct and the pump is functioning try shorting out R30. If this works the value of R30 is too high. One fault condition which has no error warning is loss of solar power. If this happens the plants will be watered until the batteries run down, however there is no warning for this. If you want a check for this condition implement the test circuit in diagram 4b. This will show when the batteries are being charged and therefore the state of the solar voltage, i.e. the LED should be bright while it is sunny. This circuit will have the penalty of a few extra mA current drain during sunlight hours.

PARTS LIST

Resistors

R30*	0.15R	2.5W
Value dependent on Pump, see text		
R4	10R	0.6W
R6 (Rcharge)	56R	0.25W
R10, R15	1K3	0.25W
R13,R27	4K7	0.25W
R11,R16	15K	0.25W
R9,R28,,R38,R39	2K7	0.25W
R8,R21,R36	47K	0.25W
R3,R5,R17,R20,R22, R23 R31,R32,R35,R37	100K	0.25W
R1,R7,R12,R13,R19,R25,R29,R34	270K	0.25W
R14	330K	0.25W
R24	560K	0.25W
R2,R26	1M	0.25W
R18,R33	2M2	0.25W
VR1,VR2	500K	MIN PRESET OR panel potentiometer.

Capacitors

C2,C7,C22,C23	10nF	Ceramic or Polyester
C18	22nF	Ceramic or Polyester
C3,C17,C20,C21,C23,	100nF	Ceramic or Polyester
C9,C13	220nF	Polyester
C11,C15,C19	1uF 10V	Tantalum
C14	2.2uF 10V	Tantalum
C5,C12,C24	10uF 16V	Electrolytic
C4,C16	47uF 25V	Electrolytic
C1,C8	47uF 35V	Electrolytic

Semiconductors

D1,D3,D4,D5,D9,D11, D14,D15		BAT85 Schottky
D13,D16,D17,D18	1N4148 G.P.	Silicon
D6	15V	ZENER
D19	4.7V	ZENER
D10,D12	1N4002	
D6, D7	Low Current LED	
Q1,Q3,Q4,Q5	BC182 (NOT 182L)	NPN Transistor
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Q6	3055LE OR IRF530	
Power	MOSFET with low Ron	

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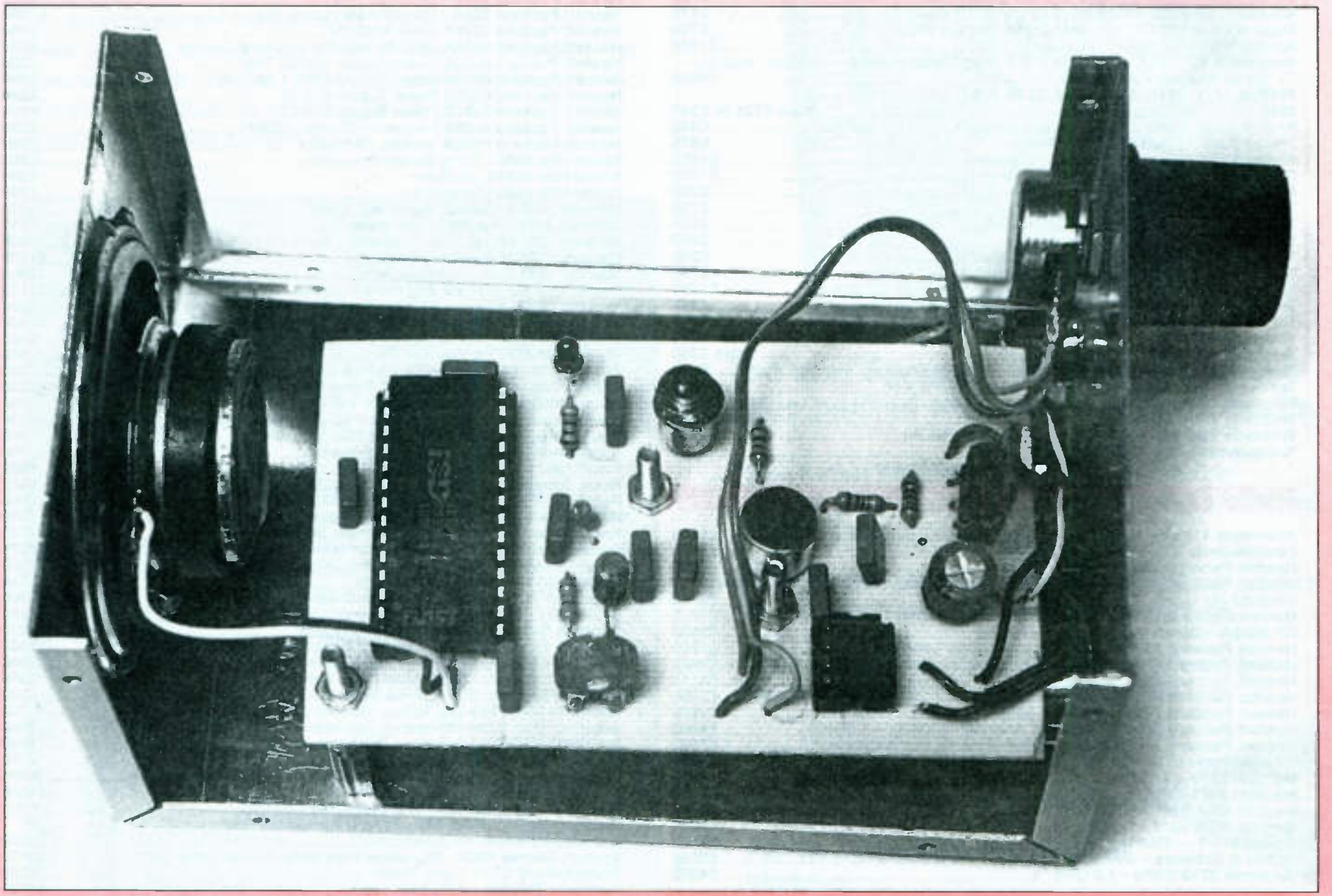
ELECTRONIC GUARD DOG

With Terry Balbirnie's latest project its bark is worse that its bite!

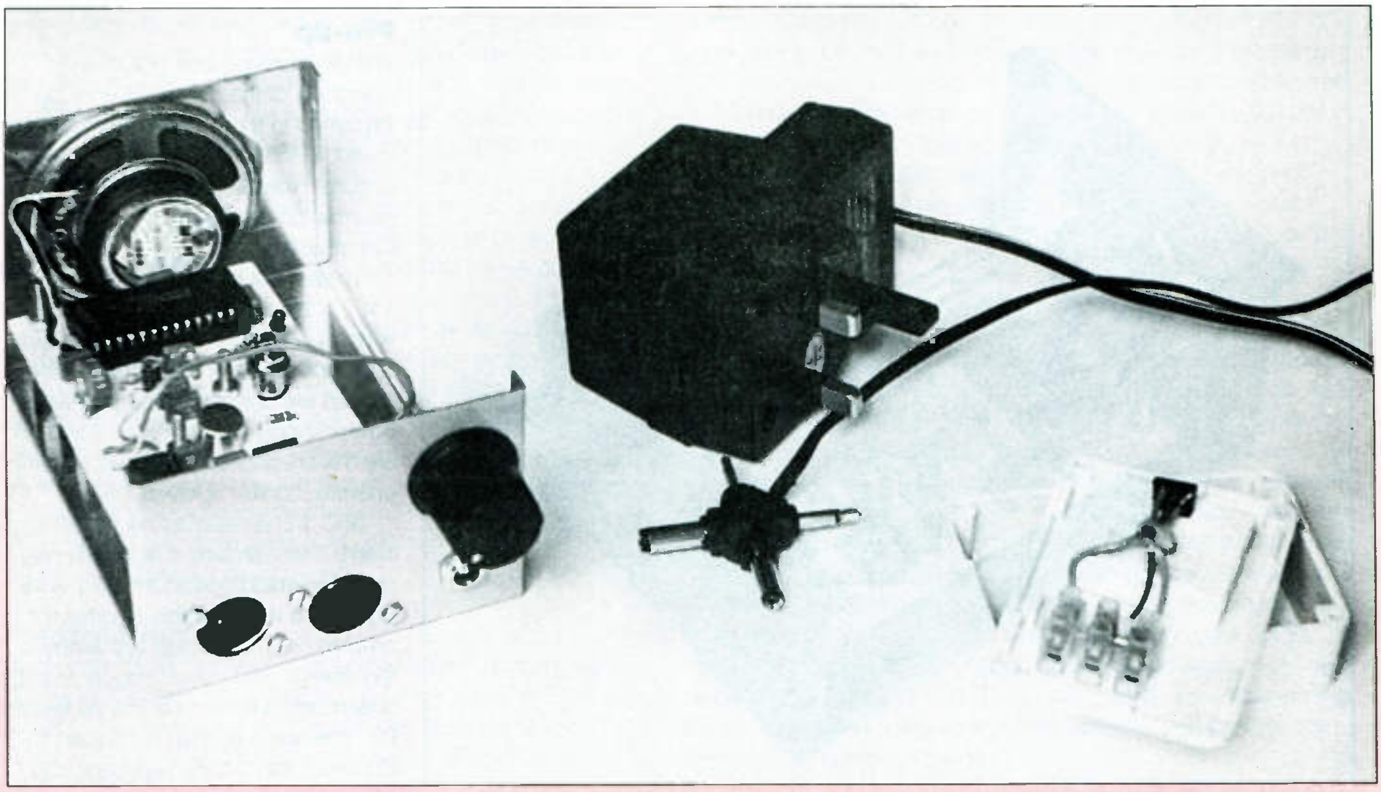


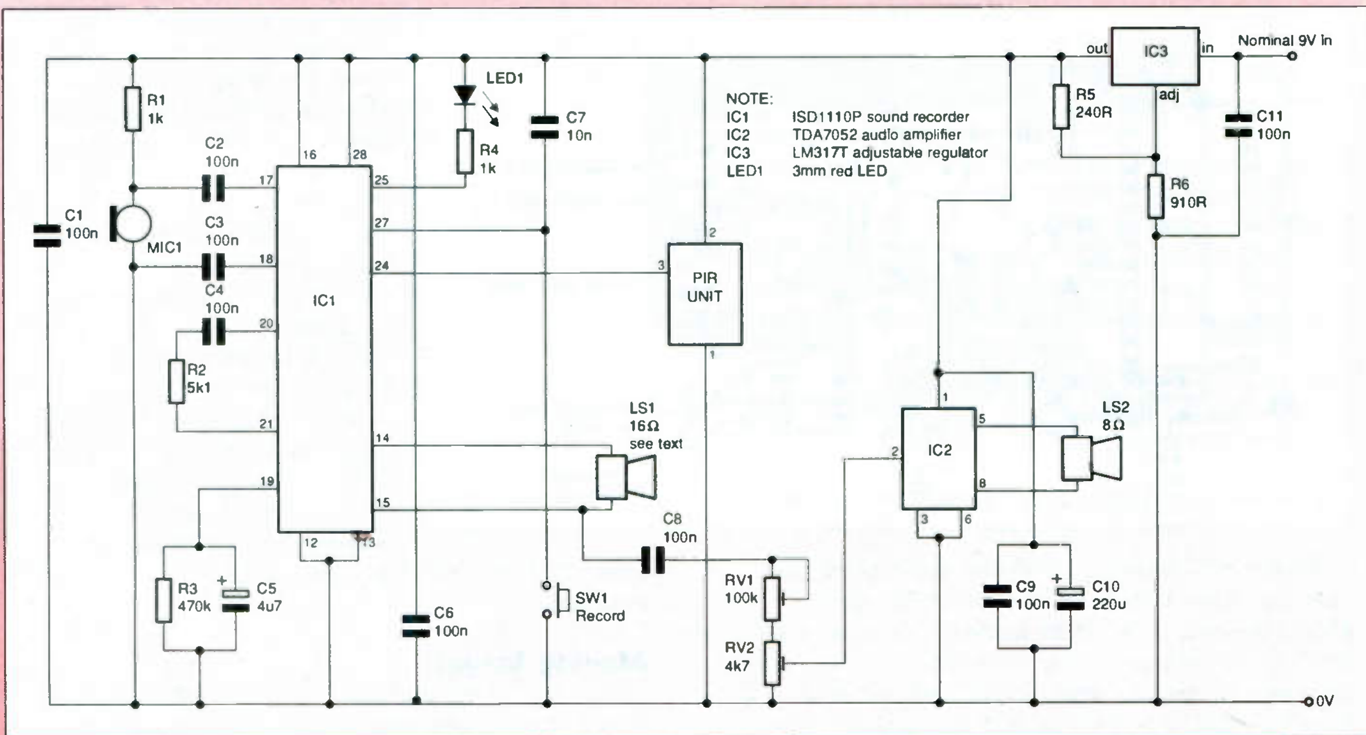
Many people believe that a dog is a good insurance against house crime. The sound of barking will make even the boldest burglar think again. However, not everyone can own one. It needs feeding, taking for walks and the occasional visit to the vet. Many people do not want the responsibility of owning a dog or are unable to commit themselves to the costs involved. Some have a lifestyle or type of property which precludes owning a canine companion.

The invisible dog

The Electronic Guard Dog needs no food or walks and costs very little to run. This is because it does not exist. The bark is a recording of a real dog and, to someone not expecting it, will sound very much like the real thing. The circuit uses a record/playback integrated circuit which does not involve moving parts such as exist in a cassette recorder. The device is therefore very reliable and needs no maintenance. The sound may be played back any number of times and can be re-recorded whenever the need arises.

Triggering is effected by a PIR (passive infra-red) sensor probably situated outside the building. This will operate when a person approaches within 10m (33ft approximately) of the property and will therefore give a response similar to that of a real dog. Readers needing only a "panic" facility could use a push-button switch, or switches, instead of the PIR unit. These could be situated in the bedroom, near the front door, etc. The recorded sound may last for up to 10 seconds and, when used with a PIR sensor, will repeat indefinitely as long as the intruder moves in the detection field.



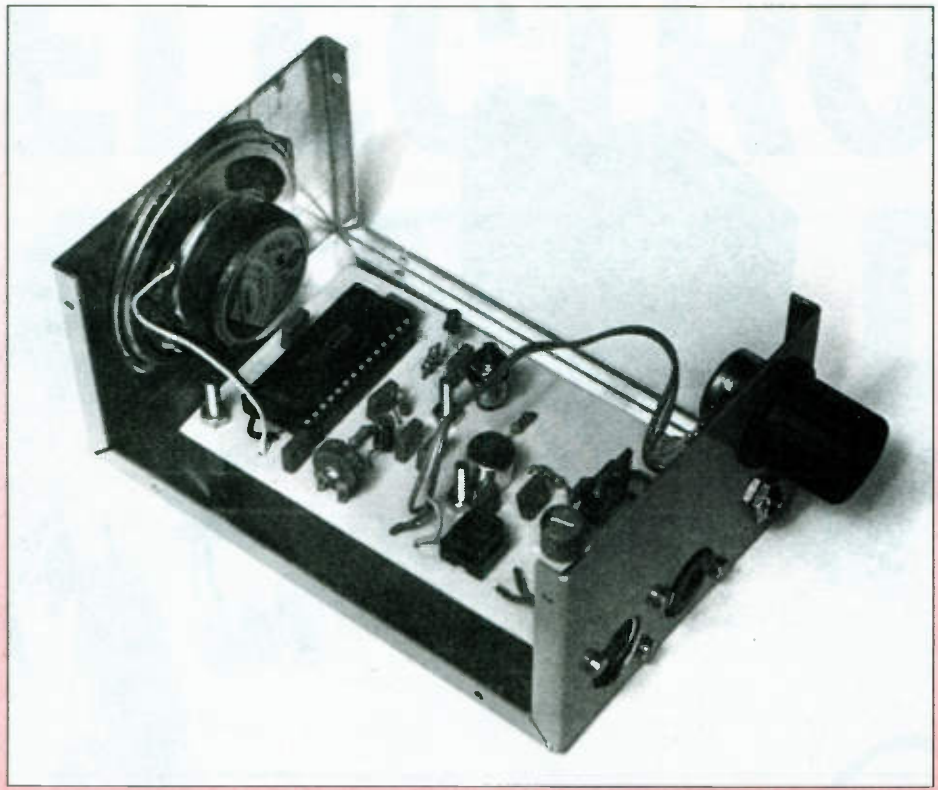


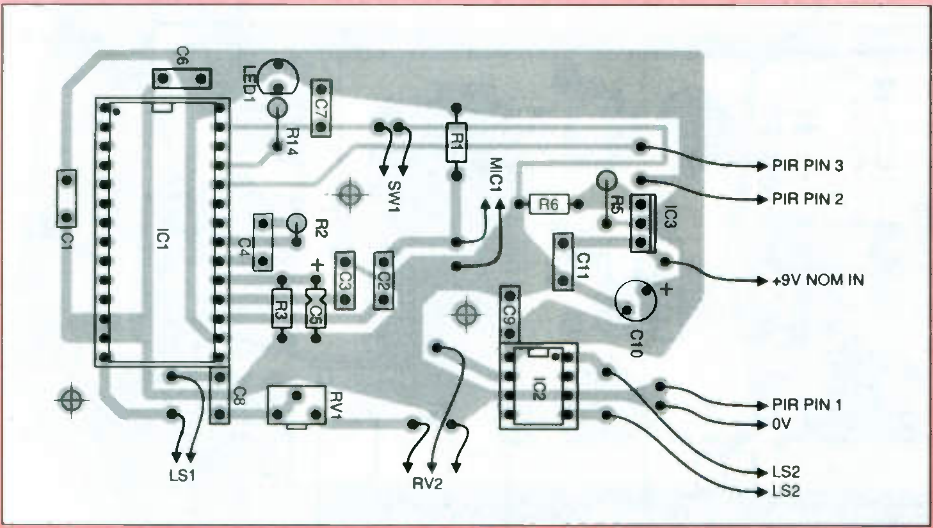
When used with a push-button switch, each momentary press will initiate a playback cycle. Most of the circuit is housed in a main section which receives power from a commercial 9V unregulated plug-in power supply. This avoids having to make mains connections in the course of construction. The unit has a volume control and sockets to which the power supply, external loudspeaker and PIR sensor are connected. There is also an internal monitor speaker which helps when making the recording. The microphone and push-button record switch are accessible only when the lid of the case is removed. This ensures that accidental erasure of previous material is impossible. Once made, the recording is non-volatile so the unit may be switched off indefinitely without losing it.

How it works

The circuit diagram of the Electronic Guard Dog is shown in Fig. 1. The positive output of the power supply is connected to the input of adjustable regulator, IC3. Resistors R5 and R6 set the output voltage and, with the values specified, this will be very nearly 6 volts. The regulated supply is then used to power sound recording chip, IC1, the PIR unit and power amplifier, IC2.

Integrated circuit, IC1, contains an array of 64,000 non-volatile EEPROM memory cells in which analogue information may be stored. As well as memory, this contains a microphone pre-amplifier, automatic gain control (AGC) circuit, filters, oscillator to clock the system and a low-power speaker amplifier.





While in record mode (push-button record switch SW1 operated), light-emitting diode indicator, LED1, glows. Microphone MIC1 picks up the sound and provides an electrical signal which is boosted by the pre-amplifier. The AGC circuit provides a compression effect so that quiet sounds are amplified more than loud ones. Thus, low level signals are recorded sufficiently while loud ones do not overload the system and cause distortion. The output from the preamplifier is sampled at the oscillator frequency of 6.4kHz. The amplitude of the wave at each sample (representing the loudness of the sound at that point) is stored in each memory cell in turn. Thus, although the actual sampling is digital by nature (it is sampled at regular intervals of time), the method of storage is analogue. The i.c. may thus be regarded as having two sections - analogue and digital. During playback, the contents of each memory cell are recovered in turn at the same frequency as that used when the recording was made. After filtering, amplifying and applying the result to a loudspeaker, a good copy of the original sound will be produced. The bandwidth of the system is about 3kHz which is adequate for speech or, in this case, barking.

Pin-up

The pin configuration of IC1 and operation of the circuit will now be explained in more detail. This could be useful to those designing their own circuits. Readers not wanting this information could simply proceed to Construction.

These pins are not connected: 1 to 11, 22, 23 and 26. Pins 12 and 13 are earth connections for the digital and analogue sections respectively. Pins 16 and 28 are corresponding positive power supply inputs. Pins 14 and 15 are the on-chip amplifier outputs which operate monitor speaker, LS1.

