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AUGUST 1992

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NOW ONLY £19.00!! REF 19P14R.
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LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R
7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.
NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R, 4 x D's £9.00 ref 9P12R, 1 x PP3 £6.00 ref 6P35R
TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32R.
CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104R. Bumper pack of 1,000 ties £14.00 ref 14P6R

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FM BUG Built and tested superior 9v operation £14.00 ref 14P3R
COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.
SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R.
As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R.
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12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.
ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43R
VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 5 tapes New low price £8.00 ref 8P161
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VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4R
25 WATT STEREO AMPLIFIERc. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia included).
BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R, PACK OF 100 £30.00 REF 30P16R
FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.
ALARM TRANSMITTERS. No data avaliable but nicely made complex radio transmitters 9v operation. £4.00 each ref 4P81R.
12V 19A TRANSFORMER. Ex equipment but otherwise ok. Our price £20.00
GX4000 COMPUTERS. Customer returned games machines complete with plug in game, joysticks and power supply. Retail price is almost £100. Ours is £12.00 ref B12P1
ULTRASONIC ALARM SYSTEM. Once again in stock these units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system £25.00 ref B25P1 additional detectors £11.00 ref B11P1
IBM XT KEYBOARDS. Brand new 86 key keyboards £5.00 ref 5P612
IBM AT KEYBOARDS Brand new 86 key keyboards £15.00 ref 15P612
386 MOTHER BOARDS. Customer returned units without a cpu fitted. £22.00 ref A22P1

BSB SATELLITE SYSTEMS
BRAND NEW
REMOTE CONTROL
£49.00 REF F49P1

286 MOTHER BOARDS. Brand new but customer returns so may need attention. Complete with technical manual £20.00 ref A20P2
286 MOTHER BOARDS. Brand new and tested complete with technical manual. £49.00 ref A49P1
UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36R.
IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167R.
RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

MIRACOM WS4000 MODEMS
V21/23
AT COMAND SET
AUTODIAL/AUTOANSWER
FULL SOFTWARE CONTROL
TONE AND PULSE DIALLING
£29

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R.
COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62R or 2 sheets for £7.00 ref 7P22R.
STRIP BOARD CUTTING TOOL. £2.00 ref 2P352R.
50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91R
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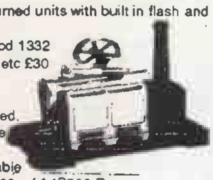
TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366R
COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57R. Atari ST conversion kit £2.00 ref 2P362R.
6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205R
WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries complete with hand charger and solar panel 14P200R

PC STYLE POWER SUPPLY Made by AZTEC 110v or 240v input. +5 @ 15A,+12 @ 5A,-12 @ .5A,-5 @ .3A. Fully cased with fan, on/off switch, IEC inlet and standard PC flyleads. £15.00 ref F15P4
ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200
ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc. £18.00 ref 18P200
MODEMS FOR THREE POUNDS!! Fully cased UK modems designed for dial up system (PSTN) no data or info but only £3.00 ref 3P145R
TELEPHONE HANDSETS Bargain pack of 10 brand new handsets with mic and speaker only £3.00 ref 3P146R
BARGAIN STRIPPERS Computer keyboards. Loads of switches and components excellent value at £1.00 ref CD40R
DATA RECORDERS Customer returned mains battery units built in mic ideal for Computer or general purpose audio use. Price is £4.00 ref 4P100R
SPECTRUM JOYSTICK INTERFACE Plugs into 48K Spectrum to provide a standard Atari type joystick port. Our price £4.00 ref 4P101R
ATARI JOYSTICKS Ok for use with the above interface. our price £4.00 ref 4P102R
BENCH POWER SUPPLIES Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R
SPEAKER WIRE Brown twin core insulated cable 100 feet for £2.00 REF 2P79R
MAINS FANS Brand new 5" x 3" complete with mounting plate quite powerfull and quite. Our price £1.00 ref CD41R
DISC DRIVES Customer returned units mixed capacities (up to 1.44M) We have not sorted these so you just get the next one on the shelf. Price is only £7.00 ref 7P1R (worth it even as a stripper)
HEX KEYBOARDS Brand new units approx 5" x 3" only £1.00 each ref CD42R
PROJECT BOX 51/2" x 31/2" x 1" black ABS with screw on lid. £1.00 ref CD43R
SCART TO SCART LEADS Bargain price leads at 2 for £3.00 ref 3P147R
SCART TO D TYPE LEADS Standard Scart on one end, Hi density D type on the other. Pack of ten leads only £7.00 ref 7P2R
OZONE FRIENDLY LATEX 250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R
QUICK SHOTS Standard Atari compatible hand controller (same as joysticks) our price is 2 for £2.00 ref 2P380R
VIEWDATA SYSTEMS Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R
AC STEPDOWN CONVERTOR Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin American output socket (suitable for resistive loads only) our price £2.00 ref 2P381R
SPECTRUM +2 LIGHT GUN PACK complete with software and instructions £8.00 ref 8P58R/2
CURLY CABLE Extends from 8" to 6 feet! D connector on one end, spade connectors on the other ideal for joysticks etc (6 core) £1.00 each ref CD44R
COMPUTER JOYSTICK BARGAIN Pack of 2 joysticks only £2.00 ref 2P382R
BUGGING TAPE RECORDER Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said. Price is £20.00 ref 20P3R
IEC MAINS LEADS Complete with 13A plug our price is only £3.00 for TWO! ref 3P148R
NEW SOLAR ENERGY KIT Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R

286 AT PC
286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included) Some metal work req'd phone for details.

35MM CAMERAS Customer returned units with built in flash and 28mm lens 2 for £8.00 ref 8P200
STEAM ENGINE Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200



TALKING CLOCK LCD display, alarm, battery operated. Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cock crowing! £14.00 ref 14P200.R
HANDHELD TONE DIALLERS Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R
COMMODORE 64 MICRODRIVE SYSTEM Complete cased brand new drives with cartridge and software 10 times faster than tape machines works with any Commodore 64 setup. The orginal price for these was £49.00 but we can offer them to you at only £25.00! Ref 25P1R
ATARI 2600 GAMES COMPUTER Brand new with joystick and 32 game cartridge (plugs into TV) £29.00 ref F29P1 also some with 1 game at £19.00 ref F19P2.
BEER PUMPS Mains operated with fluid detector and electronic timer standard connections. Ex equipment. £18.00 ref F18P1
90 WATT MAINS MOTORS Ex equipment but ok (as fitted to above pump) Good general pupose unit £9.00 ref F9P1
HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt 4R speaker and a 2" 140R tweeter. If you want two of each plus 2 of our crossovers you can have the lot for £5.00 ref F5P2.
VIDEO TAPES E180 FIFTY TAPES FOR £70.00 REF F70P1
360K 5 1/4" Brand new drives white front. £20.00 Ref F20P1

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SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 21 No. 8 AUGUST 1992

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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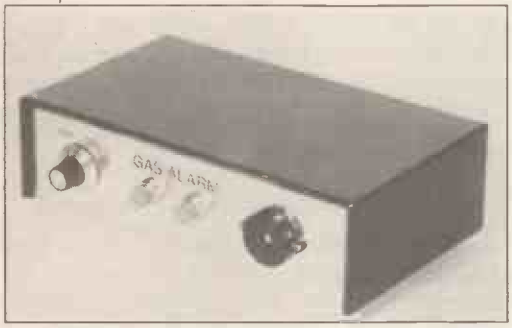
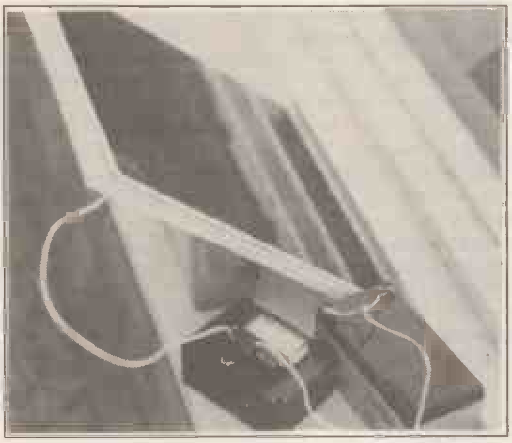
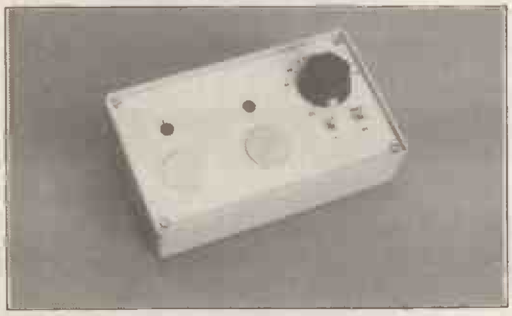
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







Our September '92 Issue will be published on Friday, 7 August 1992. See page 475 for details.

Projects

Series

Features

NEXT MONTH

L.C.D. Ultrasonic Tape Measure

Up, down or sideways, distances of up to nine metres or 30 feet can be easily measured and displayed by this pocket-sized unit. Using twin ultrasonic transducers, a decoding counter and a 3½ digit liquid crystal display, accuracies to within one decimal place are obtainable. An unusual feature is the foreground masking circuit which enables weak distant echoes to be more readily detected.

Washer Bottle Monitor

When the water runs out you are breaking the law!

A valuable accessory for the motorist. Warns when the washer fluid reservoir is nearly empty, allowing the motorist to economise in the meantime. Uses a special fluid level detector chip. Easy to build, and with full installation instructions.

Quick Test

Testing fuses and small components for continuity can be a fiddly business, involving chasing the component around the workbench with a pair of test-prods.

The Quicktest described in this article is a very simple to use piece of test equipment that will perform continuity tests on various devices without the use of test leads.

PLUS

ALTERNATIVE ENERGY: INFORMATION TECHNOLOGY: ACTUALLY DOING IT: AMATEUR RADIO: CIRCUIT SURGERY: BOOKS: VIDEOS: PCBs ETC. ETC.

EVERYDAY ELECTRONICS

SEPTEMBER ISSUE ON SALE FRIDAY 7TH AUGUST 1992

HART AUDIO KITS – YOUR VALUE FOR MONEY ROUTE TO ULTIMATE HI-FI

HART AUDIO KITS give you the opportunity to build the very best engineered hifi equipment there is, designed by the leaders in their field, using the best components that are available.
Every HART KIT is not just a new equipment acquisition but a valuable investment in knowledge, giving you guided hands-on experience of modern electronic techniques.
In short HART is your 'friend in the trade' giving you, as a knowledgeable constructor, access to better equipment at lower prices than the man in the street.
You can buy the reprints and construction manual for any kit to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.
Our list will give you fuller details of all our Audio Kits, components and special offers.

AUDIO DESIGN 80 WATT POWER AMPLIFIER.

This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get £K performance for a few tenths of the cost!. Featured on the front cover of 'Electronics Today International' this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic:- The external view is that of a thoroughly professional piece of audio gear, neat elegant and functional. This impression is greatly reinforced by the internal appearance, which is redolent of quality, both in components and in layout. Options include a stereo LED power meter and a versatile passive front end giving switched inputs using ALPS precision, low-noise volume and balance controls. A new relay switched front end option also gives a tape input and output facility so that for use with tuners, tape and CD players, or indeed any other 'flat' inputs the power amplifier may be used on its own, without the need for any external signal handling stages. 'Slave' and 'monobloc' versions without the passive input stage and power meter are also available. All versions fit within our standard 420 x 260 x 75mm case to match our 400 Series Tuner range. ALL six power supply rails are fully stabilised, and the complete power supply, using a toroidal transformer, is contained within a heavy gauge aluminium chassis/heatsink fitted with IEC mains input and output sockets. All the circuitry is on professional grade printed circuit boards with roller tinned finish and green solder resist on the component ident side, the power amplifiers feature an advanced double sided layout for maximum performance. All wiring in this kit is pre- terminated, ready for instant use!.

RLH11 Reprints of latest articles.................£1.80
K1100CM HART Construction Manual.................£5.50

LINSLEY HOOD 'SHUNT FEEDBACK' R.I.A.A. MOVING COIL & MOVING MAGNET PICKUP PREAMPLIFIER

Modern, ultimate sound systems are evolving towards a built-in RIAA preamplifier within the turntable unit, keeping noise pickup to a minimum. This new circuit by John Linsley Hood uses latest generation integrated circuits in the sonically preferred shunt feedback configuration to give an accurate and musical sound, with the ability to use both moving magnet and moving coil cartridges. Power comes from two 9v PP3 size batteries or a mains power supply. This HART kit is exceptionally easy to build with detailed instructions and all the specially selected components fitting directly on to the roller tinned fibreglass printed circuit board. Even the gold plated phono sockets mount directly on the board.
This Kit now comes with latest generation low-noise front end IC and onboard power stabilisers for any DC input voltage between 9v and 30v.

K1500 Special Discount Price for complete Kit.......... £67.99

ALPS PRECISION LOW-NOISE STEREO POTS.

To fulfil the need for higher quality controls we are now importing an exciting new range of precision audio pots in values to cover most quality amplifier applications. All in 2-gang stereo format, with 20mm long 6mm dia. steel shafts. Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability. Motorised versions have 5v DC Drive motor.

2-Gang 100K Lin.................£8.67
2-Gang 10K, 50K & 100K Log.................£9.40
2-Gang 10K Special Balance.................£10.71
2-Gang 20K Log MOTORISED.................£19.20
2-Gang 10K Special Balance, MOTORISED, zero crosstalk and < 10% centre loss with near Log/Antilog Tracks).................£19.98

HIGH QUALITY REPLACEMENT CASSETTE HEADS

Do you tapes lack treble?. A worn head could be the problem. For top performance cassette recorder heads should be replaced every 1,500 hours. Fitting one of our high quality replacement heads could restore performance to better than new!. Standard inductances and mountings make fitting easy on nearly all machines (Sony are special, see below) and our TC1 Test Cassette helps you set the azimuth spot on. As we are the actual importers you get prime parts at lower prices, compare our prices with other suppliers and see!. All our heads are suitable for use with any Dolby system and are normally available ex stock. We also stock a wide range of special heads for home construction and industrial users.

HM120 Standard Mono R/P Head.................£3.51
HC15 Standard Quality Stereo R/P Head.................£2.49
HC66 High Quality Stereo R/P Head. Permalloy.................£7.98
HS16 Sendust Alloy Stereo Head.................£21.49
HC80 NEW RANGE High Beta Permalloy Stereo head. Modern space saver design for easy fitting and lower cost. Suitable for chrome metal and ferric tapes, truly a universal replacement head for everything from hi-fi decks to car players and at an incredible price too!.................£8.30
HQ551 4-Track RECORD & Play Permalloy Head for auto-reverse car players or quadraphonic recording £14.90
H524 Standard Erase Head.................£1.90
H561 Hi Field Erase Head for METAL Tapes.................£3.49
HRP373 Downstream Monitor Stereo Combination Head.................£47.90

Many other SPECIAL cassette Heads in stock, see our LIST.

REEL TO REEL HEADS

999R 2/4 Record/Play 110mH. Suits Stuart Tape Circuits.................£13.64
998E 2/4 Erase Head 1mH. Universal Mount. Suits Stuart.................£11.98

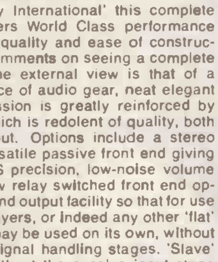
TAPE RECORDER CARE PRODUCTS

HART TC1 TEST CASSETTE Our famous triple purpose test cassette. Sets tape azimuth, VU level and tape speed.................£5.36
DEM1 Mains Powered Tape Head Demagnetizer, prevents noise on playback due to residual head magnetisation.................£4.48
DEM115 Electronic, Cassette Type, demagnetizer.........£8.91

COMPUTER CORNER

The following are a selection of our new range of VERY competitively priced, High Quality, computer systems. Due to our long experience of importing we have the necessary contacts in the Far East to buy at very advantageous prices and can pass the savings on to you. All hard disc machines ordered with DOS are fully formatted and ready to use.

HART MODEL AT-286/16WP COMPUTER



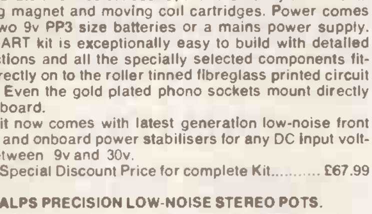
Fully fledged AT286 machine, cheap enough to use as the fastest wordprocessor in the west! Only a few years ago the AT-286 machine was the fastest standard office computer known. Now we can offer the superfast 16MHz version (earlier ones were only 10 or 12MHz) at such an incredibly low price that it can be used in any office or home. Not only that but ours comes with ultrafast memory so that the machine can run in 'zero wait state'.
Advanced features are:– Full 1MB of memory (Expandable to 4MB), 102 key UK keyboard, compact desktop case, 1.2MB 5¼" High Density Disk Drive and interface card for extra drive, Graphics/Printer Card, built in Hard Disk Interface.

HART AT-286/16WP.................ONLY £277.25
14" FST Hercules monitor, Amber.................£83
14" Paper White Hercules Monitor. (Both have T/S Base).................£86
Trust Writer W/P Software uses Wordstar commands.£19.50

40MB AT-286/16UG Hard Disk Computer

Specification as above but with 45MB 25ms hard disk, VGA Colour Graphics Card with 512K RAM, parallel printer port, 2 serial ports, 1 game port.................£523.50
14" VGA Mono Monitor, Amber £86.70 Paper White £89

HART 40MB AT-386/16SX EL



Entry level 386 machine for demanding applications at moderate cost. Spec as our AT286/16WP with 1MB Dram memory, Mini Tower case, 45MB 25ms hard disk drive, VGA Colour Graphics Card with 256K RAM

40MB AT-386/16SX EL is.................ONLY £634.30 (Ex Vat)

HART 52MB AT-386/20SX UG

Luxury version of the above with higher processor speed and amazing 9 millisecond access time hard disk. 2MB SIMM RAM, Compact Tower Case, VGA 1024 x 768 card with 512K RAM, upgradeable to 1MB of Video memory.

40MB AT-386/20SX UG.................ONLY £853.10

OPTIONAL EXTRAS

HART Computers can be 'custom made' to fit your personal requirements, at NO extra cost!. Simply select the options you require. If replacing any item in the standard specification for that model then deduct the cost of the part not needed.

SOFTWARE

MS-DOS 5 Latest Release. Full version. 3.5" or 5.25".........£59
DR DOS 6.................£77
Microsoft Windows Latest Version 3.1.................£67

MONITORS

SM1421 AM TU Hercules Mono with FST Tube and Stand, Amber.................£83
SM1421 PW TU As Above but Paper White Screen.................£86
SM1416A VGA Mono Monitor c/w tilt and swivel stand. Amber.................£86.70
SM1416W As Above, Paper white.................£89
SM1485-00 Super VGA Multisync Colour Monitor, ·28" dot pitch, 50MHz Bandwidth, up to 1024 x 768, c/w stand.........£235

KEYBOARDS

K261 102 Key Enhanced UK Layout, Tactile Click, AT/XT Switchable with dual slope feet.(Standard Keyboard supplied with systems).................£31
K108 Similar to above, single slope feet. Alps switches......£36
KB6153A As above but with heavy metal base.................£44

I/O and GRAPHIC CARDS

AT Super I/O Card 2 x FDD, 1xIDE, 2 Serial, 1 Parallel, 1 Game Ports.................£21.20
Hercules Mono Graphic & Printer card.................£11.70
16-Bit VGA Card, 256K.................£46.50
Trident 8900 VGA Card, 512K.................£67.30
Trident 8900 VGA Card with 1Mb.................£86.90

DISK DRIVES

5.25" 1.2Mb Floppy Disk Drive.................£49
3.5" 1.44Mb Floppy Disk Drive.................£45
Adapter to fit 3.5" drive in 5.25" slot, c/w power adapter.......£9
45MB 25ms Hard Disk Drive.................£165
52MB Quantum Hard Disk. Lightning Fast 9ms Access time.................£261

CASES

WE 611P Desktop Case, Flip Top, 200W PSU.................£56.40
WE727P Mini Tower Case, 200W PSU.................£84.70
108MP Mini Tower Case, Compact Style.................£89
CT107 Midi Tower Case.................£108

MOTHERBOARDS

AT-286/16 0K.RAM.................£89
AT-386-16SX 0K.RAM.................£195
AT-386-20SX 0K.RAM.................£245

PLEASE NOTE THAT ALL ITEMS IN THIS SECTION ARE PRICED EX VAT.

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INSULATION TESTER

EE APRIL 85

A reliable electronic tester which checks insulation resistance of wiring appliances etc., at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

KIT REF 444 £22.37

PET SCARER

EE MAY 89

Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V–12V or via Mains Adaptor).

KIT REF 812

Mains Adaptor £2.02

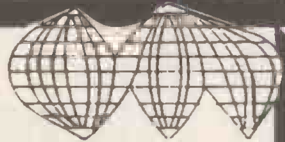
£14.81

DIGITAL LCD THERMOSTAT

EE MAY '91

A versatile thermostat with LCD read out. MIN/MAX temperature recording, clock and individually settable upper and lower switching points. Covers –10 to 110 degrees Celsius, accurate to within 0.1 degrees. Submersible probe on 3 meter lead. Kit includes punched and printed case. Save on energy bills by improved control of your hot water system. Also ideal for greenhouse soil temperature and aquarium control. Complete kit includes thermostat and probe, mains power supply and relay output, PCB's and punched and printed case.

KIT REF 841 £29.95



3 BAND SHORT WAVE RADIO

EE AUG 87

Covers 1.6–30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

KIT REF 718 £30.30

DIGITAL COMBINATION LOCK

EE MAR '91

Digital combination lock with a 12 key keypad. 4 digit code operates 250V-16A SPCO relay. A special anti-tamper circuit allows the relay to be mounted remotely from the keypad without any loss of security. Can be operated in many modes (latching/unlatching, manual/automatic setting, continuous/momentary output, etc.). Article describes operation as Vehicle Immobilising security system. Low current drain.

Kit includes drilled case

KIT REF 840 £19.86

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY

EE FEB 88

A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

KIT REF 769 £56.82

PORTABLE ULTRASONIC PEsT SCARER

EE AUG '91

A powerful 23kHz Ultrasonic generator in a compact hand-held case. A MOSFET output drives a weatherproof transducer at up to 300V peak to peak via a special tuned transformer. Sweeping frequency output requires no setting up or alignment. Kit includes all components, PCB, transducer and case.

KIT REF 842 £22.56

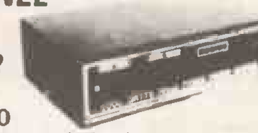
ACOUSTIC PROBE

EE NOV '87

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

KIT REF 740 £20.01

4 CHANNEL LIGHT CHASER



EE Jan '90

A 1000W per channel chaser with zero volt switching, hard drive, inductive load capability, mic sound sensor and sophisticated 'beat' detector. Chase steps to music or auto when quiet. Variable speed and mic. sens. LED mimic on front panel. Switchable for 3 or 4 channels. P552 output. Ideal for rope lights, pin spots, disco and display lighting.

KIT REF 833 £32.13

EE EQUALISER

EE MAY '87

A mains powered Ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

KIT REF 707 £17.75

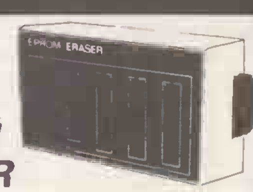
MICROCONTROLLER LIGHT SEQUENCER

EE DEC '90

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences.. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available. 1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety. Many other features.

Complete kit includes case, PCBs, all components and hardware.

KIT REF 838 £57.17



EPROM ERASER

EE OCT '88

Safe low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Operates from a 12V supply. Safety interlock. Convenient and simple to build and use.

KIT REF 790 £28.51

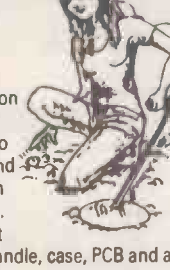
LIGHT RIDERS

EE OCT '86

Three projects under one title – all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT	£15.58
KIT REF 560 DISCO LIGHTS	£22.41
KIT REF 561 LAPEL BADGE	£11.65

EE TREASURE HUNTER



EE AUG '89

A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815

Including headphones £45.95

SUPERHET BROADCAST RECEIVER

EE MAR '90

At last, an easy to build SUPERHET A.M. radio kit . Covers Long and medium Wave bands. built in loudspeaker with 1 watt output. Excellent sensitivity and selectivity provided by ceramic I.F. filter. Simple alignment and tuning without special equipment. Kit available less case, or with pre-cut and drilled transparent plastic panels and dial for a striking see-through effect.

KIT REF 835 £17.16

ESR ELECTRONIC COMPONENTS

Station Road, Cullercoats,
Tyne & Wear NE30 4PQ
Tel. 091 251 4363 Fax. 091 252 2296

74LS Series

74LS00	£0.14
74LS01	£0.14
74LS02	£0.14
74LS03	£0.14
74LS04	£0.14
74LS05	£0.14
74LS08	£0.14
74LS09	£0.14
74LS10	£0.14
74LS107	£0.23
74LS109	£0.21
74LS11	£0.17
74LS112	£0.21
74LS113	£0.21
74LS114	£0.21
74LS12	£0.14
74LS122	£0.31
74LS123	£0.31
74LS125	£0.21
74LS126	£0.21
74LS13	£0.14
74LS132	£0.21
74LS133	£0.18
74LS136	£0.16
74LS138	£0.24
74LS139	£0.25
74LS14	£0.18
74LS145	£0.56
74LS147	£1.26
74LS148	£0.70
74LS15	£0.14
74LS151	£0.25
74LS153	£0.25
74LS154	£0.70
74LS155	£0.25
74LS156	£0.25
74LS157	£0.25
74LS158	£0.25
74LS160	£0.32
74LS161	£0.32
74LS162	£0.32
74LS163	£0.32
74LS164	£0.26
74LS165	£0.48
74LS170	£0.30
74LS173	£0.24
74LS174	£0.24
74LS175	£0.24
74LS190	£0.25
74LS191	£0.24
74LS192	£0.24
74LS193	£0.24
74LS195	£0.24
74LS196	£0.24
74LS197	£0.24
74LS20	£0.16
74LS21	£0.14
74LS22	£0.14
74LS221	£0.36
74LS240	£0.32
74LS241	£0.32
74LS242	£0.32
74LS243	£0.32
74LS244	£0.32
74LS245	£0.33
74LS247	£0.32
74LS251	£0.24
74LS257	£0.24
74LS258	£0.24
74LS26	£0.14
74LS266	£0.14
74LS27	£0.14
74LS273	£0.24
74LS279	£0.25
74LS30	£0.14
74LS32	£0.14
74LS365	£0.21
74LS367	£0.21
74LS368	£0.21
74LS37	£0.14
74LS373	£0.32
74LS374	£0.32
74LS375	£0.34
74LS377	£0.32
74LS378	£0.62
74LS38	£0.14
74LS390	£0.25
74LS393	£0.24
74LS395	£0.26
74LS399	£0.62
74LS40	£0.14
74LS42	£0.25
74LS47	£0.42
74LS51	£0.14
74LS670	£0.69
74LS73	£0.17
74LS74	£0.19
74LS75	£0.19
74LS76	£0.25
74LS83	£0.31
74LS85	£0.35
74LS86	£0.20
74LS90	£0.23
74LS92	£0.35
74LS93	£0.25

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4000	£0.17
4001	£0.17
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4009	£0.19
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4011	£0.16
4012	£0.16
4013	£0.17
4014	£0.30
4015	£0.31
4016	£0.18
4017	£0.25
4018	£0.27
4019	£0.19
4020	£0.31
4021	£0.31
4022	£0.32
4023	£0.16
4024	£0.21
4025	£0.15
4026	£0.40
4027	£0.18
4028	£0.22
4029	£0.27
4030	£0.17
4031	£0.70
4033	£0.56
4034	£1.24
4035	£0.31
4040	£0.29
4041	£0.31
4042	£0.22
4043	£0.28
4044	£0.31
4046	£0.31
4047	£0.25
4048	£0.31
4049	£0.20
4050	£0.20
4051	£0.25
4052	£0.25
4053	£0.25
4054	£0.56
4055	£0.30
4060	£0.31
4063	£0.29
4066	£0.18
4067	£1.91
4068	£0.16
4069	£0.20
4070	£0.17
4071	£0.20
4072	£0.17
4073	£0.17
4075	£0.17
4076	£0.30
4077	£0.17
4081	£0.14
4082	£0.17
4085	£0.28
4086	£0.26
4089	£0.55
4093	£0.15
4094	£0.31
4095	£0.56
4097	£1.20
4098	£0.31
4099	£0.38
4502	£0.38
4503	£0.31
4508	£0.90
4510	£0.26
4511	£0.29
4512	£0.31
4514	£0.73
4515	£0.78
4516	£0.31
4518	£0.27
4520	£0.26
4521	£0.62
4526	£0.40
4527	£0.39
4528	£0.40
4529	£0.44
4532	£0.31
4534	£2.24
4536	£1.00
4538	£0.37
4541	£0.31
4543	£0.46
4555	£0.34
4556	£0.34
4560	£1.18
4566	£1.96
4572	£0.25
4584	£0.24
4585	£0.32
4724	£0.70
40106	£0.31
40109	£0.50
40163	£0.46
40174	£0.34
40175	£0.36
40193	£0.60

TRANSISTORS

2N1613	£0.31	BC184L	£0.08	BD441	£0.41
2N1711	£0.26	BC186	£0.33	BD442	£0.41
2N1893	£0.29	BC204C	£0.72	BD534	£0.47
2N2218A	£0.28	BC206B	£0.72	BD535	£0.48
2N2219A	£0.25	BC207C	£0.72	BD536	£0.65
2N2222A	£0.16	BC208	£0.72	BD646	£0.52
2N2646	£0.80	BC209A	£0.72	BD648	£0.52
2N2904A	£0.25	BC212	£0.08	BD650	£0.53
2N2905A	£0.23	BC212L	£0.08	BD707	£0.42
2N2907	£0.20	BC212LB	£0.08	BD807	£0.80
2N2926	£0.16	BC213	£0.08	BDX32	£1.78
2N3053	£0.27	BC213LC	£0.08	BDX33C	£0.46
2N3054	£0.90	BC214	£0.08	BDX34C	£0.50
2N3055	£0.62	BC214L	£0.08	BDX53C	£0.47
2N3440	£0.50	BC237B	£0.09	BDX54C	£0.50
2N3702	£0.09	BC238C	£0.09	BF180	£0.31
2N3703	£0.10	BC239C	£0.10	BF182	£0.31
2N3704	£0.10	BC251	£0.13	BF185	£0.31
2N3705	£0.10	BC252	£0.13	BF194	£0.19
2N3706	£0.10	BC261B	£0.24	BF195	£0.19
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2N3772	£1.51	BC267B	£0.30	BF257	£0.33
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BC107	£0.14	BC547C	£0.09	BU508A	£1.37
BC107B	£0.15	BC548C	£0.08	BU526	£1.74
BC108	£0.12	BC549C	£0.10	BU806	£1.06
BC108A	£0.14	BC550C	£0.08	BUX84	£0.77
BC108C	£0.14	BC556A	£0.08	IRF540	£1.75
BC109	£0.14	BC557C	£0.08	IRF740	£1.63
BC109C	£0.15	BC558C	£0.08	MJ11015	£2.11
BC114	£0.41	BC559C	£0.08	MJ11016	£2.11
BC115	£0.41	BC560B	£0.09	MJ2501	£1.60
BC116	£0.41	BC637	£0.21	MJ3001	£1.52
BC118	£0.41	BC638	£0.21	MJE340	£0.36
BC132	£0.36	BC639	£0.21	MJE350	£0.42
BC134	£0.36	BC640	£0.21	MPSA13	£0.12
BC135	£0.36	BCY70	£0.21	MPSA42	£0.17
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BC141	£0.27	BCY72	£0.20	TIP121	£0.35
BC142	£0.31	BD135	£0.20	TIP122	£0.37
BC143	£0.34	BD136	£0.20	TIP125	£0.37
BC149	£0.12	BD137	£0.22	TIP127	£0.37
BC154	£0.36	BD138	£0.22	TIP132	£0.46
BC157	£0.12	BD139	£0.23	TIP137	£0.46
BC159	£0.12	BD140	£0.24	TIP142	£1.06
BC160	£0.28	BD150C	£0.82	TIP147	£1.12
BC170	£0.16	BD165	£0.42	TIP2955	£0.63
BC170B	£0.16	BD166	£0.35	TIP29C	£0.31
BC171	£0.11	BD187	£0.39	TIP3055	£0.63
BC171B	£0.16	BD201	£0.40	TIP30C	£0.31
BC172	£0.13	BD202	£0.40	TIP31C	£0.32
BC172B	£0.13	BD203	£0.40	TIP32C	£0.32
BC177	£0.17	BD204	£0.40	TIP33C	£0.72
BC178	£0.17	BD222	£0.40	TIP41A	£0.36
BC179	£0.17	BD225	£0.42	TIP42C	£0.38
BC182	£0.08	BD232	£0.38	TIP47	£0.48
BC182L	£0.08	BD237	£0.32	TIP48	£0.62
BC182LB	£0.08	BD238	£0.32	TIP50	£0.53
BC183	£0.08	BD240B	£0.37	VN10KM	£0.44
BC183L	£0.08	BD243B	£0.50	VN66AF	£1.50
BC183LB	£0.08	BD244A	£0.53	ZTX300	£0.16
BC184	£0.08	BD246	£1.06	ZTX500	£0.16

LINEAR ICs

TL061	£0.35
TL062	£0.42
TL064	£0.46
TL071CP	£0.32
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TL074CN	£0.48
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TL084CN	£0.46
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LM301A	£0.25
CA311E	£0.28
CA324	£0.23
LM348N	£0.31
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LM358N	£0.27
LM377	£2.57
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LM381	£2.70
LM386	£0.48
LM387	£1.60
LM392N	£0.79
LM393N	£0.28
LM394	£3.98
ZN414Z	£1.04
NE531	£1.56
CA555	£0.22
NE556N	£0.36
NE567N	£0.36
UA733	£0.64
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CA747CE	£0.39
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TBA810S	£0.68
TBA820M	£0.39
LM1458	£0.26
ULN2004	£0.48
TDA2030	£1.35
CA3046	£0.37
CA3080	£0.72
CA3130	£0.98
CA3130E	£0.98
CA3140	£0.56
CA3240	£1.22
LM3900	£0.72
LM3914	£2.70
LM3915	£2.70
MC4558	£0.36
NE5532	£0.80
NE5534	£0.66
ICL7621	£1.70
ICM7555	£0.43
ICM7556	£0.96
ZN425E	£4.68
ZN426E	£2.61
ZN427E	£8.82
ZN428E	£6.12
ZN435E	£5.31
ZN448E	£7.92
MC3340	£1.60

SOLDERING IRONS

Antex Soldering irons	
M 12 Watt	£7.75
C 15Watt	£7.75
G 18Watt	£7.30
CS 17Watt	£7.88
XS 25Watt	£7.96
ST4 STAND	£2.85
New PORTASOL HOBBY 35Watt gas iron	£11.17
DESOLDER PUMP	£3.00
ANTISTATIC PUMP	£4.30
22SWG 0.5Kg Solder	£7.40
18SWG 0.5Kg Solder	£6.60
1mm 3 yds Solder	£0.58

RF CONNECTORS

BNC Solder Plug	£0.85
BNC Crimp Plug	£0.68
BNC Solder Skt	£1.08
BNC Chassis Skt	£0.78
PL259 5.2mm	£0.58
PL259 11mm	£0.58
RND UHF socket	£0.63
SQR UHF socket	£0.40
F Plug RG58	£0.27
F Plug RG6	£0.27
N Plug RG8	£1.64

PCB EQUIPMENT

UV EXPOSURE UNIT – 229 x 159mm working area, built in timer, 2 x 8w tubes £67.38
PHOTO RESIST BOARD – single sided pre-sensitised FR4 glass fibre board. 3 x 4 in. £0.86 4 x 6 in. £1.62 6 x 6 in. £2.41
PLASTIC DEVELOPING TRAY £1.35
FERRIC CHLORIDE (0.5Kg) £2.45
TIN PLATING POWDER (90g) £8.33
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4.7	–	–	£0.05	£0.08	£0.30
10	£0.05	£0.05	£0.06	£0.08	£0.48
22	£0.05	£0.05	£0.09	–	–
47	£0.06	£0.06	£0.11	–	–
100	£0.06	£0.09	£0.11	–	–
220	£0.09	£0.12	£0.31	–	–
470	£0.15	£0.19	£0.57	–	–
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2200	£0.37	£0.57	–	–	–
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4.7	–	£0.09	£0.10	£0.10	£0.34
10	–	£0.12	£0.12	£0.12	£0.48
22	–	£0.09	£0.13	£0.17	£1.06
47	£0.10	£0.11	£0.16	£0.20	£1.33
100	£0.10	£0.13	£0.21	–	£2.46
220	£0.13	£0.18	£0.42	–	–
470	£0.21	£0.20	£0.69	–	–
1000	£0.33	£0.40	£1.05	–	–
2200	£0.52	£0.64	–	–	–
4700	£0.90	–	–	–	–

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VOL. 21 No. 8 AUGUST '92

SOLAR ECLIPSE

As regular readers will know we tend to use some unusual illustrations on our front cover and, as you can see, this month is no exception. The illustration by Steven Hunt is of a solar eclipse, it is particularly relevant to this month's magazine because this issue contains the first part of our *Alternative Energy* series.