MIC 1 is an electret microphone insert. This contains a high gain pre-amplifier which boosts the very weak signal to a level suitable to drive the on-chip one. The inbuilt pre-amplifier requires its own power supply and this is derived from the +6V line via resistor, R1. The audio output is coupled to IC1 input, pin 17, via capacitor, C2. Microphone reference, pin 18, is connected to microphone earth via capacitor, C3. This procedure reduces noise. Pin 27 establishes record mode while low and this is done by pressing switch, SW1. When power is applied, pin 27 is made high for an instant by C7 and this prevents a false recording being initiated at the instant of powering-up. This would have the effect of erasing previous material. Pin 25 operates indicator, LED1, by going low while recording. At the end of the 10-second period, it goes off.

The characteristics of the AGC circuit. are determined by resistor R3 and capacitor C5 connected in parallel to pin 19. Pins 20 and 21 are the analogue in and analogue out terminals. These are linked using capacitor C4 and resistor R2 in series.

Moving target

Pins 23 and 24 are alternative methods of initiating playback. Pin 23 does this only while maintained in a low condition. This is not appropriate here so it is left unconnected. Pin 24 operates on a momentary low trigger pulse - playback will proceed to the end of the recording then the i.c. will return to standby. This is the method used in this circuit with the PIR unit (or a push-button switch) providing the pulse. The PIR sensor has three terminals - two for the supply and an output. The output is normally high and when this state is applied to pin 24, has no effect. When a target moves within the detection field, a train of low pulses is given at the output. The first one to arrive at pin 24 triggers the device and a playback cycle begins. Further pulses have no effect. If they are still being delivered at the end of the cycle, the i.c. will re-trigger and playback will repeat indefinitely.

The on-chip speaker amplifier provides only 12 mW of power maximum. Although sufficient to operate the monitor speaker it is not enough for actual use. There needs to be an additional amplifier and this is provided by IC2. This particular type has been chosen to give an adequate power output using only a 6V supply. It can deliver 1.2W into an 8W loudspeaker and this is sufficient for the purpose. Pin 1 is the positive supply feed. Capacitors C9 and C10 are present to ensure stability. Pin 2 is the input and the audio output is obtained at pins 5 and 8. Pins 3 and 6 are grounded and pins 4 and 7 not connected.

The signal needed to drive this amplifier is derived from IC1 pin 15 - one of the internal amplifier outputs - and connected via capacitor, C8. However, the voltage level is too great to be applied direct. To reduce it, preset potentiometer RV1 operates in conjunction with potentiometer RV2 to form a potential divider. RV1 is mounted on the circuit board but RV2 is a panel-mounted volume control. In use, RV1 will be adjusted so that, when RV2 is set to maximum volume, the loudest undistorted sound will be obtained.

Construction

Construction is based on a single-sided printed circuit board (PCB) and the component overlay is shown in Fig. 2. Begin by soldering the i.c. sockets and switch into position. On no account solder the i.c's direct to the board without using sockets.

Solder all resistors, including preset RV1, and capacitors into position observing the polarity of C5 and C10 as indicated. Follow with the LED - again, taking care over the polarity (the longer, positive lead is connected to the pad near the edge of the PCB). Solder regulator, IC3, in place with the correct orientation - the metal backing faces the edge of the board. Add the microphone - the pin connected to the metal body (look underneath) is the earth one - that is, it connects to C3. If it has pad connections rather than pins, solder two short wires to these first. This component should be soldered using minimum heat to prevent damage.

Complete construction of the PCB by soldering 10cm pieces of stranded wire to the pads labelled +9V nom. in, 0V, PIR pins 1, 2, and 3, LS1 (2 off), LS2 (2 off) and RV2 (3 off). It is helpful to use coloured wires (such as "rainbow" ribbon cable) to avoid errors later. Adjust RV1 wiper fully anti-clockwise (as viewed from the edge of the PCB). for minimum signal. Insert the i.c's into their sockets taking care over the orientation. These are static-sensitive devices and it would be wise to touch something earthed - such as a water tap - before holding the pins.

Everything is mounted on the lower section of the case. In this way, no wires are put under strain when the lid is removed to make a recording. Prepare the enclosure by making three holes in the base to correspond with those in the circuit panel. Drill holes in one side for volume control RV2 and for power input, external speaker and PIR sensor sockets. In the prototype unit, the latter two were of the 2-pin (loudspeaker) DIN and 3-pin DIN type respectively. The supply connection was made using a 2.5 mm power socket. Mount these parts. Cut RV2 spindle to size, attach this component and fit the control knob.

Drill a matrix of holes in the other side of the box for the sound to pass through and secure LS1 behind it using a little quick-setting epoxy resin adhesive around the rim. Refer to Fig. 3 and complete the internal wiring. The centre (pin) connection of the power socket should be the positive one. Note that the on-chip amplifier is designed to operate a 16 ohm speaker. However, the nearest impedance which catalogues appear to list in the size required is 8 ohms. It will therefore be necessary to solder an 8.2 ohm resistor in series with it as shown. The reduction in output does not matter. Mount the PCB on 25mm (1 in.) stand-off insulators so that the copper track side remains clear of the sockets and their connections. Do not attach the regulator to the side of the case.

PIR sensor

Prepare a small box for the PIR assembly. If it is to be exposed to the weather, it will need to be waterproofed. Cut a hole for the PIR sensor window, a small one for the external wire to pass through and one for a three-way section of terminal block. Make a bracket, if necessary, to attach the unit to a wall, etc. and bolt it to the case. Secure the terminal block inside the box and glue the PIR sensor in position using a little quick-setting epoxy resin adhesive - do not get any on the window.

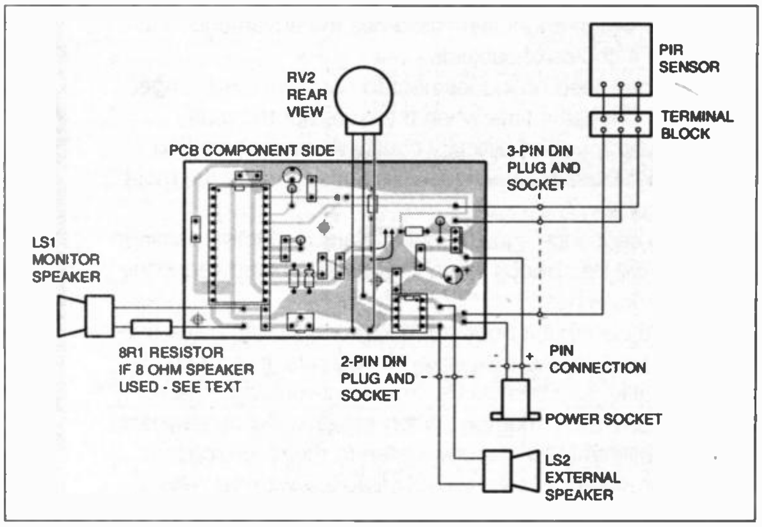
Measure a length of light-duty three-core wire to reach the main unit. Probably the best wire to use is four-core burglar alarm or telephone type ignoring one of the conductors. Fit the 3-pin DIN plug to one end. Take care to note the colour-coding of the wires at the pins so that they end up connected to the PIR unit in the correct sense.

Pass the connecting wire through the hole and tie a knot on the inside to provide strain relief leaving some slack. Do not solder the wires direct to the pins on the PIR unit - the heat from the soldering iron could damage it. Instead connect it to the terminal block and from there solder short wires to a three-pin s.i.l. (single in-line) socket.

You are unlikely to find these listed by popular mail-order suppliers. However, one is easily cut from an eight-pin d.i.l. one. Gently press the socket on to the PIR sensor terminals. Note that the connections are numbered on the plastic body and this corresponds with the numbering in Fig. 3. This is very important since the unit may be damaged if they are applied incorrectly.

The specified PIR device is relatively inexpensive so it does not have sophisticated pulse-counting circuitry to eliminate false triggering. A certain amount of spurious operation may therefore occur.

This may be minimised by careful positioning of the unit. In particular, it should not be sited near moving trees or with direct or flickering sunlight falling on its window. Also, it must be attached securely so that it cannot move.



Note that the sensor will operate over a range of about 10m and through a detection angle of 164 degrees.

If a push-to-make switch is to be used instead of the PIR unit, this should be plugged into the 3-pin DIN socket using twin wire connected to the "PIR pin 1" and "PIR pin 3" pins. As many switches as required may be connected in parallel so that operating any for an instant will trigger the unit.

Setting up

There is usually a polarity reversal plug on the power supply unit and a check must be made so that the correct polarity will be obtained before plugging it into the mains. The centre (pin) connection must be the positive one. A supply between 9V and 12V will be suitable. An 8W speaker in an enclosure will be needed. There is no point in using a high-fidelity unit. However, best results will be obtained if the cabinet is of a reasonable size. Measure the piece of wire needed, connect it to the speaker and fit the 2-pin DIN plug to the other end. Adjust volume control, RV2, to mid-position.

For initial trials, it would be a good idea to trigger the unit without using the PIR unit. This may be done using a short piece of wire pushed into the 3-pin DIN socket holes used for PIR pins 1 and 3 (it often triggers when it touches pin 3 alone). Plug in the speaker and power supply. Check that the LED operates when the record switch is pressed - hold it down and make a test recording. Speak a short distance from the microphone then release the switch.

If you speak for more than 10 seconds, the LED will go off and anything said after that will be ignored. Trigger the unit and check that the volume is increased by clockwise rotation of RV2 spindle - it should be if figure 3 has been followed correctly. If it works in the opposite sense, reverse the connections to its outer tags. Now adjust RV2 to maximum, trigger the unit and adjust RV1 to provide maximum undistorted sound. In the prototype unit, it was best left as it was. If RV1 is set at too low a resistance, the sound will be distorted and may possibly cut off due to the internal limiting circuitry within IC2. Check operation with the PIR unit plugged in. Note that this needs a short settling down period before it works properly. During this time, it may trigger repeatedly for no apparent reason.

Paws for thought

Making the recording is a simple matter but, of course, needs access to a dog willing to bark on demand. There is an alternative - you could bark yourself! With practice this can be quite convincing. If a real dog is to be used, the local kennels will probably oblige and this method has the advantage that there will be a choice of subjects.

Usually they need no inducement to bark when a stranger approaches Choose a time when there are not too many inmates or you may find difficulty confining the recording to only one dog! Experiment with the distance to make the most effective recording.

The barking sequence should not have any distinctive passage in it or this will be obvious when it repeats. A bland sequence of similar barks is best.

Take care also that it does not begin or end with half a bark. You do not have to use the whole 10 seconds. If recording is terminated after, say, 8 seconds, an end-of-message marker will be inserted in the memory. When this is found on playback, the device will return to standby. Listen to the recordings on the monitor until you are reasonably satisfied with the results, then check using the external speaker.

Note that pressing SW1 - even for an instant - will erase any previous recording. It will be found that if the external speaker is placed some distance behind a closed window or door and the volume is not turned up too high, the effect will be very realistic. There is plenty of room for experiment to produce the best results and this may be done over the following days.

Remember, distant muffled barks usually sound best. It only remains to attach the lid of the case and to place the unit on a shelf close to a mains power socket.

Buy Lines

The FIRM287 PIR sensor is available from Mailtech. The sound recorder i.c. is available from Maplin. The volume control, RV2, must be a miniature type to fit the layout - this is also available from Maplin. If a 16 ohm miniature speaker is used for LS1 the 8R1 series resistor may be omitted. The plug-in power supply may provide any voltage output from 9 to 12V. It should be of the cheaper unregulated type.

MAILTECH Electronic Components
PO Box 16
Ludlow
Shropshire
SY8 4NA.

PARTS LIST

Resistors

R1, R4	1k
R2	5k1
R3	470k
R5	240R
R6	910R
R7	8R1 (for monitor speaker - see text)
	All 0.6W 1%.
RV1	100k sub-miniature vertical preset
RV2	Miniature 4k7 potentiometer

Capacitors

C1, C2, C3, C4, C6, C8, C9	100n miniature metallised polyester - 5mm pin spacing.
C5	4m7 50V electrolytic
C7	10n miniature metallised polyester - 5mm pin spacing.

Semiconductors

IC1	ISD1110P sound recorder
IC2	TDA7052 audio amplifier
IC3	LM317T adjustable regulator
LED1	3mm red LED

PIR sensor type FIRM 287 (see Buy Lines)

Miscellaneous

S1	Sub-min. push-to-make switch
LS1	50mm 16 ohm (or 8 ohm) speaker
LS2	8 ohm speaker and enclosure - see text.
MIC1	Electret microphone insert diameter 10mm approx.
	28-pin d.i.l. socket; 8-pin d.i.l. socket; 9V 300mA d.c. plug-in mains power supply unit; Box for project. 2-pin DIN loudspeaker plug and chassis socket, 3-pin DIN plug and chassis socket, 2.5mm power socket, hardware.

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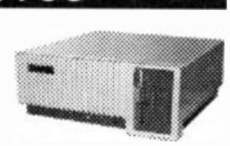

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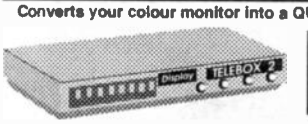

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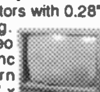

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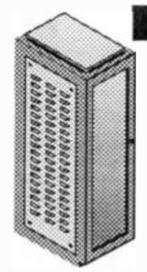

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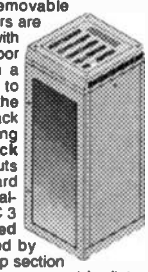

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Flash Microcontroller Programmer

Henry G Myatt offers a simple serial 89C51/52 flash microcontroller programmer

Flash microcontrollers such as the serial 89C51/52 are now widely used in commercial equipment. Their low cost, power and versatility also mean that they can be very valuable components in the experimenter's armoury. However, there is one major drawback to using these chips; the need for a cheap programmer which can be used with a standard IBM PC. In this article we look at the construction of such a programmer.

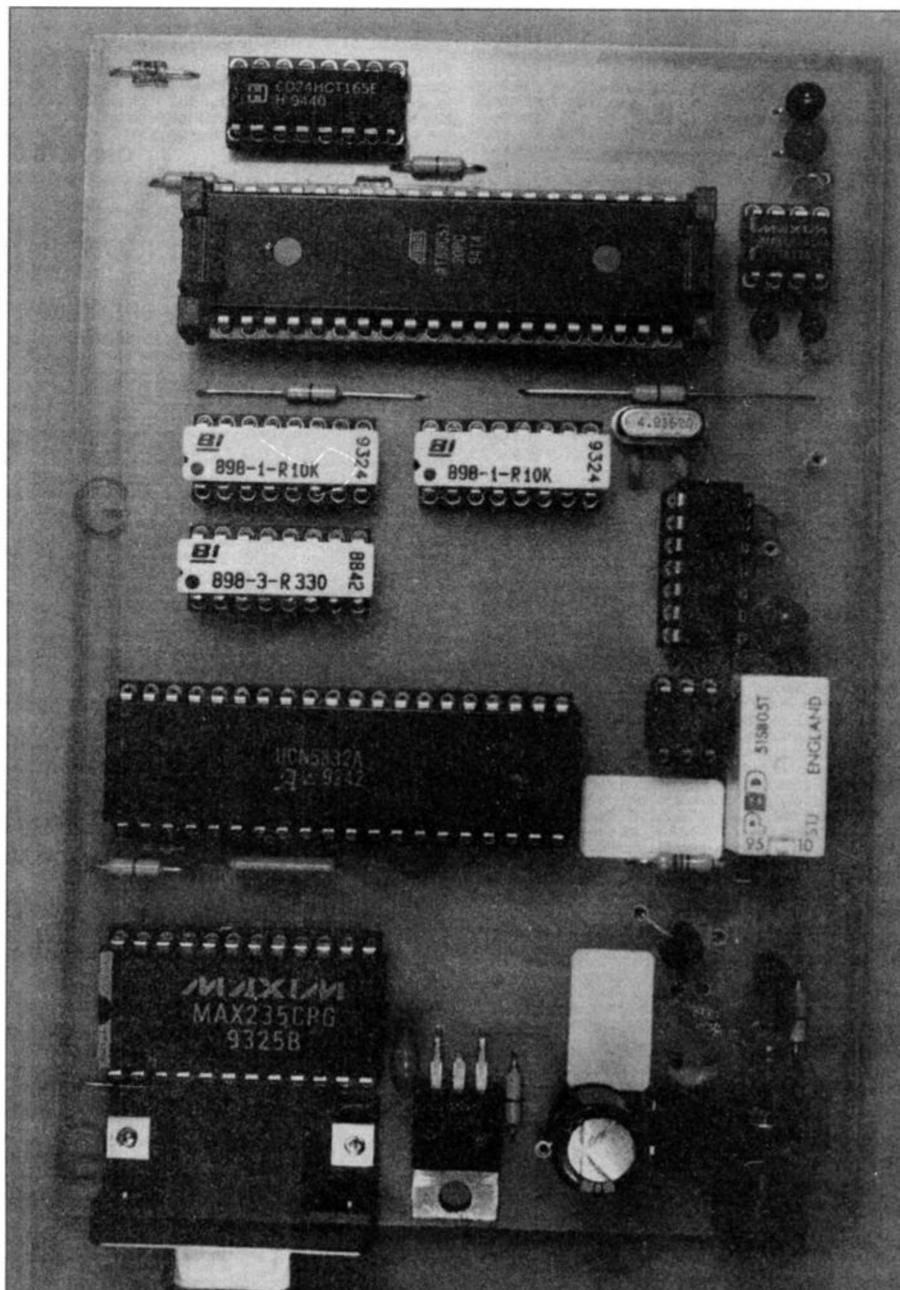
Introduction

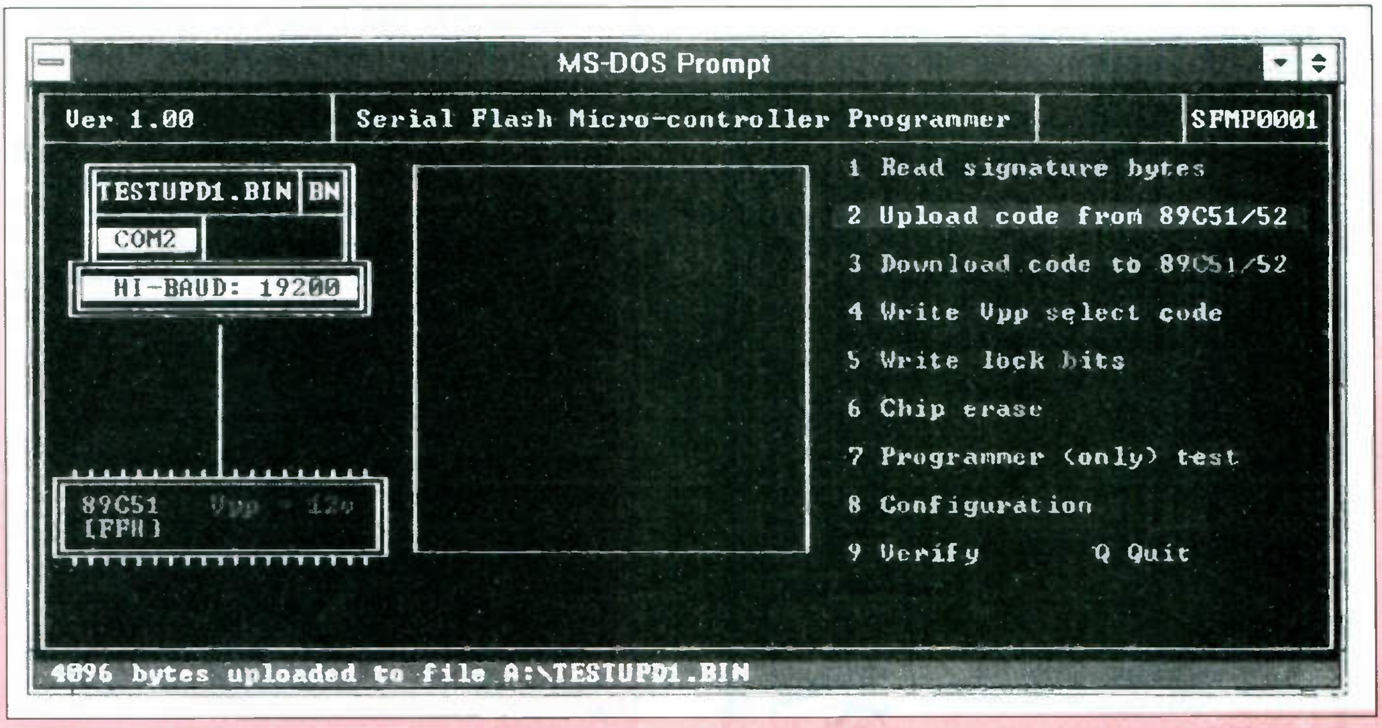
The basic circuit design uses 29 components (excluding sockets and connectors etc) on board and one SPST switch. The single-sided board measures 137mm x 91mm and requires 8 wire links. The board in the photograph uses zero ohm links for clarity. The power supply required is 5 volts regulated DC.