When you read the series you will quickly realise the importance of the sun in relation to all forms of energy except nuclear power. Man has only very recently managed to produce controlled nuclear fusion – the process which makes the sun work. Although this "clean" method of generating power probably has the greatest potential it is still in its infancy and we are possibly 50 years away from a fusion power station, the use of which might eventually eclipse the power the sun has provided.

We all tend to use power without very much thought about how it is generated and I guess few people are aware of all the methods now used around the world for power generation. Our series will give an overview and some hints on what might develop.

FREE LIGHT

Perhaps the above side heading is a little misleading, as we all know there is no such thing as a "free lunch", however our *Solar Powered Lighting Unit* will provide virtually free light once you have paid to build it. It does show in its own small way what can be achieved for a relatively small outlay.

On a larger scale the sun is being used in the U.S.A. to generate considerable amounts of power – but just one power station can contain up to 1·5 million mirrors to generate 150MW of power – not quite an EE project! By the way, it takes a 20 man team 10 days just to clean all the mirrors.

Mike Kenward

SUBSCRIPTIONS

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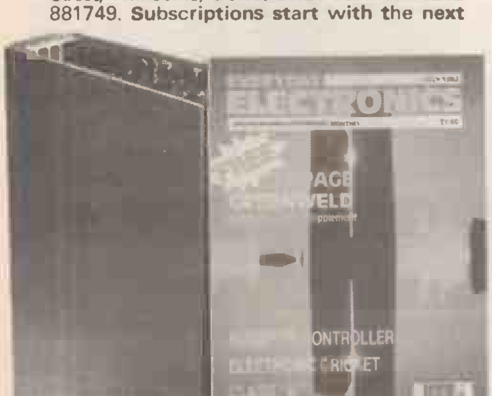

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We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

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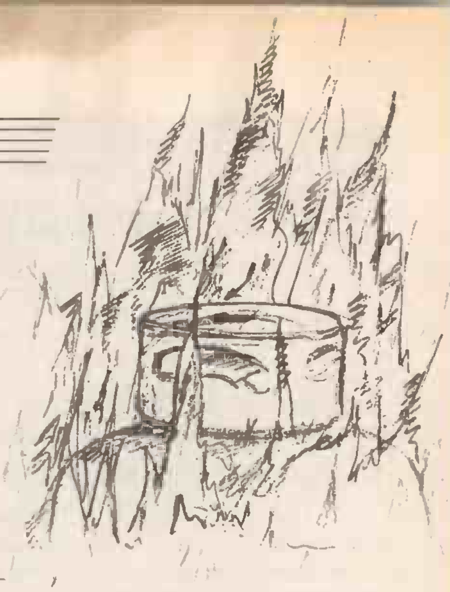
Constructional Project



GAS ALARM

ROBERT PENFOLD

Will detect the build-up of fuel gas plus many other types of inflammable gasses and vapours. It will also detect many types of smoke

GAS ALARMS are designed to detect inflammable gases and vapours before a dangerous concentration is reached. They are much used in boats and caravans, but can be utilized anywhere that is equipped with gas appliances, or where inflammable vapours could build up.

Most gas alarms, including this one, will detect all normal fuel gases, plus many other types of inflammable gas and vapour. This includes many types of smoke, and the unit will therefore operate as a fire alarm as well (but possibly less effectively than a purpose designed fire alarm). Although this device is designed to operate from the mains supply, it can be modified to operate from a 12 volt d.c. supply.

GAS SENSOR

Smoke detectors operate using a variety of methods, including simple optical methods of detection. In this case it is not just inflammable smoke that must be detected, but fuel gases as well. These are mostly transparent, and will not be detected using simple methods such as optical detectors. Detection of fuel gases requires special sensors using quite sophisticated techniques.

Gas detectors of this type are usually based on a heating element with a special coating. With some sensors the heating element oxidises due to a reaction with oxygen in the air, and has a high resistance. However, in the presence of inflammable gases a process known as reduction takes place, which means that the oxygen is to some extent removed from the heating element, causing its resistance to decrease.

This type of sensor has been much used in gas detectors for the home constructor in the past, but this unit uses an alternative (and now more readily available) form of sensor. This type of gas sensor has the usual heating element, but it is made from fine platinum wire coated with oxides and a catalyst.

The element normally heats to approximately 350 degrees Centigrade, but if a suitable gas is present oxidisation takes place. This, together with the rise in temperature that occurs, results in a rise in resistance through the sensor.

SYSTEM OPERATION

The block diagram for the Gas Alarm project is shown in Fig. 1. The sensor is connected in a bridge circuit. One side of the bridge merely consists of a potential divider circuit which provides a "reference voltage" to one input of a voltage comparator circuit.

The other side of the bridge consists of another potential divider. This is formed by the two resistances provided by the Sensor and a Compensating Element. The latter is very similar to the sensor, having an identical platinum wire element. The coating is different though, and it will not respond to inflammable gasses. The point of having the compensation element is that over a period of time the resistance through the sensor might change slightly due to changes in the ambient temperature, humidity, etc.

Any changes of this type should affect both the sensor and the compensation element almost equally, giving no change in the output voltage from that side of the bridge. This helps to avoid false alarms.

The use of a bridge circuit also helps to avoid spurious operation of the unit. If there should be a slight change in the supply voltage (which there will inevitably be over a period of time), it will affect both sides of the bridge circuit, and will not cause a false alarm.

Normally the output voltage from the sensor arm of the bridge is higher than that from the reference voltage side. This is detected by the voltage comparator, and its output goes to a very low voltage. When the unit is activated the sensor's resistance increases, and the output voltage from that arm of the bridge circuit falls below the reference voltage. This is detected by the voltage comparator, and its output triggers to virtually the full supply voltage.

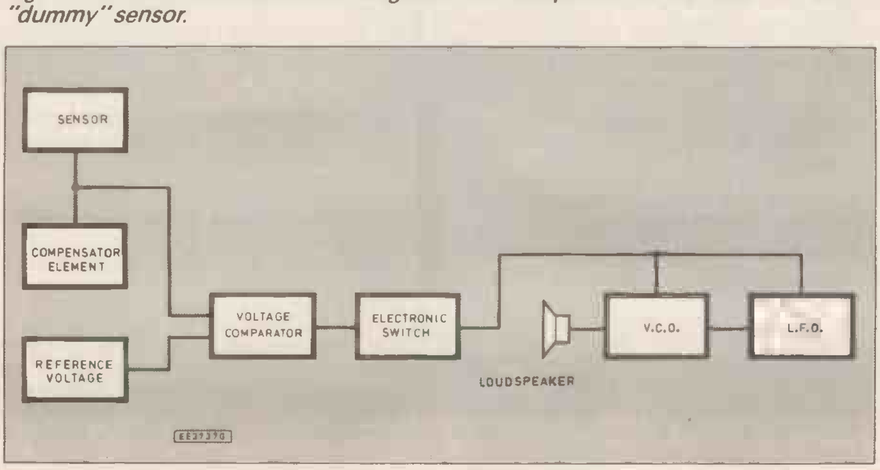
The output of the comparator operates an electronic switch, which turns on an audible alarm circuit when the unit is activated. The alarm signal is a frequency modulated tone which is smoothly swept up and down in frequency at a rate of a little over one cycle per second.

The basic audio signal is generated by a v.c.o. (voltage controlled oscillator). The operating frequency of this circuit is controlled by a voltage which is provided by a low frequency oscillator (l.f.o.). As the output voltage from the latter rises and falls, so does the pitch of the output from the v.c.o. This gives an effective alarm signal that is not easily overlooked.

CIRCUIT OPERATION

The full circuit diagram of the Gas Detector, including the stabilised mains power supply, is shown in Fig. 2. The circuit requires a 12V supply, and the current consumption is about 400 milliamps. This is predominantly the current consumed by the sensor and compensation element. The rest of the circuit consumes just a few milliamps.

Fig. 1. The Gas Detector block diagram. The compensation element is a sort of "dummy" sensor.



The power supply is a conventional type having full-wave bridge rectification provided by diodes D1 to D4, and smoothing supplied by capacitor C1. IC1 provides a well regulated and smoothed 12 volt output.

The sensor and compensation element require a total supply voltage of only about 2·2V. This is derived from the main 12 volt supply using a simple dropper circuit based on transistor TR1. This is just a potential divider circuit (resistors R1 to R3) and an emitter follower buffer stage to provide the fairly high currents required by the sensor and compensation elements.

Transistor TR1 is a power Darlington device which can comfortably accommodate the current and power levels involved here. Due to its very high gain it can operate properly from the low input current available from R1 to R3.

Preset potentiometer VR1 provides the reference voltage, and this is adjusted to give an output potential that is just below the level produced by the sensor circuit. IC2 is an operational amplifier which is connected to operate as a voltage comparator. Resistor R6 provides a small amount of hysteresis which helps to avoid "jitter" when the circuit is close to the trigger level. Transistor TR2 is the electronic switch, and this is an emitter follower buffer stage.

The v.c.o. is based on IC3, which is actually a "micro-power" CMOS phase locked loop (p.l.l.). In this case it is only the v.c.o. section that is required. The phase comparators, stabiliser circuit, etc., are simply ignored.

Resistor R7 and Capacitor C5 are the timing components. These have been chosen to give an operating frequency range that covers the middle audio range.

It is over this frequency range that the "Siren" LS1 offers peak efficiency. Note that LS1 is a piezoelectric sounder and not a normal moving coil loudspeaker. A moving coil loudspeaker, even a high impedance type, is unsuitable for operation in this circuit.

LOW FREQUENCY OSCILLATOR

A low power 555 timer, IC4, acts as the l.f.o. The roughly squarewave output from pin 3 of IC4 is of no use in this case as it would simply switch the v.c.o. between two frequencies. This can give quite an effective alarm signal, but the two frequencies might happen to be ones where the Piezo-sounder is not very efficient.

Sweeping the v.c.o. frequency ensures that the sounder is driven at its frequencies of peak efficiency for at least part of the time, giving a loud alarm signal. The waveform across capacitor C6 is a sort of slightly rounded triangular shape, and this gives a good sweep effect. The signal across C6 is at a high impedance, but this does not matter as the control input of IC3 has an extremely high input impedance.

LOW VOLTAGE OPERATION

For operation on a 12V supply the mains power supply components (T1, S1, D1-D4, C1-C3, FS1, and IC1) can all be omitted. The 12V d.c. supplies in boats, caravans, etc. are generally somewhat higher than their nominal 12 volt level, and often contain a lot of noise. It is therefore advisable to add a 100µ 16V electrolytic capacitor across the supply rails.

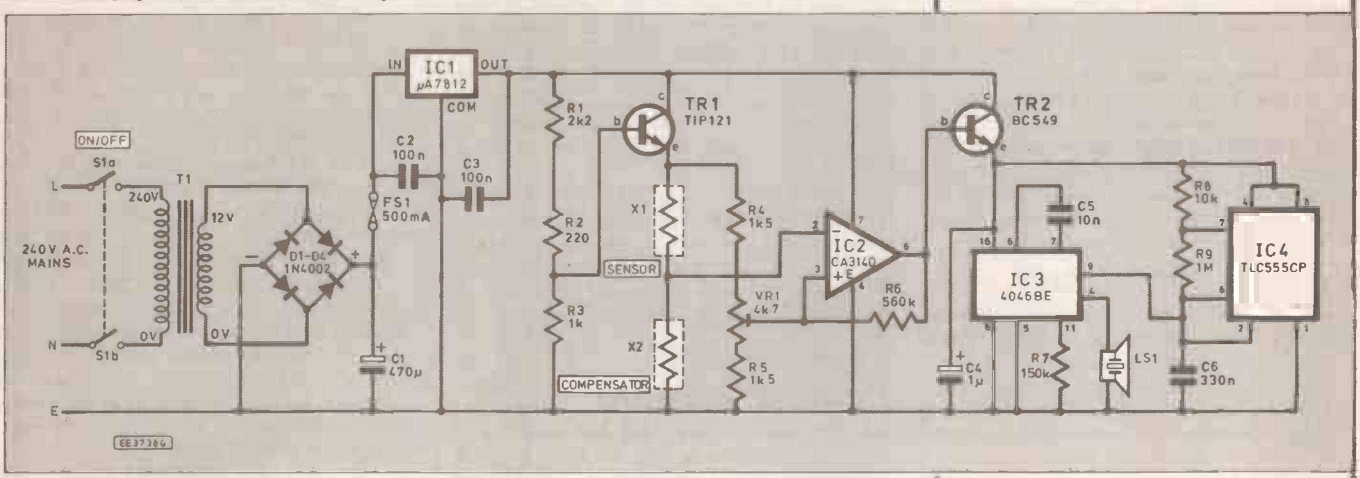


Fig. 2. The complete circuit diagram for the Gas Alarm. The detector elements are mounted on the front panel (see photograph below) together with the warning siren.

COMPONENTS

See SHOP TALK Page

Resistors

R1	2k2
R2	220
R3	1k
R4, R5	1k5 (2 off)
R6	560k
R7	150k
R8	10k
R9	1M

All 0·25W 5% carbon film

Potentiometer

VR1	4k7 sub-min horizontal preset, lin.

Capacitors

C1	470µ radial elect., 25V
C2, C3	100n ceramic (2 off)
C4	1µ radial elect., 63V
C5	10n polyester
C6	330n polyester

Semiconductors

D1-D4	1N4002 100V 1A rect (4 off)
TR1	TIP121 *npn* power Darlington
TR2	BC549 *npn* silicon
IC1	µA7812 12V 1A reg.
IC2	CA3140E CMOS op. amp
IC3	4046BE CMOS phase locked loop
IC4	TLC555CP low power timer

Miscellaneous

LS1	Panel mounting piezo sounder
S1	Rotary mains switch
FS1	20mm 500mA quick-blow fuse
T1	12V 500mA secondary, mains primary
X1,X2	Matched pair of gas detector and compensator transducers

Printed circuit board, available from *EE PCB Service*, code EE800

Metal instrument case, size 230mm x 130mm x 65mm; 20mm p.c. mounting fuse-clips; control knob; 18s.w.g. aluminium for heatsinks; 8-pin d.i.l. socket (2 off); 16-pin d.i.l. socket; mains lead and plug; solder tag; solder pins; connecting wire; solder; etc.

Approx cost guidance only **£30**

Also, a 500 milliamp fuse, a 2Ω7 2W resistor, and an s.p.s.t. on/off switch should be added in series with the positive supply lead.

CONSTRUCTION

Details of the printed circuit board component layout, full size copper foil master pattern and interwiring are shown in Fig.3. This board is available from the *EE PCB Service*, code EE800. Construction of the board is very straightforward as it is single-sided and free from link wires.

All the d.i.l. integrated circuits are CMOS types, although IC4 has built-in protection circuitry which renders the normal handling precautions unnecessary. Nevertheless, it is still recommend that holders should be used for all three d.i.l. integrated circuits.

IC4 can be any low power 555 timer (TLC555CP, ICM7555, etc.). An ordinary 555 timer might be satisfactory, but could give rather erratic results. A low power version seems to give more reliable results in this application. Note that IC4 has the opposite orientation to IC2 and IC3.

Fuse FS1 is mounted on the board via a pair of 20 millimetre fuse-clips. A 20 millimetre printed circuit mounting fuseholder should also be suitable, but might require a slightly different mounting hole arrangement.

HOT SPOT

Components IC1 and TR1 have to dissipate about 1·5W and 3·8W respectively.

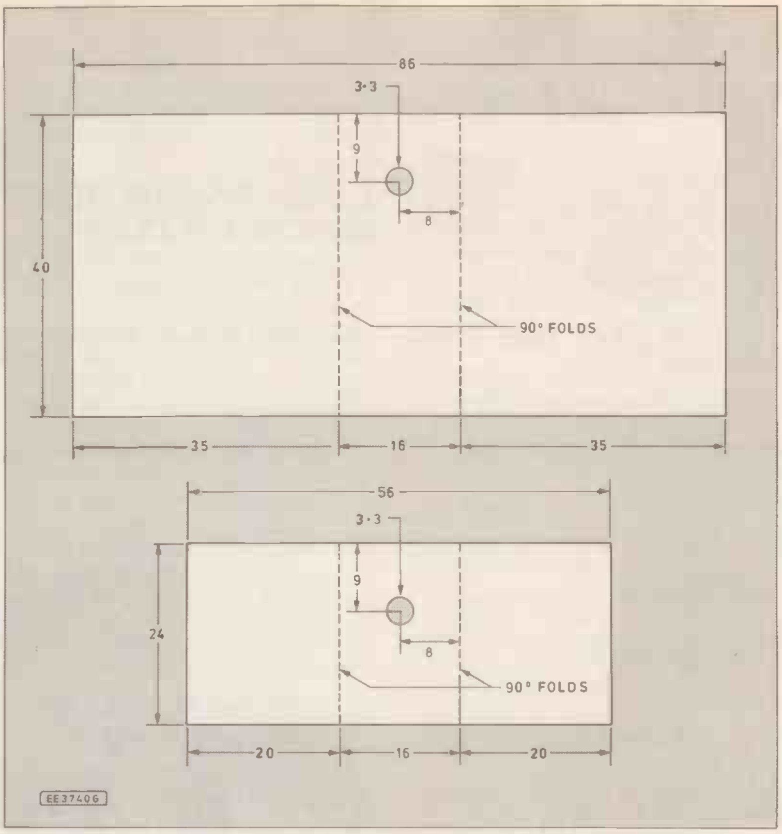


Fig. 4. Suitable heatsink designs for power Darlington transistor TR1 (top) and regulator IC1 (bottom). Dimensions in millimetres.

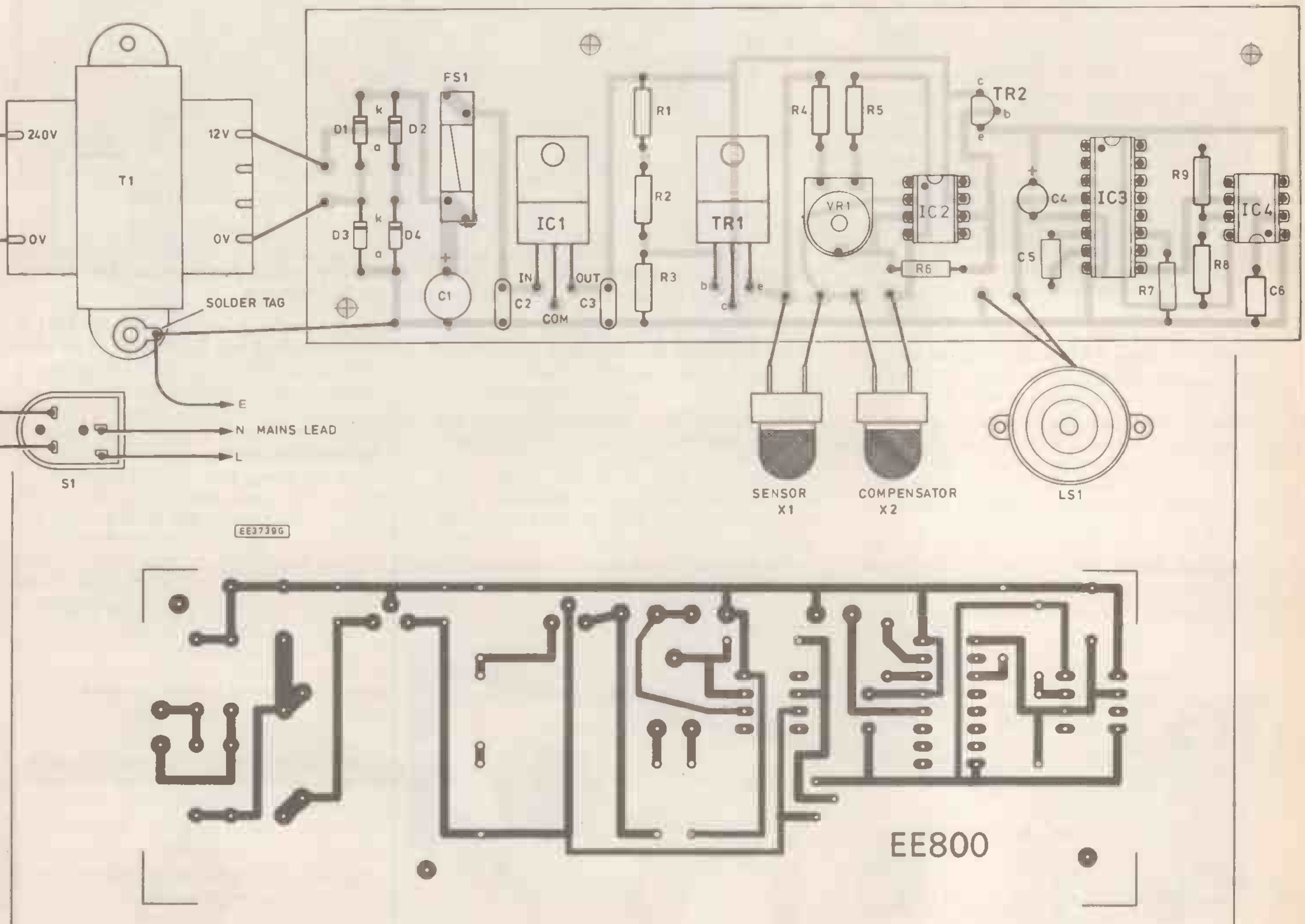
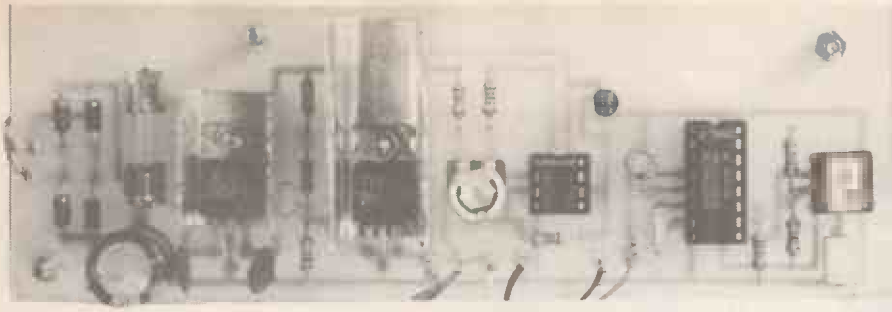


Fig. 3. Printed circuit board component layout, interwiring and full size copper foil master pattern for the Gas Alarm.



The completed circuit board showing the two heatsinks clamped to the semiconductors.

They can only do this with the aid of heatsinks. As the dissipation figures are not very high, there is no need for any large or elaborate heatsinks. The small ready made type for TO-220 and similar devices will suffice provided there is sufficient space on the board (some have bigger "footprints" than others).

Alternatively, "U" shaped heatsinks can be fabricated by the constructor from 18s.w.g. or 16s.w.g. aluminium. The thicker (16s.w.g.) grade is preferable for this type of thing, but 18 s.w.g. aluminium is much easier to work. Suitable heatsink designs are provided in Fig.4 (the larger one is for TR1).

It is advisable to use a smear of heatsink compound or a substitute to ensure that there is a good thermal contact between each heat-tab and its heatsink. Note that these heatsinks represent about the minimum that will prevent TR1 and IC1 from overheating. The heatsinks are bolted in place using M3 nuts and bolts, and it is a good idea to bolt the heatsink and transistor or integrated circuit to the board so that everything is securely held in place.

An alternative method of heatsinking is to mount TR1 and IC1 off-board, and to hard wire them to the board. They can then be mounted directly on the metal case, or on the case via a simple "L" shaped mounting bracket if preferred. This will provide them with a substantially more than adequate degree of heatsinking, but is a less neat solution.

If this method is adopted it is *essential* that transistor TR1 should be fitted with an insulating kit. Otherwise the + 12 volt supply carried by its heat-tab will short circuit to the case which is at the 0V supply level. Use a continuity tester to make sure that the insulation is fully effective. The tab of IC1 is at the 0 volt supply level, and therefore this device does not require an insulating kit.

CASE

A metal instrument case about 220 millimetres or more wide and 65 millimetres or more high should comfortably accommodate all the parts. The front panel layout has (from left to right) switch S1, the Sensor, the Compensating Element, and Sounder LS1 mounted in a neat line. A hole for the mains lead is drilled in the rear panel opposite S1, and this should be fitted with a grommet to protect the cable.

The sensor and the compensation element look much the same, but they have coloured dots so that you can tell which is which. The compensation element has a blue spot, while the sensor will probably have two or three spots of different colours.

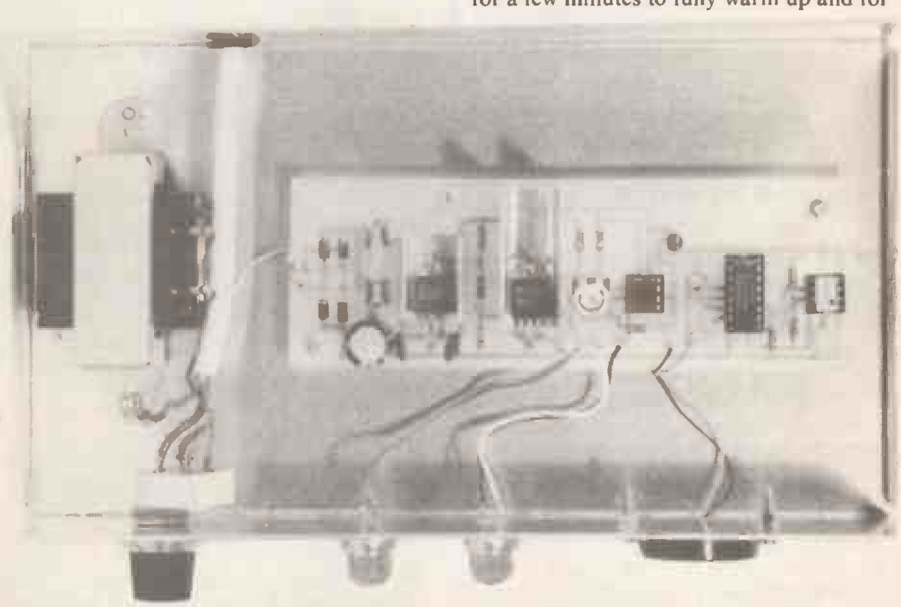
There is no obvious means of panel mounting these two components, and matching panel holders do not seem to be available. Simply drill holes about three millimetres in diameter to take their pin-type terminals, and then glue them on the panel using an epoxy adhesive. With this method you *must* make sure that *none* of the pins short circuit to the metal case.

The sounder LS1 is easier to deal with if it is mounted on the front surface of the front panel. It then requires two small mounting holes for the fixing screws, and one to permit the flying leads to pass through to the interior of the case. Use LS1 as a template when marking the positions of these holes on the panel.

The mounting holes in LS1 are for very small screws (8BA or similar). It might be better to carefully enlarge the holes slightly so that bigger mounting screws (6BA or similar) can be used.

The printed circuit board is mounted on the base panel of the case well towards the right hand side, leaving plenty of space for transformer T1 to its left. A solder tag is mounted on one of T1's mounting bolts to provide an "earthing" point for the mains Earth lead. For safety reasons the case MUST be earthed to the earth lead of the mains cable.

The small amount of point-to-point wiring is also included in Fig. 3, and this is all pretty simple. However, with any mains powered circuit you must take extra care to get everything right. Also, make sure that all the soldered joints are of good quality, and perfectly reliable.



Layout of components inside the metal case. The mains transformer and switch connecting tags should be covered with insulating sleeving.

TESTING AND USE

To set up the Gas Alarm, start with preset VR1 and set it at a roughly the middle of its adjustment range. At switch-on the alarm generator may be activated, but do not worry if it is not. You should find that the alarm can be switched on and off by adjusting VR1 in a clockwise and a counter-clockwise direction respectively. If adjustment of VR1 does not have the desired effect, switch off immediately and recheck all the wiring.

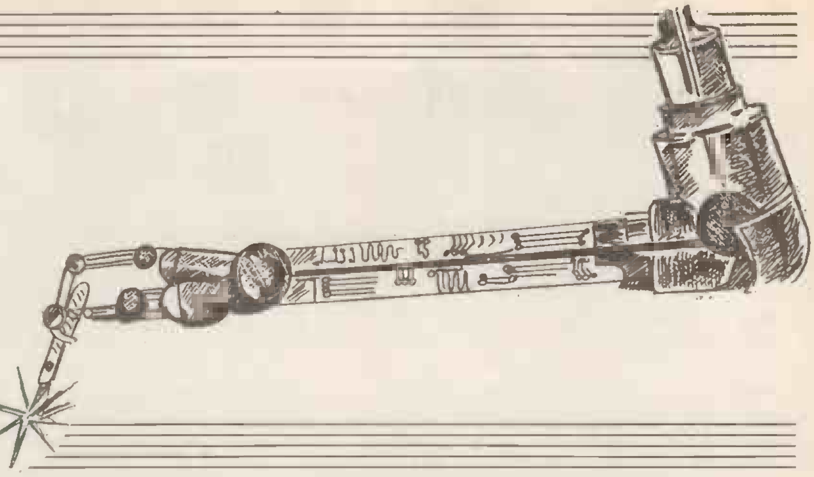
Assuming that all is well, leave the unit for a few minutes to fully warm up and for the d.c. levels to stabilise. Preset VR1 is then backed-off just far enough in an anti-clockwise direction to switch off the alarm. The unit is then ready for use.

The unit can be tested by subjecting it to a localised dose of inflammable gas or vapour. You should obviously take due care when doing this, but the gauze coverings on the sensor and compensation element should ensure that their heating elements cannot ignite the gas or vapour.

When the prototype was tested it even responded to fumes from a spirit based cleaning fluid, and to turpentine vapour. It will probably respond to just about anything inflammable in the atmosphere, and at concentrations below the level at which there is any risk of ignition. □

Regular Clinic

CIRCUIT SURGERY



MIKE TOOLEY B.A.

Welcome again to Circuit Surgery, our regular clinic for readers' problems. In this month's Surgery we shall be describing an improved low-battery warning indicator based on an operational amplifier. We also answer a query concerning the use of BNC coaxial connectors and illustrate the "definitive" method for terminating a standard "TV aerial connector". For good measure, we have also included a simple BASIC computer program which can be used to design astable and monostable 555 timer circuits.

Improved Battery Warning

A number of readers have sent in comments and suggestions concerning the low-battery warning indicator which was described in the June *Surgery*. One of the principal disadvantages of this circuit is the lack of any pre-set adjustment to determine the threshold of voltage at which the unit illuminates the l.e.d.

Jim Forester, a regular EE reader, has suggested that an improved low-battery warning indicator could be based on the comparator arrangement shown Fig. 1. I have taken this idea to heart and the resulting circuit is shown in Fig. 2. This circuit provides a very much more definite switching action as the threshold voltage is reached and can provide useful indications for battery supply voltages of between 6V and 15V (by means of an appropriate setting on VR1).

A further possibility is shown in Fig. 3. This circuit uses a low-cost piezo-electric transducer to provide an audible (rather than visual) indication that the battery is about to fail. The additional transistor, TR1, provides the extra current drive (up to 100mA) which may be required by certain larger transducers. Small p.c.b. mounted transducers, on the other hand, will normally require currents of no more than around 15mA to 20mA. In such cases, R4 and TR2 can both be omitted and the transducer can simply replace D2 and R3 in the circuit of Fig. 2.

Coaxial Connectors

Alan Brown writes from Wrexham to ask for some clarification concerning the selection of coaxial connectors for r.f. and test equipment. Alan writes:

"I have a number of items of test equipment which use BNC-type connectors. These all seem to be 50 ohm types but I understand that 75 ohm BNC connectors are also available. Does this rating actually matter and could you also tell me what advantages BNC connectors offer when compared with alternative types."

Well Alan, this is an interesting question which will require a fairly lengthy answer to really do justice to it! BNC connectors seem to have become universally fitted to most items of "quality" test equipment. Such equipment includes oscilloscopes, r.f. and pulse generators, wideband voltmeters, etc.

BNC connectors are designed to preserve a constant impedance (either 50 ohms or 75 ohms depending upon the series) within a system based on coaxial (screened) cables. The connectors are locked into place by means of a simple but effective bayonet locking action. BNC connectors are rated for operation at peak voltages of up to 500V and at frequencies up to 4GHz. This makes them ideal for wideband and r.f. applications at v.h.f. and u.h.f.

The 50 ohm BNC series is commonly used for general purpose test equipment, r.f. signal generators, and for the aerial connection to v.h.f. and u.h.f. transceivers. The 75 ohm series is invariably used with video equipment such as cameras, monitors and waveform generators.

The 50 ohm and 75 ohm series are identical save for one vitally important difference; the diameter of the terminating pins and their matching receptacles. The 50 ohm inner terminating pin is noticeably

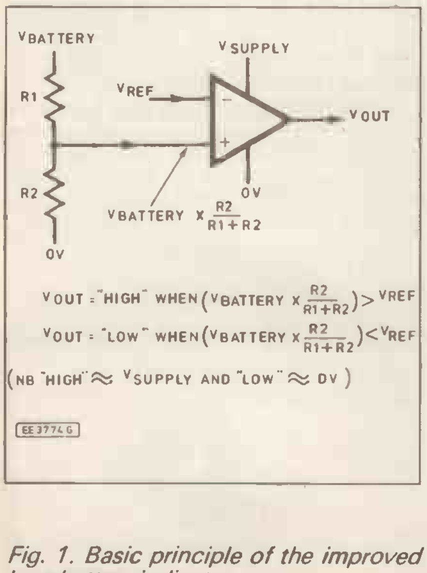


Fig. 1. Basic principle of the improved low-battery indicator.