At the bottom left of the board is an area with tracking to allow for four extra components to be fitted. These components will then allow an unregulated AC/DC source to be used. The prototype board in the photograph has all these components fitted - a total of 33 devices.

A 9-way D socket is mounted on the board to allow connection to an IBM PC. The cable used is a straight through type i.e. no crossovers or loopbacks are required.

The cable length should be screened and its length should be 1 metre or less. A low-cost 40-pin DIP lock/eject socket (Aries) is used to accommodate the 89C51/52 chip for programming or verification.





The software on the PC is designed to utilise the PC UART for all critical timing pulses i.e. ALE/PROG pulses. This means that there are no software generated timing loops that will have to be altered for faster/slower PCs.

The software also waits for UART processes to finish before proceeding with subsequent stages. The software has been tested on a PC (286) and Pentium. There is no reason why it shouldn't work on an XT. The program is written in Turbo Pascal which will run on all 80x86/Pentium variants.

The design utilises the modem and transmit lines of the RS232 port. The modem lines used are DTR/RTS and DSR/CTS. The TX line (from the PC) is used to strobe/latch the logic states to the 89C51/52 being programmed. This line also generates the correct timing for the ALE/PROG strobe pulse.

The chip count is as follows:

1 x 40 pin, 1 x 24 pin, 1 x 16 pin, 1 x 14 pin and 2 x 8 pin.

The most expensive chips on the board (1 off) cost around £12.00, £6.00 and £3.50. The remaining devices are standard 74HCT series logic elements and one cheap opto-isolator.

The two LEDs used are 5V types: 1 x green and 1 x flashing red. Three 16 pin DIP resistor network packages, one 5 pin SIP resistor network and one discrete resistor together with 6 ceramic and 5 tantalum capacitors form the passive components. One 4.91520 MHz crystal is used.

Finally, 2 Mosfets, 1 Relay and 1 Diode complete the basic board function.

As mentioned above, four additional PSU components i.e. bridge rectifier, solid-state resettable fuse, electrolytic capacitor and voltage regulator allow the unit to be powered from AC or DC (any polarisation) power supplies.

The circuit is designed so that the programming/verification of a 89C51/52 can only be done after a relay has been latched by a control pulse sent from the PC's UART. In order to latch the relay, the user must operate a switch connected to the board when requested by the software. This is a safety feature to prevent inadvertent operation if for instance, the unit was left connected and a comms program was transmitting characters to the board. A relay was used for reasons of relatively slow latching time (w.r.t. solid state flip-flops), noise immunity and simplicity.

Once the relay has been latched, the flashing red LED will operate. This indicates that the 89C51/52 is being accessed. This LED is operated directly from the relay.

The 12 volts needed for the programming (12 volt mode) is generated on the board.

Basic Operation

The program running on the PC switches the selected RS232 port (COM1, COM2, COM3 or COM4) from its normal asynchronous mode of operation to a synchronous mode. 32 bit frames are sent to the serial-in/parallel-out latch chip (UCN5833A) via the RS232/TTL translation chip (MAX235). This is accomplished by using the two PC modem O/Ps DTR and RTS (clock and data lines respectively to UCN5833A) to transmit the bits.

The TX line (from the PC) is used as a strobe to latch these bits and for the ALE/PROG timing pulse when programming the 89C51/52 chip.

The two modem inputs to the PC, DSR and CTS, are used to sample serial data out from the 74HCT165 (when reading from the 89C51/52) and programming completion (P3.4 from the 89C51/52) for an 89C51/52 address location, respectively. These five active lines (and ground) are the only connections to the PC required.

A switch/relay combination is used to ensure that the 89C51/52 can only be activated at the correct time. The relay cannot be latched by spurious noise pulses or an errant comms program alone.

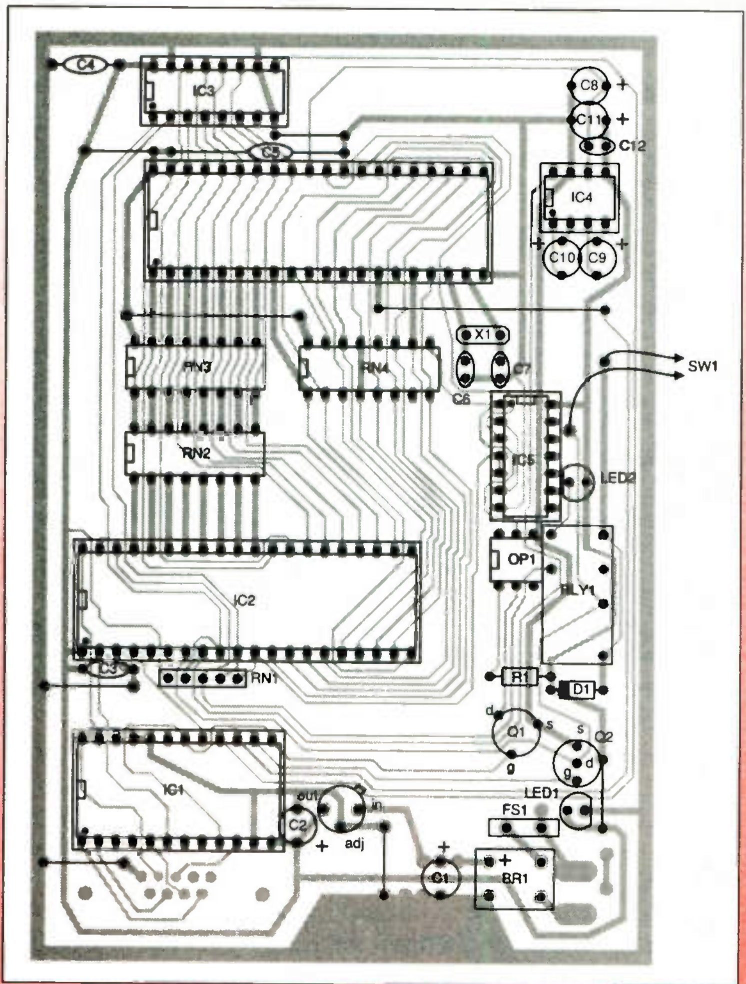
The program automatically disables the lines to the 89C51/52 when a function has finished.

Outline of chip functionalities

IC1 is a self contained RS232/TTL converter chip, the MAX235. Both positive and negative voltages are generated on the chip using the charge-pump circuitry and internal capacitors.

The RS232 receivers can be used as standard TTL inverters. In this circuit, receivers R4 and R5 are used for this purpose.

IC2, the UCN5833A is the serial-in/parallel-out latch chip



that sets up and maintains the address, data and control lines to the 89C51/52 being programmed/read in the socket. It has 32 open collector outputs that are tied high, where necessary, with the resistor networks RN1, RN3 and RN4.

Data is fed to this chip via the data line (pin 2) synchronised with the clock line (pin 40).

The strobe line (pin 4) on this chip transfers the 32 bit data to the 32 outputs simultaneously when pulsed.

The output enable line (pin 38), when low, turns all the output lines off (open circuit). IC3 is a standard 8 bit parallel-in/serial-out converter chip, the 74HCT165. It is used to latch/read data output from the 89C51/52 device in the socket. One of the UCN5833A O/Ps is used to clock this chip whilst another is used to sample/load the data.

IC4 is another MAXIM chip - the MAX662A. With five external capacitors, it will generate +12 volts to be used when programming the 89C51/52 in 12 volt mode.

The shutdown I/P to this chip (pin 8) has its own internal pullup resistor.

The 12 volts generated appears on pin 6. When the shutdown mode is entered, 5 volts is present on this pin. This shutdown function simplifies the circuit design i.e. only one input pin is required. The 4N35 opto-isolator is used simply as a delay element in this circuit. It ensures that when the ALE/PROG pulse function is disabled (from the UCN5833A - pin 11) - a 'ghost' ALE/PROG pulse is NOT generated. This could occur because of the nominal 500nS propagation delay time present in the UCN5833A i.e. a change of state in the O/Ps is not reflected until 500nS after the UCN5833A strobe has been activated. A logic level controlled N-Channel Mosfet, the 2SK1336 switches the opto-isolator on and off.

Only two of the NAND gates in IC5 (74HCT132) are used. One is used to invert the UCN5833A O/P (pin 11) to allow the delayed strobe signal (Opto-isolator O/P pin 5) to be gated via the other NAND gate to the ALE/PROG pin on the 89C51/52 chip (pin 30). A latching circuit built around a 5 volt DPDT relay, a 2SK1336 Mosfet and a push to make switch, will latch when the following conditions are met:

a). A strobe pulse (via the PC's RS232 transmit line) of sufficient duration is present.

b). O/P OUT3 (pin 7) from the UCN5833A has been programmed to a '0' state.

c). The push button contacts are closed.

The relay is unlatched by simply setting the UCN5833A O/P - OUT3 high. The unlatched relay contacts will disable the UCN5833A.

Capacitors C6 and C7 together with the 4.91520 MHz crystal form the clocking circuit for the 89C51/52 in the socket.

The components FS1, BR1, C1, C2, REG1 and LED1 in the bottom left of the circuit diagram form a standard PSU circuit.

There are the following spare circuit elements available:

a).	IC1 (UCN5833A)	3 RS232 transmitters T1, T2 and T5.
b).	IC5 (74HCT132)	2 NAND gates.
c).	RN4	3 10K pullups.

PARTS LIST

IC1	MAX235CPG
IC2	UCN5833A (or UCN5832A)
IC3	74HCT165
IC4	MAX662ACPA
IC5	74HCT132
OP1	4N35 (Optoisolator)
X1	4.9152 MHz Crystal
Q1, Q2	2SK1336 Mosfet
LED1	5 volt type 0.2" GREEN
LED2	5 volt type 0.2" FLASHING RED
D1	1N4148

Capacitors

C1	330 uF 25v Elect' Aluminium
C2	10uF 6v3 Elect' Tantalum
C3, C4, C5, C12	0.1uF 50v Ceramic
C6, C7	33pF Ceramic
C8, C11	22uF 16v Elect' Tantalum
C9, C10	1uF 35v Elect' Tantalum

Resistors

R1	330R 0.25W
RN1	4 commoned 10K SIP network (5 pin)
RN2	8 separate 330R DIP package (16 pin)
RN4, RN5	15 commoned 10K DIP network (16 pin)
BR1	Bridge rectifier DB103 DIP package
REG1	MC78T05CT 5v Regulator
RLY1	Relay 5v DPDT 125R coil 51SB05T (PED)
SW1	SPST momentary push-to-make switch
FS1	Fuse - Resettable RXE025 (Raychem)

Miscellaneous

Connectors, sockets etc.

* EXAMPLE OF INTERMEDIATE LEVEL CODE FROM SFMP01.PAS *

```
Procedure Write_lock_bit(lock_bit: byte; vpp_mode: byte);

Begin
  { Requires 100 uS ALE/PROG pulse at the requested voltage (vpp_mode).
  { In the following assignments for the lock bits - P2.6 is always 1.
  Case lock_bit of
    1: Begin
         p2_7 := 1;
         p3_6 := 1;
         p3_7 := 1;
       End;
    2: Begin
         p2_7 := 1;
         p3_6 := 0;
         p3_7 := 0;
       End;
    3: Begin
         p2_7 := 0;
         p3_6 := 1;
         p3_7 := 0;
       End;
  Else
    End;

  data_byte := $FF;
  addr_word := $FFFF;
  p2_6      := 1;
  { p2_7, p3_6 and p3_7 set as above. }
  ale_strobe := 1;
  ls165_clock := 0;
  ls165_shift := 1;
  ea_vpp     := vpp_mode;
  oe_5832a := 0;
  spare_1 := 1;
  spare_2 := 1;

  Transmit_all_bits;
  Send_FF_and_wait;
  { Vpp takes about 400 - 500 uS to reach 12v from Vcc; the }
  { frame time at 9600 baud = 1mS; at 19200 it is 500 uS.   }
  { Now send ALE/PROG pulse for approx 100 uS :-            }
  { i.e. 104 - (tr_off - tr_on) uS. tr_off/tr_on are        }
  { turn off/on times for 4N35 optoisolator.                }
  { Turn off time should never be less than turn on time.   }
  { Therefore time should never be > max allowed of 110 uS. }
  ale_strobe := 0;
  Transmit_all_bits;
  Send_FF_and_wait;

  { Disable ALE/PROG now - remove 12 volts if present. }
  ale_strobe := 1;
  vpp_mode   := 1;
  Transmit_all_bits;
  Send_FF_and_wait;
End; { Write_lock_bit }
```

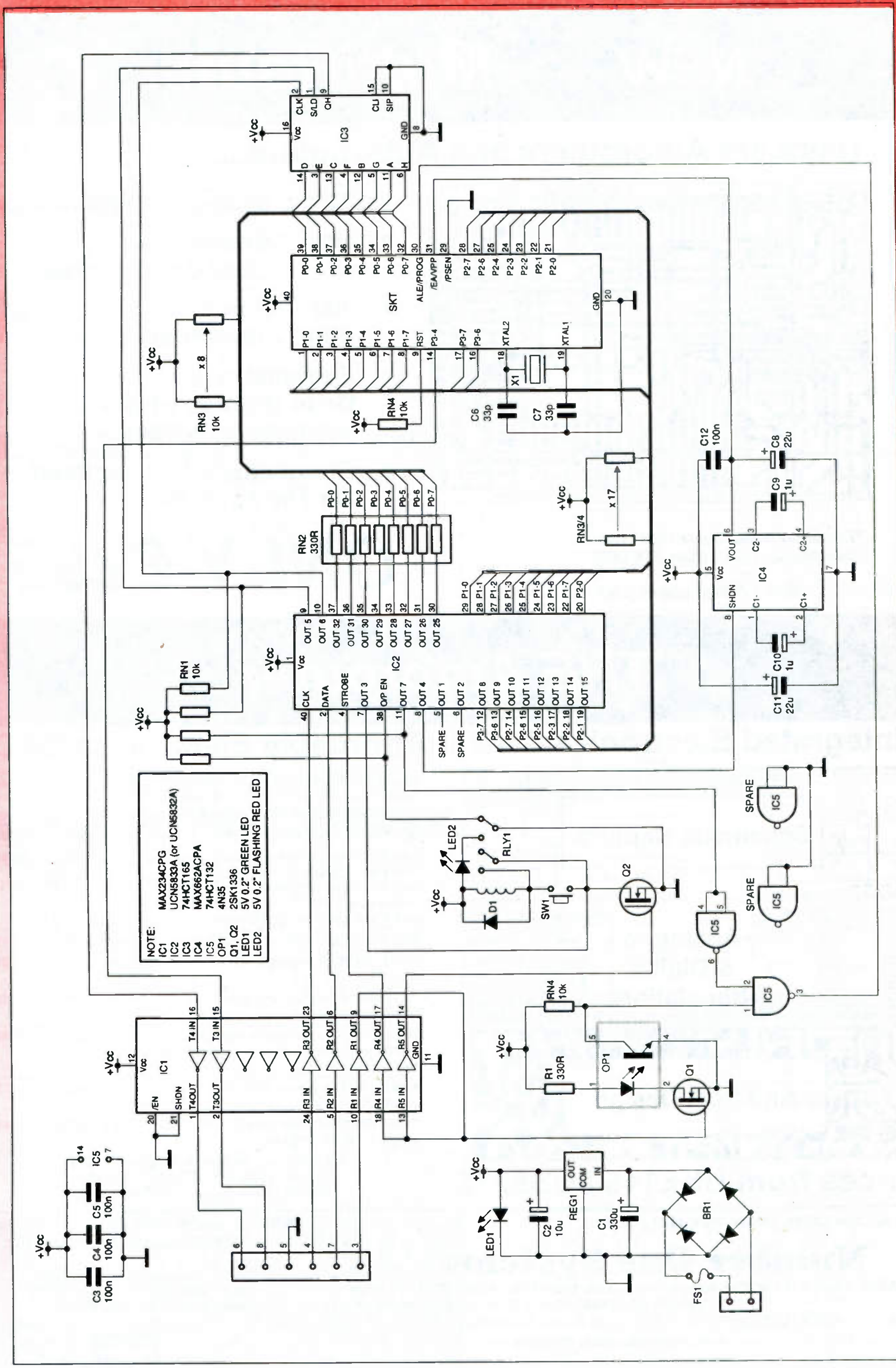
* EXAMPLE OF LOW LEVEL CODE FROM SFMP01.PAS *

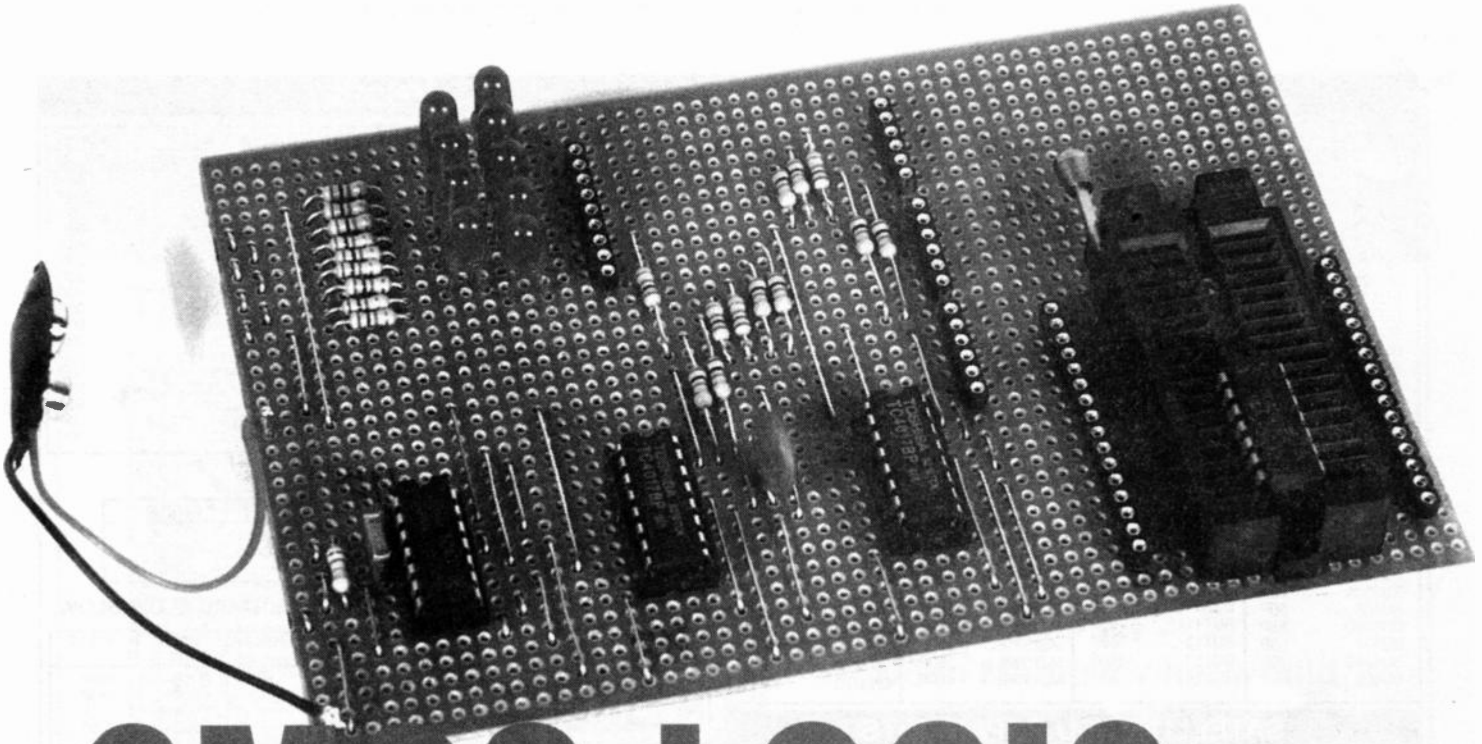
```
Procedure Read_byte(var byte_out: Byte);

Var
  _loop, _byte, bit_val, final_byte:   Byte;
  decrypt_byte:                    Byte;

Begin
  { Make sure ls165 clock and shift are at 0 & 1 respectively. }
  ls165_clock := 0;
  ls165_shift := 1;
  Transmit_all_bits;
  Send_FF_and_wait;

  { Latch data present on 89C5n pins P0.0 - P0.7 into 'LS165. }
  ls165_shift := 0;
  Transmit_all_bits;
  Send_FF_and_wait;
  ls165_shift := 1;
  Transmit_all_bits;
  Send_FF_and_wait;

  For _loop := 1 to 8 do
    Begin
      final_byte := final_byte SHL 1;

      { Read status of 'ls165 output QH; it will be inverted. }
      _byte := Read_DSR_CTS_lines(port_no);
      bit_val := (_byte AND $20) SHR 5;
      final_byte := (final_byte OR bit_val);
      ls165_clock := 1;
      Transmit_all_bits;
      Send_FF_and_wait;

      ls165_clock := 0;
      Transmit_all_bits;
      Send_FF_and_wait;
    End;

  { Now complement and decrypt the data. }
  decrypt_byte := NOT final_byte;

  ASM
    MOV AL, 0;
    MOV final_byte, AL;
    MOV AX, 0;

    @bit_a: MOV AL, decrypt_byte;
            AND AX, 1;
            JZ  @bit_b
            ADD final_byte, 64;
    @bit_b: MOV AL, decrypt_byte;
            AND AX, 2;
            JZ  @bit_c;
            ADD final_byte, 16;
    @bit_c: MOV AL, decrypt_byte;
            AND AX, 4;
            JZ  @bit_d;
            ADD final_byte, 4;
    @bit_d: MOV AL, decrypt_byte;
            AND AX, 8;
            JZ  @bit_e;
            ADD final_byte, 1;
    @bit_e: MOV AL, decrypt_byte;
            AND AX, 16;
            JZ  @bit_f;
            ADD final_byte, 2;
    @bit_f: MOV AL, decrypt_byte;
            AND AX, 32;
            JZ  @bit_g;
            ADD final_byte, 8;
    @bit_g: MOV AL, decrypt_byte;
            AND AX, 64;
            JZ  @bit_h;
            ADD final_byte, 32;
    @bit_h: MOV AL, decrypt_byte;
            AND AX, 128;
            JZ  @all_d;
            ADD final_byte, 128;
    @all_d:
  End; { ASM }

  byte_out := final_byte;
End; { Read_byte }
```