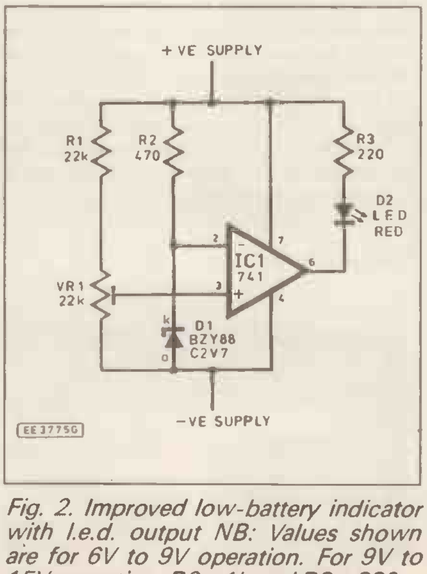


Fig. 2. Improved low-battery indicator with l.e.d. output NB: Values shown are for 6V to 9V operation. For 9V to 15V operation, R2 = 1k and R3 = 330.

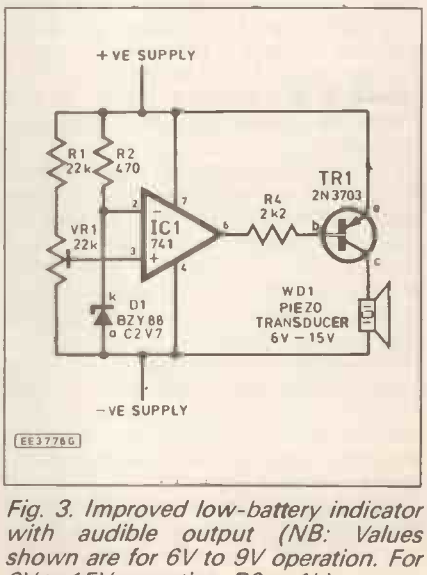


Fig. 3. Improved low-battery indicator with audible output (NB: Values shown are for 6V to 9V operation. For 9V to 15V operation, R2 = 1k).

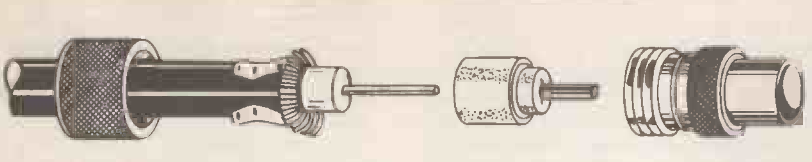


Fig. 4. The "definitive method" of fitting standard TV coaxial connectors.

larger in diameter than its 75 ohm counterpart and hence it is inadvisable to attempt to mate a 50 ohm plug with a 75 ohm socket!

Impedances (either 50 ohm or 75 ohm) are now generally marked on the outside of the body of individual BNC connectors. Alternatively, manufacturers' part numbers are invariably different for 50 ohm and 75 ohm variants of each connector type.

In conclusion, BNC connectors are an excellent choice for test equipment on both mechanical and electrical grounds. For some applications they can, however, be a little expensive and it may be worth considering alternative connector types for less critical applications. Finally, it is worth making sure that you don't "mix and match" 50 ohm and 75 ohm types!

Low-cost Coaxial Connectors

Alan Brown's query concerning BNC connectors has prompted me to review my own use of a wide variety of different types of connector within my own workshop. After a quick tour of each item of equipment I discovered no less than nine different types of connector (including BNC, TNC, N-type, SMA, SMB, F-type and the good old "u.h.f."/PL-259 series). This awesome muddle is greatly aided by a variety of "inter-series" adapters (without which inter-connection of test gear would be virtually impossible!).

Some years ago as an impecunious student I searched for a readily available coaxial connector which could be fitted to virtually any item of equipment and which would not cost an "arm and a leg". After considering several common types, I settled on the "cheap and cheerful" coaxial "TV aerial connector". This offers reasonably good performance up to 300MHz (with reduced performance to 900MHz), can reliably handle r.m.s. power levels of up to 50W, and costs very much less than any of the alternatives. Furthermore, despite the fact that this type of connector is designed for use with 75 ohm systems the consequence of mis-matching it with 50 ohm cables and terminations is usually quite negligible.

This type of connector was originated by Belling-Lee and is available from most high-street electrical and DIY stores as well as from all of the usual electronic catalogue suppliers. Provided they are of the all-metal soldered variety and are terminated correctly, they can be extremely reliable and mechanically durable.

The connectors are suitable for a wide range of applications (not just r.f.). Indeed, I must confess to having used them as a low-cost alternative to BNC connectors on a number of occasions (including some test gear and audio equipment).

Unfortunately, few people seem to know how this common type of connector should be fitted and this often gives rise to problems. Indeed, I never cease to be amazed at the peculiar attempts that people make at fitting them. To put the record straight, Fig. 4 shows the "definitive method" (note that the outer braid is trimmed, then fanned out and effectively trapped (without soldering) between collar/cable-grip and the inner plastic insulator. After tightening, the outer braid is firmly locked and solder should be carefully run into the centre pin before trimming the inner conductor.

The 555 Timer

Lawrence Inwood has written to point out a problem in our 1991 *Teach-In*. Regular readers will doubtless recall that this series was entitled *Design Your Own Circuits* and Part 6 was devoted to Timers. Lawrence writes:

"I find the 555 timer to be one of the most useful of all integrated circuit devices and have used it for everything from timing an egg to generating accurate pulse waveforms. I do find the maths a bit difficult to grasp and thus very much welcomed the two nomographs which were provided in the article.

Unfortunately I have not been able to make much sense of the astable nomograph – the values it suggests give rise to a 2:1 error in operating frequency. Can you help?"

Thanks for pointing this out, Lawrence. You have discovered a rather unfortunate error in the heading printed above the right hand column (the resistance axis) of Fig. 6.8. This should read: "R = R1 + R2" not "R = R1 = R2". Hopefully this will put the matter right and you can now use the nomograph with some confidence!

On a related matter, *Andrew Jones* (a teacher of GCSE Control Technology) has asked if I can suggest a computer program for designing timer circuits. Andrew writes:

"We have an 80386SX IBM compatible PC in the classroom and this operates with MS-DOS Version 5. We don't yet have any programming languages but we understand that Microsoft QuickBASIC would do the job. Please suggest how we might go about this as my pupils need to use the PC for their projects (which involve the use of a 555 timer i.c.)."

Fortunately, this is an easy one! The following listing (written in Microsoft QuickBASIC) should do the job:

```
'
' 555 timer circuit designer
'
' Initialise
'
ON ERROR GOTO warning
SCREEN 0
COLOR 1, 2, 3
ul$ = STRING$(31, CHR$(205))
'
' Display menu
'
DO
  main:
    CLS
    PRINT ul$
    PRINT "555 TIMER I.C. CIRCUIT
DESIGNER"
    PRINT ul$; " "
    PRINT " Select timer
configuration.."
    PRINT " [M] = monostable mode"
    PRINT " [A] = astable mode"
    PRINT " [Q] = quit"
    DO
    r$ = UCASE$(INKEY$)
    LOOP UNTIL r$ < > " " AND
INSTR("MAQ", r$)
    IF r$ = "Q" THEN CLS : END
    PRINT ul$
    IF r$ = "M" THEN GOSUB
monostable
    IF r$ = "A" THEN GOSUB astable
LOOP
'
monostable:
PRINT " Monostable timer
configuration.."
INPUT " Timing period (in ms)"; t
'Recommend a value for c
crec = t / 100
crec = INT(1000 * crec) / 1000
PRINT ul$
PRINT " Recommended value for the"
PRINT " timing capacitor is";
PRINT USING "###.###"; crec;
PRINT " uF"
PRINT ul$
r = 0
WHILE r > 1 * 10^3 OR r < 1
   INPUT " Capacitor value (uF)"; c
   r = t / (1.1 * c)
   PRINT ul$
   PRINT " Timing resistor = ";
   PRINT USING "######.#"; r;
   PRINT " kohm"
WEND
GOSUB waitkey
RETURN
'
astable:
PRINT " Astable timer configuration..."
INPUT " Capacitor value (uF)"; c
PRINT ul$
PRINT " NB: High time MUST be
greater"
PRINT " than low time..."
PRINT ul$
t1 = 0
t2 = 1
WHILE t1 < 1.05 * t2
   INPUT " High output time (ms)"; t1
   INPUT " Low output time (ms)"; t2
WEND
r2 = t2 / (.693 * c)
r1 = t1 / (.693 * c) - r2
f = 1.44 / ((r1 + (2 * r2)) * c)
PRINT " R1 = ";
PRINT USING "######.#"; r1;
PRINT " kohm"
PRINT " R2 = ";
PRINT USING "######.#"; r2;
PRINT " kohm"
PRINT " P.r.f. = ";
PRINT USING "###.###"; f;
PRINT " kHz"
GOSUB waitkey
RETURN
```

Continued overleaf

```
waitkey:
PRINT ul$
PRINT " Press any key to continue..."
DO
    r$ = INKEY$
    LOOP UNTIL r$ < > ""
RETURN

warning:
PRINT ul$
PRINT " An error has occured!"
GOSUB waitkey
RESUME main
```

The foregoing program can very easily be adapted for other dialects of the BASIC language. Many readers will probably be more familiar with GWBASIC than QuickBASIC (supplied with the MS-DOS 5 package) and the program can be very easily modified by simply adding line numbers to the beginning of each statement and replacing the labels (**main, monostable, astable, waitkey** and **warning**) by line numbers followed by a **REM** statement.

Finally, if any reader would like a copy of the source code for the program together with a fully compiled (.EXE) version, just send a blank formatted disk (either 3½in. or 5¼in.) and a stamped addressed envelope to the address given at the end.

Next month: In next month's Surgery we shall be attempting to unravel the mystery of the SCART connector. We also have some useful information concerning the selection of fuses for a variety of applications and include a novel circuit for testing inductors.

In the meantime, if you have any comments or suggestions for inclusion in *Circuit Surgery*, please drop me a line at: Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT. Please note that I cannot undertake to reply to individual queries from readers however I will do my best to answer all questions from readers through the medium of this column.

EVERYDAY READOUT

GET CONNECTED

Dear Ed.,

One of our junior members recently built the *Low Cost Capacitance Meter* described in the article by Steve Knight in your Sept 1991 issue. He wrote to me before starting on the project and I was able to supply him with a meter and most of the components he needed. Now I don't imagine your contributor, Steve Knight, uses such a simple piece of equipment to measure capacitance; he is after all an experienced technical writer, and probably has a very well equipped workshop. As I pointed out to our young member, you simply cannot connect most modern capacitors to a pair of terminals as fitted to the meter described.

A long time ago I built the *Digital Capacitance Meter* described by Mark Stuart in EE for December 1985. The illustration of this in EE showed a pair of crocodile clips for connection to the capacitor. I'm no great lover of crocodile clips, which have a tendency to come off at an awkward moment, but they are more practical than terminals, which are also much more expensive.

Just before Christmas I got a new digital multimeter which has capacitance ranges, and this has two four-way socket strips with 0.1 inch spacing, into which you can plug most of the modern small capacitors with short leads. When I built the *EE Digital Capacitance Meter* I fitted such a socket strip to it, with short crocodile clip leads in parallel, and this caters for all types of capacitor. I have had to make an adapter for my new digital capacitance meter in the form of a plug (made from a couple of ordinary pins through a strip of s.r.b.p.) with attached crocodile clip leads to provide the same facility.

As you know, I always look critically at projects to see where one can cut costs, and I also look at them from the point of view of the user rather than the designer, who may overlook some of the practical problems of the constructor and user. Before I took over the running of the B.A.E.C. I used to write for the Newsletter articles under the heading *Notes from an Experimenter's Workshop*, which you may have come across in the copies Cyril Bogod sent you. The idea was to pass on to beginners and others some of the practical experience gained over a lifetime of electronic experimenting; one doesn't get enough of this in any of the electronic magazines nowadays, although I know you publish articles by Robert Penfold entitled *Actually Doing It*. However, he builds most of his projects on breadboards, and I deduce from his writing (and I think he would probably agree) that his skills are stronger on the electronic than on the mechanical construction side. There is a lot of useful stuff in George Hylton's *Down to Earth* articles.

I can't help feeling that some project builders would benefit by spending less on components and more on tools, and take time to get experience in their use. But I recognise that finding workshop space in the average modern house can present problems – to put it mildly. One would hope that with the growing importance of technology as a school subject the number of people with the ability to design equipment and use tools would steadily increase.

I suppose one must recognise that ancient practitioners of the electronic art, like me, who were building projects long before the p.c.b. and kit era, involving chassis bashing and other workshop skills, may feel that present day project builders find the hobby rather easier, but possibly less interesting and more expensive.

H. F. Howard
Chairman, B.A.E.C.

The B.A.E.C. is a non-profit making club for everyone interested in electronics. We carry a small advertisement for the club (space donated by EE) in most issues, you can find this on the Classified Advertisement page.

COMPUTER MALFUNCTION

Dear Ed.,

In reply to J. Conners of Cambridge, *Everyday Readout*, July, and his problem with computer malfunction. Unless he lives close to a powerful radio or radar transmitter, an airport for example, or he has an industrial site next door, I would advice him to examine his home (or neighbours) environnment as almost all mains interference is generated in house so to speak.

Bearing in mind that the only items of electrical equipment which are not generators of interference are the tungsten filament light bulb, squirrel cage induction motors and static transformers, I would first of all check all my appliances for correct functioning and rectify faults or junk dicey looking items.

Thermostats, even those in good condition, are great voltage spike generators so on days he runs his computer he should send his wife home to mum to do the family ironing and switch off the immersion heater.

Portable mains filters are a good idea, three-pin plug-in types being available either in top of the range items such as supplied by Kleanpower of Oxon, or four-way filtered sockets such as are made by MK.

R. Whitaker
Halifax

WRITE IN

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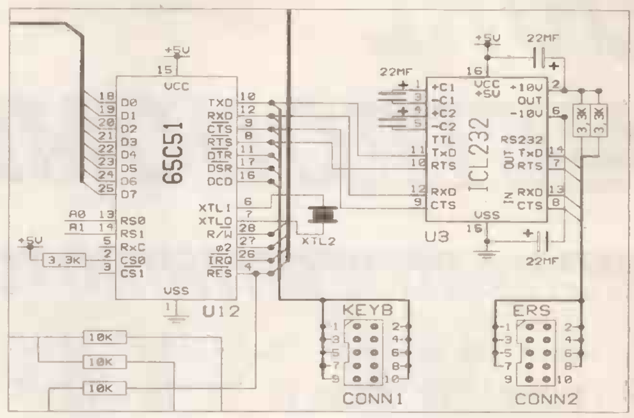

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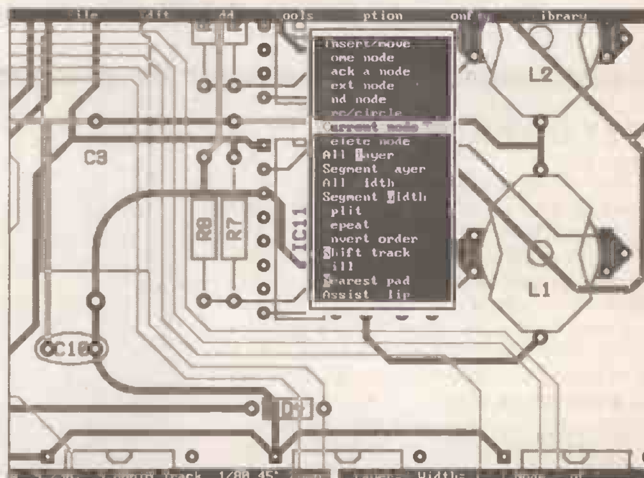

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HIGHLIGHTS

Hardware:

- IBM PC, XT, AT or 100% compatible.
- MSDOS 3.x.
- 640K bytes system memory.
- HGA, CGA, MCGA, EGA or VGA display.
- Microsoft or compatible mouse recommended.

Capabilities :

- Integrated PCB and schematic editor.
- 8 tracking layers, 2 silk screen layers.
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- 2000 components per layout. Symbols can be moved, rotated, repeated and mirrored.
- User definable symbol and macro library facilities including a symbol library editor.
- Graphical library browse facility.
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- Real-time DRC display - when placing tracks you can see a continuous graphical display of the design rules set.
- Placement grid - Separate visible and snap grid - 7 placement grids in the range 2 thou to 0.1 inch.
- Auto via - vias are automatically placed when you switch layers - layer pairs can be assigned by the user.
- Blocks - groups of tracks, pads, symbols and text can be block manipulated using repeat, move, rotate and mirroring commands. Connectivity can be maintained if required.
- SMD - full surface mount components and facilities are catered for, including the use of the same SMD library symbols on both sides of the board.
- Circles - Arcs and circles up to the maximum board size can be drawn. These can be used to generate rounded track corners.
- Ground plane support - areas of copper can be filled to provide a ground plane or large copper area. This will automatically flow around any existing tracks and pads respecting design rules.

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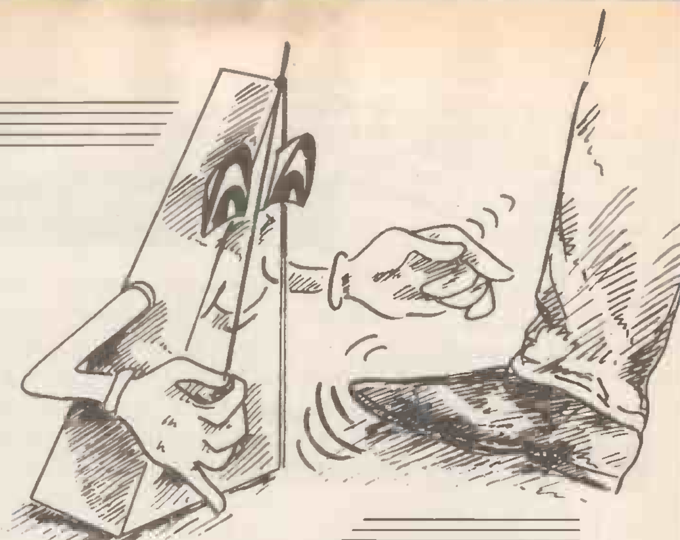
Constructional Project



DUAL METRONOME

RICHARD WORTHINGTON

An invaluable teaching aid. Tap out that rythm with this novel timekeeper and hit the high spots!

THIS PROJECT describes a new type of metronome, with features which should prove both useful and convenient.

Conventional designs allow a numerical value of "beats-per-minute" to be selected, and provide a clear, audible time signal – that part remains the same in this design.

This circuit's *principal* feature, however, is that it's also activated by just tapping out the required beat (a piezo sensor detects the pressure pulse from each individual "tap"). Just two taps will define the desired speed, which the circuit measures and instantly "memorises". It then continues to beat time, out loud, at that same rate.

To name just a few examples, this new feature should prove very useful in such applications as:

- ***A teaching aid.***
- ***When practising difficult music at reduced, but constant*** **speed.**
- ***To pick up the speed of a piece of music from a recording – for guidance when practising that piece.***
- ***To impose a constant speed while practising at, for example, sight-reading.***

A "pause" facility is also provided, using a second piezo sensor – tap once to Pause, and once again for normal operation.

HOW IT WORKS

An outline of the circuit for the Dual Metronome is provided in the block diagram Fig. 1. The two pressure sensors – no more than ordinary, unhoused, piezo elements – each trigger one voltage comparator, thereby controlling the two flip-flops. The first of the flip-flops activates the "Pause" facility; the second directs clock pulses to either one of two 8-bit binary counters, through a 2-way CMOS switch.

One counter acts as the basis for the memory of the circuit, storing a number in the range 0-255 which corresponds to the measured time interval between the "taps". The second counter, together with the binary comparator, use this number when the circuit takes over beating time by itself.

The regular output pulses of the binary comparator briefly trigger the audio tone generator, provided that (a) the Pause facility is off, and (b) the circuit isn't still waiting for the second "tap". The audio tone generator can also be triggered by the "slow oscillator", to obtain a conventional metronome action controlled by potentiometer VR2.

CIRCUIT DESCRIPTION

The circuit diagram for the Dual Metronome is shown in two sections for convenience, split between Fig. 2 and Fig. 3. The main diagram, Fig. 2 shows half of the total number of i.c.s involved in the circuit. These include op-amps, flip-flops, NAND gates and multiplexers. The memory circuit, illustrated in Fig. 3, makes up the rest of the i.c.s and consists of the counters and 4-bit comparators (IC5 to IC8).

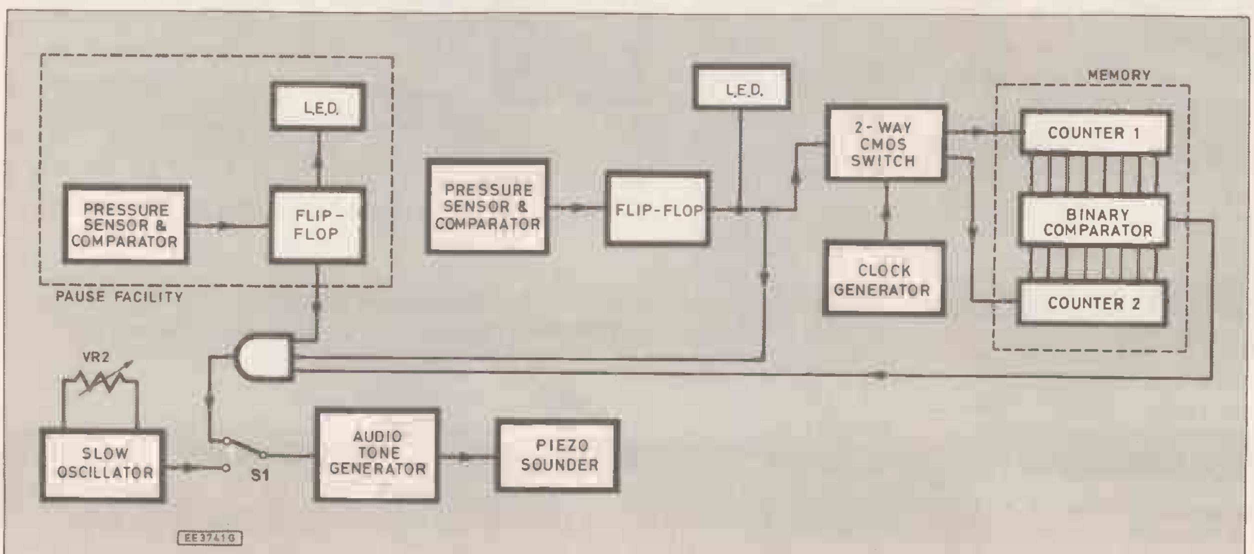
To begin, X1/IC1a/IC2a detect the pressure of each tap, as mentioned earlier. The non-inverting input (pin 3) of op-amp IC1a is biased to half the supply voltage, and preset VR1 is adjusted so that the voltage change generated by tapping sensor X1 results in the op-amp changing state; i.e. it acts as a voltage comparator.

The JK flip-flop IC2a is configured as a T-(or toggle) flip-flop by connecting both the J and K inputs to battery positive. The outputs therefore change state with each incoming clock pulse (and similarly for X3/IC1b/IC2b, which is identical).

Since the SET inputs (pin 7 and pin 9) of both IC2a and IC2b are taken to battery negative (0V), the RESET pulse – generated by C7/R20 at switch-on – ensures that the $\overline{Q}$ output of each is initially high. Referring to IC2a, this means the Pause facility is switched off and l.e.d. D2 remains unlit.

Turning now to IC2b, its output $\overline{Q}$ is also high at switch-on and (due to the clock pulses applied to Input 1 of the memory –

Fig. 1. Block diagram for the Dual Metronome. The "conventional" metronome action is controlled by the slow oscillator.



see Fig. 3) Counter 1 is continuously incrementing 0→255, 0→255 ...; initially, the circuit is just silently counting time. Output Q is low, hence l.e.d. D3 (connected to inverter IC4b) is lit, and the output of CMOS switch IC3b is held low by a pull-down resistor R14.

(Note: to minimise numbers of i.c.s, the CMOS switches IC3a and IC3b are used like 2-input AND gates – see Fig. 4a – and op-amp IC1d is used as a simple inverter. The CMOS switches are capable of passing current in both directions, and the chosen arrangement depends only on p.c.b. layout considerations).

Now, if piezo sensor X3 is tapped, flip-flop IC2b changes state as expected. Clock pulses pass instead to Counter 2 (see Fig. 3), via Input 2, and whatever value was on Counter 1 remains stored.

The third oscillator, "the conventional metronome circuit", uses one of the op-amps of IC1 (LM324). The design is standard, but with diode D1 and resistor R5 to decrease the charge time of capacitor C1.

The voltage across the capacitor C1 is compared with that across resistor R7, produced by the potential divider R7/R8. Rotary potentiometer VR2 sets the frequency of oscillation. The resulting waveform, with a much reduced mark-to-space ratio, is used to control IC4a via switch S1, producing short "bleeps" at a rate of 40-200 beats-per-minute.

MEMORY AND RESET

The memory section circuit, Fig. 3, of the Metronome is quite straightforward. Each of the counters consists of two CMOS 4-bit Binary up-counters, with output Q4 of the first (pin 6) connected to the enable input (pin 10) of the second to form an 8-bit counter. The maximum reading is, therefore, binary 11111111 (decimal 255). The "clock" inputs (pins 1 and 9 of IC5 and IC8) are connected to ground (0V) so the counters are triggered on the negative-going transition.

The outputs of the counters are compared by two 4-bit binary magnitude comparators. Each comparator has outputs corresponding to A > B, A = B and A < B, where A and B are binary numbers. However, the comparators are cascaded and just one overall output, A = B, is actually used.

The reset circuitry (see Fig. 2) consists of C3/R18/D4, C5/R17/D5 and C6/R19/D6. The first two of these are

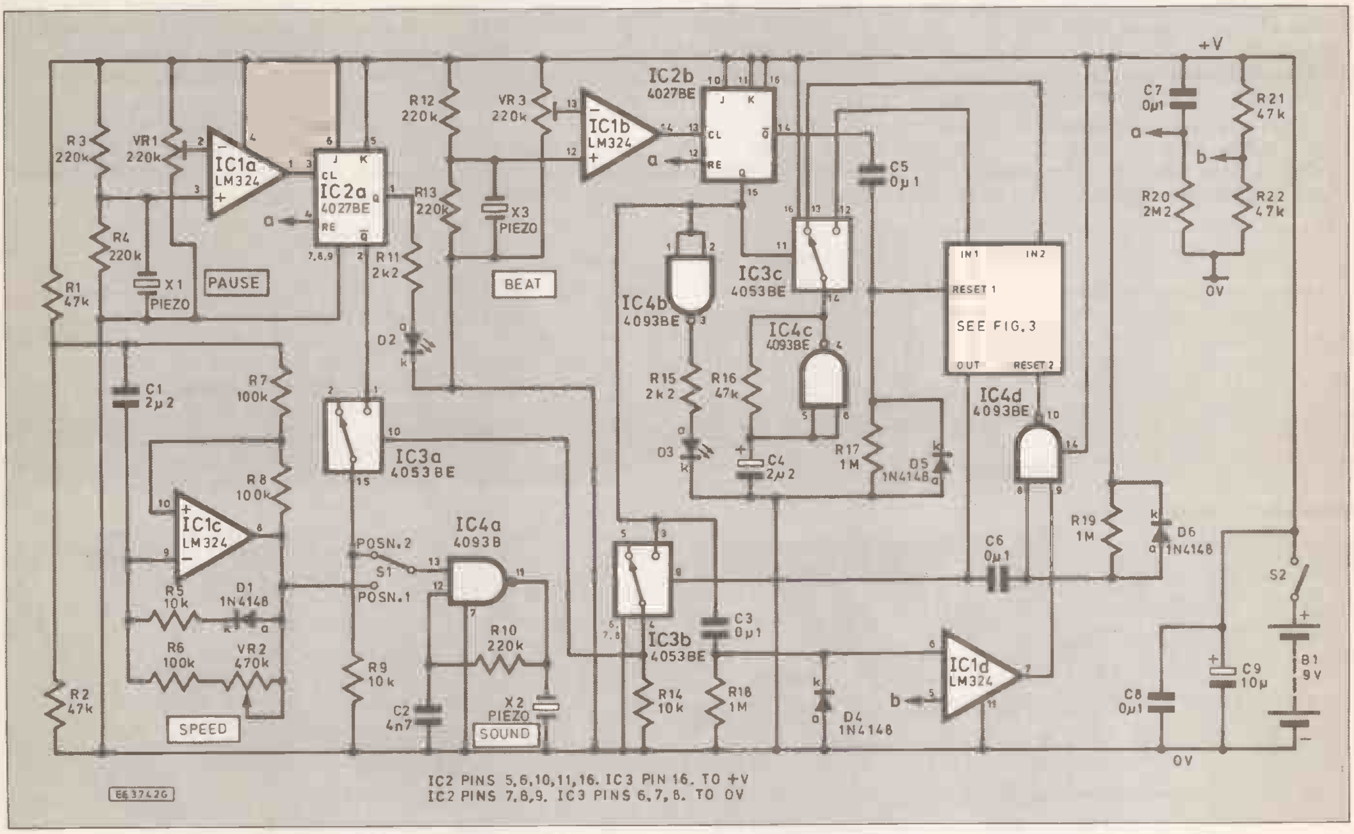


Fig. 2. Main circuit diagram for the Dual Metronome. The rate of the conventional metronome is set by VR2.

Counter 2 now counts up from zero and, whenever the values on the two counters are equal, the overall output (IC7) of the "memory" goes high. The "control" input of CMOS switch IC3a consequently goes high via IC3b and, depending of the state of flip-flop IC2a (i.e. the Pause facility), the audio tone generator IC4a sounds.

Counter 2 continues to increment, however, and the tone generator is switched off a fraction of a second later, just as Counter 2 is resetting to zero. The process repeats continually until, for example, the user taps sensor X3 once more, in order to set a new speed.

The circuit uses a total of three square-wave oscillators. The clock generator, which runs at a few tens of Hertz, is provided by IC4c/R16/C4, while the audio tone generator consists of IC4a/C2/R10. These both employ a commonplace Schmitt trigger type oscillator. Oscillation occurs because of the hysteresis of the inputs to the NAND gates (IC4a and IC4c), while the frequency depends on the time constant of the resistor and capacitor networks.

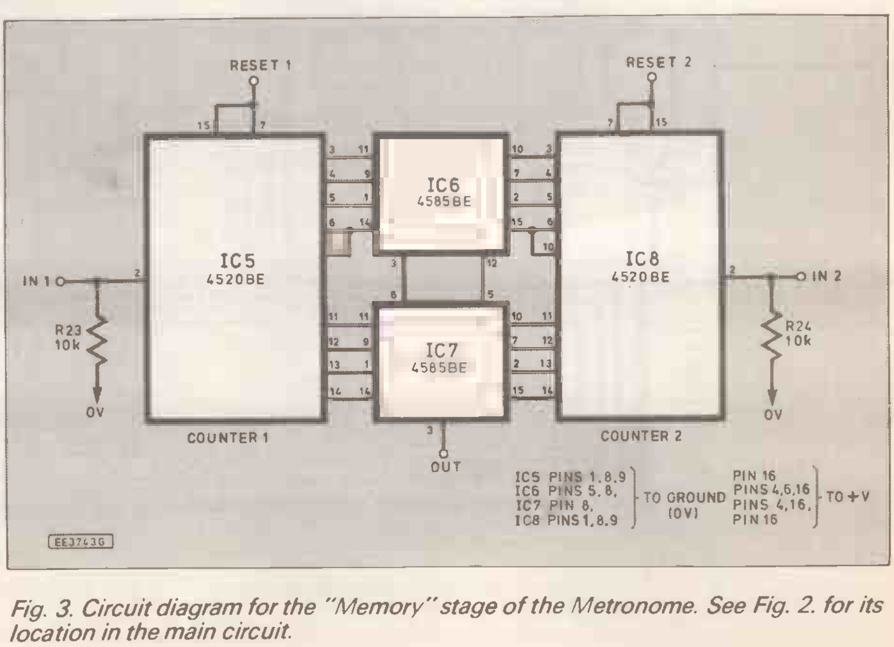


Fig. 3. Circuit diagram for the "Memory" stage of the Metronome. See Fig. 2. for its location in the main circuit.

connected to the Q and $\bar{Q}$ outputs (pin 15 and pin 14) of the flip-flop IC2b respectively; when one of the two outputs goes high, the associated *RC* network produces a Reset pulse – duration ≃70mS – while the capacitor of the other network discharges through a diode. The diodes D4-D6 prevent voltages significantly crossing the supply rails, also, the discharge time of capacitor C6 has to be shortened. (Note – D5 and D6 may, generally, be omitted on account of the built-in CMOS input protection diodes.)

Counter 2 must also be reset the instant it's value exceeds that stored on Counter 1. To permit this, the falling voltage at the output of the memory (when the condition A = B is lost) generates a low pulse at one of the inputs of NAND gate IC4d. "Inverter" IC1d, connected to the other input of the NAND gate, generates a 70mS low pulse whenever output Q of flip-flop IC2b goes high.

The truth table for this combination is given in Fig. 4b. Thus, when either or both of the NAND gate's inputs go low, it's output goes high to clear Counter 2.

Finally, note that the point marked 'a' sends the reset pulse to the flip-flops at switch-on and 'b' sets the threshold voltage for "inverter" IC1d.

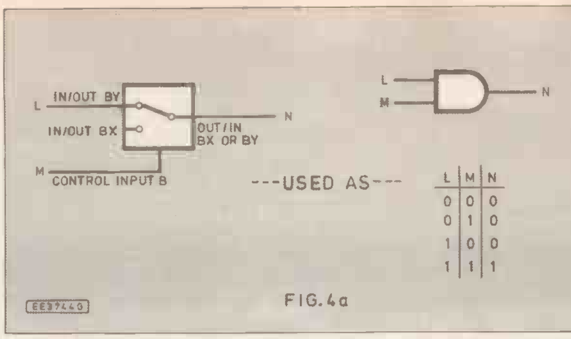


Fig. 4a. Use of IC3a and IC3b as AND gates.

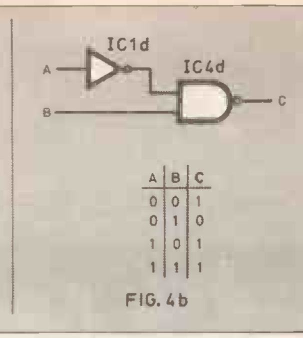


Fig. 4b. Truth table for RESET logic circuit.

CONSTRUCTION

The Dual Metronome is built on a single-sided printed circuit board (p.c.b.). The component layout and full size copper foil master pattern is shown in Fig.5. This board is available from the *EE PCB Service*, code EE801.

The overall dimensions are compact but, due to the scattered arrangement of the inputs on IC6 and IC7, the penalty is that a number of wire links are required and the orientation of the i.c.s varies. The short links can be made of uninsulated wire, but the three long ones are of plastic-coated or enamelled wire; the latter sort was used in the prototype unit. Note that two links pass beneath resistor R12, which is soldered in a vertical position.

Three very short links are also fitted to the track side of the p.c.b.; Fig. 6 gives full details. This is not the neatest method, but avoids the need for a double-sided circuit board.