* EXAMPLE OF HIGH LEVEL CODE FROM SFMP01.PAS *

```
Procedure Option_3_processing;

Var
  tot_bytes:                              Word;
  over_range:                             Boolean;
  str_04:                                 String[4];

Begin
  Display_message('blank', message_g);
  If chip_type = unknown_str_c then
    Begin
      Display_message('00012', message_g);
      Exit;
    End;

  If NOT Vpp_selected(vpp_mode_g) then
    Begin
      Display_message('00014', message_g);
      Exit;
    End;

  Blank_chip_addr_data_display;
  Blank_PC_addr_data_display;
  Blank_PC_file_name;

  Open_dialogue_window(callers_colours);
  Write('Enter the file type - (');
  TextColor(Red); Write('B');
  TextColor(Black); Write(')inary or (');
  TextColor(Red); Write('H');
  TextColor(Black); Write(')ex.');
  TextColor(Black);
  Write('). Press any other key to quit ..');

  res_ponse := Upper_case(Keyboard_char);
  If NOT (res_ponse[1] IN ['B','H']) then
    Begin
      Close_dialogue_window(callers_colours);
      Exit;
    End;

  { At this point only 'B' or 'H' has been entered. }
  If res_ponse[1] = 'B' then
    f_type_g := 'BN'
  Else
    f_type_g := 'HX';

  ClrScr;
  Write('Enter file name .. ');
  Get_disc_file_name(f_key_pressed_g, f_val_g, f_path_g);

  { Abort - if the esc key has been pressed or nothing entered. }
  If (f_key_pressed_g AND (f_val_g=esc_key_c)) OR (Length(f_path_g)=0) t
    Begin
      Close_dialogue_window(callers_colours);
      Exit;
    End;

  { See if the file name entered is reserved or invalid. }
  If Reserved_file_name(f_path_g, f_full_path_g, f_dir_g, f_name_g,
                        f_ext_g) then
    Begin
```

```
      Close_dialogue_window(callers_colours);
      Display_message('00016', message_g);
      Exit;
    End;

  { If the file doesn't already exist - abort. }
  If NOT File_exists(f_path_g) then
    Begin
      Close_dialogue_window(callers_colours);
      Display_message('00030', message_g);
      Exit;
    End;

  { Now try and open the file. }
  Assign(f_dsk_file_g, f_path_g);
  If File_opened_for_reset(f_dsk_file_g) = FALSE then
    Begin
      Close_dialogue_window(callers_colours);
      Display_message('00016', message_g);
      Exit;
    End;

  { Determine chip type. Cannot be unknown at this stage i.e. '51 or '52'. }
  If chip_type = str_89C51_c then
    tot_bytes := bytes_89C51_c
  Else
    tot_bytes := bytes_89C52_c;

  ClrScr;
  User_latch_and_test_89C5n(unit_ok);
  Close_dialogue_window(callers_colours);
  If NOT unit_ok then
    Begin
      Display_message('00010', message_g);
      Exit;
    End;

  Display_PC_file_name(f_name_g, f_ext_g, f_type_g);
  If f_type_g = 'BN' then
    Read_bin_file_and_prog(f_dsk_file_g,vpp_mode_g,over_range,tot_bytes-1)
  Else
    Read_hex_file_and_prog(f_dsk_file_g,vpp_mode_g,over_range,tot_bytes-1);

  Close_file(f_dsk_file_g);
  Set_all_lines_high;
  Clear_animation_display;
  Blank_chip_addr_data_display;

  If over_range then
    Begin
      Str(tot_bytes:4, str_04);
      If f_type_g = 'BN' then
        message_g := ' Binary file has more than ' + str_04 + ' bytes.' +
                     ' Only ' + str_04 + ' bytes were written to ' +
                     chip_type + '.'
      Else
        message_g := ' Address in Hex file => ' + str_04 + '. Only ' +
                     'bytes for addresses < ' + str_04 + ' written to ' +
                     chip_type + '.';
      Display_message('extrn', message_g);
    End;
End; { Option_3_processing }
```


NOTE:
IC1 MAX234CPG
IC2 UCN5833A (or UCN5832A)
IC3 74HCT165
IC4 MAX662ACPA
IC5 74HCT132
OP1 4N35
Q1, Q2 2SK1336
LED1 5V 0.2" GREEN LED
LED2 5V 0.2" FLASHING RED LED



CMOS LOGIC IC TESTER

A useful piece of test equipment from Robert Penfold

Testing resistors, capacitors, etc. is relatively straightforward, as is testing the more simple semiconductors such as transistors and diodes. Integrated circuits are a very different proposition, and their diversity makes it difficult to test them using any form of "universal" tester. The normal approach is to test for faults elsewhere in the relevant stage or stages of a circuit, and if no problems can be found, the integrated circuit is assumed to be faulty and is replaced.

Ins And Outs

Logic integrated circuits lend themselves to the "universal" tester approach somewhat better than linear types, as they all have something in common. They take in a set of logic levels, and produce a certain output level or set of output levels. Some devices are a bit more sophisticated than this, and provide some form of counting action, but the basic situation remains much the same, with simple logic input levels producing a certain set of output levels.

A "universal" logic IC tester can therefore be quite simple, and in its most basic form can consist of nothing more than some outputs at the relevant logic 1 and logic 0 levels, plus some indicator LEDs to permit output states to be checked. It is helpful if a low frequency clock signal is included, as this facilitates testing of various counting devices. The low frequency signal is applied to the clock input of the counter, and the LEDs are used to check that the outputs cycle through the appropriate sets of output levels.

This CMOS tester can be used to test practically any 4000 series CMOS device, plus 74HC** and 74HCT** integrated circuits. The only obvious exceptions are the CMOS analogue switches, such as the 4016BE and 4066BE. These devices are as much linear as logic in nature, and as such can only be tested using a test setup specifically designed for the purpose. The tester has six outputs at logic 0, six outputs at logic 1, and eight LEDs for monitoring outputs. These LEDs are connected between the outputs and the 0 volt supply rail, and are therefore switched on by an output which is high, or switched off by an output that is low. There is a ninth LED which can be connected between an output of the test device and the +6 volt supply rail. This LED is switched on if the monitored output is low, or off if it is high. The reason for including this LED is that CMOS logic devices sometimes fail due to one of the output transistors

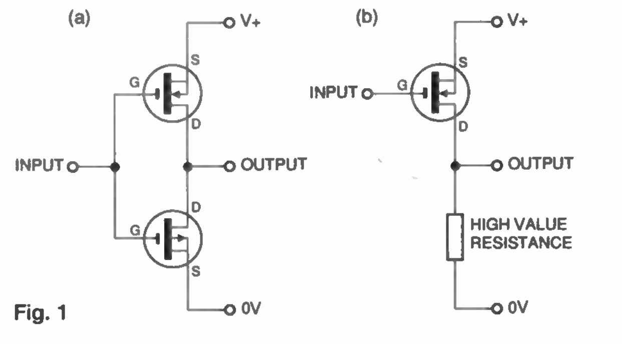


Fig. 1

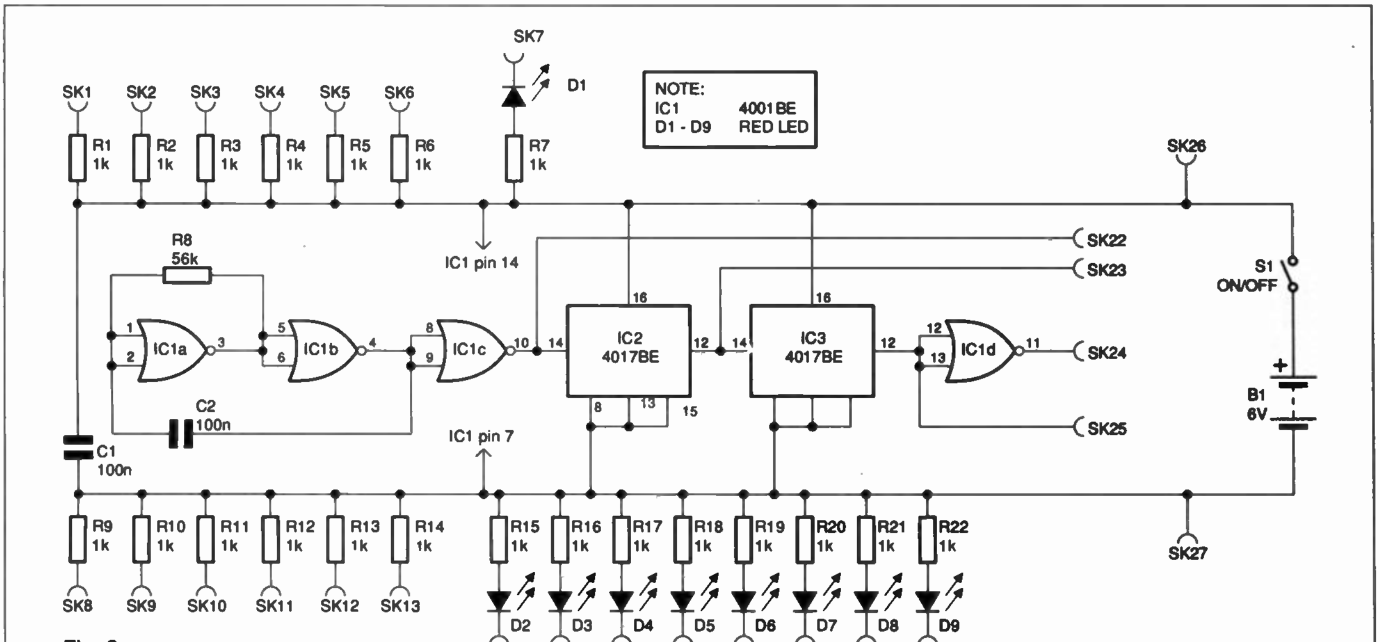


Fig. 2

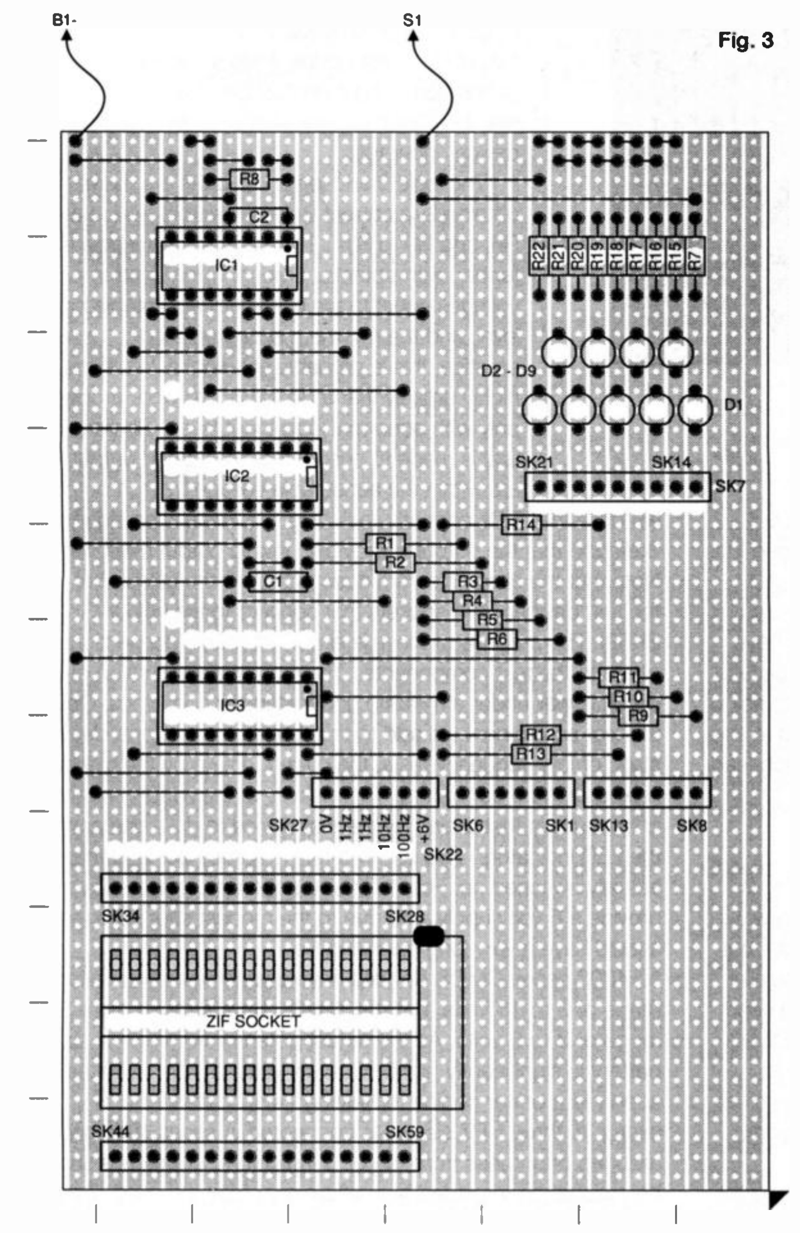


Fig. 3

becoming damaged, and acting as a very high value load resistor. Fig.1(a) shows the complementary arrangement used in a standard CMOS output stage, and Fig.1(b) shows the effective circuit if the N channel output transistor is damaged in this way.

When used in static tests, or tests at very low frequencies, the circuit can appear to work well, with the LED being driven properly by the P channel output transistor. However, when the test device is used in a "real" circuit it fails, as the very low current through the output stage (plus the input capacitance of the subsequent stage) gives an inadequate switching speed. With an enigmatic device of this type it is a good idea to test its outputs using the ninth LED. If an N channel output transistor is faulty it will not be able to drive the LED, and the problem will be revealed. In addition to the twelve static outputs the tester also has anti-phase outputs at a frequency of one hertz. This low frequency enables the action of counter chips to be easily monitored via the LEDs. There are additional (single phase) outputs at frequencies of 10 hertz and 100 hertz. These are useful when testing long binary divider chips, where the one hertz clock signal could give a final output frequency of one cycle every 15 minutes or more! The higher clock frequencies enable these chips to be operated at a speed that gives a more satisfactory final output frequency. This tester has sufficient inputs and outputs to check virtually any CMOS logic device, but there is a slight problem in that each device requires a different test procedure. With hundreds of CMOS logic chips currently available, this means that hundreds of different test procedures are needed in order to accommodate them all. Due to space limitations, it is not practical to provide more than a few test procedures for the most popular devices in this article. Therefore, in order to use this tester properly you need to have a reasonable

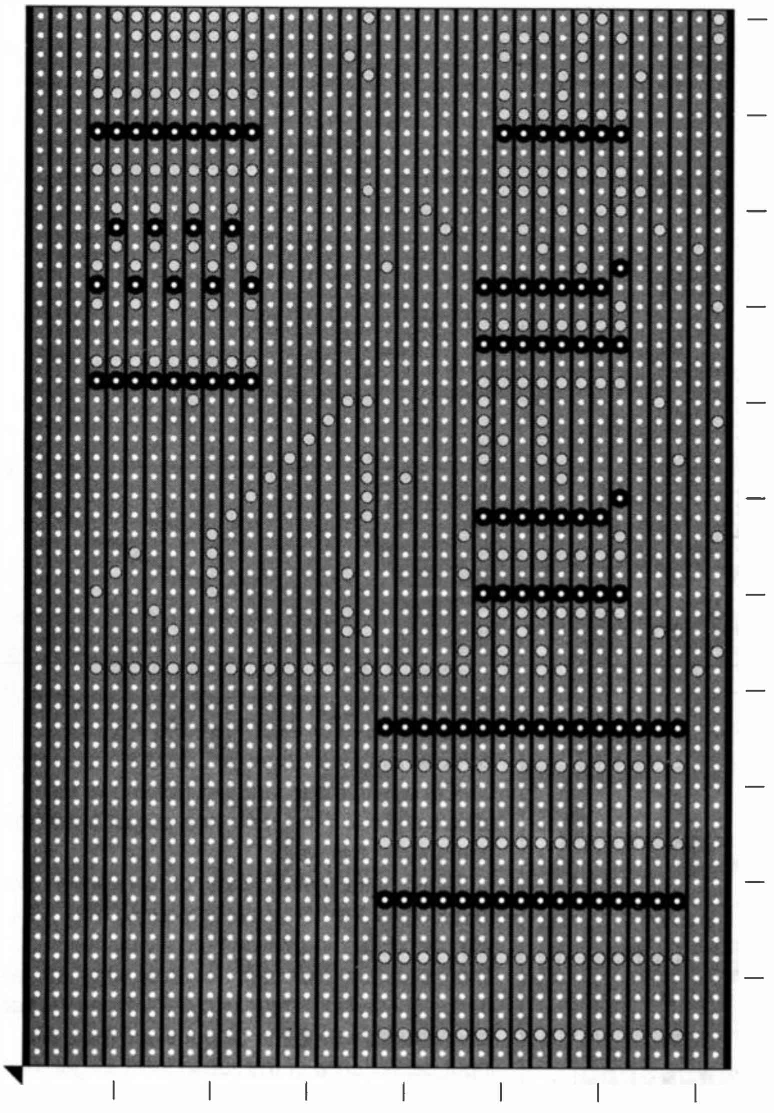


Fig. 4

decoders, but a conventional divide by ten output is also available at pin 12 of each device. In this case the one-of-ten decoders are not of any interest, and it is only the divided by ten signals that are of interest. IC2 and IC3 are connected in series and used to process the 100 hertz signal. This generates the additional output signals at 10 hertz and one hertz. The 4017BE has a"reset" input at pin 15, and an "inhibit" input at pin 13. Neither of these inputs serve any useful purpose in this application, so these pins are simply wired to the 0 volt supply rail so that both counters operate continuously. The "spare" gate in IC1 is used to generate the anti-phase one hertz output. Note that the divider action produces 10 hertz and one hertz test signals that have a very accurate one-to-one mark-space ratio, even though the input signal does not. D9 is the LED indicator that is referenced to the +6volt supply rail, and R7 is its current limiting resistor. D2to D9 are the normal LED indicators, and they have current limiting provided by R15 to R22. The logic 0 and logic 1 levels could simply be provided by direct connections to the 0 volt and +6 volt rails respectively. This would not be a very good way of doing things in practice, as there is a real risk of an output on a test device being inadvertently connected to an output of the tester. This could result in a high current flow, and damage to the device under test.