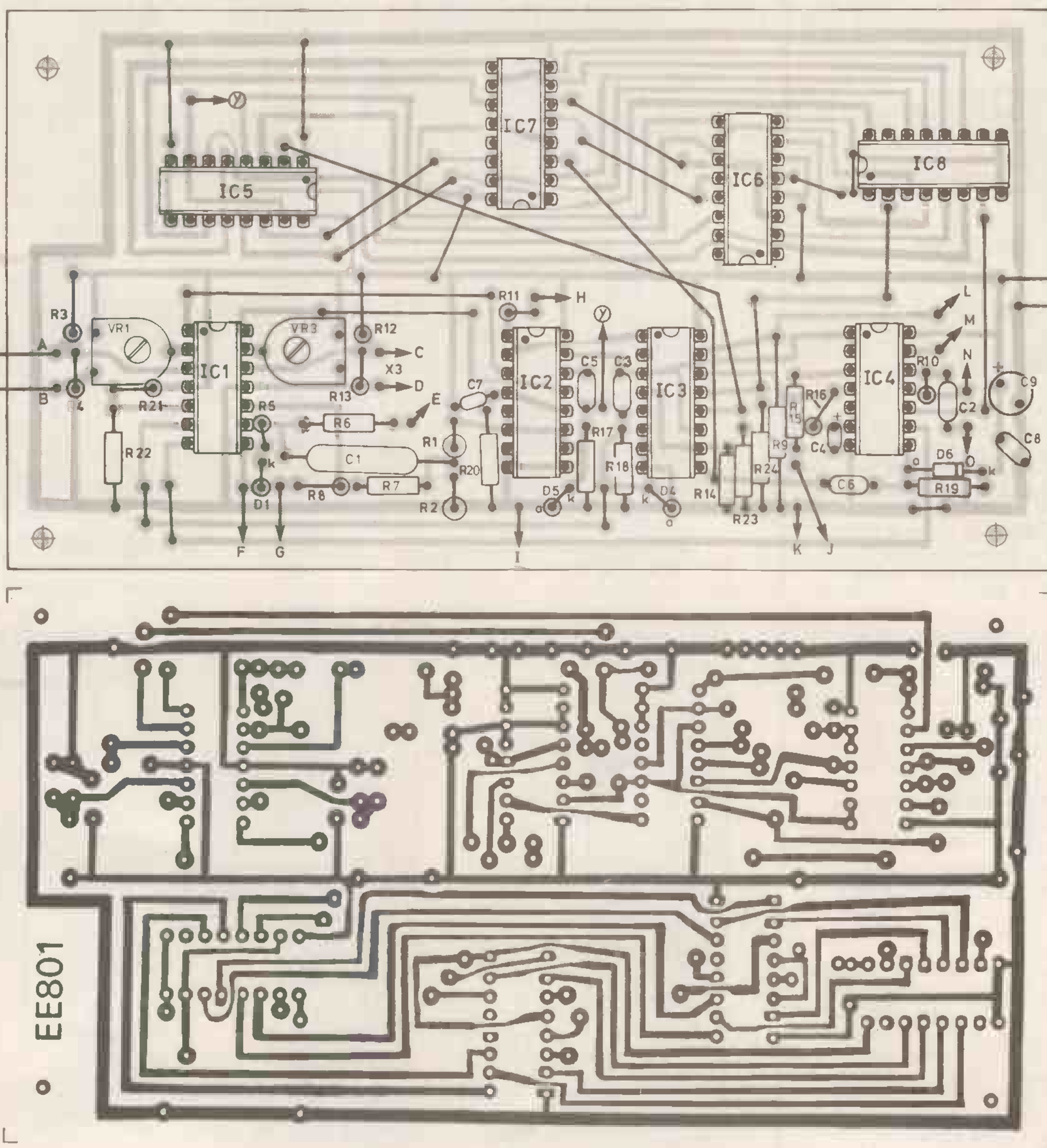


Fig. 5. Printed circuit board component layout and full size copper foil master pattern. The circled letters 'Y' are a single link wire.

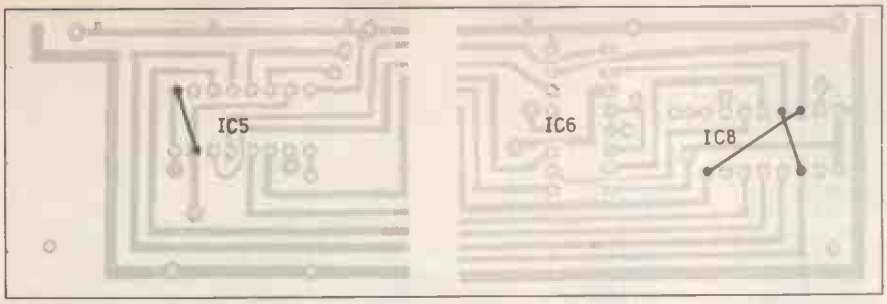


Fig. 6. Details of the underside link wires. These should be insulated leads.

COMPONENTS

Resistors

R1, R2, R16, R21, R22	47k (5 off)
R3, R4, R10, R12, R13	220k (5 off)
R5, R9, R14, R23, R24	10k (5 off)
R6, R7, R8	100k (3 off)
R11. R15	2k2 (2 off)
R17, R18, R19	1M (3 off)
R20	2M2

All 0·25W, 5% carbon

Potentiometers

VR1, VR3	220k min. enclosed preset, horizontal (2 off)
VR2	470k rotary carbon, lin.

Capacitors

C1	2μ2 polyester
C2	4n7 Mylar
C3, C5 to C8	0μ1 ceramic (5 off)
C4	2μ2 tantalum, 35V
C9	10μF radial elect. 16V

Semiconductors

D1, D4 to D6	1N4148 silicon diode (4 off)
D2, D3	Red 5mm l.e.d. (2 off)
IC1	LM324 quad op-amp
IC2	4027BE dual JK flip-flop
IC3	4053BE triple 2-channel multiplexer
IC4	4093BE quad NAND Schmitt trigger
IC5, IC8	4520BE dual binary counter (2 off)
IC6, IC7	4585BE 4-bit magnitude comparator (2 off)

Miscellaneous

X1, X3	Unmounted piezoelectric transducer element, 27mm dia. (2 off)
X2	Enclosed piezoelectric sounder
S1, S2	Miniature s.p.d.t. toggle switch (2 off)
B1	9V PP3 battery

Plastic case, size approx. 165mm x 102mm x 51mm; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (6 off); multi-strand connecting wire; 1mm plastic sleeving; single-core plastic-coated or enamelled wire; double-sided adhesive pads; PP3 battery clip; plastic p.c.b. mounting blocks (4 off – see text); fixing screws (4 off); control knob, approx 35mm dia. for VR2; offcut of stripboard, approx. 6 strips x 4 holes; l.e.d. clips (2 off); solder pins; solder.

Printed circuit board available from the *EE PCB Service*, code EE801.

Approx cost guidance only **£20**

The p.c.b. construction should be quite simple, with just a few points to note:

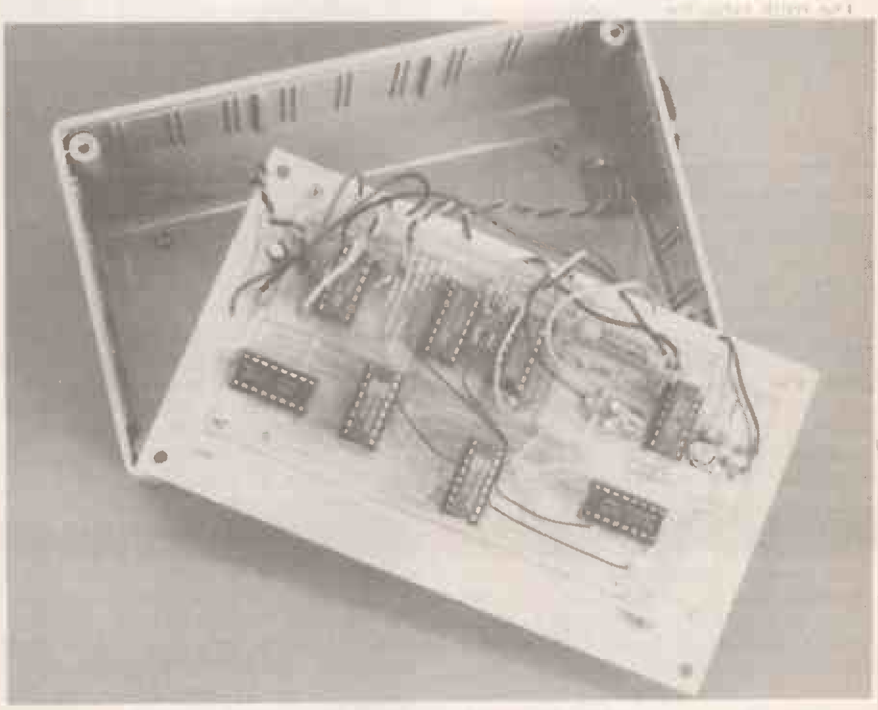
First, it's important that only the 4585B chip is used for IC6 and IC7. The functional equivalent, 4063B, has a completely different pin-out.

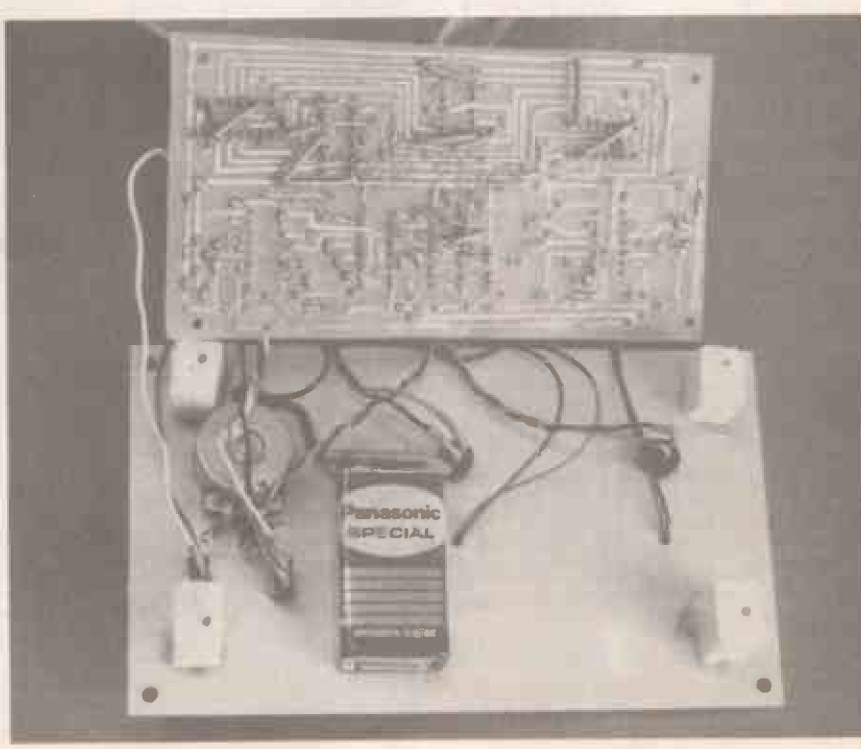
All the usual anti-static precautions should be taken when handling IC2 to IC8 as they are CMOS types. The pins of new i.c.s often need to be bent slightly inwards, to fit the i.c. sockets or the holes in the p.c.b.; use an "Earthed" metal surface, and try to avoid touching the pins while doing this.

Capacitor C1 needs to be a non-polarised type e.g., polyester, while C4 (also 2μ2) was a tantalum bead capacitor in the prototype unit; remember that C4 is polarity conscious. The remaining capacitors will, of course, need to be selected to fit the circuit board; for example the 0·1μF capacitors are the miniature ceramic multilayer type, with lead spacing 5·08mm (0·2 in.).

INTERWIRING

Details of the interwiring between the p.c.b. and panel mounted components are given in Fig. 7. All the connections should be of multistrand wire, and the type of "hook-up" wire – 7 x 0·2mm dia. copper – used in the prototype unit is ideal.





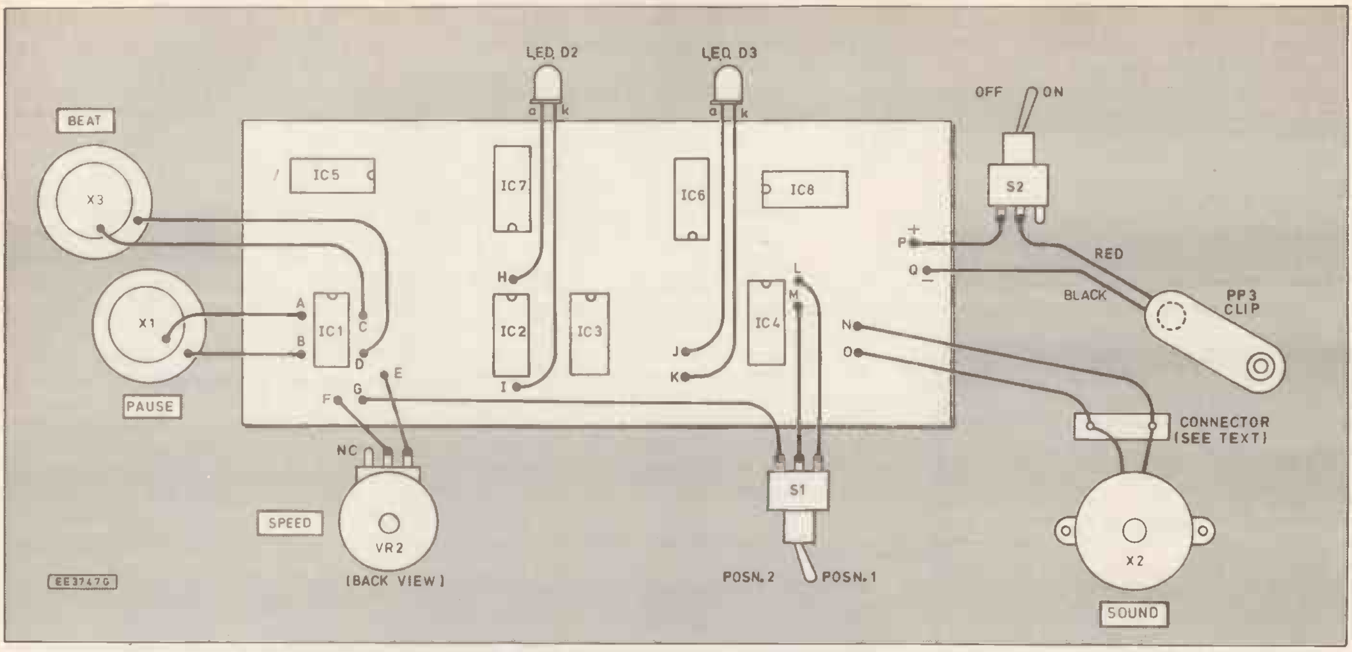


Fig. 7. Interwiring from the printed circuit board to all off-board components.

In Fig. 7, connections are shown leaving the p.c.b. in all four directions for clarity; in practice, however, all connections should pass across the same edge of the circuit board. This allows the board to be removed from its fixings and turned over for examination, without the need to unsolder connections.

The wiring-up process should not cause problems, despite the total of seventeen leads leaving the p.c.b. The wires run in groups of either two or three, and they should be twisted together or bound with cable ties to keep things tidy.

The use of p.c.b. solder pins (single-sided, 1mm diameter) is strongly recommended, and the joints are insulated and strengthened by 1mm plastic sleeving. The sleeving should be slid well back from the joints during soldering, since the p.v.c. begins to melt at a relatively low temperature, fusing to the insulation of the wire itself. All the wire/p.c.b. joints should be completed *before* starting to make the connections to the front panel mounted components.

First of all, the piezo transducers – the polarity of their connections is not significant but it is, obviously, important to match the correct transducer to each of the two l.e.d.s (i.e. D2 with X1, D3 with X3). Then, the l.e.d.s themselves must be connected the right way round; the cathode (k), indicated by a flattened side to the body of the device, and by the shorter lead, is wired directly to battery negative line in both instances.

The connections to front panel rotary potentiometer VR2 determine the direction of the scale for the Conventional Metronome circuit. The arrangement shown gives increasing "rate" with clockwise rotation of the control.

This leaves just the two s.p.d.t. toggle switches. When wiring up the function switch S1, make sure that connection "M" (see Fig. 7) goes to the central terminal of the switch. Check that none of the switch connections touch the circuit board; plastic sleeving can be used here also.

TRANSDUCERS

The piezoelectric transducer elements X1 and X3 are mounted on the "outside" front panel of the case, silvered side down, using double-sided adhesive pads. This has advantages over just glueing the elements in place, since the adhesive pads help to absorb the impact of each tap, reducing the risk of physical damage.

Alternatively, the elements could be mounted inside the case, fixed to the underside of the front panel. In theory, they would still pick up the "shock-wave" from each tap, whilst being protected from accidental damage; however, the reliability of this method has not been tested.

Returning to the method actually used: The elements are generally supplied with leads attached, and it may be helpful to resolder the outer lead at 90 degrees to its original position. This allows both connections to pass neatly into the case through a hole hidden beneath the piezo element (see Fig. 8). Note that the elements would almost certainly be broken by an attempt to reposition them after they're stuck down.

The final piezo transducer, sounder X2, should be an enclosed type for maximum volume; the rigid attachment round the rim of the element produces a much higher sound output than if an unhoused element is used – despite the reduced size (approx. 20mm diameter). The sounder is glued onto the side of the case, with a small hole drilled to take its two connections.

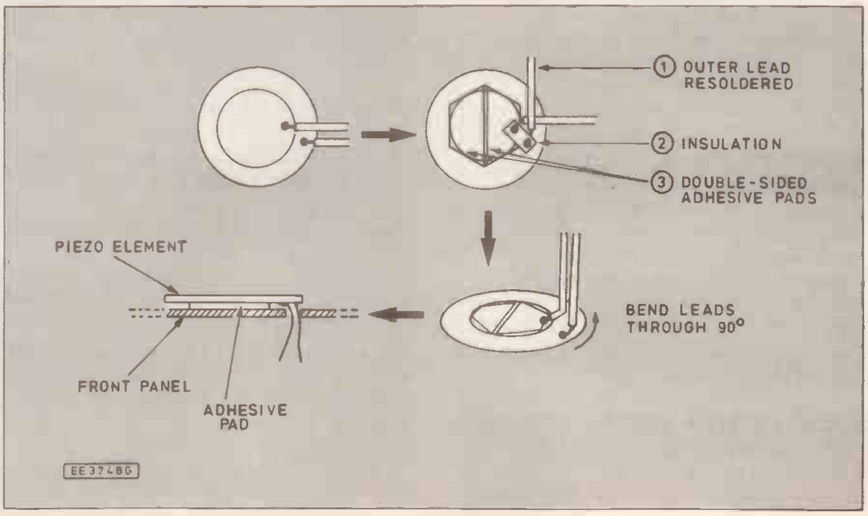
Since the leads of such piezo sounders are sometimes extremely thin, measures may be needed to reduce the risk of breakage. In the prototype unit the leads were joined to tougher multistrand wires via a piece of stripboard, about 6 strips by 4 holes, fixed to the floor of the case by a self-adhesive pad.

CIRCUIT BOARD

When all the p.c.b. components are in place, check for the usual problems, such as broken tracks, incorrectly fitted components, solder blobs etc. In particular, examine the places where tracks pass between i.c. pads to ensure there are no short circuits or open circuits. Lastly, recheck the orientation of the i.c.s and the polarised capacitors – especially if you don't have spares!

The completed circuit board will then need to be attached to the rear of the front panel. Space is provided on the p.c.b. for four fixing holes, but bolts are best avoided due to their effect on the external appearance of the unit. The solution used in the prototype was to securely glue four blocks of plastic (each approx. 18mm x 15mm x 10mm) in place on the panel, before mounting the p.c.b. on these using four self-tapping screws.

Fig. 8. Preperation of the piezoelectric sensors X1, X3 for attachment to the front panel.



Finally, the battery (9V PP3) is fixed to any convenient space near the p.c.b., using a double-sided adhesive pad or Blu-tack "putty". Recheck the polarity of the battery connections before applying power, or all eight of the i.c.s may meet an untimely death!

TESTING

Probably the simplest initial method of testing is just to briefly measure the completed circuit's overall supply current, with a 9V power source connected. The current should not exceed 5mA to 10mA and, as a further check, only diode D3 out of the two indicator l.e.d.s should be illuminated at switch-on. A large supply current might suggest an error in the direction of fitting some i.c.s.

Adjustment of the presets VR1 and VR3 across their range and back should change the state of l.e.d.s D1 and D3 respectively. With function switch S1 set to Position 1, a regular time signal should also be heard. Leave the presets at about one-third of the way along their tracks for the moment.

Now, set switch S1 to Position 2 and tap the "Beat" sensor X3 once, to switch *off* l.e.d. D3 (if necessary). The memory will be holding any old number at present, so tap the beat sensor X3 twice to establish the musical speed of your choice; the circuit "memories" it, hopefully continuing to beat time at that rate. The presets may still need some adjustment to increase/decrease the sensitivity of triggering; further information on this is provided later, in the section "Setting Up".

If the main circuit seems dead, though the conventional metronome circuit works, the most probable causes would include: a missing wire link or interwiring error; a non-soldered joint; a diode connected back-to-front or a flaw on the p.c.b. If a buzzing noise is heard after tapping sensor X3, the cause is multiple triggering (Counter 1 stores the number zero, hence the circuit runs at it's maximum speed); readjust preset VR3.

HEARING AID

Correct operation of counters IC5 and IC8 can be tested by connecting a crystal earpiece from the supply negative to each of the eight outputs (Pins 3, 4, 5, 6, 11, 12, 13, 14) in turn; the frequency of clicks should halve at each successive output. The state of the CMOS switch IC3c determines which one of the two counters – IC5 or IC8 – is active at any particular time, of course. Remember that the stored value on IC5 determines the maximum value reached by IC8.

The crystal earpiece can also be useful in checking whether Reset pulses are being produced; e.g. an earpiece connected to the output of "inverter" IC1d, or to the Reset 1 terminal, should click every other time the "Beat" sensor X3 is tapped. Multiple triggering, due to over-sensitive setting of comparator IC1b, can also be detected.

A further useful technique is to connect a 47µF electrolytic capacitor in parallel across capacitor C4, *correct way around*, using test leads. This slows down the clock pulse generator, IC4c, by a factor of about 20 and allows measurement of the changing logic levels using an ordinary analogue or even digital multimeter.

SETTING UP

The main adjustment required is to the presets VR1 and VR3, which are wired as potential dividers. Their output voltages may be set on either side of the reference values provided by resistors R3/R4 and R12/R13, since the piezo sensors produce both a positive and negative voltage fluctuation when pressure is momentarily applied.

The centres of the presets' tracks therefore give maximum sensitivity, and the extremes the minimum. As might be expected, triggering becomes unreliable close to the centre, and a lower sensitivity gives the best results.

A few other component values can also be fine-tuned if desired. The range of speeds from the conventional metronome circuit is determined by rotary potentiometers VR2, capacitor C1 and resistors R6-R8, working out at roughly 40-200 beats-per-minute, though component tolerances will affect the exact figures. If this is a problem, it is of course the user's decision whether it's worth changing component values slightly, to obtain the complete standard musical range.

Returning to the main circuit, the maximum interval between beats (i.e. the slowest speed) depends on the clock frequency. The specified values for resistor R16 and capacitor C4 allow for very slow speeds – as low as ≃6 beats per minute. If these are not needed, and a greater resolution is required between the higher speeds, then reduce the value of R16 to, say, 43k, 39k, 33k or even less.

It should also be checked whether the metronome exactly follows the beat which is tapped out by the user. The accuracy depends mainly on the three RC networks which provide the memory-reset pulses – each network adds the same small, constant delay (approximately 70mS) to the interval between beats, during which time one of the two counters is reset to zero.

The manufacturing tolerances of the resistors and capacitors used (5 per cent and 20 per cent respectively, in the prototype unit), together with the different input threshold levels of IC4d (Schmitt trigger) and IC5 and IC1d (ordinary inputs) may occasionally introduce detectable timing differences.

The simplest solution, if required, is to slightly increase or decrease the value of resistor R19 as appropriate; connect a "spares-box" potentiometer or preset in parallel with, or in place of, this resistor. After careful adjustment for perfect behaviour, the potentiometer's measured resistance setting is used to obtain the best new value for R19.

The final step of setting up is to calibrate the Conventional Metronome circuit. The Speed control – potentiometer VR2 – should first be fitted with a large control knob, thereby spreading out the scale. A control of 35mm diameter, type 'K2', was used in the prototype unit.

The resulting scale isn't linear by any means, but nevertheless remains easy to use. The set of "preferred values" of musical speeds is also non-linear, the difference between the values increasing with the beat-rate; these effects go some way towards cancelling out in practice. Even with this scale, experiment showed that any speed from 40 to 200 beats-per-minute can be set with a good level of accuracy.

IN USE

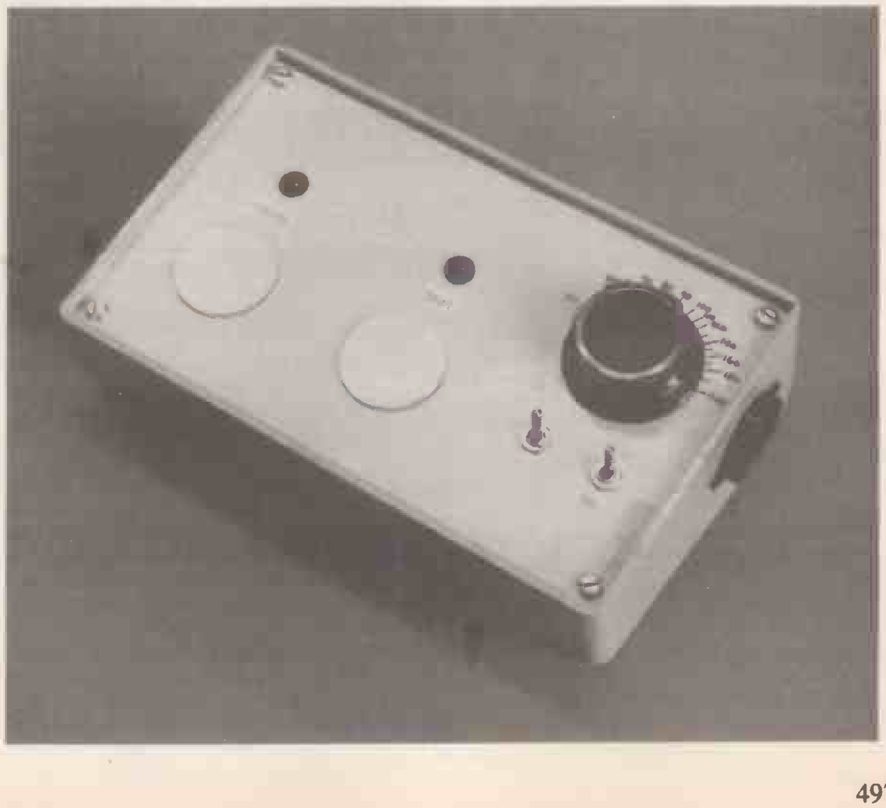
To finish off, a few points to help the use of the working unit:

1. *Battery Condition* – remember that the Beat indicator lamp (l.e.d. D3) *always* lights up when the circuit is first switched on. If it's weak or unlit, then the battery needs replacement.

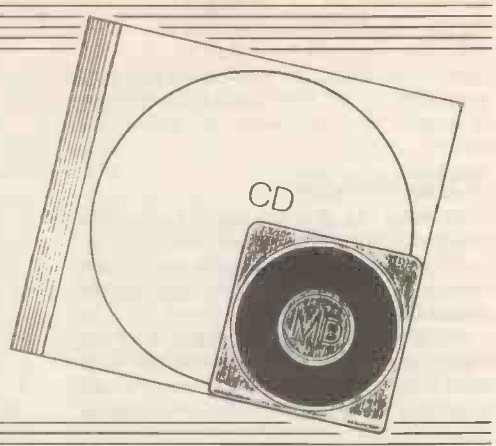
2. *Pause Facility* – this is not available when the "conventional metronome" circuit is operating. In this case, to silence the time signal *either* switch off, *or* flip the function switch S1 *then* activate the Pause facility.

3. *Beat Indicator Light* – remember, the "memorised" time signal *only* sounds when this light is off. If it's ON, this means the circuit is awaiting another tap.

4. *Battery Life* – the circuit has very modest power requirements and the battery should have a long life, provided the unit is switched off after use. Fortunately, the likelihood of forgetting is much reduced – the circuit always has one or both its l.e.d.s lit up, on the occasions when it isn't making a noise, beating time. □



INSIDE THE MINI DISC



IAN GRAHAM

A new type of personal stereo is due to hit the streets later this year. We take the Mini Disc apart and look at how it works.

ONCE upon a time record shops sold records, but now we can choose between vinyl discs, audio tape cassettes, compact discs and in many places VHS music videos. Although the CD has its detractors who criticise its clinically clean digital sound quality, it has nevertheless become by far the preferred music medium since its introduction in 1982. It dominates the market to such an extent that the days of the vinyl disc are now numbered.

Other music media are going digital too. Digital Audio Tape (DAT) is here already and the Digital Compact Cassette (DCC) will make its first appearance on the market this autumn. And Sony is to launch yet another audio format – the Mini Disc.

Including the rapidly sinking vinyl disc, by the end of 1992 there will be six different audio formats – six different ways of getting the same piece of music off a tape or disc. In reality the music buyer won't stock each title in six different formats. Tapes and CDs dominate the market at the moment. The CD will probably continue to go from strength to strength, but DCC and the Mini Disc will threaten the existing analogue tape cassette if the price is right. Price is important. DAT hasn't made any inroads into mainstream hi-fi because of its high price

Mini Disc and its player share a lot of technology with the CD, but it is not primarily intended to challenge the supremacy of the CD. Instead, it is aimed at the personal audio market. It is therefore a direct challenge to the tape cassette and the personal stereo.

Scheduled for introduction in late 1992, Sony claims that the Mini Disc will offer the same digital sound quality, quick random access and durability of the CD, combined with shock resistant portability and recordability. In other words, the Mini Disc has been designed to behave like a recordable CD that is also packaged to resist knocks and jolts while the listener is on the move.

Vital Statistics

The disc itself is 64 millimetres (2½ inch) across, almost half the size of a CD (120mm), and is housed in a protective sleeve or "caddy". The disc and caddy together are roughly half the weight of the conventional analogue tape cassette.

The disc can store 74 minutes of music, virtually the same as a CD. Sony has achieved this by compressing the digital data onto the Mini Disc more efficiently than on a CD. Compact discs (and DAT) currently use a 16-bit linear encoding system. The analogue musical signal is sampled roughly once every fiftieth of a millisecond. Or, to put it another way, the sampling frequency is 44.1 kilohertz. Each sample is given one of 65,536 numerical values. (65,536 is 2^{16}, hence "16-bit" linear encoding). So, 16 bits of data must be used for every 0.02 milliseconds of recording/playback time. Even if there is no signal present, the system carries on encoding or decoding at this rate.

Mini Disc Recording

The encoding system used by Sony's Mini DIsc, called ATRAC (Adaptive Transform Acoustic Coding) starts off with the same 16-bit data, but it analyses the signal and only encodes the elements that will be audible to the human ear. It doesn't waste time encoding data for sound that the ear won't hear. It divides the digital data into 20 millisecond chunks. Each of these is then broken down into the various sine wave components that it is composed of and each of these is assessed for amplitude (loudness).

Now for the clever bit. The ATRAC system looks at the relationship between the frequency and amplitude of the components of each 20 millisecond chunk. It's programmed to discard anything that will be inaudible to the human ear, either because it isn't loud enough or because it's masked by other sounds. The remaining data is recorded on the disc along with the usual error correction data bits.

During playback, the whole process is reversed. The various components of the signal are recombined by the ATRAC decoder into the 20 millisecond chunks, which are then combined to form a continuous digital pulse-train representing the original music. This is processed by the 16-bit DAC (Digital to Analogue Converter) in the usual way to recreate the original music. Despite discarding so much of the digital data, Sony claims that there is no significant difference in the sound quality of the source and the recording.

Magnets and Lasers

So much for the electronics, but what is the physical process used to record new data on the disc? Sony calls it Mag-

Prototype Sony Mini Disc player.

neto-optical Overwrite (MO) technology. A magnetic head sits directly across from the laser source on the opposite side of the disc. The laser raises the temperature of a spot on the disc. This neutralises the magnetic polarity of the disc under the laser spot and effectively erases the signal that was recorded on it. As the disc spins, the temperature of the spot falls again and it takes on the polarity of the applied magnetic field. So, by feeding the magnetic head with the signal to be recorded, the track illuminated by the laser as the disc spins loses its previous recorded signal and takes on the new signal.

As Mini Disc was intended to be a highly portable medium, Sony went to great lengths to reduce its power consumption and prolong battery life. Conventional magnetic coatings used to make audio tape require a certain size of magnetic field to erase them. The field strengths needed range from 380 Oersteds for normal ferric tapes to 1,100 Oersteds for pure metal tape. The Mini Disc uses a magnetic layer composed of Terbium Ferrite Cobalt that will change polarity with a coercive force as low as 80 Oersteds. It also uses a new low power consumption magnetic head capable of reversing polarity every 100 nanoseconds – that's a ten millionth of a second.

Once a signal is recorded on the disc, it's played back by reading it off the disc using the same laser that helped to record it. This begs the question – how can a laser read *anything* on a magnetic surface? When light is reflected from any surface, it becomes polarised. The effect is used by polarising sunglasses to block the light polarised by bouncing off, say, a glass surface, and allow the rest of the unpolarised light from behind the glass to pass through the sunglasses. When the Mini Disc laser beam is reflected by the disc surface, its direction of polarisation depends on the magnetic polarity of the surface. So, as the laser tracks across the disc surface, its direction of polarisation flips to and fro in step with the signal recorded on the disc. Therefore, it's a *relatively* simple matter to convert this into an audio signal.

The system shares a lot of technology with conventional CD hardware. And it means that a Mini Disc player will be able to play pre-recorded CD-type optical discs. The smaller disc size of the Mini Disc means that Mini Disc sized pre-recorded optical discs would have to be pressed specially for Mini Disc players. But their similarity means that existing CD pressing plants should be able to turn out pre-recorded optical Mini Discs quite easily.

Prototype Sony Mini Disc recorder/player.

Performance

One of the practical problems that was addressed from day one was how the system could play high quality music while its user was on the move. Conventional optical pick-ups are knocked out of position very easily. Most manufacturers use an array of hardware devices – springs, buffers and servo mechanisms – to isolate the pick-up from shocks. Sony has taken a different approach. The pick-up can read data off the disc at 1.4 million bits per second, but the ATRAC decoder only needs 300,000 bits per second for real-time playback.

This difference in data rates is very useful if you know what to do with it. Sony has used it to produce an electronic music store that can "paper over" any skips or jumps caused by sudden jolts. The pick-up sends data from a disc to a one megabyte memory chip. This is equivalent to about three seconds of music. The chip then feeds the ATRAC decoder. If the pick-up is knocked out of position, the chip can continue to feed the decoder and provide uninterrupted music for up to three seconds while the pick-up finds its place again. Then the chip fills up again. When the chip is full, the pick-up stops reading data off the disc until there is room for some more. The pick-up knows where it is and where it should be because address information is recorded on disc every 13 milliseconds. If the pick-up is jolted, it recognises that its at the wrong position and looks for the correct address before resuming playback.

The random access nature of Mini Disc means that any piece of music at any point on the disc can be found and played within one second. Try doing that with a tape cassette! □

ACTUALLY DOING IT!

by Robert Penfold

THIS MONTH and in the next *Actually Doing It* article, we will consider the topic of semiconductor pinouts and leadouts. It is a subject that is rather more straightforward now than it was some years ago.

In the past you could order two transistors of the same type from different retailers, and find that you were supplied with two transistors that had totally different case styles. Worse still, you could sometimes end up with two components that looked the same, but which actually had different leadout configurations. There was usually a suffix letter at the end of the type number which indicated the leadout configuration in use, if you knew what to look for.

Integrated circuits (i.c.s) also caused problems, as some types were available in two or three different encapsulations. Again, there was usually a suffix letter tucked away somewhere at the end of the type number which showed the device's encapsulation type. Of course, it was obvious which particular type of case an integrated circuit had as soon as you examined it, but you had to be careful what you were ordering when buying components "blind" by mail order.

These days you are less likely to be troubled by semiconductors which have the wrong leadout configuration, a case of the wrong size or shape, too many pins, or whatever. It is not a possibility that can be totally discounted though. There are still a few traps for the unwary to stumble into.

Also, cheap surplus components are often "older than they used to be", and the semiconductors tend to be in obsolete and strange looking encapsulations. Some of these are actually quite usable if you know what you are doing, but for the beginner some are likely to be more trouble than they are worth.

DIODES AND RECTIFIERS

Diodes and rectifiers are much the same, the only difference being that rectifiers can handle high currents whereas diodes are only suitable for low power applications. These components have only two leadout wires, but they must be connected the right way round if they are to give the desired result. Fig.1 shows the standard methods of polarity indication for most of the popular rectifiers and diodes.

The standard method for identifying the leadouts of diodes and rectifiers is to have a coloured band around one end of the body. This indicates the cathode (k or "active" +) end of the component.

A slightly different method is used for some high current rectifiers. This is to have the cathode (k) end of the body thinner than the rest of the body.

Some diodes, rather unhelpfully, have a number of coloured bands, rather like those on a resistor. In fact, the bands do represent a number in something not too far removed from the standard resistor fashion, but this is the serial number in the component's 1N???? type number.

Each colour in the code represents a digit of the serial number, and this system operates in the same way as the first two digits of the standard resistor colour coding. You are most likely to encounter this system with the popular 1N4148 silicon diodes. The 4148 serial number is coded as yellow – brown – yellow – grey.

If you look carefully at a diode of this type you should find that one band is much *thicker* than the others. This one indicates the cathode end of the component.

Unfortunately, with many of these multi-band diodes the thicker band is something less than obvious. In these cases it helps to remember that the *first* band in the code is the one nearest the cathode leadout wire.

A few diodes seem to be marked with two coloured bands. These are offset towards the cathode end of the component. In effect, there is the usual band to indicate the cathode leadout, plus an extra band which is probably of little practical importance.

ACID TEST

When you are unsure of the polarity of any rectifier or diode, remember that a quick test using a multimeter set to a middle resistance range will soon determine its polarity.

Using a digital multimeter, there is a *low* resistance through a diode when the positive test prod is connected to the anode terminal, and the negative prod is connected to the cathode leadout. Swapping over the connections should give a high reading that will be off the scale with silicon diodes. If you do not get this high reading one way and low reading the other, then the diode or rectifier is faulty.

The same method of testing works with analogue multimeters, but they provide a test voltage of the *opposite polarity. Thus a low reading should be obtained* with the positive test lead connected to the cathode, and the negative prod connected to the anode. As before, reversing the connections should give an extremely high reading.

When using diodes there will probably be no major problem if you should get one or more of these components round the wrong way. The circuit will not work, but nothing is likely to be damaged as a result of the mistake.

Getting rectifiers round the wrong way is a different matter. This could produce a virtual short circuit on a mains transformer, or produce a supply having its output polarity reversed. Always be especially careful when dealing with high power circuits. If in doubt, always check the polarity of a rectifier before connecting it.

ON THE BRIDGE

Many mains powered projects use a bridge rectifier in the power supply. This is basically just a "ring" of four rectifiers which can either be made up from individual rectifiers, or bought as a single component with the rectifiers wired together internally.

The two leads which connect to the mains transformer are usually marked "A.C.", or with a wavy line (presumably intended to represent an a.c. waveform). The other two leads are marked "+" and "–", and these provide the positive and negative d.c. outputs.

There used to be quite a range of rectifier case styles in use, including the aptly named "top hat" type, and stud mounting rectifiers which could be bolted directly onto heatsinks. While I hate to recommend that any working components should be thrown away, it is probably the best course of action if you should somehow happen to obtain some of these older rectifiers.

While they might be fine electrically, they are invariably far too large to fit into the component layouts of modern equipment. At best they might be suitable for emergency repairs, and for experimental purposes.

TRANSISTORS

Ordinary bipolar transistors are three lead devices. The three leads are called the *"base"*, *"collector"*, and *"emitter"*, or just *"b"*, *"c"*, and *"e"* for short. You might very occasionally encounter transistors having a fourth lead, called the "shield". This is something that is only found on some high frequency transistors, and it simply connects to the metal case of the transistor.

Often when using transistors it is merely a matter of following the component overlay. This should clearly show

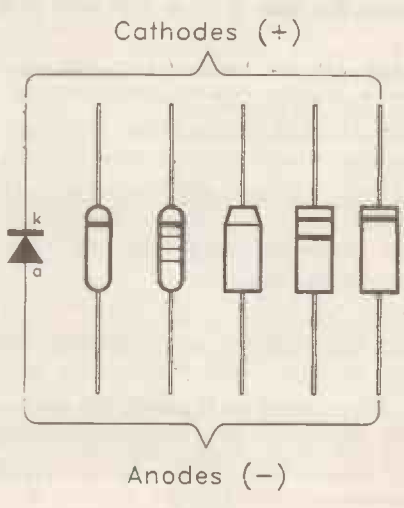


Fig. 1. Diode and rectifier polarity.

exactly where each transistor goes on the board, and which way round it fits. Provided you follow the diagrams carefully, and avoid any accidentally crossed-over leadout wires, there should be no difficulties.

Rather more care has to be exercised if you find yourself working from transistor leadout diagrams. The convention is for these to be *base* views (i.e. the device as viewed looking onto its leadout wires).

For power transistors the views are still base types, which means they are viewed looking onto the surface that fits against the heatsink. Note that this base view convention is the opposite to the one for integrated circuits (i.c.s), which are normally depicted in *top* views.

Transistor base views tend not to be too easy to work from when constructing projects, since you view transistors from above when fitting them onto a circuit board. If you have difficulty in mentally flipping-over base view diagrams, it is a good idea to sketch out top views and to then work from these.

In the past there have been different versions of the same transistor in common use. The silicon chip and the encapsulation were the same for each device; it was only the leadout configuration that was different.

A suffix letter on the type number indicated which leadout configuration a particular device actually had. The BC184L and BC184K were two transistors which sometimes caused problems, but these days the less popular "K" suffixed version

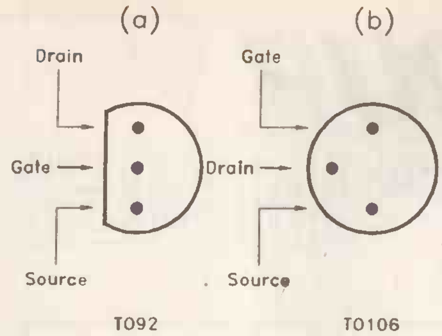


Fig. 2. F.e.t. base corrections.

seems to have disappeared from the component catalogues.

In fact, this practice now seems to have completely died out. There are some transistors which have an "A", "B", or "C" suffix, but this is concerned with gain grouping, and is nothing to do with different case or leadout styles.

There are still transistors which are available with a variety of leadout configurations and case styles, but they are sold under quite different type numbers. For example, the BC169, BC549 and BC109 are all basically the same device. This eliminates the possibility of any mix-ups over which leadout configuration a particular device happens to have.

EXCEPTION TO THE RULE

The only exceptions to this that I have encountered in recent times are certain Jfet transistors. In particular, the popular BF244 and 2N3819 seem to be available in two different case styles. There seems to be no suffix letter or anything else in the type number to indicate which encapsulation one of the transistors actually has.

The base view for the original TO92 cased version is shown in Fig. 2a, while Fig. 2b shows the base view for the later TO106 cased devices. The three terminals of a field effect transistor (f.e.t.) are called the *drain (d), gate (g),* and *source (s),* which roughly correspond to the collector, base, and emitter of a bipolar transistor.

Jfets having both of these case types are currently in circulation, and there is no way of telling which type will be supplied to you. This is obviously rather unhelpful. On the other hand, the two encapsulations are quite different, and there is no risk of mistaking one for the other.

As a point of interest, when the 2N3819 was first introduced, some of the base diagrams that were published had the drain and source terminals swapped-over. Devices that were connected in accordance with these incorrect diagrams often seemed to work perfectly well.

They were probably working somewhat below par, but nevertheless showed a degree of tolerance that you would not obtain from a bipolar transistor with their collector and emitter connections reversed. In fact germanium bipolar transistors are instantly destroyed by this sort of treatment.

SHOP TALK

with David Barrington

Solar Powered Lighting

The first question to be encountered when looking down the list of components required to build the *Solar Powered Lighting Unit* is: "where do I find the 305mm (12in.) x 305mm (12in.) solar cell panel?" The price of the solar panel seems to vary quite considerably and can be as much as £23 plus.

The answer is in two parts. The solar panel used in the prototype model was purchased from **Bull Electrical** (☎ *0273 203500*), code 15P42R, and cost £15 plus VAT and £3 p&p. The other alternative is to use two of the 305mm (12in.) x 152mm (6in.) panels from **Robert Keys (GW41ED), Dept EE, 4 Glanmoor Crescent, Newport, Gwent, NP9 8AX.** These panels (£4.50 each inclusive) are rated at 12V nominal at 80mA and joining two together should meet the requirements for this simple project – although they have not been tried "in-circuit".

The panel meters used in the prototype models were purchased from **Marco Trading** (☎ *0939 232763*) codes Pan.173 (100mA) and Pan.174 (500mA). These 51mm x 45mm panel meters are also stocked by **Greenweld, Cirkit and Cricklewood.**

The five-lead L200 adjustable voltage and current regulator called for in the Current Limited version is a fairly common device and carried by most good component stockists. Electrically, the device is claimed to be virtually indestructible, but if the leadout pins do need slight bending to fit on the circuit board extreme care must be exercised when carrying out this operation.

Sub-Woofer

Most of our component advertisers carry very good stocks of quality loudspeakers that could be used in the *Sub-Woofer* project, but, as mentioned in the article, the problem of matching two together could still prove troublesome. The latest excellent **Cirkit** Constructors Catalogue lists one bass speaker which they claim can be used in pairs.

To overcome the speaker matching problem the author is offering to supply matched pairs for the sum of £39.95 plus £3 for post, packing and insurance. For further details write to: **Henderson Electronics, 1 The Market Lanes, Terminus Road, Littlehampton, West Sussex BN17 5BS.**

The cabinet vent tube is a piece of plastic pipe bought from a DIY store. The loudspeaker grille cloth should be available from most of our component advertisers. The equalising circuit components are standard items and should be available from your local supplier.

Gas Alarm

The only item or items that are special to the *Gas Alarm* are the matched pair of "platinum", hot-wire, sensor and compensator transducers. These appear, after looking through our components catalogue library, to be only available from **Maplin**, code FM87U. Note that the compensator is marked with a blue spot, otherwise they are identical.

The power Darlington transistor and phase locked loop 4046BE i.c. are listed by most component suppliers, as is the low power CMOS timer TLC555CP or ICM7555. The Vinyl covered metal case also seems to be readily available. Other cases can, of course, be used but they *must be metal* types.

The printed circuit board for the *Gas Alarm* is available from the *EE PCB Service*, code EE800 (see page 539).

Dual Metronome

The piezoelectric buzzer transducers called for in the *Dual Metronome* should be widely available and are stocked in several guises. They are widely known as type PB2720 piezo sounders and the "membrane" or uncased elements are stocked by most of our advertisers.

If you are unsure about your soldering skills, then attempting the tricky task of repositioning the connecting leads should be avoided. Instead, appropriate small holes can be drilled in the front panel to take the transducer leads.

It is important that only the 4585BE 4-bit magnitude comparator be used in this circuit for IC6 and IC7. Some suppliers may offer the 4063BE instead; be warned, although functionally the same, it has a different pinout arrangement and would necessitate changing the p.c.b. layout.

The *Dual Metronome* printed circuit board is obtainable from the *EE PCB Service*, code EE801 (see page 539).

Artwork Light Box

There should not be any problems acquiring the materials and light fitting for the *Artwork Light Box* project.

The "box" materials, including the corner blocks, may be purchased from any of the DIY Superstores. The Thorn 2D lighting fitting (2D tube plus BC adaptor) and the 45 degree BC batten mounting light socket may be purchased from any large electrical shop. When ordering the 2D fitting, quote part number: 2DA10/BC. **Greenweld** also stock these parts.

The opaque plastic screen could prove a problem and, if constructors cannot locate a local plastics stockist, it may, as an extreme measure, mean purchasing a clear sheet and resorting to "washing" one surface with scouring powder or pad to give the desired "Light diffuser" effect.

FOR YOUR ENTERTAINMENT

by Barry Fox

Shock-Horror

The press recently came up with a shock-horror item on GPS, the global positioning satellite system.

When the US Government gave the US military funds to put up a network of satellites to guide military missiles, like Cruise, it was on condition that the military would also make the system signals available for domestic use.

Each satellite continually generates a very accurate clock signal. The receiver picks up signals from four satellites simultaneously and compares their time codes. This gives it a very accurate fix on location, by longitude, latitude and altitude

Several years ago Sony sold a GPS receiver in Japan which was used by offshore oil drilling crews to get an accurate fix on their position. Many well-heeled yachtsmen now have GPS receivers to make navigation more accurate. Sony UK now sell the first, relatively low cost (£1,000) portable receiver.

On The Map

Car navigation systems, such as Philips' Carlin, are already under development. These will use GPS signals to control an on-board computer which reads digitised maps from a CD-ROM disc.

The main obstacle holding up the "public launch" is the cost of the maps. Organisations such as Ordnance Survey worry that once they have converted their maps into digital code and pressed the code onto a CD, the maps can be copied as easily as music from a CD.

One CD can store all the maps for a country, so the potential for piracy is enormous. Based on current map prices, a CD containing all maps for the UK would cost £4.5 million!

Sinister aims

The popular press has now latched onto the idea that someone could connect a portable GPS receiver to the auto pilot of a light aircraft, put a bomb on board and turn it into a Cruise missile. Doubtless this could be done and would make a nice plot for an action movie. But in reality, the weapon would be a very blunt instrument.

The signals transmitted by the GPS satellites come in two types, one intended for use by the military, the other for civilians. The military time codes give accuracy sufficient to guide a Cruise missile through the front door of the Kremlin. This was the technology used in the Gulf war. But these signals are digitally encrypted and are not available for civilian use.

The civilian signals have an accuracy of at best 30 metres and more often 100 metres. So the bomb would have to be very powerful to destroy a chosen target.

There are, unfortunately, a lot easier, lower-tech, ways for a terrorist to do damage. Think for instance of the Channel tunnel. Cars will be loaded in bulk on a trailer and carried by train through the tunnel. Each car will have petrol in its tank. One incendiary device will turn the whole train into an enormous petrol bomb.

If authorities run security checks on each car before each journey, this would put hours on the journey and make the tunnel a commercial dead duck.

CDTV Disaster

As Philips starts its roll-out of CD-I, with adverts and selected sales outlets in London and the South East, I wonder how long Commodore can go on pretending that its rival multimedia interactive CD format, CDTV, is a contender.

I also wonder whether Commodore's management in the US will ever be answerable to the company's shareholders for the CDTV marketing disaster. There must come a time when Commodore in the USA has to stop citing Europe as a successful market. CDTV has been such a fiasco, both in the USA and Europe, that Philips long ago stopped worrying that confusion between CDTV and CD-I might hurt CD-I sales.

Sadly, Commodore's shareholders may never know how some lone voices inside the company's UK subsidiary saw early on that the marketing pitch for CDTV was all wrong. Commodore's management has experience in the home computer and games market, but none in "brown goods" consumer electronics. And this has cost the company dearly.

More than a year after the "launch" of CDTV, it is still an invisible product with a non-existent profile. Dixons, who were supposed to stock CDTV standalone players, and demonstrate them, either keep CDTV hidden in a back room for the benefit of customers who ask, or stack them on a shelf like CD players. There is only one way to sell multimedia and interactive CD, of any format, and that is to let people get hands-on experience of what it can do.

As a quite separate issue, I happen to think that CDTV is technically a mess, with bug-ridden hardware rushed onto the market along with mainly unappealing software.

Commodore's damage control plan was to re-launch CDTV, as a CD-ROM peripheral for the Amiga 500 using software ported from existing Amiga libraries. The launch date was given as May, but by early June there was still no further word from Commodore.

Caddy Puzzle

The most puzzling design feature of CDTV is that the program discs must be loaded into a CD-ROM caddy before they can be used in the CDTV player. Although CD-I players do not use caddies, Commodore's justification for caddy-loading is that data discs must be protected from handling.

Commodore has also advocated the use of CDTV players for playing music CDs.

It is clearly inconvenient to have to load discs, especially music discs, in caddies before playing them. To take a disc out if its jewel box, put it in a caddy, then later take the disc out of the caddy and put it back in the jewel box, clearly involves far more handling than just popping it into the loading tray of a music or CD-I player. If I were using CDTV, then I would surely want more than the one caddy that comes with the player.

As an experiment I went shopping for CDTV caddies. Dixons in Oxford Street (the Tottenham Court Road end) said they stocked CDTV players, although none were on show. They had no spare caddies, and seemed suprised that anyone should want more than the one that comes with the player. The staff showed no interest in ordering me some.

Instead they sent me a few doors down Oxford Street to the Virgin Megastore. On the way I tried Microbyte, a games software shop, who did not stock any CDTV material.

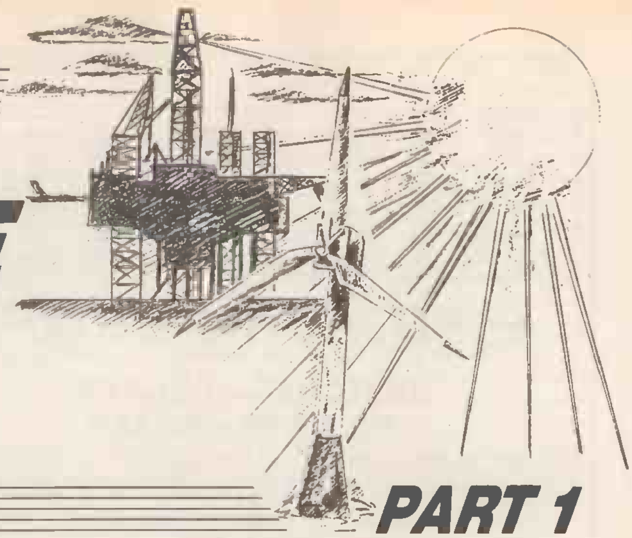
Virgin's games department sold CDTV discs, but no caddies for them. Try Tottenham Court Road, they said.

It is the kiss of death for a product when shops are happy to send potential customers somewhere else to buy it.

I tried some shops in Tottenham Court Road, including Lasky's, but no joy. Finally I found two caddies in the Silica Shop at £7 each (which I bought for use with a CD-ROM player).

Draw your own conclusions on the impact of CDTV's year on the market, and its chances of still being around in a year's time.

Special Feature



ALTERNATIVE ENERGY

T. R. de VAUX BALBIRNIE

PART 1

Developments using renewable energy sources.

THIS is the first article in a short series about renewable energy – that is, sources of energy which are everlasting rather than those derived from the so-called *fossil fuels* which will eventually run out.

This month we shall take an overview of the topic and look in some detail at the *direct* use of solar power. In the following months we shall examine some particular examples of renewable energy which have the potential for large-scale exploitation in the U.K.

Wind power has particular importance already so some of next month's work will be devoted to this particular topic. The month after that will involve a trip to Denmark to examine at first hand the technology used in the design, construction and operation of modern wind turbines used to generate electricity.

THE GLOBAL PROBLEM

At the moment, much of the world economy is based on the use of *fossil fuels* – coal, oil and natural gas – to supply our energy needs. When we use these, perhaps in the form of petrol or diesel fuel for transport, or when coal is burnt for simple heating or to generate electricity we are actually using *solar energy* which was stored up long ago.

Battersea Power Station showing the main turbine hall.
(Sinclair Stammers/Science Photo Library)

Coal is the remains of ancient forests – the trees grew using carbon dioxide from the air and water, together with the energy of the sun, for photosynthesis. Unfortunately, the use of fossil fuels carries with it problems of pollution and the release of carbon dioxide – a greenhouse gas which causes *global warming*. We shall look at this in detail next month.

Another problem with the fossil fuels is that they will eventually run out. Estimates of when this will be vary due to the difficulty of estimating the yield of as-yet undiscovered reserves and also in predicting future demand. However, it is said that oil supplies may be exhausted in some 35 years, gas in 50 years and coal in 200-300 years. Although not a fossil fuel, *uranium* – the raw material used for nuclear power generation – is also a finite resource.

The fossil fuels will not, of course, run out overnight. The price of oil and gas will rise as they become scarce. This will put pressure on coal and the price of this – together with uranium – will also increase. Remaining reserves of the fossil fuels will become too valuable as raw materials for the chemical industry than to be used as fuels. It is vital, therefore, that we conserve energy and seek alternative sources to fill the energy gap and assure our power supplies in the 21st century.

ELECTRICITY

Electricity is the most convenient form of energy since it is so easy to control. We have therefore come to depend on it. In Britain, most of our electricity is generated by burning coal (and sometimes oil or gas) in power stations. This boils water and raises steam which is then used to turn a *turbine* connected to a *generator* – a so-called *turbogenerator* (see photograph).

Everyone is responsible for using electricity both directly and indirectly so we are all responsible for burning coal and the other fossil fuels. We are not particularly efficient at doing this either. Only 30 per cent of the coal's energy ever finds its way to the power socket. Most of it is simply thrown away, uselessly, in the form of heat.

Serious interest is being shown in schemes – *combined heat and power* – which utilize this waste heat for central heating of private homes, office blocks, public buildings and the like. Unfortunately, the power stations are not necessarily close to the centres of population where the heat is most needed – they are generally sited near the source of fuel.

THE ALTERNATIVE VIEW

Presently, the sun pours ten thousand times more energy on to the earth than we actually use. This energy is non-polluting and will be available for millions of years to come. So why do we not make use of it on a day-to-day basis rather than in the form of stored-up energy in the fossil fuels?

This is indeed possible and there are two approaches. The first is to use the solar energy *direct*. However, large-scale schemes tend to involve very expensive technology and at the moment it seems that their use will be limited to local production of power – perhaps where other methods are difficult. The other possible way forward is to use solar power *indirectly*, using such natural phenomena as waves and wind. Here, the sun's energy has already been converted into a form more suited to exploitation using familiar and cheap technology.

Some such schemes are already off the ground, some have possible longer-term potential and some are fanciful long-shots. We shall be looking at a number of these over the coming months.

WIND POWER

Wind power promises to provide a useful contribution to Europe's energy needs in the short term – perhaps up to 10 per cent in the next ten years or so. The technology is cheap, safe and well-established.

Wind power is really a convenient way of exploiting solar energy because it is the sun which causes the differences in temperature which makes the wind blow in the first place. We shall say no more about this aspect of Alternative Energy now since some of next month's article will be devoted to it in detail.

A SPOONFUL OF SUGAR

When we burn wood, we are again using indirect solar energy – that is, the sunlight absorbed by the green leaves over the previous few years while the trees grew. Since wood is a good fuel it may simply be used as a coal substitute. It is, however, rather dirty to burn. In some countries, this idea is taken a step further and crops are cultivated specially for their *fuel* rather than their *food* value. This is called *biomass*.

Sugar cane, a perennial grass, is a remarkable material which converts more solar energy than most other plants. Special strains have been cultivated which do even better than the old ones in this respect. In Brazil, sugar cane is grown and the sugar obtained fermented to an alcoholic brew. The liquor is then distilled to provide pure alcohol. This is a flammable liquid and a *clean* fuel which may be used directly to power cars or blended with a proportion of petrol for the same purpose.

It is quite possible to convert a petrol engine to burn alcohol instead. Brazil has to rely on expensive imported oil so using such alternatives saves quite a lot of money. One advantage of biomass is that there is no overall greenhouse effect. This is because the carbon dioxide released by burning the fuel matches the amount absorbed by photosynthesis as the plant grew – this will be used by the next crop and so on.

The only other product obtained by burning alcohol is water which, again, is simply the water which was absorbed during photosynthesis. The only overall effect, then, is simply to have used the sun's energy.

Using alcohol made in this way could provide a partial solution to a future world energy shortage. There is excess production capacity of sugar cane anyway since the demand for sugar has fallen over the years. Also, sugar *beet* has now become a major source of sugar – especially in Europe. Using alcohol as a fuel could mean that the cheap well-understood technology of the internal combustion engine could be utilized into the foreseeable future. Traditional forms of transport – including air travel – could then continue to be used.

DIESEL TREE

On a similar theme, a tropical tree, *copaifera multijuga* produces an oil which is almost a diesel substitute. Research is going on at the moment in an effort to transfer the gene responsible for this process to a tree which can grow in cooler climates. This could rival other ways of obtaining energy for heavy transport in the future.

Rotting plants produce methane gas. This is the same as *natural gas* obtained from the North Sea reserves and supplied to homes and industry. This method is, again, making use of the energy given by the sun to the plant during photosynthesis. On a small scale, decaying material is placed in a large vessel from which gas may be drawn as required. This is commonly used as cooking gas in some countries such as India and China.

Landfill gas is formed in this way and there are some schemes in the UK which use it to generate electricity. We shall be looking at these in a future article.

FALLING WATER

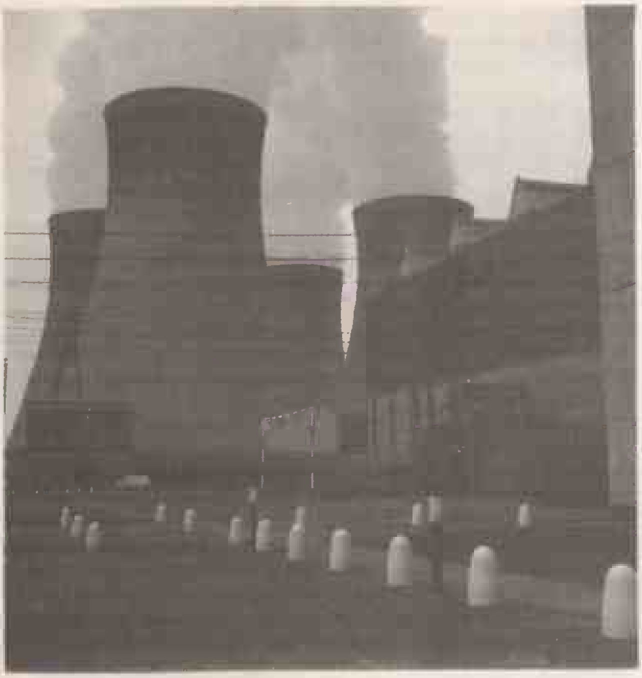
Hydro-electric power (electrical energy gained from falling water) is yet a further indirect way of harnessing solar energy. Note that it was solar energy which evaporated the water to form water vapour which was carried to the high ground and eventually fell as rain (the water cycle). Flowing water may be used to turn special turbines and conventional generators. However, a considerable amount of flowing water and preferably a large height (head) through which it falls is needed to make this method commercially viable.

A really large hydroelectric scheme can generate 10,000MW – equivalent to the output of several large coal-fired power stations. Some countries, such as Canada, are fortunate in having immense quantities of falling water so it is not surprising that this country is a world leader in hydroelectric power technology.

Sweden produces half her electricity needs using hydroelectric schemes (the other half coming chiefly from nuclear energy) – very little coal is used for the purpose. Although scope is limited, the UK has some large-scale hydroelectric schemes – around 100MW – in operation.

We see that one way or another, almost all the energy we use has come from the sun – either stored up long ago or that which shone on to the earth more recently. However, when people talk about using solar power they usually mean the *direct* use of sun's energy and exploiting this poses more of a problem. There are two ways used at present. One is to use the heat energy as it is and the other to convert the heat and light energy – *the solar radiation* – into electricity.

Hoover Dam across the Colorado river, completed in 1936. It is 1,244 feet long and 726 feet high making it the highest dam in the USA. The hydro-electric power station has a generating capacity of 1,000MW from its 18 generators. The reservoir stores 30 million acre-feet of water in Lake Mead which extends 115 miles up the river.
(Lowell Georgia/Science Photo Library)



The West Burton coal-fired power station showing the cooling towers and the generator building.
(John Howard/Science Photo Library)

Pipes leading to a hydro-electric power station at the Alcan aluminium works, Fort William, Scotland.
(Martin Bond/Science Photo Library)

FACTS AND FIGURES

The unit of energy is the *joule* (J) – named after James Joule (1818-1889) a Manchester brewer. The watt (W) – named after the British engineer, James Watt (1736-1819) is the rate of *converting* energy and is equal to one joule per second. To give some idea of the size of a joule – we would need about 40,000J to boil the water needed to make a cup of tea.

The amount of solar energy which falls on the earth in one day is in the region of 10^{22} joules – that is, one followed by 22 zeros! This amounts to some 700W per square metre although it varies with the latitude of the place, the time of day, the season of the year, the amount of cloud, the height above sea level and other factors. On a bright sunny day it will exceed 1kW (1000 watts) per square metre.

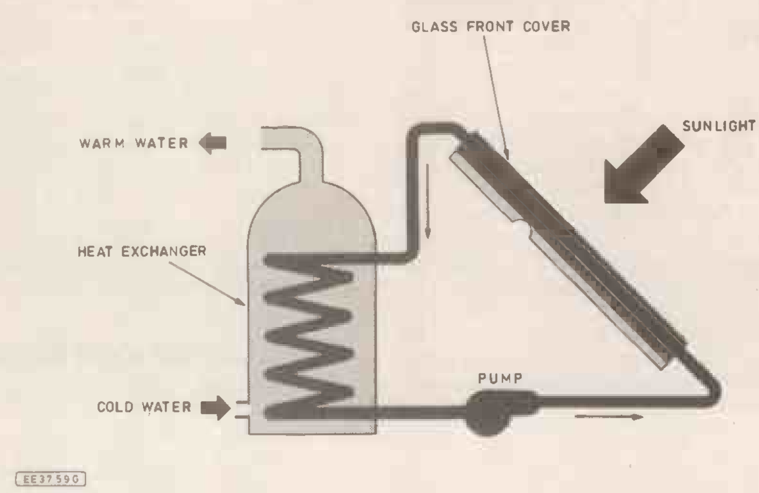
Several things happen to this energy. Much of it (about 30 per cent) is simply reflected back into space. Some (about 20 per cent) falls on water, causes evaporation and brings about the water cycle mentioned earlier. A little is used by green plants to perform photosynthesis. This leaves nearly half the energy simply warming the ground.

DIRECT SOLAR POWER

Imagine a conventional coal-fired power station producing 1000MW i.e. 1,000,000,000 watts (a large power station). If the whole of the sun's energy could be collected and used, it would need about 1.5 million square metres of land area to produce the same power. This may be pictured as a square with sides rather more than 1km in length.

It seems that by using a few tens of square kilometres of land area, we could obtain all the electricity needed for Britain! However, there are some flaws here. Firstly, the energy is only available during daylight hours and then only on relatively cloud-free days – certainly not to be guaranteed in the UK. Also, no one has found a way of collecting *all* the energy – it would really need at least ten times the land area than theory suggests. This would not be a great problem but the cost of setting up the scheme would be prohibitive at the present time.

Fig. 1. Operation of a solar panel.



It would need cheaper technology coupled with rising prices elsewhere for this to prove commercially viable in the medium term. On the other hand, small-scale local schemes seem attractive – perhaps to provide electricity in remote places.

In hot countries it is possible to fry an egg on the pavement. Solar radiation causes significant heating of the surface on which it falls. Dark-coloured surfaces, particularly black ones, absorb the radiation much more effectively than light-coloured ones so these get hotter.

A solar panel is a simple type of passive solar energy collector which uses circulating water to carry the heat for some purpose – perhaps for household hot water or for a swimming pool. The general principle is shown in Fig. 1. Water is pumped through tubing which is laid zig-zag fashion under a glass cover. The water becomes warm and gives its heat to other water in a heat-exchanger.

The tubing and other parts inside the panel are painted black to improve absorption of the sun's energy. The glass top surface acts like a greenhouse, traps the sun's energy and improves the overall efficiency. It is necessary to use an electric pump to circulate the water through the panel and heat exchanger so, when calculating whether or not it is worthwhile to use the solar panel, it is essential to take into account the electrical power needed by the pump.

It is a useless exercise gathering less energy from the sun in terms of warm water than the pump uses! Microprocessor-based systems using temperature sensors may be used to switch on the pump only when it is advantageous to do so.

The solar panel will work fairly well even in Britain but, of course, it works much better in hot countries with more guaranteed sunshine. Under the best conditions, the water can emerge at 70 degrees C but it will not boil. More likely, especially in Britain, it will be made warm which, nevertheless, means that less fossil fuel or nuclear energy is needed to raise it to a useful temperature.

Solar panels are often seen on house roofs (see photograph) since here they can be

Solar panels (used for domestic water heating) incorporated into the roof of a house in South East London.
(Martin Bond/Science Photo Library)

The parabolic reflector at Odeillo-Font-Romeau solar power station composed of 9,500 mirrors. The furnace is capable of generating 1MW of thermal power.
(Tony Craddock/Science Photo Library)

angled to face the sun. Since a solar panel cannot raise the water to boiling point, it cannot generate steam. This means that it cannot be used to produce electricity using the cheap and well-developed technology of the turbo-generator. This, in practice, means that solar panels are limited to relatively small schemes for producing warm water. Even so, their contribution is worthwhile.

SOLAR FURNACE

A *solar furnace*, on the other hand is designed to raise steam. Here, enormous mirrors concentrate the solar radiation to a focus. This works in a similar way to a hand lens which can focus the sun's rays and set a piece of paper alight. A boiler is placed at the focus and the water circulating through it rapidly boils. This makes steam and operates a conventional turbo-generator.

Unfortunately, the mirror needs to be of gigantic proportions – about 7000 square metres for each megawatt of electricity produced – and this is very expensive to construct. To generate 1000MW, would need a colossal mirror. Serious schemes using mirrors are used in Odeillo in the French Pyrenees (see photograph) and the United States where there is more-or-less guaranteed sunshine. At the focus of the rays, the temperature is sufficient to melt steel.

Of course, the solar furnace provides energy only during daytime. A further problem is that the sun appears to rise and set in the sky so there must be some means of tracking it and this involves even more expense. Due to high cost, large-scale use of solar furnaces for electricity generation is definitely a long-shot and it is difficult to see the method becoming economically viable in the future.