The logic 0 and logic 1 outputs are therefore obtained via current limiting resistors, which are R1to R6, and R9 to R14. Things could be taken a stage further, with potential dividers being used to provide voltages equal to the maximum acceptable logic 0 level, and the minimum acceptable logic 1 level. In practice, this is probably not worthwhile, since it is highly unlikely that a device would work properly, but only with abnormal logic input levels. Similarly, no test is made to ensure that the loaded output levels are within the acceptable voltage limits. If outputs will drive the LEDs correctly (including D1), there is no significant likelihood that the output is providing invalid output potentials. Note that the circuit diagram does not show the holder that takes the test devices, and sockets that connect to the holder (SK28 to SK59). The purpose of these is simply to enable connections to be made to the test components. The current consumption of the circuit is well under a milliamp under standby conditions. Obviously the test component will add to this, but as the unit provides only static or low frequency tests, the current drawn by the test device itself should be quite small. The majority of the supply current in normal use is that drawn by the test device to drive one or more of the LED indicators. This is only a few milliamps per LED that is actually switched on. Four HP7 size batteries connected in series provide a 6 volt supply, and due to the modest supply current they should have a very long operating life.

4000 series CMOS devices have a wide operating voltage range of 3 to 18 volts, but the 74HC** have a much more limited range of 2 to 6 volts. As the actual potential from a new six volt battery is significantly higher than six volts, a 4.5 volt battery supply is a better choice for testing 74HC** devices. For example, three HP7 size cells connected in series. This gives reduced brightness from the LED indicators, but results should be satisfactory provided high efficiency LEDs are used. 74HCT** series devices are more problematic as they have an operating

knowledge of CMOS logic devices, so that you can work out your own simple test procedures. The test device is plugged into a special ZIF (zero insertion force) socket that will accept d.i.l. integrated circuits having up to 28 pins. This includes devices having 0.6 inch row spacing and the smaller types which have 0.3 inch row spacing. The ZIF socket enables integrated circuits to be easily fitted to the tester and removed again, with no risk of physical damage occurring. The test devices are wired up to the inputs and outputs of the tester using the socket and patch lead method.

The Circuit

The circuit diagram for the CMOS IC tester appears in Fig.2. The main circuit uses IC1 to IC3 to generate the four squarewave test signals. IC1 is a CMOS 4001BE quad 2 input NOR gate, but in this circuit all four gates have their inputs connected in parallel so that they operate as simple inverters. IC1a and IC1b are used in a conventional CMOS astable(oscillator) circuit. R8 and C2 are the timing components, and they set the output frequency at approximately 100 hertz. IC1c simply acts as a buffer which gives a slightly better output waveform. The output is roughly square, but due to a slight lack of symmetry in the switching characteristics of the inverters, the mark-space ratio is unlikely to be exactly one-to-one. IC2 and IC3 are 4017BE one of ten voltage range of just 4.5 to 5.5 volts. A reasonably fresh 4.5 volt battery will provide an actual output voltage of about 4.5 to 5 volts and should give satisfactory results. Alternatively, the unit could be powered from a bench power supply set for an output potential of 5 volts.

Construction

The tester is built on a piece of 0.1 inch matrix stripboard which measures 55 holes by 36 copper strips. Fig.3 shows the component layout, and Fig.4 shows the underside view of the board, including the numerous breaks in the copper strips. Construction of the board follows along normal lines, but there are a fair number of components and link-wires to contend with, so a little more care than usual is required. Note that all three integrated circuits are CMOS types, and that they require the normal anti-static handling precautions. In particular, they should be fitted in holders, but should not be fitted to the board until the board is otherwise finished. For one reason or another, several of the components are worthy of further comment. The ZIF socket must be a "universal" type intended for devices which have the rows of pins 0.3 inch or 0.6 inches apart. An ordinary 28 pin ZIF socket will only accept components that have 0.6 inch row spacing, and is not suitable for use in this tester. The prototype is fitted with a Maplin "Universal Test Socket", which is actually a 32 pin type. I do not know of any CMOS logic integrated circuits that have 30 or 32 pins, but the extra pins on the socket obviously do no harm, and the board layout has been designed to accommodate them.

The RS/Electromail 28 way universal ZIF socket should also be suitable for use in this project.

The nine LEDs have 0.2 inch (5.08 millimetre) spacing on the board, and in theory 5 millimetre diameter LEDs should fit into this layout without difficulty. In practice it might be something of a tight squeeze, since many LEDs have a ridge around the rear of the casing which enables them to clip into certain types of panel clip. This ridge is a little over 5 millimetres in diameter. Of course, there should be no problem if you use 3 millimetre diameter LEDs, or a type intended for "stacking"with 0.2 inch spacing. It is advisable to use some form of high brightness LED, and a type specifically intended for operation at low currents is probably the best choice. Note that D1 has the opposite orientation to the other eight LEDs. The sockets must be a type that enable the required test setup to be quickly "patched" together. I found that the Maplin 2.54 millimetre "Strip Sockets" worked well in conjunction with pieces of 1/0.6 insulated connecting wire. The wire is cut into suitable lengths, and a few millimetres of insulation is removed from each end of every lead. The leads will then plug straight into the sockets without too much difficulty. The sockets are sold in 20 way and 32 way strips, but are easily broken into shorter lengths.

Two 32 way strips of sockets are sufficient to provide all the sockets for this tester. It should be possible to use other sockets which can be used with 2.54millimetre (0.1 inch) spacing, but I have only tried the specified Maplin type.While it is normally advisable to fit projects into cases, this is one exception. Although it would be possible to fit it into a case, it is probably not worth the considerable effort that would be involved. The unit is likely to be easier to use if it is left uncased, but it is advisable to at least fit it with small cabinet feet or to mount it on some form of baseboard. This prevents the leadout wires on the underside of the board from scratching the work surface. If the unit is mounted on a baseboard the latter can be fitted with a front panel to take on/off switch S1, or S1 can be omitted. The battery is thensimply disconnected when the unit is not in use.

Whatever method of construction is adopted it is advisable to store the unit in a plastic bag when it is not in use. This prevents dust from accumulating in the sockets.

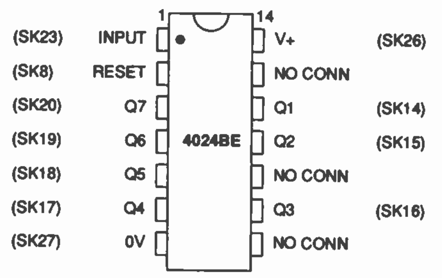


Fig. 5

Testing, Testing

It is advisable to make a few tests on the completed unit to ensure that everything is connected up properly and functioning as it should. Connect SK26 in turn to SK14 to SK21 to ensure that D2 to D9 are functioning correctly. The appropriate LED should light up when a connection is made to each of these sockets. Similarly, D1 should switch on if a connection is made between SK7 and SK27. Check that all the logic 0 outputs are working correctly by linking SK7, in turn, to SK8 to SK13. This should result in D1 lighting up, but at something slightly less than full brightness. The logic 1 outputs can be checked by linking SK14, in sequence, to SK1 to SK6. D2 should light up while each link is present, but again, it should be at something less than full brightness.

Three of the squarewave outputs can be checked by linking SK14, in turn, to SK22 to SK25. D2 should switch on and off at about one hertz with the connection made to either SK24 or SK25, or about 10 hertz with the connection made to SK23. D2 will appear to light continuously with the link made to SK22, as the strobe rate of 100 hertz is too high for a human observer to percieve the flashing. However, if the other three outputs are functioning correctly, it is highly unlikely that there will be a problem with the 100 hertz output signal.

Remember that CMOS logic devices (including 74HC** and 74HCT** types) are static-sensitive. Ideally the unit should be used on an earthed anti-static mat or worktop, and the user should wear a proper earthed wrist-band. As CMOS logic devices are mostly very cheap you might consider that such precautions are not worthwhile, but at the very least the unit should be used well away from any obvious sources of static charges (computer monitors, etc.). Also, try not to handle the pins of the test components. They should drop easily into the ZIF socket with its lever set to the "open" position, with no need for the usual struggle associated with fitting integrated circuits into their holders. Always complete the supply connections to a test device before connecting any of its inputs to the tester.

Open And Shut

Gates are simple to check, and it is just a matter of setting up each of the possible sets of input states, and ensuring that the appropriate output level is produced for each one. With multiple gate packages test the gates one at a time. Truth tables show the correct output for each set of input conditions, and are helpful when checking gates. However, they are far from essential, as gates are so simple in operation. With a NAND gate for example, the output is only low if all the inputs are high. It is therefore a matter of first taking all the inputs high and checking that the output goes low. Then the other sets of input states should be tried, and these should all produce a high output level. With gates that have just two inputs it does not take long to try all four sets of input states. With gates having several inputs it is possible to rationalise things slightly. Suppose that you are testing a four input NOR gate. The output is high if all four inputs are low, but is low for any other set of input levels. The first test would be with the inputs all low, which should obviously give a high output level. The inputs could then be taken high, one at a time, to ensure that each one was capable of setting the output low. This would require five tests to be made rather than the 16 needed if every possible input combination was tried. It is possible that the abridged test procedure would fail to show up a fault in the test component, but it is extremely improbable. The more complex devices do not necessarily require particularly complex test procedures. Fig.5 shows pinout details for the 4024BE seven stage binary counter, together with a suggested test setup. The "Reset" input at pin 2 is tied low so that the device can operate normally, and the clock input at pin1 is fed with the 10 hertz squarewave signal.

With seven stages of binary division the final output frequency is one cycle every twelve seconds or so, and the output from the first divider is at five hertz. This enables the divide by two action of each stage to be checked visually via the LED indicators which are driven from the seven outputs ("Q1" to "Q7"), but avoids an excessively low final output frequency. The "Reset" input can be checked by taking pin 2 high. All seven LEDs should then switch off, with the counting action being disabled.

There are a few awkward CMOS devices which have large numbers of outputs, making it impossible to check them all at once. The 4017BE for example, as used for IC2 and IC3 in this design, has a total of eleven outputs. These are then divided by ten output at pin 12, and the ten outputs of the one-of-ten decoder. The latter go high, in sequence, for one clock cycle. It is not absolutely essential to check all eleven outputs at once.

The 4017BE could be checked by using one led to monitor the main output at pin 12, and another five to monitor outputs "0" to "4". It could then be checked further using basically the same setup, but with outputs "5" to "9" being monitored instead of outputs "0" to "4". The unit should have sufficient inputs and outputs to give a reasonably thorough check of virtually any standard CMOS logic device. It is obviously more than a little helpful if you have a comprehensive data book for CMOS logic devices. Maplin catalogues prior to the 1995/96 issue are also an excellent source of data, giving pinout details and brief descriptions for a wide range of CMOS logic devices.

PARTS LIST

Resistors
(all 0.25 watt 5% carbon film)

R1 to R7, R9 to R22	1k (21 off)
R8	56k

Capacitors

2	100n polyester

Semiconductors

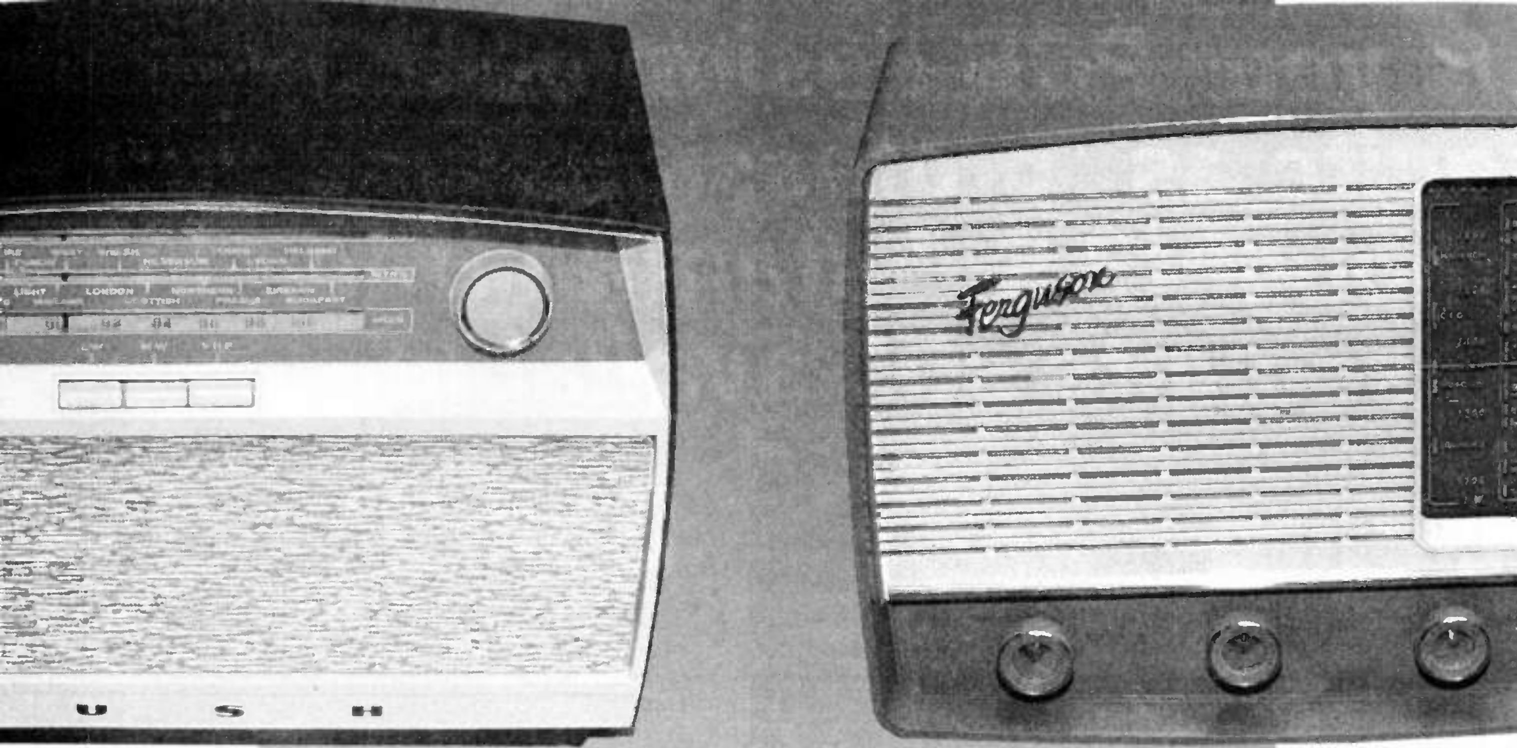
IC1	4001BE
IC2,IC3	4017BE (2 off)
D1 to D9	High brightness LEDs (9 off)

Miscellaneous

SK1 to SK59
2.54mm strip sockets (2 x 32 way strips)

S1	s.p.s.t. min toggle
B1	6 volt (4 HP7 size cells in holder)

32 pin or 28 pin "universal" ZIF socket (see text), 0.1 inch pitch stripboard having 55 holes by 36 strips, battery connector(PP3 type), 1/0.6 insulated connecting wire, solder, etc.



valve radio SERVICING AND RESTORATION

PART 4

Paul Stenning continues his exploration of 'antique electronics'

The usual indications that the set requires realignment on MW and LW are poor reception and interference. The alignment will not normally vary greatly on its own, so if there is no sign that it has been disturbed in the past you should look for other causes of the problem first. In particular check the AGC and IF decoupling capacitors and resistors.

Replacing valves can affect the alignment slightly, but this is normally insufficient to give poor reception unless the replacements are not direct equivalents. If the IF transformers and RF trimmers appear to have been disturbed previously and the performance is below par, it is worth checking the alignment. I strongly suggest that you obtain a copy of the service sheet for the set before attempting any realignment. Unless you have a suitable signal generator, do not disturb any adjustments. Never fiddle with the adjustment, as one can do a great deal of damage to a perfectly aligned set by the over-zealous use of a trimtool.

AM IF alignment

I will use our sample Ekco circuit again for this discussion. The IF circuits must be aligned before the RF circuits.

Switch the set to MW, and set the tuning to a point near the centre of the scale where there is no station. Set the volume to maximum and connect an output level meter (or oscilloscope) to the speaker terminals. A suitable design for an output level meter is shown elsewhere in this issue. If you wish to disconnect the speaker, replace it with a 3R3 wirewound resistor.

Connect the RF output of a signal generator to the control grid of the mixer-oscillator valve via a 0.1uF capacitor. Connect the ground of the signal generator to the receiver chassis via another similar capacitor. Select a low output level, and switch the internal modulation on.

Vary the signal generator frequency around the expected IF (normally 470KHz) until the peak level is indicated on the output meter. If the IF does not need adjustment there should be a clearly defined peak as the signal generator is tuned close to the IF frequency. If the peak is not clearly defined, the IF probably needs adjustment.

Carefully adjust the cores of the IF transformers for maximum reading on the meter. Start with the transformer closest to the detector and work backwards. Reduce the RF level as necessary so that the output level meter reads about half of full scale (if the level is too high the AGC will mask the peaks). If the set has AM and FM bands, take care to only adjust the AM IF transformers.

Always use a proper tool for adjustments - NEVER USE A SCREWDRIVER!

The transformer cores will have been sealed in place with paint or wax. Take great care when attempting to adjust them, as it is very easy to damage the core. If the core has not been disturbed previously and will not move easily it is best to leave it alone.

Dealing with jammed IF cores

It is possible for a core to become jammed at a position away from the correct position, and attempts to free it usually result in further damage. The best hope of obtaining the correct tuning is to insert a second core. Depending on the position of the original core, the additional core should be either ferrite or brass (ferrite will increase the inductance and brass will decrease it). Try inserting the end of a piece of thin brass rod (such as a short piece of studding) to see if it makes the mistuning better or worse. If brass is wrong, a ferrite core salvaged from an old IF transformer will be right. Having established what is needed, fix it in place with some wax (scraped from an old wax coated capacitor) melted with a soldering iron.

AM RF Alignment

Before attempting to align the RF and local oscillator circuits, check the performance of the set. Often realigning the IF is sufficient to resolve reception problems.

The usual indications that the RF circuits need realigning are inaccurate calibration or poor reception towards one end of the scale. If the calibration is out (stations are not at the correct point on the scale), check the pointer is correctly positioned. There will often be dots or marks at one end of the scale, and the pointer should coincide with these when the tuning is set to this extreme. Do not expect great precision in the calibration, particularly on cheaper sets.

RF and oscillator alignment methods vary with different sets, so it is definitely worth obtaining the service sheet rather than guessing. In the absence of any other information, we will align the MW band at 250 metres and 500 metres.

Transfer the signal generator leads to the aerial and earth sockets on the set. If the set does not have these sockets, connect a loop of two or three turns of wire about 150mm (6") in diameter to the signal generator and place it near the internal aerial. Switch the set to MW.

Tune the set to 250 metres and set the signal generator to 1200KHz (1.2MHz). Adjust the trimmer capacitors that are connected in parallel with the tuning capacitor (C5 and C12 in the Ekco) for maximum output.

Now tune the set to 500 metres and set the signal generator to 600KHz. Adjust the cores of any inductors in the MW oscillator and RF circuits for maximum output. In the Ekco, adjust L6. If the set has a ferrite rod aerial, adjust the position of the MW coil.

Repeat these adjustments a couple of times until no improvement can be made. Adjust the RF level from the signal generator as necessary to give a reasonable reading on the output level meter.

The easiest way to align the LW RF circuits is to tune the set to 1508 metres (199KHz), and adjust any settings that are only operative on LW (C14 in Ekco) for the best reception of Radio 4. Also adjust the position of the LW coil on the ferrite rod. Do not attempt to realign SW circuits without the service sheet.

VHF IF alignment

If the VHF IF alignment needs adjustment, the set may give distorted reception and lack sensitivity. If the set has a tuning indicator, the best reception may not occur at maximum indication.

For this discussion we will use the Bush circuit. Connect a volt meter across the ratio discriminator capacitor (C53) to act as a level meter. Switch the set to VHF and disconnect the aerial. The meter should read less than 1V.

Set the signal generator to the expected IF (normally 10.7MHz) and switch the internal modulation OFF. Connect the signal generator between one of the aerial sockets and the chassis via 0.1uF capacitors as previously. Vary the signal generator frequency around the expected IF, and try to find a peak. If the IF adjustment is OK you will find one clearly defined peak.