Mirrors of the Luz Solar Power Station seen in moonlight. The 1·5 million mirrors concentrate the sun's light onto narrow tubes containing synthetic oil. The oil is then fed to a heat exchanger where it boils water to provide steam for turbines, this installation can generate 150MW of power.
(Roger Ressmeyer, Starlight/Science Photo Library)

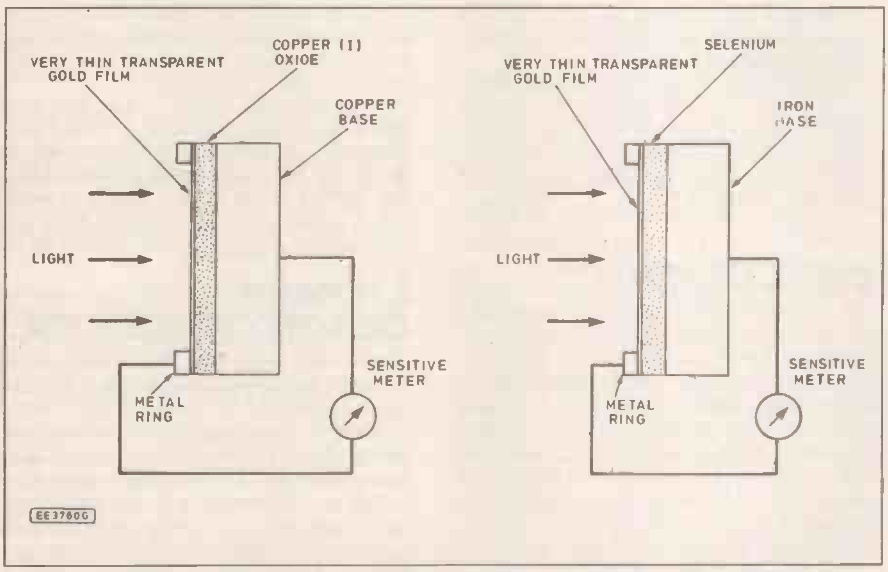


Fig. 2. Early photovoltaic cells.

SOLAR CELLS

A different approach is to use *solar cells* to convert the sun's energy directly into electricity without going through the steam stage. This uses a phenomenon called the *photovoltaic effect*. This was first observed by Antoine Becquerel in 1837 when sunlight shone on to one of his electrodes during an electrolysis experiment. The first "serious" devices, however, date from the 1870's and were based on the element *selenium* deposited on an iron base. More recently, a copper base coated with cuprous oxide – copper (I) oxide – was used (see Fig. 2).

In both cells, a very thin and therefore transparent gold film made a window through which the light passed. This made the front connection to the working material. The gold film was in contact with a metal ring around the periphery of the device and this formed one of the output terminals. The other connection was made to the base material at the back of the cell.

These cells develop a voltage of around 0.4V in bright light. However, they are very inefficient, converting only about one percent of the sun's energy striking the sensitive surface into electricity. They are sometimes used to *measure* light intensity (in, for example, some photographic exposure meters). Here, the cell output is connected to a microammeter with its scale calibrated in terms of light level instead of current.

Modern semiconductor devices are also photo-sensitive. Transistors and diodes are usually housed in opaque encapsulations to prevent light from entering. This prevents photovoltaic emission with possible unpredictable results when the device is built into a circuit. This effect may be demonstrated using an old OC71 *germanium p.n.p.* transistor. These are still available new from certain suppliers but are often to be found in junk boxes or in old equipment.

Such transistors are coated with black paint to prevent light from entering but this is easily scraped off to reveal the translucent encapsulation beneath. If this is done and the base wire (the centre one) is connected to the negative terminal of a 0-50μA meter (a multitester set to its most sensitive d.c. current range) and either the collector or emitter wire touched on to the positive terminal, the photovoltaic effect may be observed. Thus, when sunlight falls on the transistor, a current of 10μA or more is registered (see Fig. 3). The working part is the junction between *p* and *n*-type germanium.

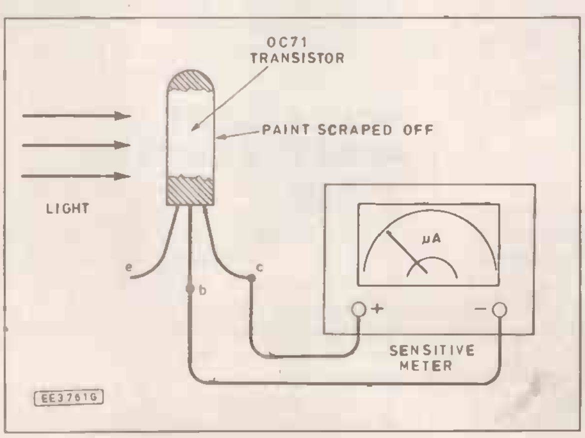


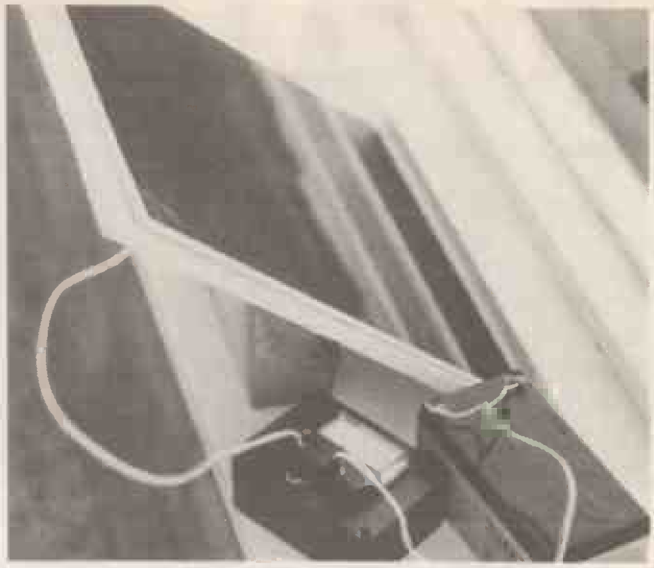
Fig. 3. The photovoltaic effect.

MODERN DEVICES

More recently, purpose-made solar cells based on *crystalline silicon* have been developed. These also consist of junctions formed between *p* and *n*-type material. It is beyond the scope of this article to explain *p* and *n*-type semiconductor materials in terms of atomic structure – any reader interested in this topic should refer to a standard electronics or physics text book.

To understand basic operation, it must be realized that light has a *dual nature*. Although usually thought of as *waves* it may also be regarded as consisting of small particles called *photons*. Photons have energy and when they

A solar powered calculator.



An experimental solar panel for battery charging.

strike the sensitive material they knock out electrons. When electrons are removed they leave regions of space deficient in electrons called *holes*. The electron-hole pairs can re-combine with electrons flowing in an external circuit back to the holes.

The greater the light intensity the more electron-hole pairs will be created and the greater will be the current. Unfortunately, electrons can re-combine with holes directly without going through an external circuit. Also, the electrical resistance of the material reduces the current and much of the energy is dissipated as waste heat.

Some of the radiation reflects from the surface without ever reaching the active region although making the surface black helps to minimize this effect. For this and other reasons, solar cells are not particularly efficient. Silicon solar cells can convert up to about 10 per cent of the energy striking them into electricity although a solar cell design based on *gallium arsenide* instead of silicon is said to produce 1V per cell with an efficiency of 25 per cent.

SOLAR CELL USE

At present, probably the best use for solar cells is for small scale production of electricity. Solar-powered calculators are now commonplace but a more ambitious use is to provide the electrical energy needed for a satellite. These need electrical power to operate the electronic equipment on board – radio transmitters, receivers and so on. They can take advantage of the much more intense sunlight which exists in space.

At the earth's surface, much of the solar radiation has been absorbed by the atmosphere. In a satellite, a relatively small number of solar cells is therefore needed. In a typical installation, some 5000 cells are arranged on *solar sails* to provide a 30V supply delivering about 100W of power (see photograph in the *Information Technology* article).

One problem is that solar-powered equipment will only work when the light is strong enough. If necessary, this can be overcome by using the solar cells to charge a small battery which can then be drawn on when there is insufficient light – for-example, in a solar-powered watch.

Solar-powered cars – and even solar aircraft – have been developed as experimental prototypes. Other more down-to-earth uses for solar cells include emergency telephones, marine beacons, radio transmitters and receivers for use in remote regions, computerised information-gathering equipment and battery-chargers.

Solar cells may be used to charge batteries by day and provide electric lighting by night in regions too remote from a conventional electricity supply. They are also used to drive water irrigation pumps – it is even possible to make solar-powered refrigerators!

CELL OUTPUT

A typical silicon solar cell provides a voltage of approximately 0.6V at a current of 15mA per square centimetre in bright sunlight. groups of cells can be connected in series to increase the voltage output (much in the same way as chemical cells are often connected in series for the same reason). They may also be connected in parallel to increase the current. A *series parallel* arrangement of solar cells is usually used to increase both the voltage and the current.

Single silicon solar cells and ready-made groups of cells (solar cell panels) may be bought quite cheaply and make an interesting basis for experiments in solar energy. For example, a typical small arrangement can produce an output of 12V at 50mA.

A more ambitious solar cell panel has a sensitive surface 30cm (1ft) square and can produce 12V at 200mA in bright sunlight (see photograph). This has a sensitive surface made from *amorphous silicon* coated thinly on a glass base. Although amorphous silicon is less efficient than the crystalline variety. It is much cheaper. Such a solar panel can operate various small pieces of electronic equipment direct or charge batteries so that the energy may be used later – in a caravan or boat, for example.

SOLAR CELL POWER COSTS

Generating bulk electricity using solar cells, would be about ten times more expensive than by using conventional means at present prices. On the other hand, the cost of solar cells is coming down and the price of fossil fuels will rise in the medium term so this type of exercise – using land for "solar farming" – may possibly become attractive in the future.

In bright desert regions where the land is not much use for anything else, banks of solar cells could farm the sun's energy and provide large-scale electricity. It has been estimated that 30,000 square kilometres of solar cells (an area of 100 miles square approximately) could provide the total electrical needs of the United States.

A fanciful idea is to place banks of solar cells in space to take advantage of the more powerful sunlight. The only problem would be getting the power down to earth where it is needed! Perhaps, the energy could be turned into *microwaves* and beamed down to receivers on the ground.

LATEST DEVELOPMENTS

Now, after 20 years of research, Brian O'Regan and Michael Gratzel of the Institute of Physical Chemistry, Swiss Federal Institute of Technology in Lausanne Switzerland have developed a more advanced type of solar cell. This has an efficiency close to that of a conventional amorphous silicon cell i.e. around 7 to 12 per cent depending on conditions. Its importance is its *potentially low cost* rather than its efficiency. This is because it uses cheap and relatively impure materials in its construction.

In this cell, the working semiconductor material is a very thin layer of high surface area polycrystalline titanium dioxide. On to this surface is coated a special dye. Energy-harvesting molecules having an "antenna" arrangement absorb the sun's energy and channel it to the semiconductor surface. Advantages are to be gained by separating the jobs of energy absorption and electricity production in this way.

It is interesting to note that the natural phenomenon of photosynthesis also uses a molecular antenna system to direct solar energy to the chlorophyll. In this respect the new type of cell imitates nature.

It would seem that the direct use of solar power for large-scale generation of electricity is too expensive. Perhaps a better way forward is to exploit natural processes – wind, waves, biomass, etc. which already absorb the energy of the sun and put it into a more easily used form.

Next month: We shall examine in more detail the problems associated with using fossil fuels. We shall then look in some detail at wind energy as an example of existing alternative technology.

NEW VIDEOS

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(All videos are to the UK PAL standard on VHS tapes)

Constructional Project

SOLAR-POWERED LIGHTING UNIT

T. R. de VAUX-BALBIRNIE

"Free" power for the garden shed, boat or caravan.

THIS solar power supply was designed to provide lighting in a remote garden shed without having to rely on throw-away batteries. This may be cheaper than laying on a mains supply and is much safer. Also, being a low-voltage system, it is suitable for use by children.

A simple version will work as a trickle-charger for a 12V caravan or boat car-type battery. This will keep the battery in good condition during the out-of-season months and also allow limited use of the lights, water pump, etc. This may be found useful for the occasional visit to the caravan at night to recover odd items of crockery, the tin opener, etc.

The Solar-Powered Lighting Unit (Standard Version) will operate a small, inexpensive 12V 8W fluorescent light by charging a 12V nickel-cadmium battery pack during daylight hours. Tests carried out during late autumn on the prototype unit show that up to 20 minutes operation per day (depending on the available light) is available from an 8-watt fluorescent light. This will be found sufficient for most purposes. Even during the winter, a useful operating time will be available.

Taking account of the cost of the solar panel itself and the nickel-cadmium cells, this may be considered an expensive way of obtaining energy in the short-term even though the energy itself is free. However, it scores highly in terms of convenience since, once fitted, the installation can be forgotten and will always be ready to operate at peak efficiency. Using throw-away batteries to provide a similar light output would prove prohibitively expensive.

USING SOLAR PANELS

The solar panel specified for the Solar-Powered Lighting Unit is 30cm (1ft) square and has a sensitive surface made from amorphous silicon. This provides a current output of 200mA in bright sunshine. In moderately bright autumn and winter weather, an output of 10mA to 20mA may be expected and 100mA is not uncommon.

These test figures were obtained with the solar panel placed behind a glass or plastic window since, in use, this will be necessary to protect it from the rain. To charge a caravan battery, the solar panel may be placed on a table near a south facing window using a wooden frame – or simply a pile of books – to point it slightly upwards to face the sun. Tests will need to be performed where windows are heavily tinted since these could reduce the efficiency.

The battery pack used in the prototype unit (standard version) consisted of ten AA size nickel-cadmium cells in a suitable holder. The maximum continuous charging current for these is 50mA approximately.

Since in bright summer sunshine this figure could be exceeded by a factor of four, it is necessary to provide some current-limiting to prevent damage. During the winter, the output current is normally less than 50mA so the limiting circuit will have little effect – it will simply reduce the charging current slightly – typically by 4mA.

A Normal/Boost switch is provided on the unit so that, in summer, the limiting circuit may be bypassed and the extra current used to "quick-charge" the battery pack. It may also be used during winter to squeeze every available milliamp out of the system. *In summer, this will need to be used with extreme care to prevent possible damage due to overcharging.*

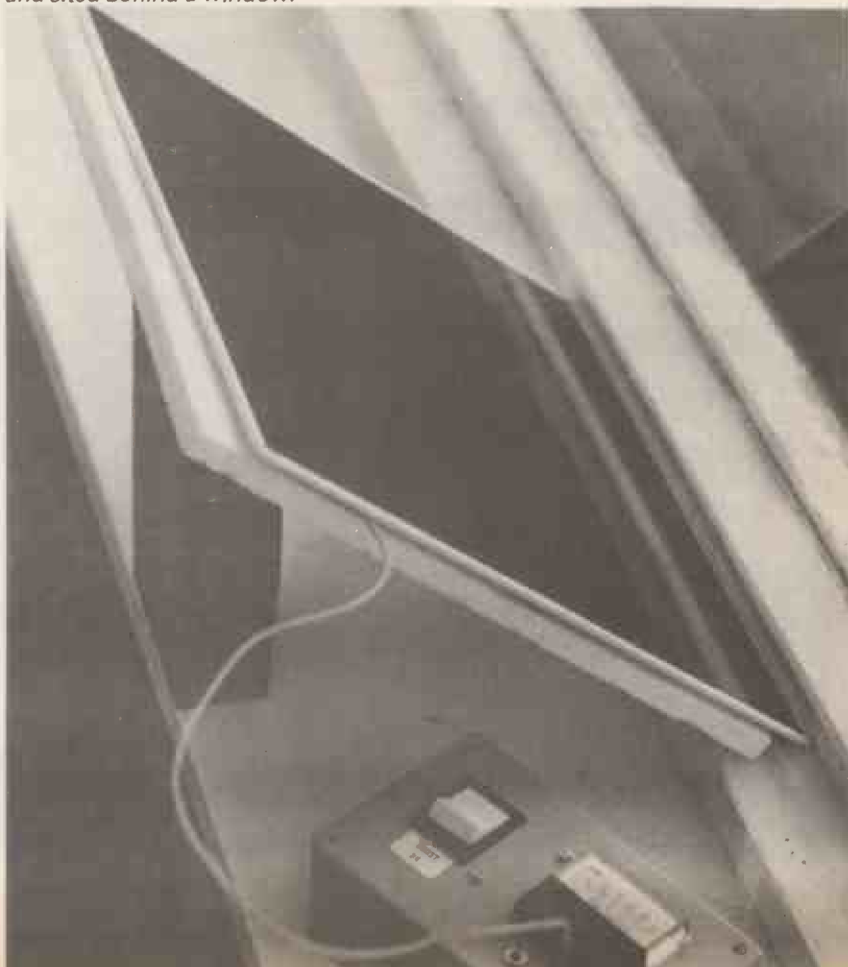
GREATER CAPACITY

Although most of the following description assumes that AA size cells are to be used as the supply, some readers will wish to use larger capacity batteries. This may be of no advantage during the winter because AA cells are sufficient to hold one day's worth of lighting energy (one hour maximum).

However, in situations where the light is not in daily use, it could be an advantage to allow the charge to accumulate over several days. Larger-capacity cells could then provide an extended period of occasional use. Note that AA cells having a slightly higher capacity – 600mAh rather than the more usual 500mAh – are available from some suppliers. It may be worthwhile using these.

By using standard (1·2Ah) C-size cells, approximately one hour's light may be expected on a three-day cycle even in the autumn. With these cells, a higher limiting

The 30cm solar panel plugged into the "Standard" prototype unit and sited behind a window.



current – nominally 140mA – may be set to take advantage of the bright summer weather.

No current limit need be set when trickle-charging 12V car-type batteries or the smaller lead-acid batteries now available. This simplifies the circuit required and details for this are given later.

POWER-IN

To provide a 12V supply, ten nickel-cadmium cells are needed. This is because this type of cell produces an output of only 1·2V instead of 1·5V for the conventional "throw-away" variety.

An AA size battery pack may be housed inside the main unit using the specified box (see photograph). For larger cells, a correspondingly larger box will be needed or the battery pack could, of course, be sited externally.

Plugs and sockets are used to make the external connections – a "power-in" type socket for the solar cell and a 3·5mm jack socket for the light. This ensures that these items are connected to the correct socket.

An ammeter may be mounted on the front panel (as in the prototype unit) to indicate the charging current – see photograph. This is useful for checking that the charge rate falls within specification and also to help in adjusting the mounting angle of the solar panel for best effect.

Costs could be saved by omitting the meter and connecting a multimeter to a pair of sockets on the unit instead. This would be used just for setting-up purposes then removed afterwards. When the multitester is not in use, a link wire would simply connect the sockets together to maintain continuity. It is possible to avoid the use of a meter altogether, but the charging current would need to be taken on trust and positioning the solar panel carried out by common sense!

LIGHTING-UP

Although a 12V 8W fluorescent light fitting is specified in the components list, it would be possible to increase the light output by using a 13W fitting. This would, of course, run down the battery pack in a correspondingly shorter time.

It may be appropriate to use the brighter lamp in some situations, especially where it is backed up by a high-capacity battery pack. However, in tests, the smaller 8W lamp was found to be perfectly adequate for garden sheds and similar places. It is not really satisfactory to use filament lights – for a reasonable light output, these would run the battery down too quickly.

CIRCUIT DESCRIPTION

For trickle charging lead/acid (car-type) batteries or nickel-cadmium cells which can accept a continuous charging current in excess of 200mA (industrial type C- or D-size cells – 2Ah and 4Ah respectively) refer to the circuit diagram shown in Fig. 1 (Car Battery Trickle-Charger). Here, current flows from the solar panel through diode, D1, meter ME1 and fuse FS1 hence through the battery being charged. Diode D1 prevents the battery from discharging back through the solar panel under dark conditions.

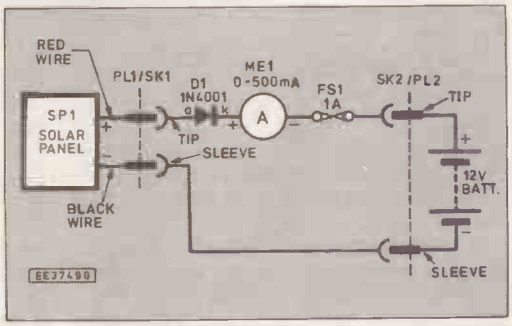


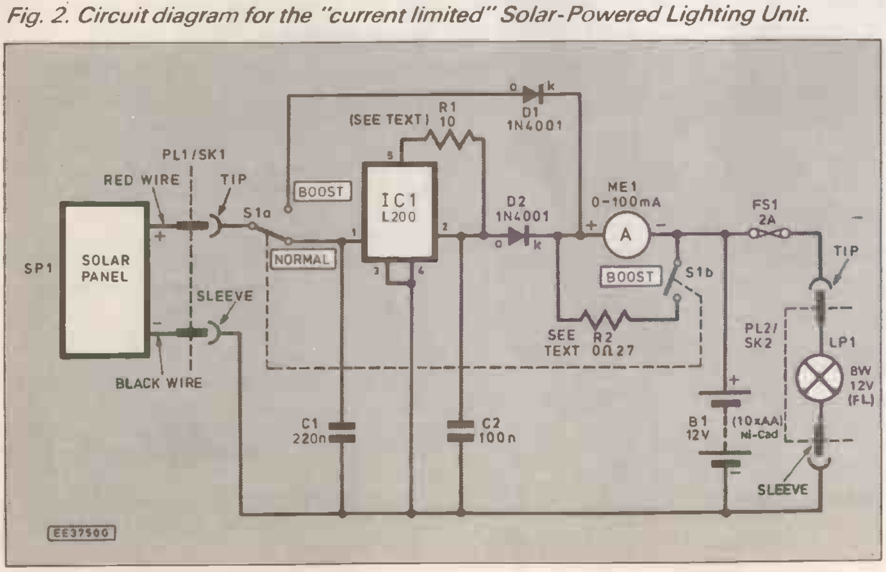
Fig. 1. Circuit diagram for the solar powered battery trickle-charger.

For charging nickel-cadmium batteries where a current limit needs to be set (50mA for AA size cells or 140mA approximately for C- or D-size *commercial* type cells) refer to Fig. 2 circuit diagram. Here, the main component is IC1 – an integrated circuit regulator.

Suppose the Normal/Boost switch, S1, is set to Normal for the moment. When bright light falls on solar panel, SP1, current is supplied to IC1 input, pin 1. Although IC1 is a sophisticated device providing on-chip regulation of voltage and current, in this application it is connected simply as a *current limiter*.

Fixed resistor, R1, connected between pin 5 and pin 2, sets the threshold current to the correct nominal level – 10 ohms for 50mA (for AA cells) or 3·3 ohms for 140mA (for commercial C-cells). If the current supplied by SP1 lies below this threshold, the regulator has little effect (it simply reduces the output current a little).

Fig. 2. Circuit diagram for the "current limited" Solar-Powered Lighting Unit.



COMPONENTS

SIMPLE VERSION
(Trickle-Charger)

Semiconductor
D1 1N4001 50V 1A rect. diode

Miscellaneous
SP1 30cm square amorphous silicon solar panel – output 12V at 200mA nominal
FS1 20mm chassis fuseholder, with 1A quick-blow fuse
PL1/SK1 3·5mm mono jack plug and matching chassis socket
PL2/SK2 2·1mm "power-in" plug and matching chassis socket
ME1 250mA or 500mA f.s.d. moving-coil panel meter, face size 51mm x 45mm approximately – see text
Plastic box, size 100mm x 75mm x 40mm, – see text; stranded connecting wire; nuts, bolts and washers; solder etc.

Approx cost guidance only **£20**

STANDARD VERSION
(Current Limited)

See SHOP TALK Page

Resistor
R1 10 ohms (for AA size cells) 3·3 ohms (for commercial C- and D- size cells – see text)
R2 0·27 or 0·2 ohms (4 or 5 off 1 ohm – see text)
All resistors 0·25W 5% metal film

Capacitors
C1 220n ceramic
C2 100n ceramic

Semiconductors
D1, D2 1N4001 50V 1A rectifier diodes (2 off)
IC1 L200CV adjustable voltage and current regulator in *Pentawatt* package

Miscellaneous
SP1 30cm square amorphous silicon solar panel – output 12V at 200mA nominal
B1 AA size nickel-cadmium cells (10 off) and holder – see text
S1 Miniature d.p.s.t. toggle or slide switch
FS1 20mm chassis fuseholder, with 2A quick-blow fuse
PL1/SK1 3·5mm mono jack plug and matching chassis socket
PL2/SK2 2·1mm "power-in" plug and matching chassis socket
SK3/SK4 2mm sockets – if required. See text. (2 off)
ME1 100mA f.s.d. moving-coil panel meter, face size 51mm x 45mm approximately – see text
LP1 12V 8W fluorescent light fitting
Stripboard 0·1in matrix, size 10 strips x 18 holes; plastic box, size 150mm x 90mm x 52mm approx; battery connector for battery holder; stranded connecting wire; nuts, bolts and washers, solder etc.

Approx cost guidance only **£25**
excluding Light & Batts

When the input current rises above the threshold, a steady output current equal to the threshold is obtained from pin 2 with the excess energy being dissipated as heat. IC1 is amply-rated and the power developed will never be great enough to warrant the use of a heatsink.

The output current from IC1 charges the battery pack, B1, with current flowing through diode, D2, milliammeter, ME1, (or external meter via 2mm plugs and sockets) and fuse, FS1. Diode, D2, prevents the cells from discharging back into IC1 when the solar panel is in dim light, during the night for example.

BOOST

When the Normal/Boost switch is set to Boost, two things happen. The switch pole of S1a disconnects the solar panel from IC1 input, pin 1, and connects it instead to the output via diode D1. This allows the maximum current provided by the solar panel to flow to the battery pack.

Meanwhile, switch S1b pole shunts fixed resistor, R2, across the meter terminals. The value of this resistor is chosen to bypass three times the meter current through itself. In practice this means that resistor R2 should have a value of one-third that of the meter. The meter scale is then effectively multiplied by four i.e. its full-scale deflection is 400mA.

Diode D1 prevents the battery pack from discharging through the solar panel under dark conditions when switch S1 is set to Boost. Capacitors, C1 and C2 are necessary to provide electrical stability to IC1.

A fluorescent light is much brighter for a given current input than a filament lamp. Note, however, that a fluorescent light designed for *12V* operation *must* be used. This already contains the necessary inverter which increases the low input voltage to that needed to operate the fluorescent tube. These lights are stocked by mail-order suppliers or may be obtained from camping and caravanning shops.

Holders for ten AA cells are available from some suppliers. Otherwise, use a holder for six and a holder for four (or some other suitable combination) connected in series. This will also be necessary where cells other than AA size are used since holders for ten of any other type do not appear to be available.

Front panel component layout for the Simple Trickle-Charger version. The solar cell panel plugs into the "power-in" socket on the left.

CONSTRUCTION

If constructing the simple circuit (Car Battery Trickle-Charger – Fig. 1), i.e. having no current-limiting, this needs no circuit panel. The only active component is diode, D1, and this is suspended in the wiring.

Follow the wiring layout photograph/diagram shown in Fig. 3, noting the polarity of the meter and of diode D1. The meter should have an f.s.d. (full-scale deflection) of 250mA or 500mA.

If constructing the standard version circuit, having current-limiting, refer to Fig. 4. First calculate the value needed for resistor R2. The internal resistance of the specified type of meter is typically 0·6 to 0·8 ohms and will be found in the supplier's or manufacturer's data.

For a 0·6 ohm meter, R2 will need to have a value of 0·2 ohms and for a 0·8 ohm meter, R2 will need to be 0·27 ohms approximately. This value is not too critical since great accuracy is not required. In any case, there is a certain amount of contact resistance in the switch which can cause deviations.

It is possible to buy single resistors having these values but they will probably be of the bulky high-power type. A cheaper and more compact solution is to buy four (for 0·8 ohms internal resistance) or five (for 0·6 ohms internal resistance) one ohm resistors and connect them in parallel as shown. This will give values for 0·25 ohms and 0·2 ohms respectively.

For other meter resistances work accordingly. Fig. 4 shows four one ohm resistors in parallel on the circuit panel but there is space for a fifth one if required.

STANDARD VERSION

Construction of the Standard Version of the Solar-Powered Lighting Unit is based on a circuit board made from a piece of 0·1 in. matrix stripboard, size 10 strips x 18 holes. Cut this to size and solder the link wire used to inter-connect IC1 pin 3 and pin 4.

The standard version stripboard component layout is shown in Fig. 4. The regulator IC1 comes in a rather curious 5-pin "Pentawatt" package. Bend its pins gently to conform with the stripboard matrix and, noting its orientation, insert them through the holes and solder the device into position using minimum heat from the soldering iron.

Follow with the other on-board components noting that diodes D1 and D2 must be connected the correct way round as indicated. Drill the two fixing holes and solder 8cm pieces of light-duty stranded connecting wire to copper strips *B, C, D, E* and *F* along the left-handed side as shown.

CASE

Prepare the box by making holes for switch S1, fuse FS1, sockets SK1 (for solar panel connection) and SK2 (for the light), for circuit panel and battery holder mounting according to type (see photograph). Make holes for the multitester sockets if needed.

Make a large hole for the meter. This may be done by drilling a circle of small holes then joining them together using a small hacksaw blade. The hole need not be particularly neat since the edge will be covered over when the meter is in position.

Mount all components. Note that everything, apart from the battery pack, is mounted on the lid of the case. This keeps the wiring short and neat and imposes less strain on it.

Referring to Fig. 5, complete the interwiring shortening any wires as necessary. Note the polarity of the meter. If 2mm

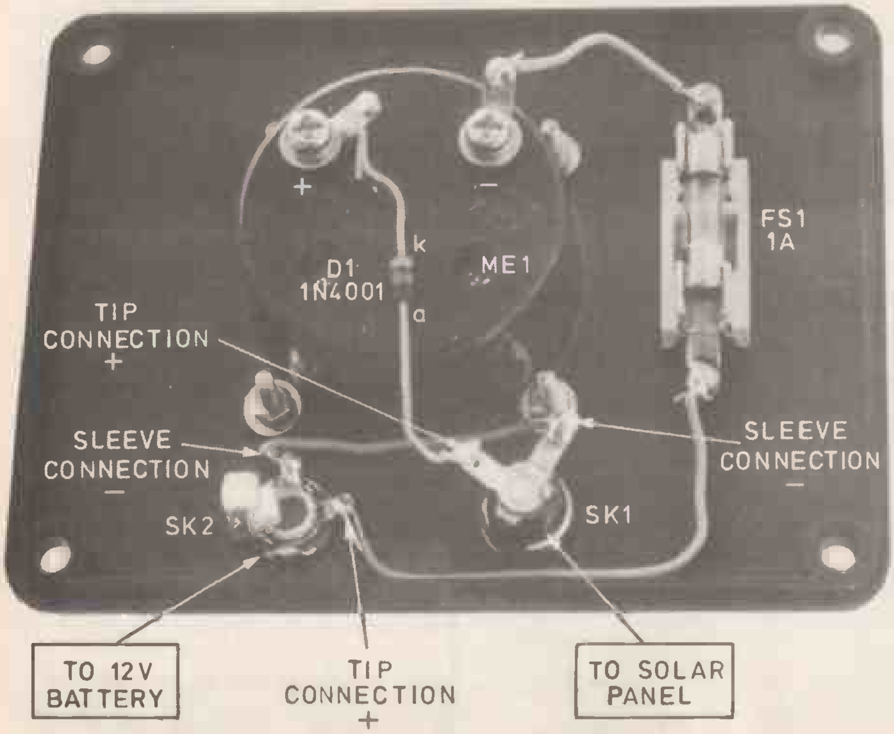
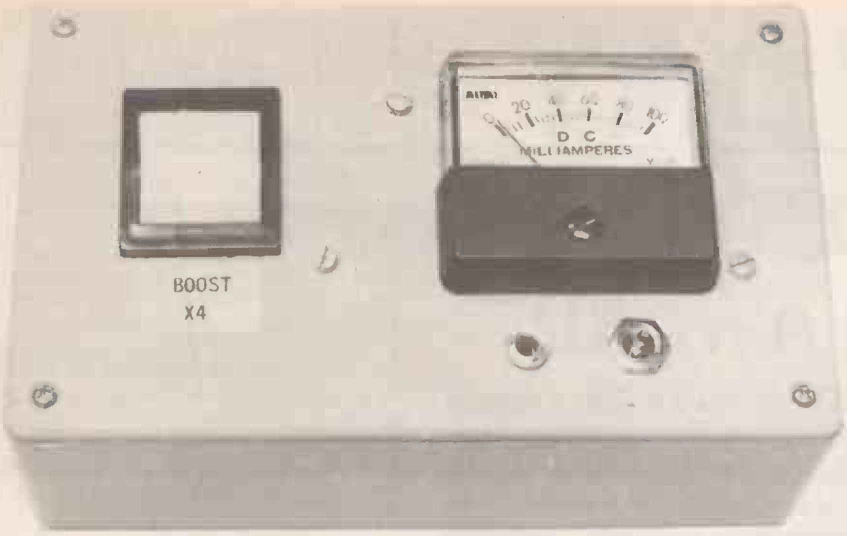


Fig. 3. Component layout and interwiring for the Simple Trickle-Charger version.



Front panel component layout of the Standard Version showing the "boost" switch position.

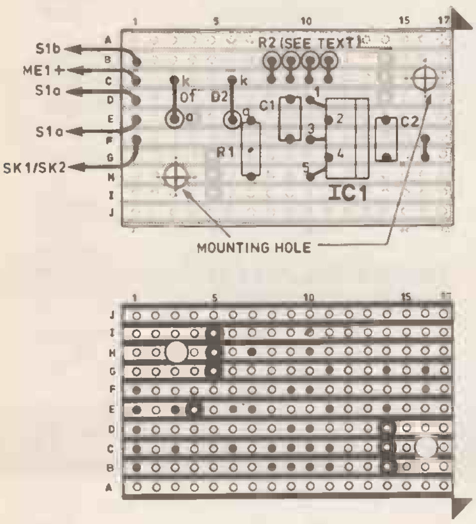


Fig. 4. Stripboard component layout and details of breaks required in the underside copper tracks.

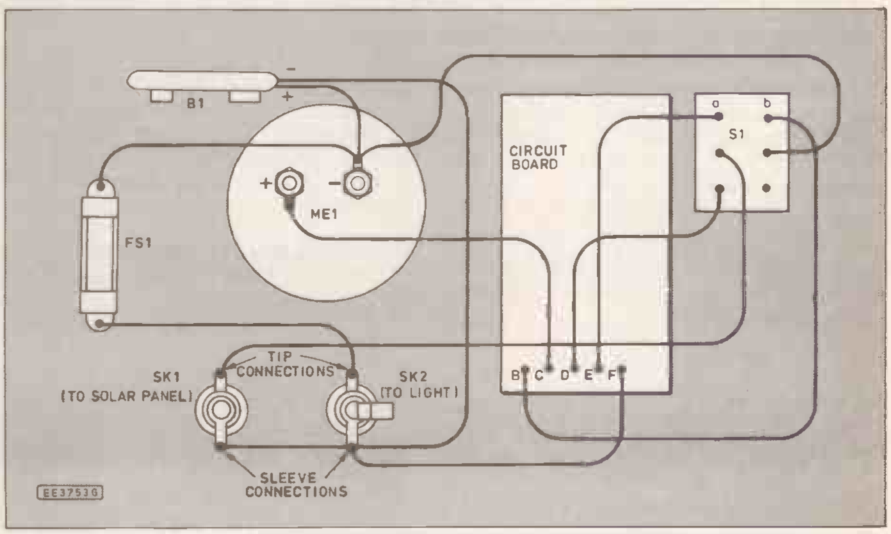


Fig. 5. Component layout and interwiring for the Standard Version. All components, except the battery holder, are mounted on the rear of the case lid.

sockets have been fitted for a multitester to be used, make up a short lead with matching plugs on the ends so that the sockets may be linked together when the meter is disconnected. Place the cells in their holder and connect them up. Insert the fuse into its holder.