If not, adjust the cores of the VHF IF transformers for maximum reading on the meter. Start with the transformer closest to the tuner and work forward. The first IF transformer is in the VHF tuner unit. Adjust the RF level as necessary to keep the output meter reading at about 4V.

Before adjusting the final IF transformer you need to establish which core is the secondary. If you have the service sheet you can check this, otherwise you may have to dismantle the transformer to check. The primary of the final IF can be adjusted as previously.

The setting of the final IF secondary affects the performance of the ratio discriminator circuit. The various service sheets describe different methods of doing this, some requiring specialised equipment. I normally ignore these, and use the Bush method which is described here. It requires no specialised equipment and works fine. Connect two 47K 1% resistors in series, across C53. Connect a microammeter between the junction of these resistors and the junction of R23, C51 and C52. With the signal generator connected as previously, adjust the core of the secondary of the final IF transformer for a reading of zero on the microammeter. This will be between a positive and negative peak.

VHF RF alignment

If the VHF RF alignment needs adjusting, the scale calibration will be incorrect (the stations will be in the wrong places). The calibration may vary slightly if the ECC83 valve is changed.

There is normally some adjustment where the VHF tuner links to the main tuning drive mechanism. This should be adjusted to bring the stations back into line. If there is no obvious method of varying the calibration you should obtain the service sheet. Random fiddling could easily make things worse.

The VHF aerial matching transformer (L2/L3 on the Bush) should be adjusted for best reception of a weak station around the centre of the dial. This adjustment often has little effect.

I must emphasise again that it is easy to ruin a perfectly good set by fiddling with the alignment, particularly if the cores become broken or jammed. Unless you are certain that adjustment is necessary, and have the necessary skill and equipment - leave well alone.

Levels of restoration

Before embarking on the restoration of the cabinet and chassis, you should consider carefully what you are trying to achieve. This will vary with different sets, and everybody has their own preferences.

Many restorers do not try to make the set look like new, as this can appear artificial. The normal aim is to restore the set to the condition it would be in if it had been kept on a sideboard since it was new, and lovingly dusted occasionally. Small scratches and chips are signs of general wear and tear, and should generally be accepted as such.

A set's potential value can be decreased dramatically by over-restoring the appearance of the cabinet. Many collectors look for originality and evidence that the set has been used and enjoyed.

Removing all "user marks" such as finger wear marks under the knobs, surface knocks, scratches and dents will make the set look new 1996 and not vintage 1946. These marks are part of the set's history and should be retained whenever possible. More serious damage may reduce the value of the set, and should be repaired sympathetically.

These comments apply more to wooden cabinets, which tend to show their age. Bakelite sets sometimes lend themselves to being restored to a newer appearance. Carefully examine the condition of the various sections, and consider how they will clean up.

For consistency everything must be restored to the same level, otherwise it will look awful. For example, I have a small plastic Philips set with a clear plastic illuminated grill over the speaker. The painted cabinet was in a terrible state, and I had no choice but to strip and repaint it. I used the same light grey colour paint as the original would have been.

When I came to the clear plastic grill I found it had become yellowed, and could not be cleaned. When the set was put back together, the "new" cabinet contrasted badly with the yellowed grill. The only option was to repaint the cabinet with a more appropriate colour.

Cleaning the chassis

Remove the valves, and carefully clean the glass envelopes with a dry tissue (such as kitchen towels). Breathing on the glass - as though you were cleaning spectacles - may help. Take great care not to remove the markings, which are often fairly soft. If the valves are in a filthy state you may need to use a little Isopropyl Alcohol. This is available in small quantities from component suppliers as Tape Head Cleaner, and can be obtained in more sensible quantities from chemists.

Over the years the chassis will accumulate a layer of dust and grime. The aim is to clean this away without damaging the components. Servisol Foam Cleaner is good for this; it should be sprayed onto the tissue and not the chassis.

Toothbrushes or cotton buds are useful for getting into the awkward gaps. It takes time and patience to achieve good results, but it is worth the effort. The foam cleaner can also be used to clean other metal components, such as control shafts, transformer mounting brackets and loudspeaker frames. Take care to avoid getting it on transformer cores, speaker cones and electronic components.

Aluminium RF cans sometimes become ingrained with dirt, which can be difficult to shift. SolvoAutosol paste (available from car accessory shops) is good for cleaning these. Take great care not to let it get inside the cans or under the chassis.

Painting the chassis

If the chassis is badly rusty or corroded, the only option may be to paint over it. Smooth Finish Hammerite is good for this, as it is designed for painting over rust. I would suggest a grey colour, as the more obvious choice of silver looks artificial. You will need to remove any loose rust with a small wire brush or by scraping with a screwdriver.

Printed circuit boards

PCBs are more of a problem to clean, because the cleaning products can cause damage to the components. You can try using foam cleaner, taking care to avoid rubbing the components. Cotton buds are useful for this. Allow it to dry out thoroughly afterwards.

Tuning drive cord

The tuning drive cord often breaks or becomes weakened. Replacement cord is available from component suppliers. Normally the broken cord will retain some of its shape, and this should be carefully noted before disturbing it.

On many sets the drive cord arrangement is fairly simple, but a few can be more complex. If you can't work it out, obtain the service sheet for the set. If you are not thinking clearly it is easy to get the pointer moving in the wrong direction, or the knob working backwards. The pointer should move towards the high waveband (low frequency) end of the scale as the vanes of the tuning capacitor close.

The pointer should move to the right as the knob is turned clockwise, otherwise it is confusing to operate! The tuning pointer can be repainted if necessary. Model paint intended for plastic construction sets (such as Airfix or Humbrol paint) is ideal for this. You may also wish to repaint the plate behind the tuning scale. Car spray paint is ideal for this, and its use is described later. You will need to remove the plate or mask the chassis carefully.

Tuning scale

The printing on the tuning scale glass is usually very soft and can easily be removed if the wrong cleaning product is used. The best approach is not to clean the printed side at all unless it is really necessary and you are sure the printing is sound. Even then you should only use a dry duster or possibly a tissue slightly dampened with water. Be very careful as a replacement tuning scale will be almost impossible to obtain. If the printing is flaking off, it is worth spraying it with a clear lacquer to hold the printing that remains in place. Car accessory shops stock a clear lacquer with the cans of car spray paint, which is intended as the top coat on metallic finishes. This is generally suitable, but try a small amount in a corner first to make sure it does not soften the printing. If some of the printing is missing, and you are reasonably artistic, you may like to repaint it. Remember that you are working backwards, and that the first layer of paint is the one that will be seen. Model paint is ideal, but if you have previously sprayed the glass with car lacquer you should use car touch-up paint. The car paint products and model paints react with each other so use one or the other - never both.

The outside can be cleaned with Auto-Glym car windscreen cleaner or another glass cleaning product that dries to a powder which is then polished off. Make sure this does not get onto the printed side.

Next Month

In the final part of this series we will cover the cleaning and restoration of wooden and bakelite cabinets and trim in some detail.

Suppliers

In earlier parts of this series, we have made reference to Anode Electronics but, due to restricted space, have been unable to publish their details. We are now happy to rectify this. Please write, enclosing a stamped addressed envelope, to: Anode Electronics, 80d Hyde Park Road, Plymouth PL3 4RQ, England.

COMPUTER GAME
HEADPHONE AMPLIFIER

A project by Paul Stenning which brings a little peace and quiet to a games machine owning household

The peace and quiet in our household has recently been shattered by the arrival of a Sega MegaDrive. For anyone who is not actually using the machine, the sound from Sonic the Hedgehog or whatever can soon become very monotonous and annoying. The obvious solution was a pair of headphones, but Sega did not feel it necessary to provide a suitable socket - nor did the manufacturers of our TV set!

There is only one audio/video output connector on the MegaDrive, and this is used for the RF modulator so that the unit can be connected to the TV. Fortunately this is a standard 9 pin mini-DIN connector, and the stereo audio output is on pins 8 and 9. So all we need is a low power stereo amplifier capable of driving a pair of headphones, and some method of allowing this to be connected to the 9 pin socket on the MegaDrive, along with the RF modulator. Since cable mounting mini-DIN sockets are not readily available, I decided to have a flying lead from the amplifier, fitted with a 9 pin plug to connect to the mega-drive. A 9 pin socket is then fitted to the back of the amplifier, for the modulator.

The amplifier itself is mains powered, and the prototype was left powered all the time because the power consumption is minimal. I initially considered powering the amplifier from the DC output on the MegaDrive 9 pin connector, but this is only 5V which is not really adequate, bearing in mind that it would need significant decoupling to get rid of the noise from the digital circuits.

PLEASE NOTE THAT ANY DAMAGE CAUSED BY CONNECTING UNAPPROVED DEVICES TO THE SEGA MEGADRIVE WOULD NOT BE COVERED BY THE GUARANTEE.

This amplifier may also be suitable for other computer games machines, although the audio/video connectors will be different. You will have to work out the necessary connections yourself!

Circuit operation

The complete circuit diagram is shown in figure 1. Only the left amplifier channel is shown, the right channel is identical with component references starting from 101.

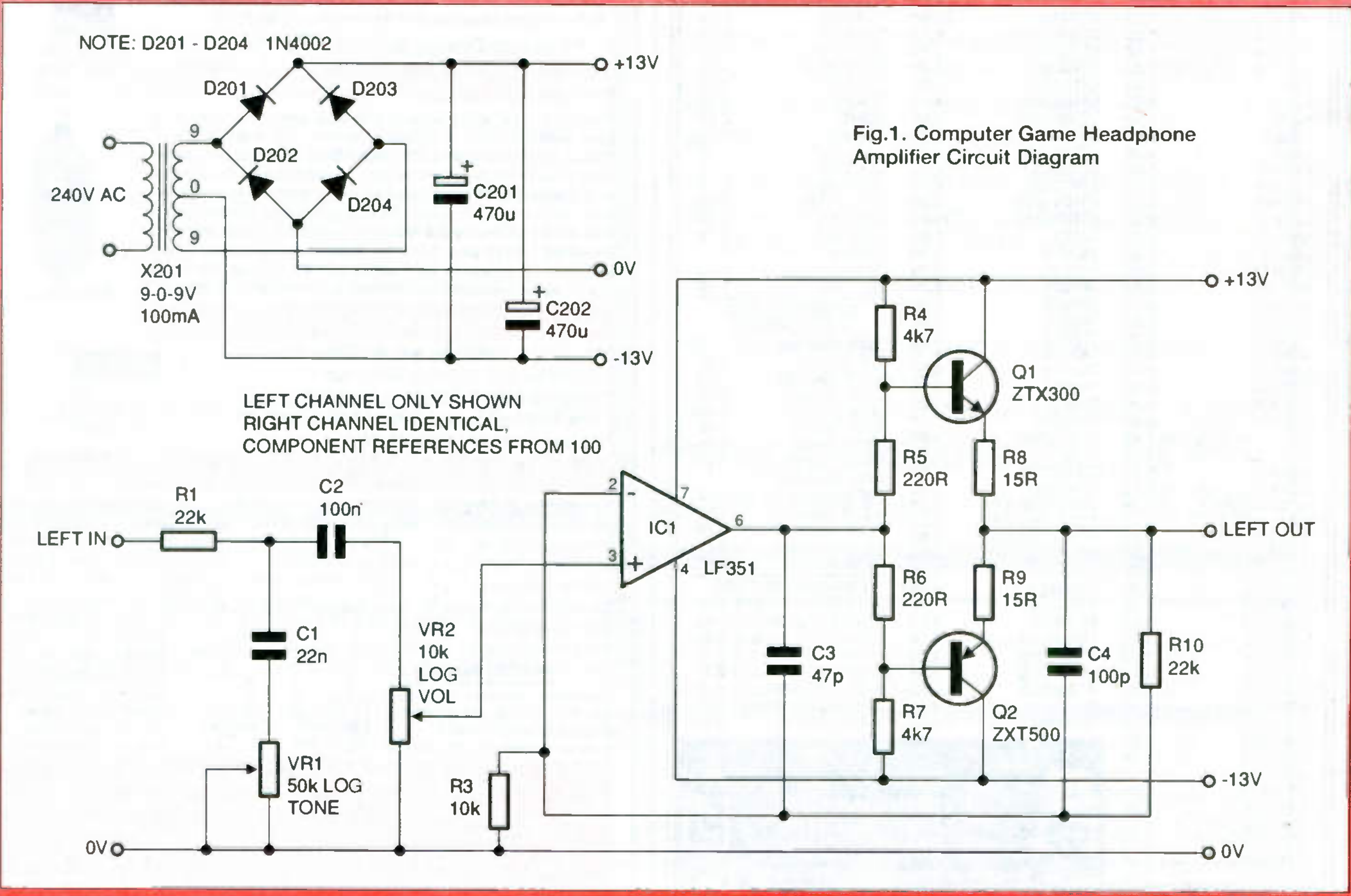


Fig.1. Computer Game Headphone Amplifier Circuit Diagram

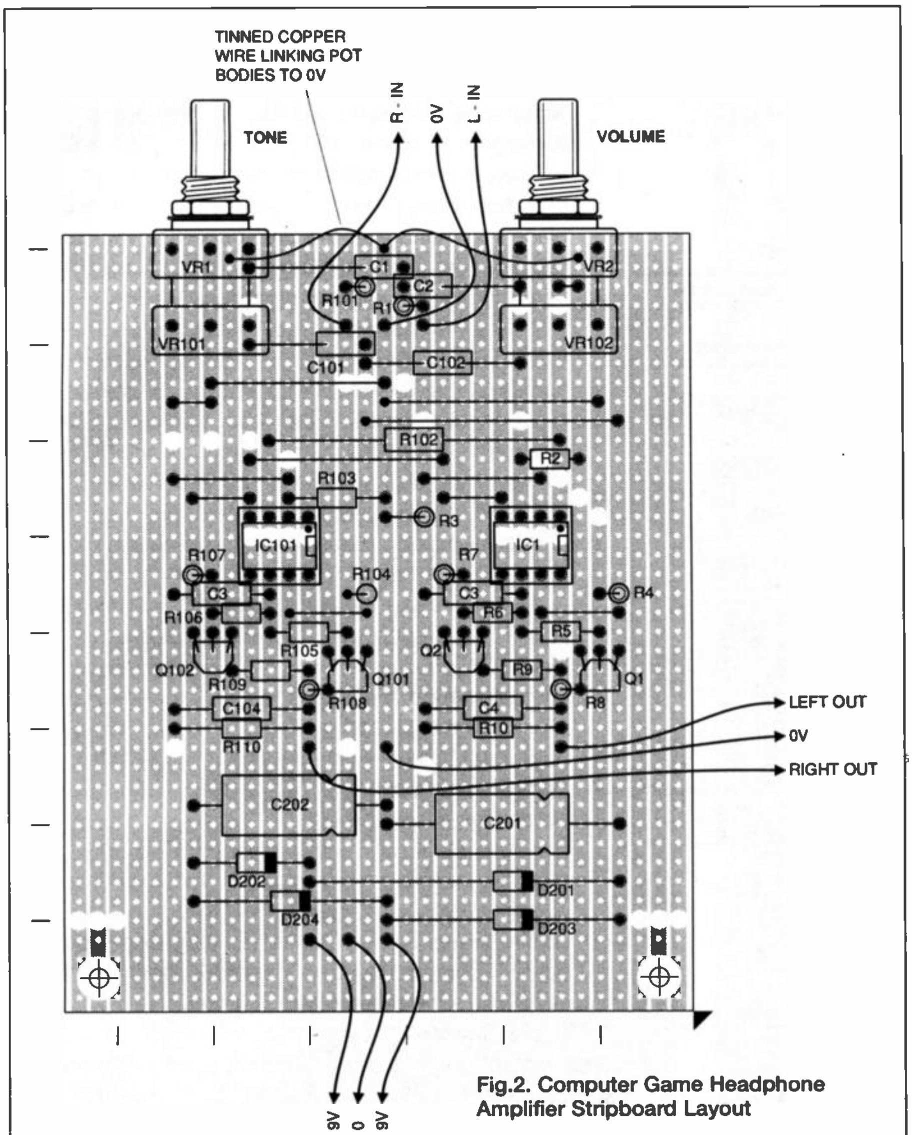


Fig.2. Computer Game Headphone Amplifier Stripboard Layout

Obviously this is insufficient to drive the circuit into clipping, but gives more than adequate volume from the headphones. If you like having your ears blasted you could increase the values of R10 and R110 to 33K or even 47K - but I wouldn't recommend this unless you want to risk damaging your hearing!

The power supply is a conventional full wave split rail arrangement. This is not regulated due to the low current consumption of the amplifier. A 100mA transformer is adequate.

Construction

The circuit is constructed on a piece of stripboard. The layout is shown in figure 2.

Note that a few component leads and links pass underneath the pots, so the pots should be fitted last. Do not forget the 35 track cuts and the 12 wire links. The IC's are static sensitive and should be handled with the usual care. IC sockets may be used if desired, but since the IC's are cheap it is questionable whether sockets are really necessary. Terminal pins should be used for the off-board connections, as these allow the board to be fitted into the case before the wiring is started. The bodies of the two pots should be connected to the 0V rail with tinned copper wire as shown. This may either be soldered to the bodies after filing away a little of the plating, or positioned around the bushes so that it is clamped in place when the nuts are tightened.

Due to the use of mains power, a small metal case is recommended. This should be properly earthed, by means of a solder tag under one of the transformer fixing bolts. It may be convenient to choose a case which fits neatly underneath the Mega-Drive. This would allow the link wire to be kept short.

The circuit board is mounted in the case by the pot nuts and the two fixing nuts. Position this to one side so that the headphone socket can also be fitted on the front panel. A standard 0.25" socket was used on the prototype, but a 3.5mm socket could be used instead if this suits the plug on your headphones. Many new headphones are now fitted with a 3.5mm plug and supplied with an adaptor for use with 0.25" sockets. The rear panel should be fitted with a 9 pin Mini-DIN socket. Maplin stock a range of panel mounting types which are suitable. Two additional holes are needed, for the mains input cable and the Audio/Video cable from the MegaDrive. Both holes must be fitted with suitable grommets and the cables must be adequately supported with strain relief clips. The transformer should be positioned on the base of the case in a position well away from the audio input (Mini-DIN) connector, but close enough to the circuit board that the wires reach.

The interwiring is shown in figure 3. The Mini-DIN connectors are connected together with a length of thin 9 core screened cable. Connect pin 1 to pin 1, pin 2 to pin 2 etc, and use the screen of the cable to link the metal bodies of the connectors. Since this cable carries video signals it should be reasonably short (no more than about 1 metre).

Some of you may be wondering why I didn't use a dual power amplifier IC. The simple answer is that the unit was built using bits from my "junk box" - which contained plenty of op-amps and transistors, but no power amp chips! Two single op-amps were used in preference to one dual device because this simplifies the board layout.

R1, C1 and VR1 form a simple top-cut tone control. I had not originally planned to use any form of tone correction, but the sound through a pair of good quality headphones was found to be slightly fuzzy due to the audio signals being derived by digital methods. The tone control allows this effect to be minimized, although there is an inevitable reduction in the higher frequencies. C2, together with the track of VR2, causes the lower frequencies to be rolled off gently below about 30Hz.

The remainder of the amplifier is a standard non-inverting op-amp circuit with the addition of a class B push-pull output stage. The transistors TR1 and TR2 are held close to the point of conduction by R4 to R7. Cross-over distortion is removed by the use of a considerable amount of negative feedback (R10 and R3). This arrangement works well with a low gain low power amplifier such as this.

C3 and C4 gives additional negative feedback at high frequencies (above the audio range) to ensure stability. R8 and R9 limit the output current to a reasonable level if the output is short circuited. The overall gain of the unit with the volume control at maximum is approximately unity.