Check that the lid fits – it may be necessary to bend the switch tags slightly to give sufficient clearance. This must be done with great care since it is very easy to crack the plastic body. It is best done by gripping the tag with fine-nose pliers close to the body then bending it with a second pair of pliers.

SETTING-UP AND TESTING

Prepare the solar panel by fitting a suitable length of flexible 2-core wire terminating in the 2·1mm power-in plug. Do not try to remove the existing wires soldered to the solar cell output since damage could easily result. Instead, shorten these wires and make soldered and sleeved connections to the new lead. Tape the wire securely to the back of the panel to provide some strain relief. Prepare the light by attaching the 3·5mm jack plug to the end of the wires taking care over the polarity.

In sunny summer conditions, testing the unit could result in overcharging the batteries – especially if AA size are used. This may be avoided by starting tests with the batteries in a discharged state. Switch the light on to discharge them if necessary.

They may now be safely charged at up to 250mA for two hours or so. With higher-capacity cells, greater liberties may be taken. If a built-in meter has not been used, the multitester set to an appropriate d.c. current range should be connected to the 2mm sockets observing the polarity.

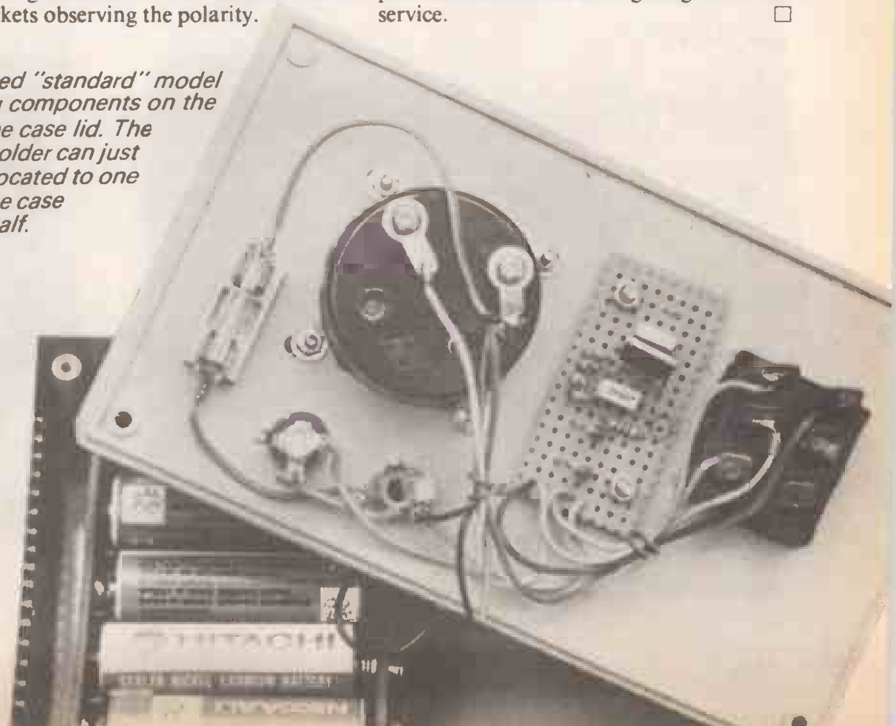
Select a suitable site for the solar panel. This must not be placed in the open but behind a window to protect it from the weather. Switch S1 to "Boost" and adjust the direction of the panel for best overall effect. This may be revealed by checking the output current every so often. If no meter is used, then direct the solar panel by common sense.

Check operation of the Boost/Normal switch in the Normal position. Providing the light is bright enough, the meter should read the limit preset by resistor R1 – approximately 50mA or 140mA as appropriate. Otherwise a reading will be given depending on the amount of light falling on the panel. Note that if using the unit to charge a caravan battery, any existing charger should first be disconnected.

During the summer, boost charging at 200mA may be carried out on AA size cells for two hours providing the cells are in a *discharged* state. In the winter, the switch may be set to Boost continuously providing the current remains below 50mA. This will add a few milliamps to the charging current.

It only remains to label the switch and put the Solar-Powered Lighting Unit into service. □

Completed "standard" model showing components on the rear of the case lid. The battery holder can just be seen located to one side of the case bottom half.



EVERYDAY NEWS

YOUNG ELECTRONIC DESIGNER AWARD

THE winners of the 1992 Young Electronic Designer Award (YEDA) were announced recently at the Science Museum, where HRH The Duke of York made the presentations to successful finalists. The Young Electronic Designer Awards scheme is open to students in secondary schools, colleges and universities between the ages of 12 and 25, and challenges young designers to invent and produce an electronic device that meets an everyday need.

Presenting the awards, the Duke of York said, "Of course, electronics has a special significance to me in my career with the Royal Navy. Our aircraft and ships depend very largely on electronics in instrumentation, as well as control and communications. I was therefore particularly interested to accept this engagement to see how schools and universities are applying today's technology."

SENIOR CATEGORY
(18-25 years inclusive)

1st – YEDA Trophy, £1,000 and course sponsorship: Jeff Crofts (22), Royal Naval Engineering College, Plymouth – The Midi Accompanist.
2nd – £500: Stefan Cook (23), Cheltenham & Gloucester College of Higher Education – The Mouse Emulator.
3rd – £250: William James (19), Kings College, Taunton, Somerset – A fully controllable print and film driver.

INTERMEDIATE CATEGORY
(15-17 years inclusive)

1st – YEDA Trophy, £750: Mark Stewart (17), Cowes High School, Isle of Wight – Beam music design to encourage movement in handicapped children.
2nd – £200: Marion Hore (18), Farnborough Sixth Form College, Hampshire – A water flow meter.
3rd – £200: Benjamin Brierton (17), Mortimer Wilson School, Derby – A bike alarm.

JUNIOR CATEGORY
(Under 15 years)

1st – YEDA Trophy, £500: David Issott (15) and Tom McEwan (14), Cheltenham College – A portable monitor to evaluate the presence of carbon monoxide.
2nd – £250: Lucy Boize (14) and Claire Guerlain (14), Woldingham School – An electronic digital destination display for a bus.
3rd – £150: Jonathan Pepper (15) and Nick Davies (14), Cheltenham College – An iron for the blind, partially sighted, elderly or handicapped.

SCHOOLS PRIZES

Joint winners of the Texas Instruments Award – £2,500 (divided) for the most commercially viable project:

Mark Stewart (17), Cowes High School, Isle of Wight – Beam music design to encourage movement in handicapped children.

BEAM MUSIC was designed for use with handicapped children, but can be used for various other applications.

Handicapped children respond well to music, and by breaking the light beams notes can be played. The computer can generate the notes internally or alternatively send them to a keyboard. This allows high quality sounds to be created and accompaniments to be added. Popular tunes can be played using this setup.

Beam Music is not limited to just music. It can be used with various computer games etc, the frame is used in a similar way to a joystick.

Jonathan Pepper (15) and Nick Davies (14), Cheltenham College – An iron for the blind, partially sighted, elderly or handicapped.

SAFE-N-EASY is a standard iron, modified in several ways to provide extra safety and to make it easier to use. Firstly, an auto-turn-off feature is included, so that the iron will turn itself off after 30 seconds if left flat, or 5 minutes if left upright.

Secondly, for ease of use, the iron sounds an audible warning as the water in the reservoir reaches the maximum level during the filling operation. A further alarm option alerts the user to the fact that the water in the reservoir requires replenishment.

A small internally mounted NiCad battery, which is recharged during normal use, provides power to the alarm circuit.

Mercury 'Planet' Award – £2,500 for the most environmentally/socially aware technology.

David Issott (15) and Tom McEwan (14), Cheltenham College – A portable monitor to evaluate the presence of carbon monoxide.

The COSMOS detects different levels of carbon monoxide concentration. It gives an accurate reading and is very concerned with safety and warning if an area is unhealthy.

The sensor uses nine l.e.d.s, one each to warn when the batteries are low, when you can start taking readings that are valid, and seven to tell you the concentration of carbon monoxide in the immediate atmosphere.

HRH the Duke of York who presented the Young Electronic Designer Awards discusses Farnborough Sixth Form College student Marion Hore's project, a Water Flow Meter.

First place in the Intermediate Category of the Young Electronic Designer Awards went to Cowes High School student Mark Stewart (17) for his project, Beam Music.

NEW IMAGING TECHNIQUE

A NEW, safe technique for looking inside the body was demonstrated in London recently. The patient wears a belt which carries, on the inside, regularly-placed contacts which allow current (5mA at 50kHz) to flow into the skin. If the voltage is applied to one pair of contacts (1 and 2 in Fig. 1a) the pattern of current paths (dotted lines) is set up. If a sensitive voltmeter is placed at another pair (e.g. 3 and 4) a small voltage is picked up.

If the medium through which the current flows (in this case the body) is not electrically uniform but contains an insulating region such as an air pocket then the current paths are distorted (Fig. 1b). For a constructive anomaly such as a blood clot the paths are distorted in a different way. Voltages picked up by detectors at contact pairs such as 4 and 5 are now slightly different.

In the system developed by Sheffield University and the Royal Hallamshire Hospital 16 contacts are used. The driving voltage is commuted so that it is applied successively to every pair of adjacent contacts (1 and 2, 2 and 3, 3 and 4 etc) and measurements are logged automatically for every non-driven pair in succession. After computing, these yield an image of the slice of the body which is encircled by the belt.

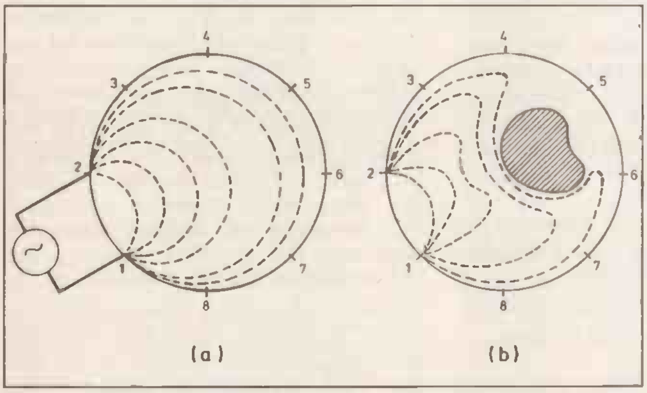


Fig. 1. Electrical Impedance Tomography. (a) Current paths through uniform object. (b) Paths distorted by an insulating region.

The first, rather simple system is being used to monitor the contents of the stomach. A conducting liquid (fruit juice) drunk by the patient produces an image showing how the stomach walls move as the liquid slowly passes through. In this way abnormal stomach contractions can be identified.

A "print out" in the form of a bar graph records changes in stomach volume and is useful for diagnosis. The Sheffield team (led by Professor of Medical Physics, Brian Brown) has now developed a real-time system which should enable doctors to study blood flow and breathing. The British Technology Group is doing the marketing.

The technique has two names, Applied Potential Tomography and (preferred) Electrical Impedance Tomography. Teams in many centres are working on it. From the medical point of view its attractions are safety, comfort, portability and low cost. A simple system should cost about £15,000 and a real-time system about twice this. Comparable alternatives like magnetic resonance scanners cost £1 million or more.

Present systems display the "slice" as a circle, not as the actual shape of the body. Ways of correcting this distortion (which could be important if the image is to be used to guide surgery) are being explored. So is a possible extension to brain scanning to pinpoint the foci of epileptic seizures.

Electrical Impedance Tomography is a perfectly general technique with applications far removed from medicine. One team is using it to examine core samples drilled out during oil exploration. It might also be adapted as a geological tool to examine underlying strata or by archaeologists to detect buried buildings.

The Sheffield system is essentially a detector of changing images. An alternative, under development at the Renssalear Polytechnic in the USA applies current simultaneously to all electrodes and generates a static image. (Successive static frames can of course be stored and played back in sequence to give a moving picture.)

High-Speed Mass-Storage Medium of the Future

The first Sharp Palmtops and Notebooks with "flash memories" are already on the market. These new storage media could soon make conventional disk drives and hard disks with their sensitive, slow reading mechanisms obsolete. According to Dataquest, Intel, the US semiconductor giant, has over 85 per cent of the market for these new mass-storage devices. Sharp sees a wide range of potential applications for this exciting new storage technology in their products. Both companies have recently signed an agreement calling for long-term cooperation in the development and production of flash memories.

Flash memories are highly integrated storage devices that are faster and less prone to failure than conventional drives because they have no moving parts. First of all, they can be used as ROMs, which means that data remains intact without power. On the other hand, they can also be erased and rewritten, which makes them more like RAMs. However, they most resemble EEPROMs, electrically erasable read-only memories.

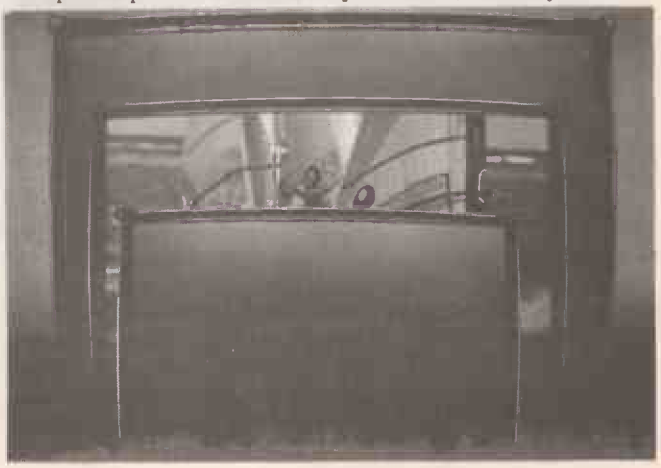
As the name implies, flash memories use a very fast, strong pulse of curent for erasing. Both operations, erasing and writing, take place within the system and not, as is the case of conventional EEPROMs, in separate accessory devices. In addition, flash memories are designed to handle up to several hundred thousand erase-rewrite cycles. Due to the high degree of integration and the low number of components required per information unit, a single tiny chip can combine a storage capacity of 1 Mbit with an access time of under 100 ns!

SIXTEEN BY NINE

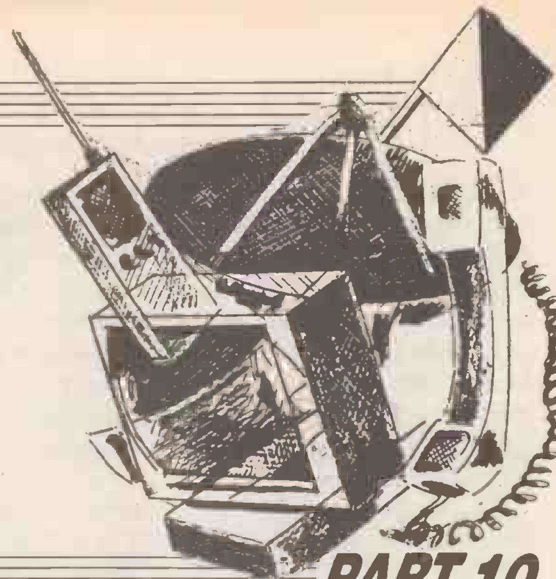
The shape of things to come TV wise appears to be 16:9. Philips components are now producing a range of "Cineline 16:9 wide screen picture tubes" and 16:9 sets are now available. Wide screens represent a large piece of glass and well developed technology; like most forms of technology the c.r.t. is continually being improved.

The latest picture tubes from Philips have higher brightness, improved contrast and better colour, mainly due to the use of invar rather than iron for the shadowmask. This enables greater beam energies to be used producing higher brightness and allowing darker tinted glass which gives better contrast.

Shown here are three new 16:9 tubes, two of which (36 inch and 28 inch) are now available in Philips sets. The tubes are made by Philips Components at their factory in Aachen, Germany



Special Series



INFORMATION TECHNOLOGY

AND THE NATIONAL CURRICULUM

T. R. de VAUX BALBIRNIE

PART 10

THIS is the tenth in a 12-part series concerning Information Technology, communication systems and related matters in and around the Science National Curriculum.

This month we shall explore the use of IT devices in monitoring and controlling experiments. We shall follow with a look at the operation of modern communications devices in the transmission of large amounts of information including some economic and social implications.

COMPUTER MONITORING

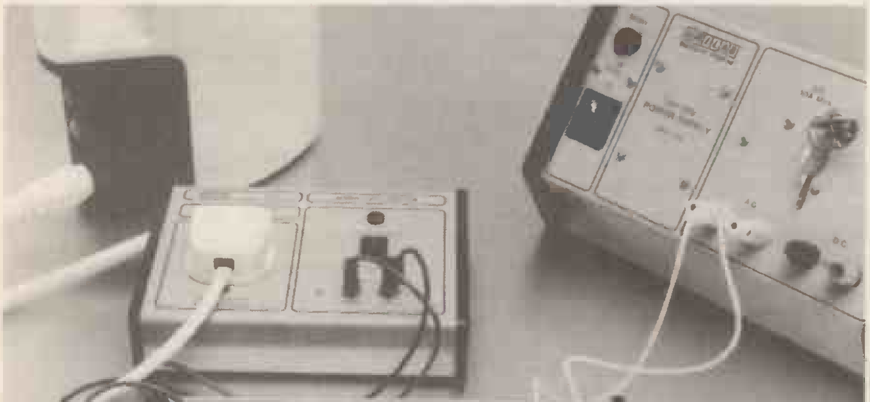
Computer monitoring no longer involves the makeshift methods which were necessary only a few years ago. There is now available a wide range of devices to suit all types of experiments in science and technology. Electrical quantities such as current, voltage and charge may be monitored as well as non-electrical ones such as temperature, humidity, sound level, magnetic field strength, position, light intensity, pH and oxygen levels.

To monitor any of these, a sensor is plugged into the host computer – often via a connecting box – and the software provided by the manufacturer loaded from disc. The computer samples the variable being measured at specific time intervals and processes it. It may then display the results in the form of tables and graphs. It can also operate a printer to give a permanent "hard" copy of the results. Data may be saved on disc and re-loaded at a future date. It may then be compared with new results.

The BBC computer is still widely used by schools for monitoring since it is well supported by software. Also, these computers are common in schools and colleges and will be for some time to come.

AT LOGGERHEADS

An extension to computer monitoring is *data logging*. Here, the sensor is plugged into a portable *logging box* which has its own memory. This may be carried anywhere – even where a mains supply is unavailable – because it is battery-powered. This could be particularly useful for biology experiments carried out in the field. The data logger may be left to gather information over an extended time period if necessary.



The Unilab Simple Logger in use.

In the case of the Unilab "Simple Logger" (illustrated) samples may be taken at any time intervals between 200µS and seven days. Afterwards, the logger is taken back to the laboratory and plugged into the computer. The data in the logger's memory is then unloaded and the results processed, displayed and printed as in "straight" computer monitoring.

It is best for this type of work to be addressed at various times during the course while doing topics in technology, chemistry, physics, biology, etc. It will then crop up naturally several times during the course of a year. It would not be altogether successful to have a "data logging day" unless, of course, the equipment has to be borrowed and was only available for a short time.

Computer data-gathering techniques are readily understood by students of a wide ability range. For the more able, much more work can be covered in a given time than by using traditional methods. Also, the results can be processed in various ways, some of which would involve a great deal of work otherwise. For the less able, results are obtained without the use of mathematics and this generates enthusiasm to continue where otherwise they would lose interest. Data loggers are ideal for students who find mathematics difficult since this method frees them to see the *science* in the experiment rather than being bogged down by the maths.

On the other hand, this can be the downfall of this method if it is not used sympathetically. Traditional skills are easily abandoned and this would be a big mistake. Setting-up apparatus, using measuring instruments, gathering information, drawing tables and graphs, processing and evaluating the results are as important today as they have ever been. It is essential that new technology is used *alongside* traditional methods and not as a substitute for them.

MONITORING ILLUSTRATION

To illustrate computer monitoring and data logging, let us examine a typical package – the temperature module from the Philip Harris range. For simple monitoring a temperature sensor, connecting box, a BBC computer and the software supplied on disc are needed. For data logging, in addition to the computer and sensor, you need the special data logging box and a different piece of software.

For collecting data in the laboratory, the temperature sensor is first plugged into the connecting box and this, in turn, is plugged into the analogue input socket on the computer. The software is then loaded. The appropriate sensor is selected from the main menu. The temperature range to be covered is now chosen: 0°C to 100°C, −10°C to 40°C or any 10°C span between 10°C and 40°C.

It is also necessary to calibrate the sensor against a known temperature such as a beaker of water whose temperature has been measured using a mercury thermometer. The red function keys are programmed by the software to produce various results. For example, f3 saves data on disc, f4 loads data from disc, f5 re-scales the axes and so on.

COMPUTER CONTROL

The computer is a necessary part of modern control systems. Some knowledge of this is appropriate to various technology courses but could apply to some science topics too.

As with computer monitoring, there is now available a range of devices together with supporting software to control a system or experiment such as a robot arm, lathe or buggy. It could also operate a motor to stir a liquid at specified time intervals, switch on electrical appliances, control stage lighting or operate hydraulic or pneumatic systems. It could control gas valves to admit oxygen or carbon dioxide into a system during a biology experiment. The possibilities are endless.

LARGE-SCALE COMMUNICATION SYSTEMS

The invention of the electric telegraph in the early part of the 19th century revolutionised communication – see Part 1 of this series (November, 1991 issue). It meant that a message could be sent hundreds of miles and a reply received within minutes. This was such a monumental advance that no one worried about its chief drawback – only one message at a time could be sent along the line. The early telephone suffered from the same disadvantage.

Today, we exchange enormous amounts of information with all parts of the world. Some of this sent by *telephone* (using copper wire, optical fibre or a combination of the two) – this includes private and business conversations, telex, fax (facsimile transmission) and binary data being transferred between computers.

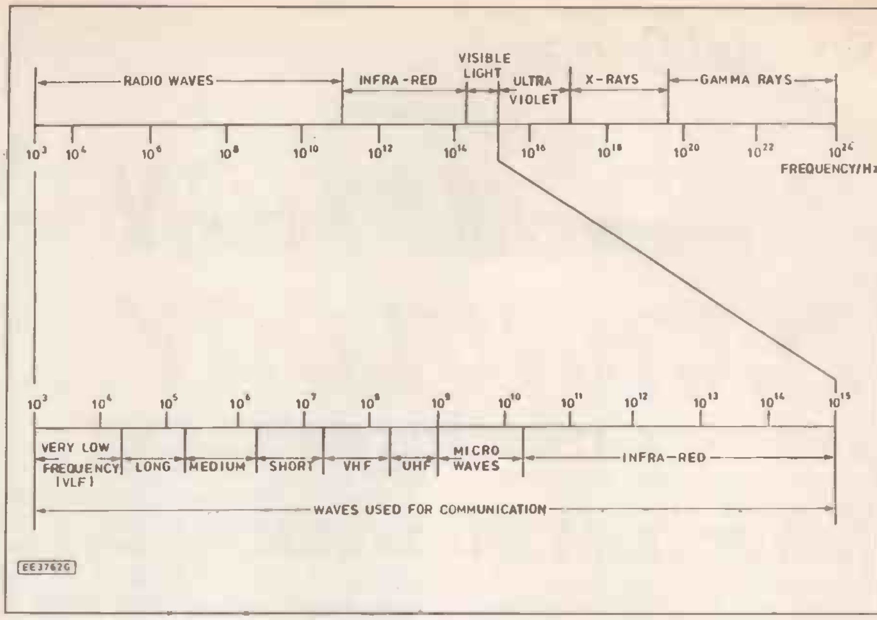


Fig. 1. The electromagnetic spectrum.

Some information is sent by *radio* using, perhaps, satellite links. This includes telephone conversations, radio and television broadcasts, use by emergency services, links with ships at sea and military communications.

All waves used for communication purposes are members of the wide family of *electromagnetic waves*. All members of this family have important properties in common. For example, they all travel at the same speed – 300,000 kilometres per second (186,000 miles per second in free space) – the so-called *speed of light*. Fig. 1 shows the entire electromagnetic spectrum and it will be noted that it covers a vast range of frequencies – that is, the number of waves per second expressed in Hertz (Hz).

The frequencies are indicated using a type of mathematical shorthand called *standard form*. This avoids writing a lot of zeros. Thus, 10^3Hz means 1000Hz (that is, 1 followed by three zeros). By the same rule, 10^{14}Hz means 10 followed by 14 zeros! Note also that 1kHz (kilohertz) = 1000Hz, 1MHz (megahertz) = 1000kHz and 1GHz (gigahertz) = 1000MHz.

At one end of the scale, very low frequency radio waves extend from 1kHz or so and at the other end, gamma rays (emitted by radioactive materials) have frequencies of many millions of GHz. Note how the radio wave frequencies blend into *infra-red* which then become *visible light*. It is these waves which are used for communication purposes.

THE APPROPRIATE FREQUENCY

It is found that waves of different frequencies have subtle differences in their properties – this allows us to choose the best frequency for a particular job. Very low frequency (VLF) radio waves penetrate water reasonably well whereas the higher frequencies are absorbed very quickly. VLF waves are therefore used to communicate with submarines.

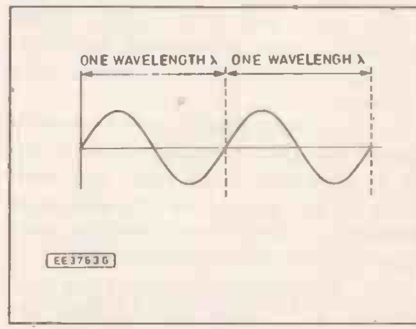


Fig. 2. Wavelength of a wave.

For much longer-range communication, waves of a low to medium frequency are used – so-called, *short*, *medium* and *long* waves. Note that the terms *short*, *medium* and *long* here refer to the *wavelength* (the size of one complete wave – see Fig. 2) rather than the frequency. We find that waves of short wavelength have a high frequency and vice-versa. Think of someone throwing pebbles. If many pebbles are thrown per second (high frequency) the space between them in flight (representing the wavelength) will be small. If fewer are thrown per second, the space between them will be larger.

Today, it is usual to refer to the *frequency* of a wave rather than its wavelength but this has not always been the case. For historical reasons, therefore, terms such as *short* (i.e. high-frequency) waves are still widely used and are often seen marked on the tuning dials of older radio receivers.

CHARGED LAYERS

Waves of a frequency less than about 30MHz reflect from layers of charged particles (called the ionosphere) which exist some 80 to 500km above the earth (see Fig. 3). If such waves are transmitted upwards at an angle, they tend to reflect back to earth some distance from the transmitter. They may then reflect from the earth back to the ionosphere and repeatedly "skip" several times before,

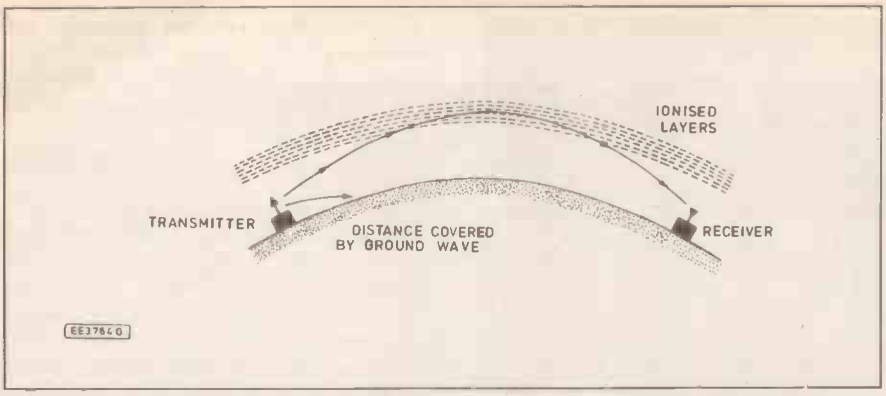


Fig. 3. Reflection of waves by ionised layers.

eventually, reaching their destination or become too weak to be intelligible.

Repeated reflection can give these radio waves a very large range when conditions are favourable. However, this is rather unreliable as it depends on the reflecting state of the ionosphere which, in turn, depends on the time of day, the *11 year sunspot cycle* and other factors. Radio amateurs know how to exploit this. However, commercial systems demand *reliable* operation.

Long (low frequency) waves tend to spread out around the curvature of the earth so gain a large range this way. They can also pass round obstructions by diffraction making them ideal for communications in mountainous areas.

Very high frequencies (VHF) and even more so, ultra high frequencies (UHF) are close to visible light in the electromagnetic spectrum – they therefore have light-like properties. Such waves are used for regional radio and television broadcasts because they operate chiefly within line-of-sight of the transmitter. They are not picked up very well by receivers over the horizon or behind mountains. The transmitter service areas are therefore easily predicted and will not overlap with adjacent ones. The same frequencies may therefore be used for broadcasts in other areas without interference.

The highest frequency (shortest wavelength) radio waves are called *microwaves*. Apart from their use in cooking, they are used for radar (which includes monitoring the positions and speed of aircraft and ships, control of traffic lights, police speed detectors, etc.

Microwaves are very close to light in the electromagnetic spectrum, so in many respects, they behave like light. They reflect from certain objects very well rather than passing through them, being absorbed or going round them. This makes them ideal for the jobs just mentioned. Aerials used to transmit (and receive) microwaves are located in a dish reflector which projects them in a beam – this is rather like the reflector in a torch or car headlight and serves to emphasise the light-like properties of these waves.

Depending on the frequency of the radio waves, they may reach their destination by *direct line of sight*, by following the *curvature of the earth* or by *reflection from the ionosphere*. Otherwise they may pass through the ionosphere and be lost in space or they may be absorbed by an object in their path. The foregoing is a much simplified account. Anyone seriously interested in this vast topic – for example, if they wish to study for the radio amateur exam – should consult a textbook on the subject.

SEPARATION

It is found that information carried using one frequency of radio waves will remain separate from that using a different frequency. The receiver is simply "tuned" to the frequency required. This may suggest that any number of simultaneous signals may be sent by radio because there is an infinite number of frequencies available. This, however, is not the case.

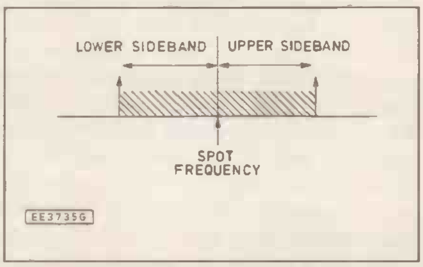


Fig. 4. Sidebands generated around the spot frequency.

When carrying information there will be a *spread* of frequencies on each side of the nominal or "spot" frequency called *sideband* (see Fig. 4). It is essential to leave enough space so that there is no overlap of the sidebands of adjacent channels. Again, this is a large topic and has only been touched on here.

Infra-red waves and *visible light* have an important place in modern communications systems. This is because they may be passed along optical fibres and carry digital telephone and other information. They may be used in free space but only over short distances such as in a television remote control handset. Readers who have not been following this series should note that Part 8 (June, 1992 issue) gave certain information about optical communications systems.

COMMUNICATION SATELLITES

If you could throw a ball fast enough in a horizontal direction it would become a *satellite* – that is, it would go into orbit around earth. This is because as it was falling to the ground, the ground would be falling away from it at the same rate due to the curvature of the earth. All the time gravity would be pulling the ball towards the centre of the earth so it would simply go round in a circular orbit. Remember "down" means *towards the centre of the earth.*

There would be several problems here. Firstly, the speed with which the ball would need to be thrown would be far too great for any normal apparatus to achieve (about 8km – or 5 miles – per second). Secondly, there would be things in the way such as tall buildings, mountains, etc. Also, friction with the air would burn it up in a very short time.

A gun can fire a shell over the horizon but it eventually strikes the ground. Isaac Newton suggested that if a sufficiently powerful cannon could be built, it could be used to launch a satellite (see Fig. 5). In practice, a *rocket* is used. The orbit is made very high to leave most of the air behind and avoid the problems with atmospheric friction mentioned earlier. It should be said that the earth's atmosphere, although much reduced, still exists even at these great heights and all satellites gradually spiral towards the earth and burn up as they enter the denser atmosphere. The first artificial satellite was the Soviet 83kg *Sputnik 1* launched on 4th October, 1957. This is believed to have stayed in orbit for almost 10 years.

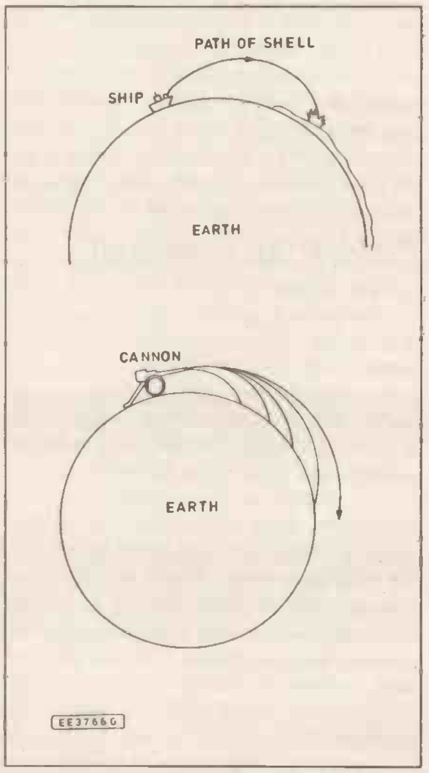
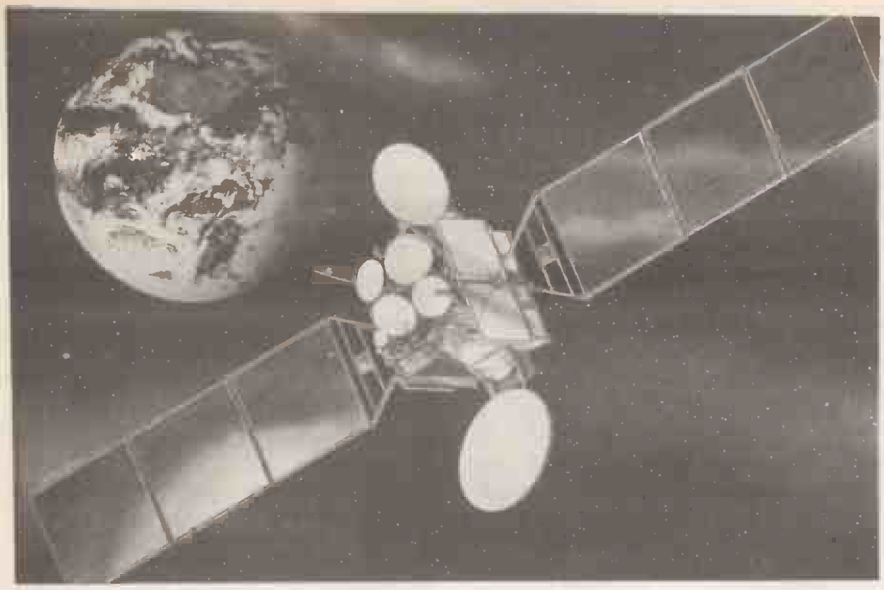


Fig. 5. Newton suggested that a powerful cannon could launch a satellite.