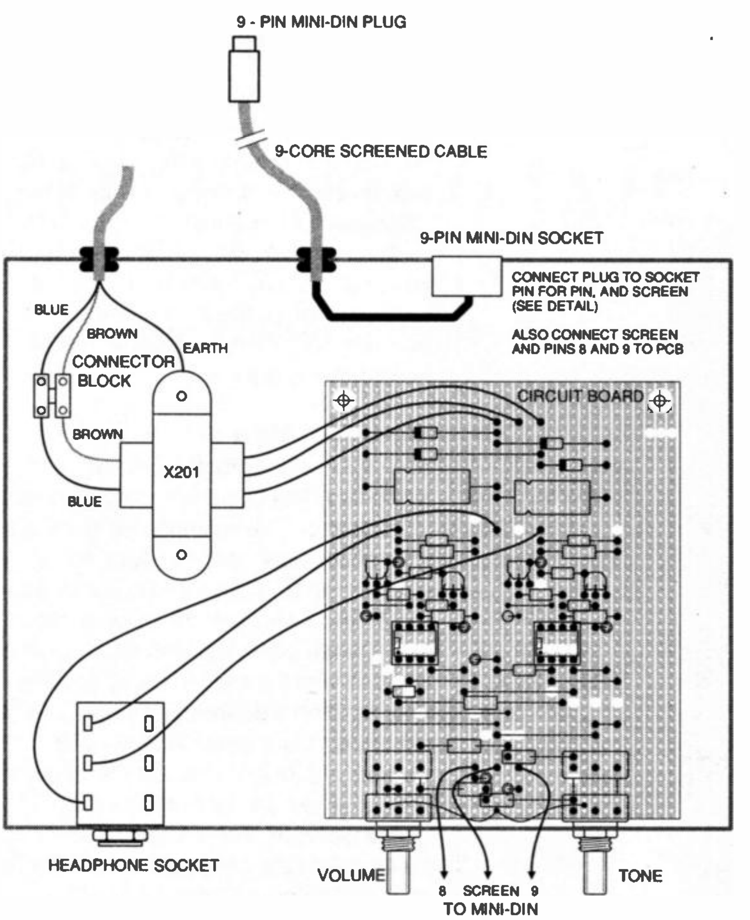


Fig.3. Computer Game Headphone Amplifier Wiring Diagram

The contact layout for the connectors is shown on the wiring diagram. Take care when soldering to the Mini-DIN plug and socket as the pins are close together. Also connect pins 8 and 9, and the screen of the Mini-DIN socket to the terminals indicated on the circuit board with a length of two-core screened cable. The cover of the Mini-DIN plug may need to be cut back a little to allow the plug to fit into the back of the MegaDrive.

Connect the transformer secondary to the circuit board pins as shown. If you are using one of the small types of transformer with flying leads, the secondary wires will be two of one colour and one of another colour (usually black). Connect the single coloured wire to the centre pin on the PCB. The primary leads are connected to the mains lead with a choc-block type connector. The earth lead should be connected to a solder tag fitted under one of the transformer mounting screws. The other end of the mains flex should be fitted with a 13A plug fitted with a 3A fuse.

The headphone socket connections assume the use of a cheap insulated 0.25" headphone socket. If you are using a different type of socket (such as a 3.5mm type) the connections may be different. In this case, the "Left Out" pin goes to the tip of the plug, the "Right Out" goes to the ring and "0V" goes to the sleeve.

Testing

If the unit has been built with care it should work first time without any problems. However it is worth carrying out a few simple voltage checks to ensure all is well before connecting the headphones and MegaDrive.

Due care should be taken when carrying out these tests, as part of the unit is live at mains voltage. This is limited to the choc-block connector which may be covered with insulating tape if desired.

Connect the amplifier to the mains and switch on. After about 20 seconds, switch off again and place your hand over the circuit board. If you can feel any heat this should be investigated and corrected before proceeding further.

Switch the power on again. Set your test meter to the 20V DC range and measure the voltage across C201. This should be around 13V (between 12V and 15V). Measure the voltage across C202, which should be about the same.

Now measure the voltages between the LEFT OUT and 0V terminals and between the RIGHT OUT and 0V terminals. These should both be 0V (between -0.1V and +0.1V).

Next, measure the voltages across R5, R6, R105 and R106. In each case, this should be around 0.6V (between 0.45V and 0.7V). Finally, measure the voltages between L-IN and 0V and between R-IN and 0V. These should both be 0V

Set the Volume and Tone controls fully anti-clockwise, and plug in a pair of headphones. Both earphones should be silent.

Touch the tip of a screwdriver onto the L-IN terminal, and place your finger on the screwdriver blade. Gradually increase the volume - a buzzing sound should be heard in the left earphone. Don't deafen yourself! Now turn the tone control clockwise - the buzzing may become sharper. Repeat this with the right channel.

If you have reached this point without problems, you can be reasonably satisfied that the unit is working OK. The tests may seem excessive for a simple circuit, but it is worth spending a few minutes to avoid the risk of damaging your headphones or even your MegaDrive.

You can now connect the unit to your MegaDrive and give it a functional check. If you cannot get a picture and/or sound from the TV set, switch off and check the wiring to the 9 pin connectors. If the TV works OK but you get no sound from one or both earphones, check the wiring from the circuit board to the 9 pin connector.

In use

There is not much to say about this. The volume should be kept to a reasonable level to avoid the possibility of headaches or even hearing damage. The tone control should initially be set fully clockwise (maximum treble) and may be backed off if necessary.

We have found that the cheaper headphones are perfectly adequate for use with this amplifier. In some respects they may be better than the "CD quality" types since they are less responsive to the highest frequencies and therefore do not emphasize the slight fuzziness caused by the digitising of the sound.

Partially or fully enclosed headphones are an advantage to the rest of the household, as they are not so prone to giving off that irritating tinny sound produced by Walkman earphones.

Also, please take note of the advice given in the instruction manual about the safe use of computer games consoles. In particular, don't sit too close to the TV, don't play in a darkened room, take regular breaks, and stop playing IMMEDIATELY if you feel any ill effects such as dizziness, sickness or headaches. Ideally the games console should be in a communal room in the home such as the lounge, and not in a child's bedroom where he/she can play for hours alone.

I hope this amplifier brings a return to the peace and quiet you enjoyed previously!

Computer games headphone amplifier - use with Super Nintendo

With very slight modifications, the headphone amplifier can be used with a Super Nintendo Entertainment System (SNES).

The SNES has the RF modulator built-in, and has a separate Audio/Video output socket. This simplifies the connections somewhat, since the loop-in arrangement is not needed.

The amplifier is simply connected to the appropriate connections on Audio/Video output socket.

This socket is not a standard type, but a suitable plug can be fabricated.

The connector resembles the edge of a PCB, with six connection tongues on each side. This is recessed in a cut-out that is basically rectangular in shape, but with the corners cut. A locating recess is at the top. This socket is difficult to describe, the general shape is shown in the illustration.

Making a suitable plug

A small piece of 0.1" PCB edge connector can be filed down to fit into the socket. It may be worth buying a large connector, such as a 36-way type, as you will probably need to have two or three goes at it!

Having got it the right shape, solder a length of two core screened cable to the pins shown in the illustration.

There is no obvious method of protecting these connections. I potted the connections in epoxy resin (Araldite), using a mould made from cardboard lined with Sellotape.

This could then be painted black to make it look more professional. The result is a reasonable sized lump that supports the connections, and enables the plug to be gripped when being inserted or removed.

The other end of the cable is connected directly to the appropriate points on the amplifier PCB.

In use

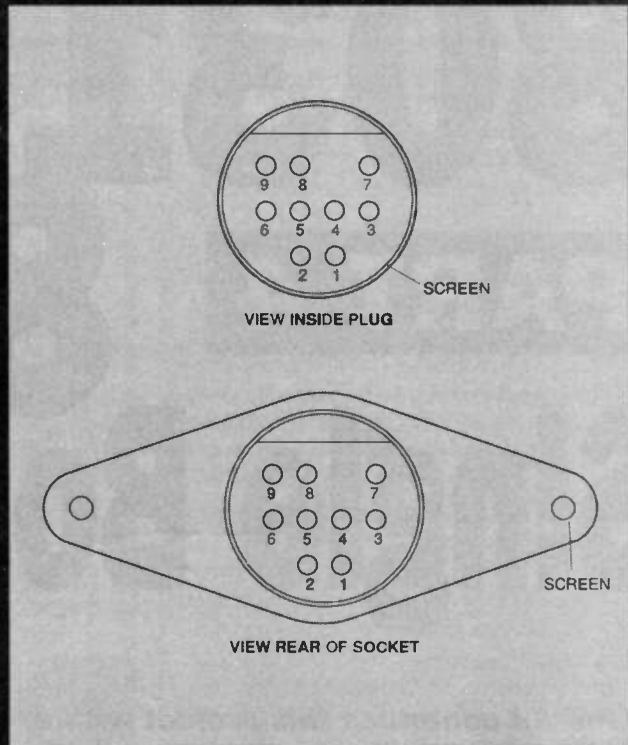
The first thing I noticed when testing the amplifier with the SNES, was that the sound quality is much better than that from the Sega Megadrive.

The digitising noise that was evident on the Sega audio output is completely absent on the SNES. Consequently the Tone control may be left fully clockwise (maximum treble), or even omitted altogether.

It is possible that I may have the Left and Right connections transposed since I do not have the official information from Nintendo.

I have not yet encountered any games where the connections are obviously wrong (or right), but it would be a simple matter to swap the connections at the amplifier end if necessary.

SNES connector plug.



PARTS LIST

Resistors (all 0.25W 5% or better)

R1,10,101,110	22K
R2,3,102,103	10K
R4,7,104,107	4K7
R5,6,105,106	220R
R8,9,108,109	15R
VR1+101	50K Log PCB Mounting Pot (1 off)
VR2+102	10K Log PCB Mounting Pot (1 off)

Capacitors

C1,101	22nF Polyester
C2,102	100nF Polyester
C3,103	47pF Polystyrene
C4,104	100pF Polystyrene
C201,202	470uF 16V Axial Elect

Semiconductors

IC1,101	LF351 Op-Amp
TR1,101	ZTX300 NPN Transistor
TR2,102	ZTX500 PNP Transistor
D201,202,203,204	1N4002 Rectifier Diode

Miscellaneous

9-0-9V 100mA Mains Transformer
0.25" Stereo Jack Socket
9 pin Mini-DIN Plug
9 pin Mini-DIN Socket
Choc-Block Connector
3 Core Mains Flex
Thin 9 Core Screened Cable (1 Metre)
Stripboard
Case
2 Knobs
Hook-Up Wire
Thin 2 Core Screened Cable
Tinned Copper Wire (about 24SWG)
13A Plug with 3A Fuse

8031 & 8035 Single Board Computer

PART 4

Dr Pei An continues this project with a look at the keyboard unit.

This SBC system is able to run under two operation modes. The first one is the keyboard monitor mode which allows users to develop application software in a pc environment. The two modes can be selected by a selector SW1. The keyboard monitor mode is rather useful in that it provides a unique environment for uses to learn MCS-51 instructions and to understand basic operations of the SBC.The on-board battery backup keeps the program data in the RAM after the SBC is switched off. The pc monitor mode is advanced and used for high level software development.

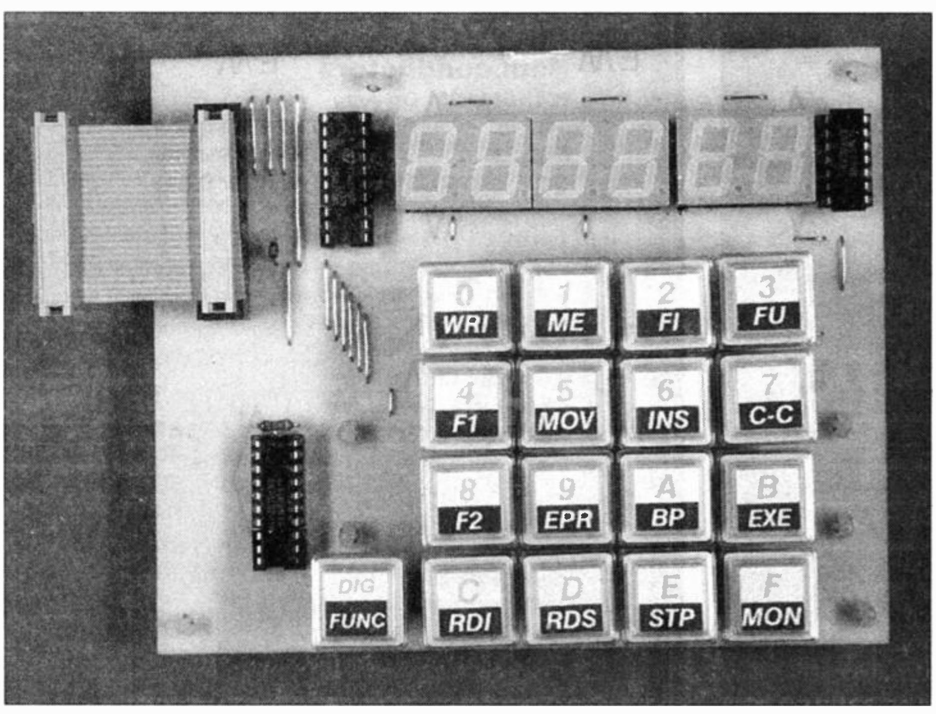
Keyboard monitor of the SBC

To select the keyboard monitor mode, set SW1 on the memory and I/O expansion card to the keyboard mode and switch on the power to the SBC. A message 'IIE-51' will appear on the displays.

The display keyboard

On the display and keyboard, there are 16 multi-function keys arranged in a 4x4 matrix keypad.

There is also a mode selection key, [DIG/FUNC] (see Figures 4 and 5). If the mode selection key is not pressed, the keypad serves as a numerical keypad for inputting digits (0-F). This function is used for inputting address and data. If the mode selection key is pressed, the keypad becomes a control keypad which is used during program editing. The SBC provides a comprehensive set of controls, the details of which will be reviewed later. The six LED displays are divided into two fields: the left-hand 4-digit address field and the right-hand 2-digit data field. In most cases, the address field shows an address and the data field shows the data.

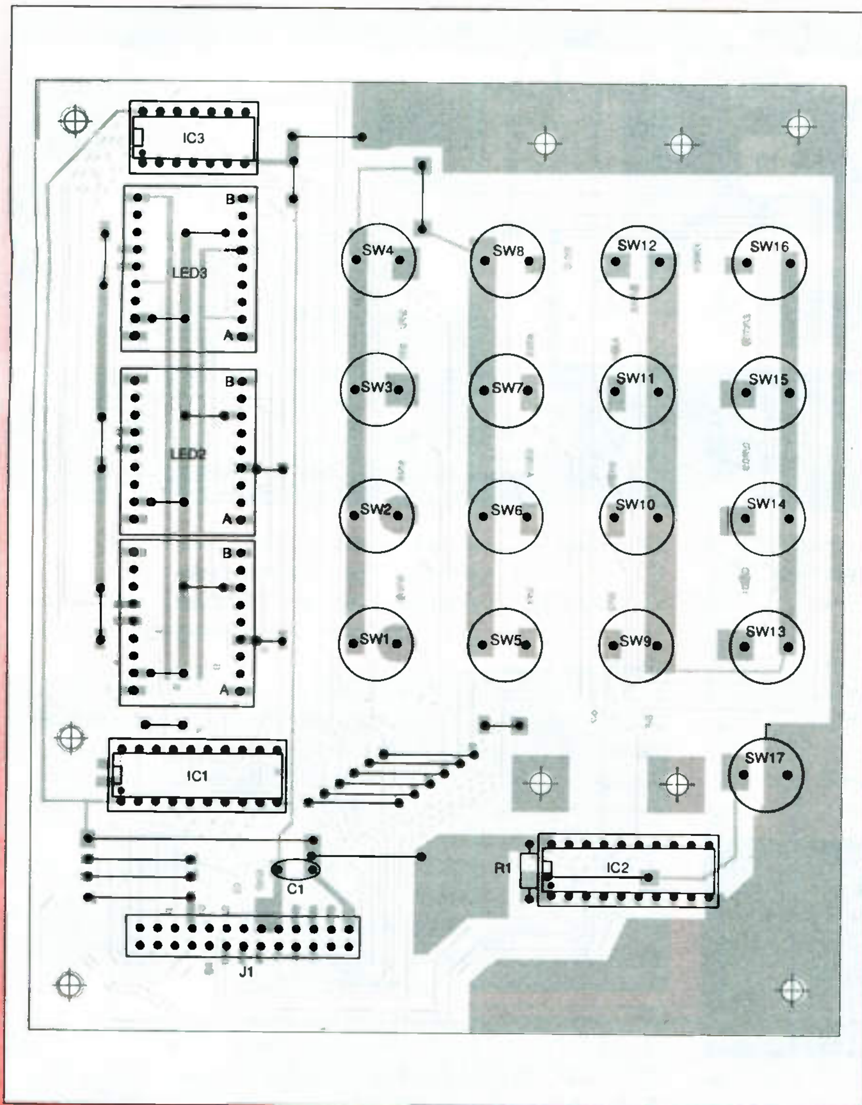


Keyboard monitor

The keyboard monitor provides extensive facilities for program editing.

They include:

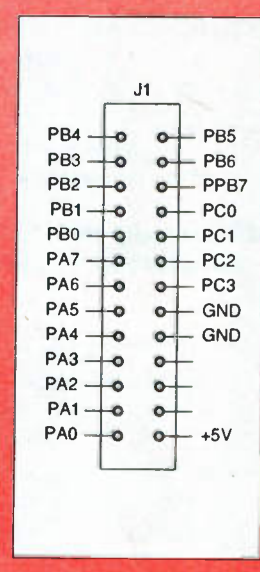
Program editing -Delete a memory block
Input program -Compare two memory blocks
Check program - Fill a block of memory
Check/modify internal RAMs
Check/modify special function registers
Program executing controls
Check/modify R0 - R7 and program counter
- Single-step operation mode
Search a byte or bytes -Non-full speed with breakpoints
Move a memory block from one location to another
Full speed operation with breakpoints
Insert a byte -Continuous operation

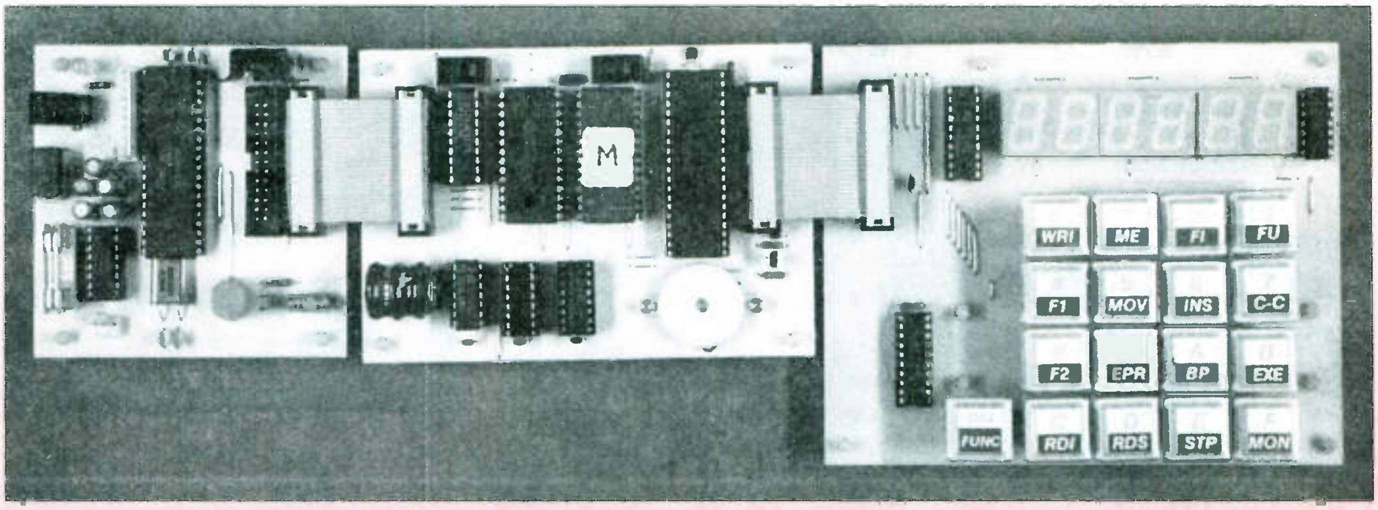


Key functions

[0-F] Digits from 0 to F

[/WRI] Write/address increment. When this function is activated, the computer writes the data displayed in the data field to the memory address displayed in the address field. It also makes the address to increase by one.
[/F1] Flag 1. This is a multi-function key and is used together with other keys. It defines an address which could be the start address of a block to be moved, compared, searched or a breakpoint under interrupt operation mode etc..
[/F2] Flag 2. Again, this is a multi-function key and is used along with other keys. It defines the other address which could be the end address of a block to be moved, compared, searched or a breakpoint under interrupt operation mode etc..
[/RDI] Read and increase address. If the function is activated, data in the address displayed in the address field appears on the displays. A further activation of the key causes the address to increase by 1 and the data in the new memory location is displayed.
[/RDS] Read and decreasing address. Once the SBC is in the RDI mode, the address displayed in the address field will be decreased by 1 and the data stored in the new address location is displayed.
[/MOV] Move a block. After the start and end addresses of a memory block are defined by [/F1] and [/F2] and a new start address is specified, pressing the key moves the data block to a new start address. After the operation, the new start address and the data in that address are displayed.
[/INS] Insert. After the start and end addresses of a memory block are defined by [F1] and [F2] and the inserted data is keyed in, pressing the key moves the data block backwards in the memory by 1 and the new data is moved to the start address. After the operation, the address and the inserted data are displayed.
[/C-C] Memory block comparison. Firstly, the start and end addresses of the first memory block are defined using [F1] and [F2]. It is followed by specifying the start address of the second block The SBC starts to compare the contents in these two blocks. If the contents in the two blocks are different, the comparison stops and the data in the first memory block is displayed. Press the key [WRI] once, the data in the second memory block is displayed. If [/RDS] is pressed, the contents in the first location will be displayed again. If [/RDI] is pressed, the comparison continues.
[/STP] Step and breakpoint. When SW2 on the memory and I/O expansion board is set to the single-step operation mode, the SBC runs the user's program in step-by-step. Activating the function, the SBC executes only one instruction and the address of the next instruction and the first byte of the op-code is displayed. When the SBC returns to the monitor mode, users can modify data in registers of the CPU and external RAM. The user can also modify his own program. By changing the PC value, the system can jump to any locations of the program memory. After keying in the address and value of the breakpoint and pressing [STP], the SBC operates under the breakpoint mode. When a breakpoint is reached, the address and the first byte of the instruction code at the breakpoint are displayed and the SBC returns to the monitoring mode. At this stage, users can check the contents of the associated registers and RAMs. If no breakpoint is found, the display is blank. Pressing a key, the contents of PC and the data stored at this address appear on the displays.It should be noted that under the breakpoint mode, the CPU is not running at full speed. Each time when executing an instruction, the CPU will return to the monitoring mode to check breakpoints.
[/BP] Full-speed BreakPoint operation. With SW2 set to the continuous mode, to input the breakpoint address and then press BP enable the SBC to run at full speed. When a breakpoint is reached, the address and first op-code appear on the display. Again, when the SBC returns to the monitoring mode, the modifications of the contents of registers and RAMs can be made. If no breakpoint is found, the 8031 will only return to the monitoring mode after resetting.
[/EXE] Continuous execute. With SW2 set to continuous mode, pressing [/EXE], the SBC starts to run the program continuously from the input address or the address contained in the PC. The SBC will only return from the user mode to the monitoring mode after resetting.
[/MON] Monitoring mode. Under editing mode, pressing [/MON] returns to the monitoring mode. A '-' appears on LED6. After a single-step breakpoint operation, the key MON should be pressed before inputting another instruction. After continuous breakpoint operation, pressing the reset key and then pressing MON enables the SBC to accept other instructions.





A step-by-step explanation of the keyboard operation is given in the workshop manual which is supplied with the kits and from the author.

PC monitor

Firstly, connect the SBC (J1 on the mother board) to the pc's COM1 interface using the RS232 lead. Then set SW1 (on the memory and I/O expansion board) to 'PC' and switch on the power to the SBC. Finally, run the program 'IIESBC' on the floppy disk provided.
The following message appears on the screen to ask users to select a Baud rate.

```
SELECT BAUD RATE                 (1-8):
BAUD RATE          9600              1
                   4800              2
                   3600              3
                   2400              4
                   1800              5
                   1200              6
                   600               7
                   300               8
```

The Baud rate for the SBC is 1200. Therefore input number 6. Now press the RESET (SW2) button on the motherboard and then press RETURN on the pc's keyboard. The following message appears on the screen:

```
@pr: COMMUNICATION LINK BETWEEN PC AND SBC
     COPYRIGHT 1996 INNOVATIVE INTERFACING ENTERPRISE
     Use ^D to put the screen into file
     Use ^L to send hex file to SBC
     Use ^E to send Intel HEX file to SBC
     Use ^B to replace ^C
     Use ^R to replace ^S
     Use ^O to replace ^P
```

If the RS232 link operates ok, a '*' sign appears on the screen:

The sign '*' is the prompt of monitoring status. If the message and '*' are not shown, press the RESET key on the motherboard again and press RETURN on the computer's keyboard. Following the monitor status, various commands can be typed in. The available commands are summarised in the following table

Summary of commands in the PC monitoring mode

ACC!	Display and edit of ACC
B!	Display and edit of B
BIT n1!	Display and edit bits
C-C n1,n2,n3!	Compare
D!	Display contents in the 8031 RAMs
DA n1,n2!	Display external memory in character format
DC n1,n2!	Display external ROM in hex format
DI n1,n2,n3!	Disassemble
DPTR!	Display and edit DPTR
DX n1,n2!	Display external RAM in hex format
E n1!	Run a program continuously
FI n1,n2,n3!	Initialise a portion of RAM with the same value
G n1, n2! mode	Run a program in the breakpoint operation
L n1 ^E!	Receive a hex file from a computer
M n1,n2,n3!	Move a data block moving in the external memory
PSW!	Display and edit PSW
R!	Display internal status of the Single-board computer
REG n1!	Display and edit the present register
R0!	Display and edit R0
R1!	Display and edit R1
SD n1!	Display and edit the internal RAM of the single board computer
SP!	Display and modify the stack pointer
SX n1!	Edit the external RAM
SX n1, n2! n3 - ni!	Search
T n1!	Operate in single-step mode
T n1, n2!	Operate in multi-step mode

A step-by-step explanation of these functions is given in the workshop manual which is supplied with the kit and is available from the author.

Using keyboard and pc monitor modes

The procedure for running a user program on the SBC consists of four steps.
Step 1. Write program in assembler language
Step 2. Translated the assembler language into machine codes either by hand or using a MCS-51 micro assembler program (such as the MASM51).
Step 3. Input the codes into the SBC. This can be done using either the keyboard or under the control of a pc.
Step 4. Run the program on the SBC. The following is a practical example of how to do this in the keyboard and pc monitor modes. The program in this example makes each bit of Port 1 of the 8031 to generate a square-wave signal. Port 1 is available from the connector J2 on the motherboard. The signal can be observed using a volmeter or a logic probe. The program codes start from 9000H in the memory location. A time delay subroutine is stored from a 9010H. The program in assembler language is listed as follows.

```
ORG   9000H                                ;Define
the start address of the codes
STA1: MOV   P1,#11111111B          ;Move #11111111
(binary) to Port 1
      LCALL TD1                      ;Long call of
the time display subroutine at TD1
      MOV   P1,#00                         ;Move
```

```
#00 to Port 1
      LCALL TD1                  ;Long call of
the time display subroutine at TD1
      LJMP  STA1                         ;Long
jump to STA1
TD1: MOV R6,#11111111B         ;Move #FFH to R6
L1:  MOV R7,#11111111B         ;Move #FFH to R7
L2:  DJNZ R7, L2
;Decrement R7, if not zero, jump to L2
     DJNZ R6, L1
;Decrement R6, if not zero, jump to L1
     RET                                ;Return
END                                     ;End of
program
```

Next, we translate this program into machine codes. This could be done by hand. It can also be done smartly using MCS-51 micro assemblers.

The author prefers the second one! To do so, an ASCII text file is generated using a text editing software package (for example, the DOS editor, edlin, Turbo Pascal editor or Turbo C editor). Let us give a name to this file, 'PROG1.ASC'.

After running the MASM51 macro assembler, three files are generated: 'PROG1.LST', 'PROG1.HEX' and 'PROG1.OBJ'. PROG1.LST contains a list of the original assembler program together with the corresponding machine codes.

```
9000 ORG 9000H
9000 7590FF              STA1: MOV  P1,#11111111B
9003 12900F                    LCALL TD1
9006 759000                    MOV  P1,#00
9009 12900F                    LCALL TD1
900C 029000                    LJMP  STA1

900F 7EFF                TD1:  MOV R6,#11111111B
9011 7FFF                L1:   MOV R7,#11111111B
9013 DFFE                L2:   DJNZ R7, L2
9015 DEFA                      DJNZ R6, L1
9017 22                        RET
0000 END
```

PROG1.HEX contents the translated machine codes in the Intel hex format:

```
:109000007590FF12900F75900012900F0290007EE5
:08901000FF7FFFDFFEDEFA2204
```

Next, the machine code is input into the single board computer. This can be done by hand using the keyboard. It can also be done quickly and easily using the pc monitor mode. The details of these are given in the workshop manual of the SBC. The last stage is to run the program on the SBC. A square waveform should now be observed on pins of port 1 of the microcontroller.

PARTS LIST

Display and keyboard

Capacitors

C1	100nF ceramic disc capacitor

Resistors

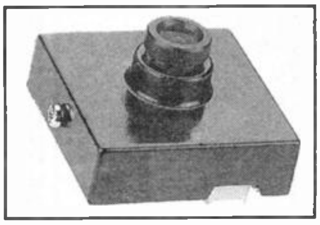
R1	4K

Semiconductors

IC1	74LS245
IC2	74LS241
IC3	7406
LED1,3	2-digit common-cathode 7-segment LED displays

Other

J1	26-way IDC male connector
SW1,17	Key switches
PCB	PCB board of the display and keyboard



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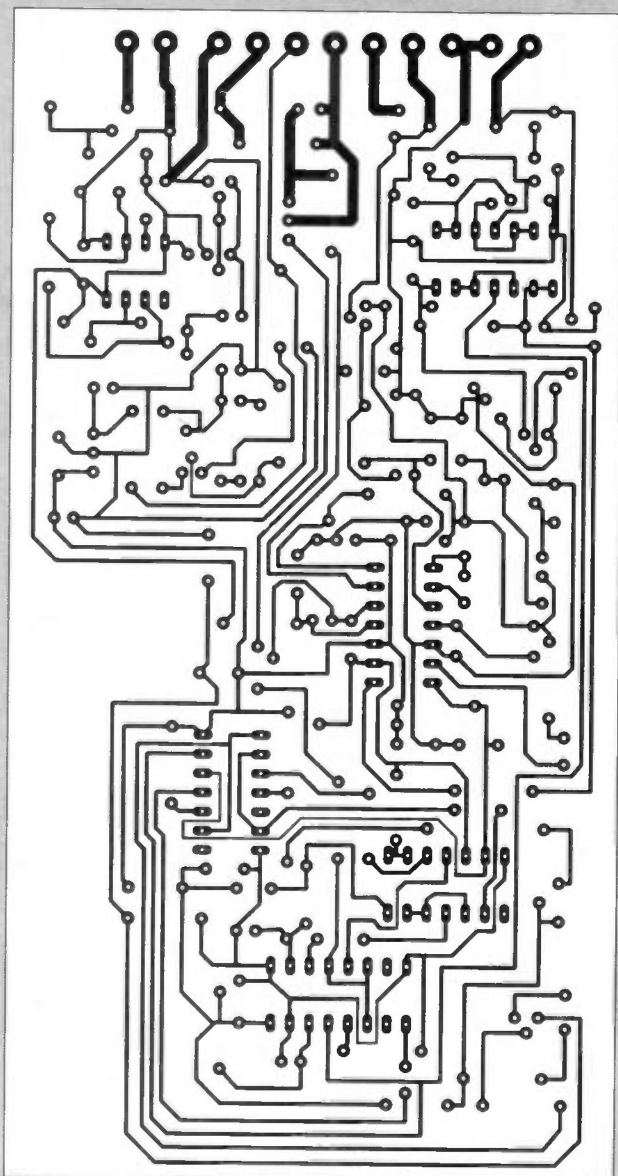

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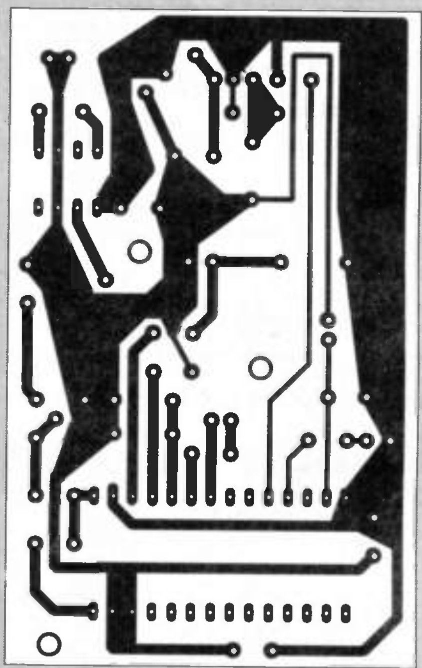

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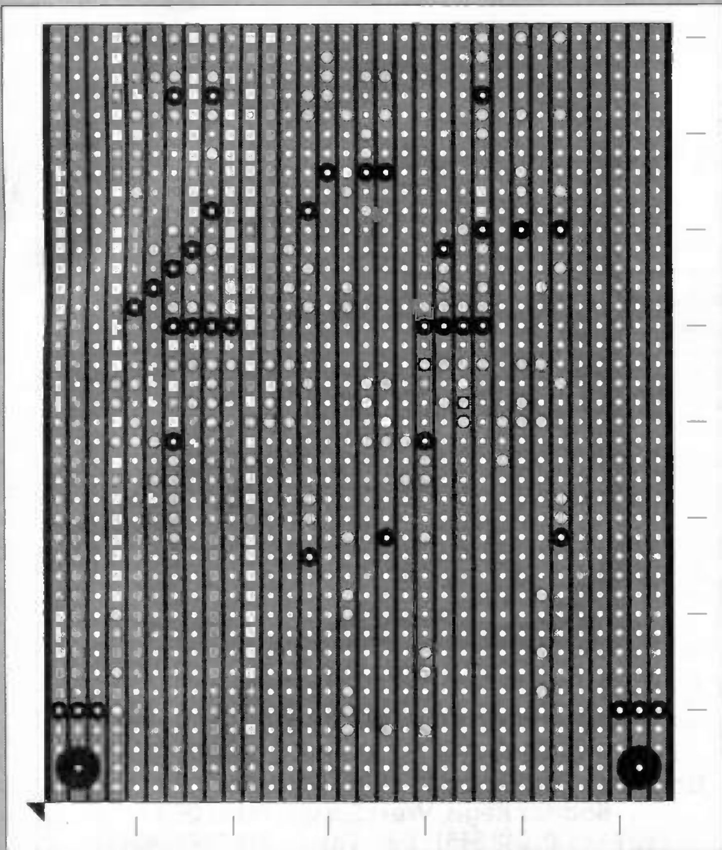
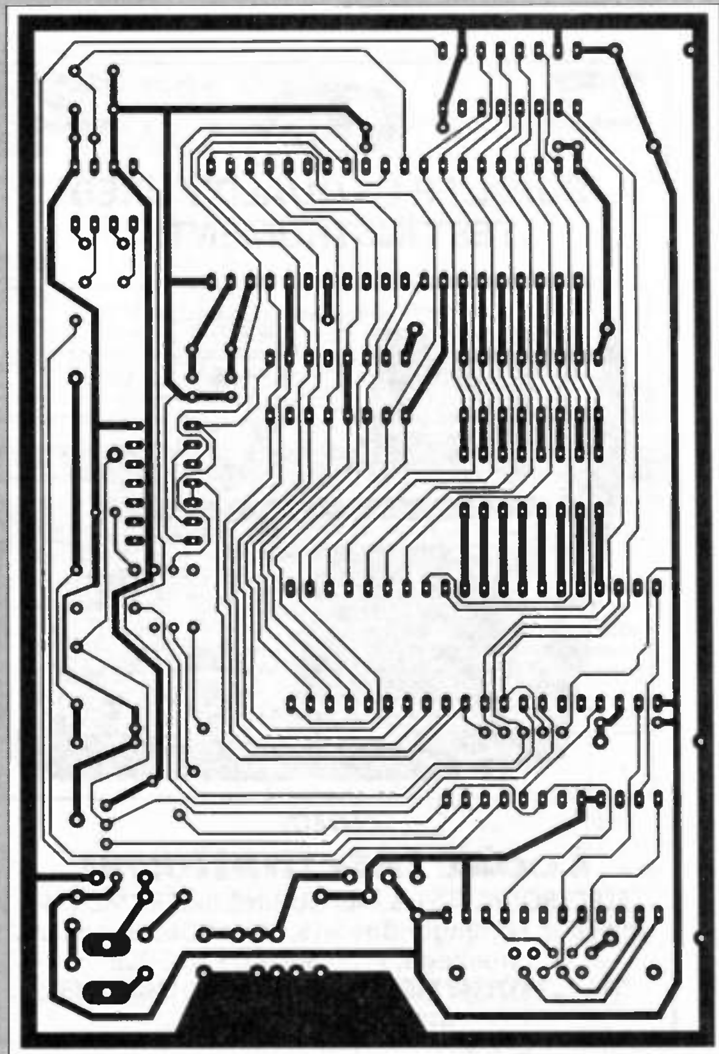
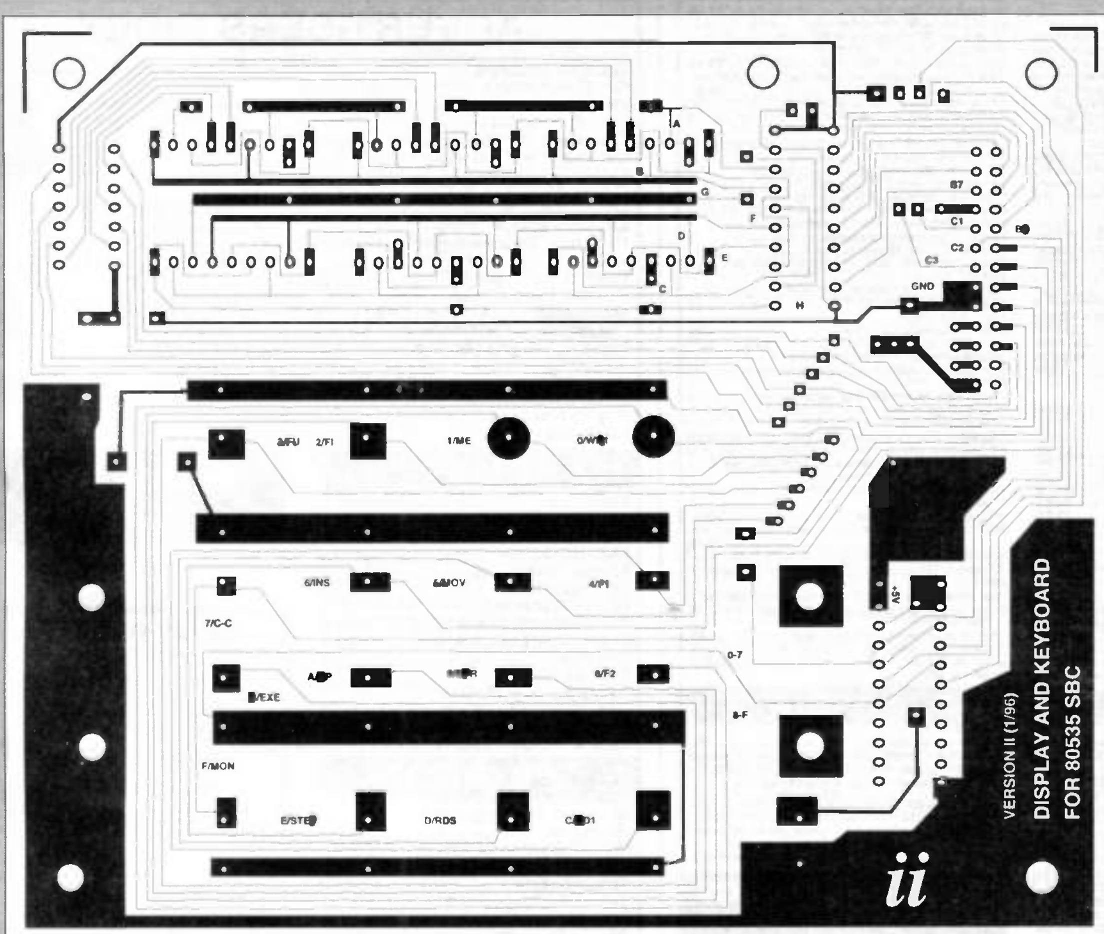


GAMES HEADPHONE AMPLIFIER





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