ACTIVE SATELLITE SYSTEMS

It had been known for many years that satellites would be useful for communication purposes – long before the technical means of launching them was estab-



Artists impression of Intelsat 7 communications satellite.

lished. By using a satellite, microwaves can be sent up from a ground station whereupon the satellite can send them back to another ground station in some distant part of the world. Microwaves have a frequency too high to be reflected by the ionosphere so they pass through to the satellite.

The earliest satellites were passive – they simply reflected the waves down to earth again and much of the energy spread out and was lost before it reached the ground station. This made communications rather unreliable. Modern satellites are *active* – that is, they receive the waves from the earth station, amplify the signal and re-transmit the information using a different frequency. Obviously, for this they need a power supply to operate the on-board electronic circuits which receive, process and re-transmit the signal. Moreover, these circuits need to work reliably for many years. The usual power supply consists of *silicon solar cells* which provide enough energy to operate the equipment and charge batteries while the satellite is in sunlight. Power is then drawn from the batteries when the satellite is on the dark side of the earth.

At the working height of the satellite, the sun's rays are very powerful since they have not been reduced by the earth's atmosphere. A relatively small number of solar cells is therefore sufficient. Early satellites used *analogue* techniques but today they work *digitally* – some relevant information was given in Part 8 of this series (June, 1992 issue). A digital signal – perhaps derived from the voice or music – can undergo more than one trip to a satellite – perhaps combined with transmission along copper wires and optical fibres – and hence reach any part of the world without loss of quality.

CATCHING THE WORM

The first satellites were placed in a low orbit where their period of rotation was about 90 minutes. This meant that the aerial on the earth station had to "track" the satellite as it rose and set in the sky. This had to be done with great precision and was not always successful. The maximum continuous communication time was therefore 45 minutes followed by a delay of 45 minutes until the satellite appeared once again. In practice the communication channel was opened for a shorter time than this.

At such a low orbit, satellites soon spiralled back to the earth due to the considerable friction with the air. Today, satellites can be put into *geostationary* (synchronous) orbit.

Launching a synchronous satellite involves placing it at a height of 36,000km above the earth's surface and giving it sufficient horizontal velocity. At this height, the satellite orbits the earth in 24 hours – the same time as it takes the earth to spin once on its axis. Thus, to an observer on the Earth, the satellite appears stationary. This technique has two advantages. Firstly, it means that the base station can point its aerial in a fixed direction (in fact, the satellite drifts in position to some extent but this is less of a problem). Secondly, communication can be guaranteed 24 hours a day.

The first commercial geostationary communications satellite was *Early Bird* launched on 6th April, 1965. Today, everyone is familiar with satellite dishes on private houses which enable commercial TV broadcasts to be received. It is even possible to set up temporary base stations so that television and radio reporters can send back news items via a satellite link instantly.

It is necessary to use waves having a frequency of more than 30MHz for satellite communications since, otherwise, they would not penetrate the ionosphere and would be reflected back to earth instead. In practice, much higher frequencies – greater than 1GHz are used. Communication satellites generally use microwave frequencies above 4GHz. Waves over about 100GHz are absorbed by the atmosphere and are therefore unsuitable.

MAXIMUM USE

The cost of launching a satellite is considerable. It is necessary, therefore, that those who have provided the money get value from their investment. If a satellite could only send one piece of information at a time the cost of using it would need to be very high. However, if many pieces of information can be sent simultaneously, each may be carried cheaply. The system may then be of benefit to more people and still be commercially viable.

Imagine we wish to send telephone messages by satellite. The digital data from the national telephone network would arrive at the ground station. In one form of operation, a fixed-frequency carrier wave is used to send signals to the satellite using a parabolic dish reflector. The carrier wave is switched on (to represent a 1) and off (for a 0), according to the data being transmitted.

Instead of a continuous stream of information, the system pauses then sends a lot of data in a 2ms burst (1 millisecond = 1/1000 second). The next burst would be from another conversation and the next from yet another one and so on. Eventually it is time for a burst from the first one again. To guard against the bursts possibly overlapping there is a space of 1µS (one millionth of a second) between them. In this way, several conversations may be interleaved with one another. This technique is called Time Division Multiple Access (TDMA).

TDMA can be combined with another technique called CME (channel multiplication). This relies on the fact that most of a given telephone conversation is actually silence. Not only is there silence while the reply is received, but there are natural gaps between words, hesitations, etc. These gaps can be made use of by filling them with data from other calls. A computer constantly checks the most efficient way of filling the spaces. It all happens so rapidly that no user is aware that he or she is sharing the equipment with other people.

It is relatively difficult keeping track of which piece of information is which and re-assemble it in the correct order but where time is money, it is certainly worthwhile. Once the information has been re-assembled, each user will think that he or she has sole use of the equipment – rather like the flat in a time-share holiday.

DELAY

One problem with sending information to and from a geostationary satellite is *propagation delay*. With the satellite at a height of some 36,000km, the waves will need to travel more than twice this distance to make a complete round trip. Since radio waves travel at the speed of light – i.e. 300 million metres (300,000km) per second – the round trip by satellite will take 0·25 seconds approximately. This may not sound much but where more than one satellite is involved the signal may take anywhere up to one second to reach its destination. Any reply will then take the same time to be received. This could involve two seconds between questions and answers. This is noticeable in conversations but is a nuisance rather than a great disadvantage.

Satellites are now used for many purposes such as for surveillance and scientific research. These gather information using on-board cameras, digitize it and relay it to an earth station where the data is processed. Surveillance "spy in the sky" satellites photograph the ground in considerable detail. Where weather conditions obstruct the view, *infra-red* cameras may be used to penetrate the haze. It would be possible to note any military build-up which could signal that a country was preparing for war.

Satellites have other uses too. They can survey the ground and provide information for crop growing, mining, archaeology and other activities. Military communication in the field can be carried out using back-pack satellite equipment. Weather satellites collect data and allow for much more accurate weather forecasting than was possible only a few years ago.

Satellite-based scientific equipment can gather data from distant parts of the universe and help scientists piece together some of its mysteries. Navigation satellites emit radio signals which can be received by ships and aircraft to enable them to pinpoint their position very accurately. Even on the ground, navigation satellites can be used to find the exact position to begin construction work. Moreover, this is now done with relatively small and inexpensive equipment.

SOCIAL AND ECONOMIC CONSIDERATIONS

We discussed in Part 8 of this series (June, 1992) the common features of an information transmission system. Whatever channel of communication is used, a modern system is so sophisticated that the user is unaware of the means by which the information is carried. For example, we would be unaware if optical fibres were used or whether satellites were involved.

Speedy and efficient communication seems to make the world a smaller place. It has certainly spread understanding and tolerance between nations. It has made us more aware of the plight of others in distant countries – we see the effects of famine, war and disease on our TV screens almost as it happens. We see injustice and put pressure where required to do something about it. On a smaller scale, distant families can keep in touch relatively cheaply. With international trunk dialling, we can reach anyone with a telephone almost anywhere in the world – instantly.

Modern communications are changing our patterns of work. For example, people now find it much easier to work from home. Using a computer and telephone line with which to send information back and forth to the main computer, a printer, word-processing package, desk-top publishing, spreadsheet and, perhaps, computer-aided design (CAD) software and a fax machine it is quite easy to make a corner of a room in the house into a fully-operational office. All this equipment is now relatively inexpensive.

MOBILE BUSINESS

It is not unknown for people to run businesses from a car or van using a portable cellular telephone. One person can attend to all the duties which were once carried out by a whole team – typist, filing clerk, office junior etc. This, of course, could increase unemployment. On the other hand these activities should – in theory at least – reduce the number of cars travelling to and from the traditional place of employment in the city so reducing pollution, conserving energy, wasting less time travelling and reducing traffic congestion.

It allows freedom for a person to choose where to live rather than being under the constraint of the company for which he or she works. It is even possible to work from a foreign country and, perhaps, enjoy the better climate there. It could also mean that people in the future will need leisure training to help in using the extra hours of freedom which our grandparents did not enjoy.

DIGITAL MONEY

Efficient communication of digital data means that money can be transferred almost instantly to most parts of the world. This has revolutionized banking. On a small scale, bank and building society cash dispensers are now commonplace in every town. We can even do our banking from home. By using a secret number (PIN) we can access our bank account over the telephone and check our balance, pay bills and transfer funds to other accounts instantly.

Building societies have been particularly quick to see the benefits which this new technology brings. One implication is that it is becoming less common for large sums of cash to be carried around. People are often paid electronically by transferring funds direct to their bank account. On the other hand *computer crime* is on the increase. Those with sufficient knowledge and skill, including that needed to extract secret codewords, can access accounts and withdraw funds fraudulently. The proliferation of plastic credit cards has also brought its own form of crime.

Efficient communications has made our lives less private. Without careful control and data protection laws we could have all manner of personal information banded about from one computer database to another. Even so, certain information may be legally passed on to third parties who can, in turn, send junk mail or inconvenience us with telephone calls about their products or services.

Using a personal computer, a modem and a telephone line, a *hacker* can break into computers and extract sensitive or personal information, change data or use it for illegal purposes. Note that such *hacking* is illegal and those found guilty face heavy penalties.

That's all for this month. Next time we will be chiefly concerned with problem solving and the effect of feedback in a control system.

A modern computer the RM Nimbus PC-186 as used in many schools.

A Canon FAX-260E fax machine.

Constructional Project

SUB-WOOFER

PAUL HENDERSON

An add-on for your hifi setup which should provide a dramatic improvement in bass.

IT'S A SAD fact that 90 per cent of existing speaker systems are incapable of delivering good solid bass. A recent look through a hi fi magazine's *"Loudspeaker Reviews"* showed only two models out of fifty tested had a −3db point below 60Hz. This state of affairs would not be tolerated in any other piece of audio equipment where a bare minimum response is required down to 20Hz, −3db.

Some audiophiles would point out that some organ music contains full power output at 16Hz. This is not all, in addition there are mysterious bass transients, even speech contains explosive sounds which are actually at sub audio frequencies.

SACRED COW

The reasons for the shortcoming in the bass region are not hard to find. Speaker systems are designed as basically mechanical devices which follow well known physical laws. The available materials dictate that domestically acceptable speakers must either be large or be subject to some form of equalisation to operate at low frequencies.

Unfortunately, the audio industry is fragmented. There are loudspeaker manufacturers and amplifier manufacturers. The latter have to design their equipment for a flat frequency response. The former are confined by this fact. It is quite possible to build a speaker system with an extended low frequency response but this requires that the hi fi's most sacred cow, flat frequency response from amplifiers has to be sacrificed.

While the audio punters are satisfied with the existing state of affairs nothing is likely to change. However, the recent introduction of CD with it's vastly better low frequency response than either tape of disc is beginning to force a change. In the meantime what can be done to improve matters?

One solution is to use a separate speaker system to deliver the extra bass. Such a system can be designed without regard to mid-range reproduction and can thus be optimised for it's task. This doesn't need to cost an arm and a leg either, all that is required is good design. Before getting deeply embroiled in the nuts and bolts of this project it will be as well to consider some of the basic theory behind it.

WEIGHTY PROBLEM

An often used and quite apt analogy to a loudspeaker is a weight suspended on a spring. If the weight is pulled downward it will oscillate at some low frequency dependent upon the stiffness of the spring and the size of the weight. In a loudspeaker the weight is the mass of the cone and the spring is the 'speaker surround. Both systems operate like a mechanical tuned circuit.

In free air the resonant frequency of a loudspeaker is often quite low. Some units even manage a free air resonance at 20Hz or thereabouts. Unfortunately it is not possible to operate a loudspeaker without a cabinet, at least if you want to hear any bass at all.

This is because of the nature of sound itself. Sound is a pressure wave that travels through air at a velocity of about 343m/sec. The easiest way to visualise this is to use another analogy.

If you tie a rope to a door handle and jerk it rapidly while holding it loosely you will see a wave travel along the rope. Note that the rope doesn't move itself very far but the wave can travel along at a fair rate.

If you take a loudspeaker and feed a bass signal into it you will not hear much. As the cone moves to and fro a bass sound wave is generated both from the front and the rear of the cone. As the dimensions of

Fig. 1. The system response curves.

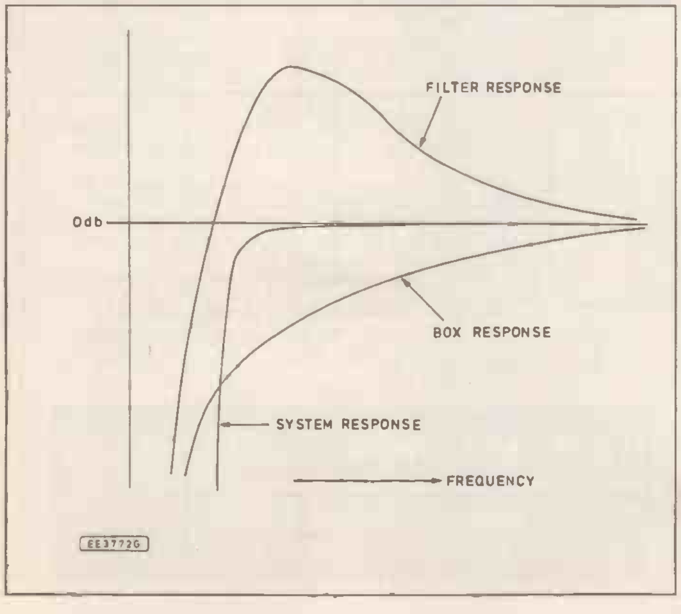


Table 1: Bass Response of Enclosure, before top cut applied

Frequency Hz	Response db	Max Spl db	Max Power watts(W)
20	−14.49	87.65	3
30	−1.71	100.43	15.6
40	−2.04	102.14	30
50	−1.51	102.14	30
60	−0.93	102.14	30
70	−0.52	102.14	30
80	−0.27	102.14	30
90	−0.12	102.14	30
100	−0.04	102.14	30
110	0.01	102.14	30
120	0.03	102.14	30
130	0.06	102.14	30
140	0.06	102.14	30
150	0.06	102.14	30
160	0.06	102.14	30
170	0.06	102.14	30
180	0.06	102.14	30
190	0.06	102.14	30
200	0.05	102.14	30

Computer predicted response for optimum system.

the speaker are small compared to the wavelength of the sound generated the front radiation cancels that from the rear. The result, no bass!

The solution is to mount the loudspeaker in a cabinet. If this is totally enclosed the back radiation is effectively contained. However, a price has to be paid for this.

Going back to our weight on a spring analogy the enclosed air effectively stiffens the spring raising the resonant frequency. This is important because the response of a speaker below the resonant frequency rolls off rapidly. Either one must enlarge the enclosure to unreasonable dimensions or find another way of obtaining bass.

GOOD REFLEXES

The Reflex Enclosure is one very useful solution. A duct is fitted into the cabinet and acts as a tuned acoustic circuit. Here the mass is the mass of air in the enclosure and the spring is the compliance of the air in the enclosure.

One advantage of this is that the rear cone radiation is used to excite the resonance and is thus not wasted. Properly done the response of such an enclosure extends downwards into the deep bass range.

Until recently the correct design of such cabinets was a matter of hit and miss. However, since the work of Theille and Small on 'speaker system behaviour it is now possible to design speaker enclosures with a computer program from the comfort of one's chair.

This Sub-Woofer project described here has been designed with the help of one of these programs. The computer predicted bass response, before "top cut" being applied, is given in Table 1 and the system response curves shown in Fig. 1. In practise a suitable design was evolved, built measured and then optimised.

The so called "sixth" order speaker system has been adopted, which uses electronic equalisation in conjunction with a "Reflex Enclosure" to obtain a low cut-off frequency. The design is −3db down at 30Hz, a full octave lower than most existing speaker enclosure systems. At the top end the response is rolled off with an internal filter to suit the speakers in use.

In a conventional 'speaker system a single driver (loudspeaker) is employed to cover the bass range. Here two identical 200mm diameter 'speakers are used back-to-back in a push-pull arrangement. Using this technique the necessary cabinet size is halved while even harmonic distortion from the drivers is cancelled.

CIRCUIT DESCRIPTION

Regular readers will no doubt have noticed that I have a liking for the TLO series of j.f.e.t. input op. amp i.c.s. I make no apologies for this.

It is hard to find any devices with the same mix of good audio properties. High input impedance, low distortion, high slew rate, and which are still relatively cheap.

The "equalising" circuit for the Sub-Woofer is designed around two of these i.c.s (TLO72's) and is shown in Fig. 2. Input signals are taken from the right and left speaker outputs of your stereo-amplifier, or alternatively directly from the speaker terminals. As the signals from these points in the circuit are of very low impedance this ensures no deleterious effects on the stereo image.

The audio input signals are passively mixed by feeding them through resistor R1 and R2 to the volume control VR1. At frequencies below 100Hz there is no separation in phase between channels.

Some audio "experts" have argued that phase must be maintained to ultra low frequencies. However, I have yet to come across either a record or CD which shows any difference either in level or phase below 100Hz. Even if such information were presented to the ear it is doubtful whether we would be able to locate relative direction within a stereo sound field due to the long wavelengths involved.

SELECTIVE FEEDBACK

The mixed signal from the slider of VR1, the Volume Control, is fed into the bass boost filter IC1a, one half of a TLO72 op.amp. As mentioned earlier the system requires bass boosting to operate correctly and this is provided by a second

COMPONENTS

Resistors

R1, R2	470 (2 off)
R3	12k
R4	560
R5	330k
R6, R7, R8	15k (3 off)
R9, R13, R14	1k (3 off)
R10	36k
R11	100
R12	4k7

All 0·25W 5% carbon film.

See SHOP TALK Page

Potentiometers

VR1	47 rotary carbon
VR2	22k dual-gang rotary carbon

Capacitors

C1, C2, C3, C4	100n polyester, 100V (4 off)
C5, C8, C9	100µ radial elect., 25V (3 off)
C6, C7	4700 radial elect., 25V (2 off)

Semiconductors

D1, D2	1N4007 1A 1000V rec. diode (2 off)
TR1	2N1711 *npn* medium power transistor
TR2, TR4	2N3442 *npn* 10A power transistor (2 off)
TR3	2N2905 *pnp* high speed medium power transistor
IC1, IC2	TLO72 dual low-noise op.amp (2 off)
REC1	W005 1·5A 50V bridge rectifier

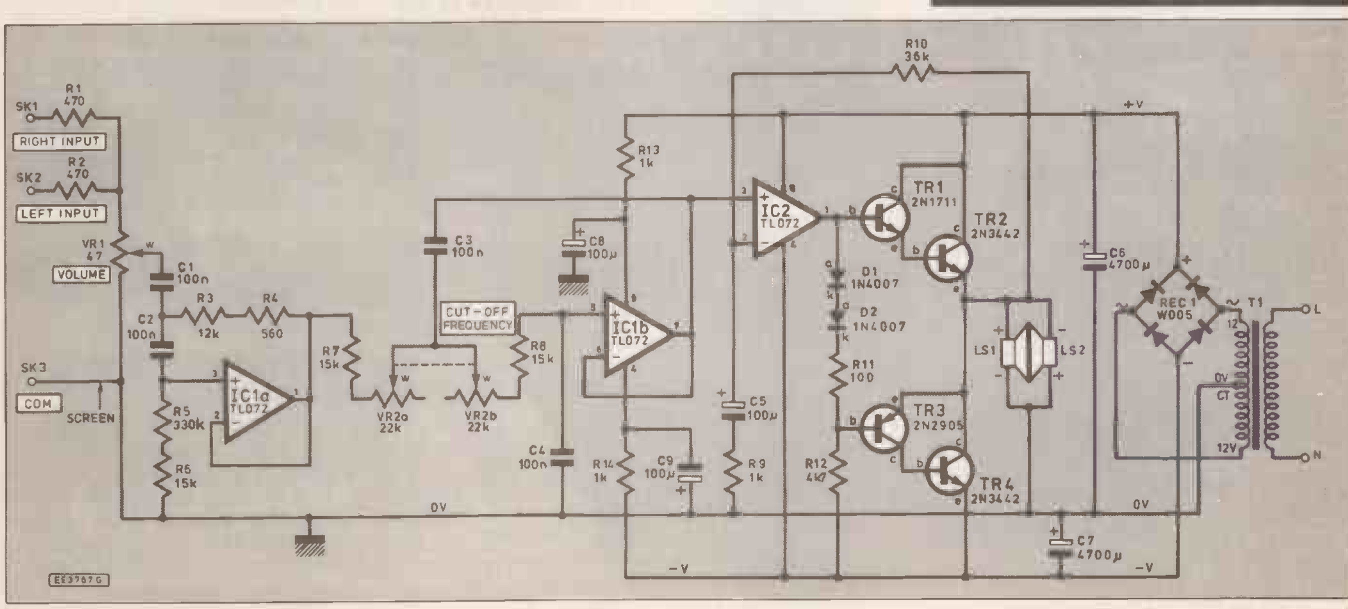
Miscellaneous

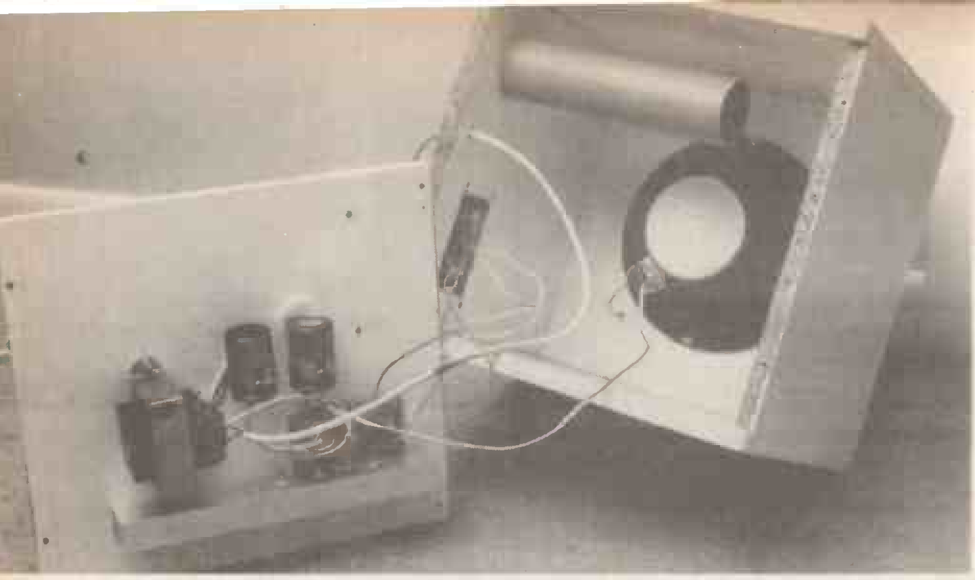
LS1, LS2	Matched pair loudspeakers 200mm 8Ω (see Shoptalk)
T1	Mains transformer, 48VA 12V-0V-12V secondary winding

Stripboard, 0·1in. matrix size 16 strips x 34 holes; cabinet, see "cutting list"; 4mm input socket (3 off); TO3 transistor mounting kit (2 off); plastic tube vent, 51mm internal diameter and 232mm long (drainpipe); heatsink 25cm length of 2.5cm "U" section aluminium; control knob (2 off); recess component mounting dish; chipboard screws; 6BA screws and nuts; speaker lead; connecting wire; solder etc.

Approx cost guidance only **£62**

Fig. 2. Equalising circuit diagram used in the Sub-Woofer.





order filter. What this means is that unlike a simple *RC* filter which provides an ultimate attenuation of 6db/octave we require 12db/octave. This is accomplished by using an op.amp circuit with frequency selective feedback.

Resistors R3, R4, R5, R6 and capacitors C1, C2 are used to produce a standard Sallen and Key second order filter with the correct characteristics. R3 and R4 provide positive feedback to the junction of capacitors C1 and C2 simulating an inductance which is tuned by C2 and damped by R5 plus R6. By varying the ratio of these passive components a whole range of filters can be produced. Unfortunately design details are beyond the scope of this present article.

From the output of this filter, pin 1, the signal is fed, via resistor R7, into a second Sallen and Key filter. This is built around IC1b, the other half of the op.amp.

To maximise the circuit usage, we need to "roll-off" the top response to suit the particular speaker system we are using. Filter IC1b sets the upper bass roll-off to suit the characteristics of the existing speaker system. As such the cut-off frequency has to be variable and this is achieved by the dual control VR2. With the component values shown the filter operates between 50Hz-100Hz.

The output from the woofer system will now resemble a bandpass filter response accurately tailored to suit the existing speaker system. Finally to finish the description of the filter stage, resistors/capacitors R13/C8 and R14/C9 decouple the supply lines to provide power for IC1.

INTERNAL AMPLIFIER

The internal amplifier is quite conventional. Based on the "brains/brawn" configuration, the op.amp supplies the brains whilst the brawn is taken care of by a pair of 2N3442 power output transistors. IC2 is the other op.amp which provides all the required open loop voltage gain. It drives the output stage comprising transistors TR1, TR2 and TR3, TR4.

To prevent crossover distortion from rearing it's ugly head a small bias must be provided between the bases of TR1 and TR3. Crossover distortion is produced by the fact that in a conventional power amplifier, such as this, the output stage is operated with very little quiescent current.

Positive going signals are handled by TR1/TR2 and negative going signals by TR3/TR4. If the current is reduced sufficiently lots of distortion can be generated as one pair of transistors switches off and the other switches on. This problem can be easily avoided by applying a little current through the output stage under no signal conditions.

The required small bias voltage is produced by the voltage drop across diodes D1/D2 and resistor R11. The circuit is completed to the −V line by resistor R12.

Transistors TR1 and TR2 are configured as a Darlington pair. Connected in this fashion the two devices act as a "single" high gain *npn* transistor.

Transistors TR3 and TR4 are used in a complementary feedback configuration. Again, connected in this way they appear as a single high gain *pnp* transistor.

Overall negative feedback is applied via resistors R10 and R9. Closed loop gain being determined by the ratio between these two resistors. Capacitor C5 is included in the loop to reduce the gain at d.c. to unity, thus allowing direct connection of the speakers to the output stage.

POWER SUPPLY

Turning now to the power supply stage of the circuit diagram Fig. 2. This is very conventional. Mains voltage is stepped down by the mains transformer, T1.

The resulting a.c. voltage is full-wave rectified by the bridge rectifier, REC 1. The raw d.c. is then smoothed by capacitors C6 and C7. Lastly, the 0V line is provided by the transformer centre tap.

BUILDING THE ENCLOSURE

Construction can be broken into two parts, the 'speaker enclosure and the electronics. Probably it's better to build the cabinet first.

The first essential in building successful 'speaker cabinets is to go to a reliable wood merchant to get the panels accurately cut. However, a few notes on this aspect of the design wouldn't go amiss. Firstly the volume of the box is 0·8 cu. ft. As long as this volume is adhered to the box can have any appropriate dimensions.

The details and dimensions of our prototype design is shown in Fig. 3 and the project can be built to these instructions. As you can see from the Cutting List, a piece of 15mm thick shelving board is used. This is entirely adequate for this application and has the advantage that it can be purchased in a variety of finishes.

The cabinet is glued and screwed together. Use 38mm (1½in.) No. 8 countersunk chipboard screws for this job. Leave the front panel separate and fix the sides and rear panels together initially.

Having half assembled the cabinet it's as well to seal along the joins with Polyfiller or similar. Mix up some filler into a fairly stiff paste and work it in with your finger along the panel seams. Any excess can be wiped away with a damp cloth.

Once completed the front baffle can be marked out and cut as shown in Fig. 3. Also cut out the apertures for the vent and recess speaker terminal socket dish. Make a small hole near the speaker aperture to take the speaker interwiring.

SPEAKER UNITS

In a project such as this it is necessary to ensure that the 'speaker units acquired for use will be suitable. For this reason, arrangements have been made with the designer to supply matched speaker units of the correct specification – see *Shoptalk*. If you have the facilities to test speakers yourself you can select a suitable pair. However, you may need to purchase several to get a good match.

The loudspeakers used in this project are 200mm diameter pulp coned types, with a roll surround. They have been selected because of their large linear cone excursion and specific characteristics.

Technically there are three parameters of importance. They are: the free air resonant frequency, Q_{ts} and V_{as}. Where Q_{ts} is the "Q" of the fundamental resonance whilst V_{as} is the volume of air whose compliance, the opposite of stiffness, is equal to that of the speaker surround.

To design a speaker system correctly it's imperative that these parameters are matched between the two loudspeakers used in the enclosure and that of the design values specified. One of the attractions of the speaker unit used is that these parameters are within a few percent of the nominal values. Nevertheless matching speakers together in pairs ensures that the design functions as intended.

A complicating factor is that the speaker parameters, measured straight out of the box are misleading. After a period of use the resonant frequency lowers as the cone suspension loosens.

Fortunately, the solution to this problem is quite simple. The speakers are taken from the box and put onto a rig which feeds large signals at low frequencies into them. After a few hours the suspension compliance reaches it's final value. The measured parameters are then stable for the life of the loudspeaker.

The nominal resonant frequency is 45Hz. Matched pairs can be produced by using speakers whose resonant frequencies are equally spaced above and below this nominal value. For example a 46Hz unit matched with a 44Hz until will produce a system with the optimum response.

LOUDSPEAKER MOUNTING

Now the 'speakers can be mounted using four, 2BA 50mm long screws and nuts. *Note that the 'speakers are mounted face to face.* Before mounting smooth the edges of the 'speaker mounting aperture with a file. The "drivers" (loudspeakers) must be tightened up on their mounting gaskets to ensure an airtight fit.

Wiring up the 'speakers comes next. Note that the external driver is connected in *reverse* phase to the internal driver or else there is no bass output from the combination. The use of twin figure-8 speaker flex or alternatively 5A mains cable is all that is required here. Leave about a 610mm (2ft) length of lead from the internal speaker to ensure easy connection to the electronics stripboard panel.

As one of the drive units protrudes

CUTTING LIST

MAIN CABINET

Panel A: 305mm (12in.) × 336mm (13¼in.) – 2 off

Panel B: 305mm (12in.) × 336mm (13¼in.) – 2 off

Panel C: 305mm (12in.) × 273mm (10¾in.) – 2 off

All cut from a single length of veneered chipboard measuring 305mm (12in.) wide × 244cm (96in.) long × 15mm (⅝in.) thick.

SKIRT

Panel D: 336mm (13¼in.) × 102mm (4in.) × 15mm (⅝) – 2 off

Panel E: 305mm (12in.) × 102mm (4 in.) × 15mm (⅝in.) – 2 off

Length of Vynair speaker grille cloth to cover top of "skirt".

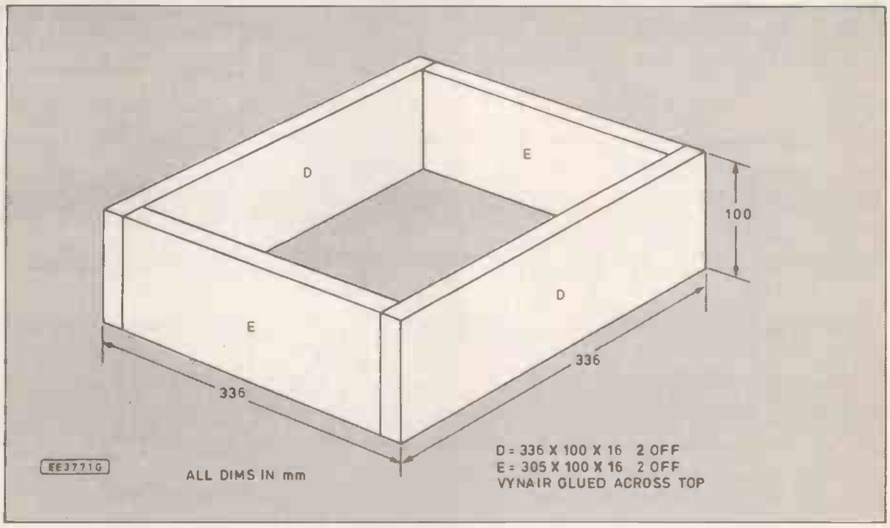
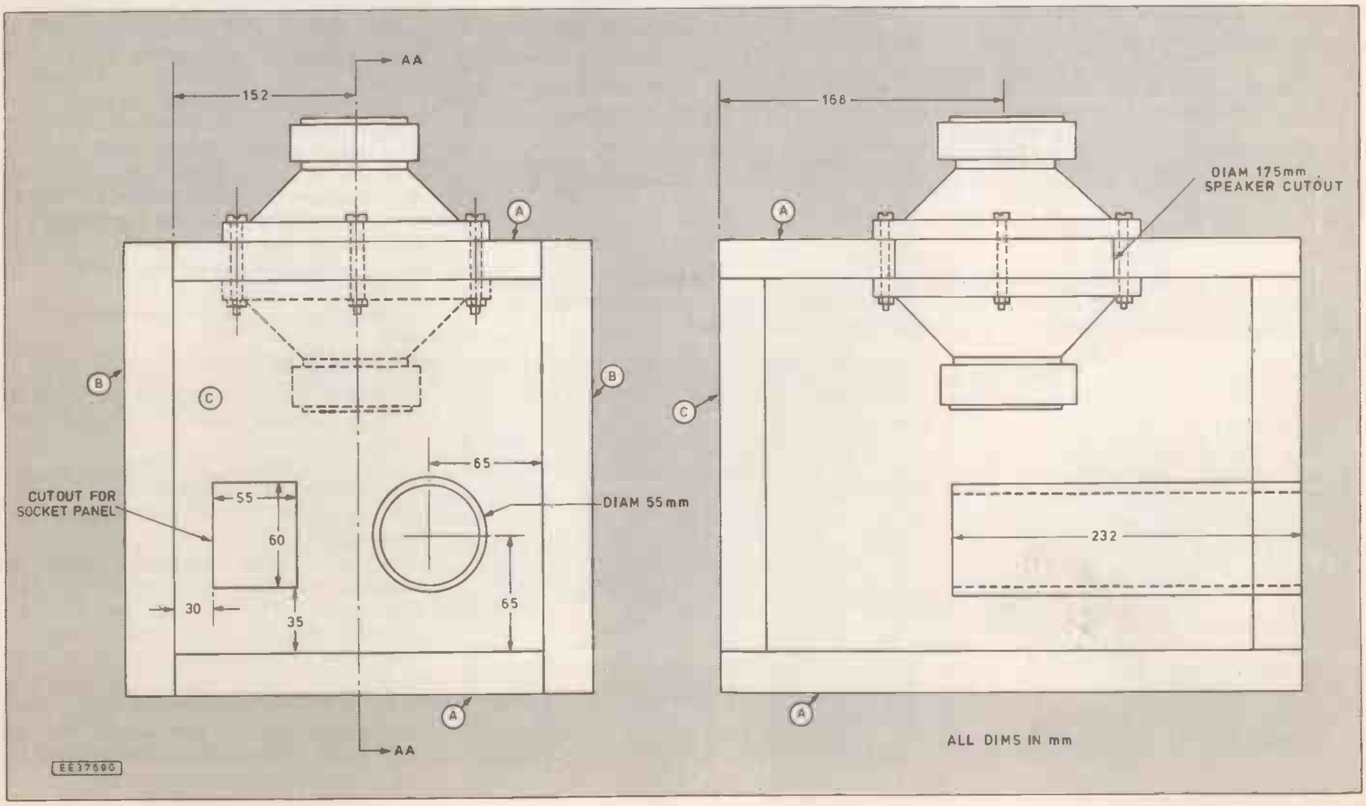
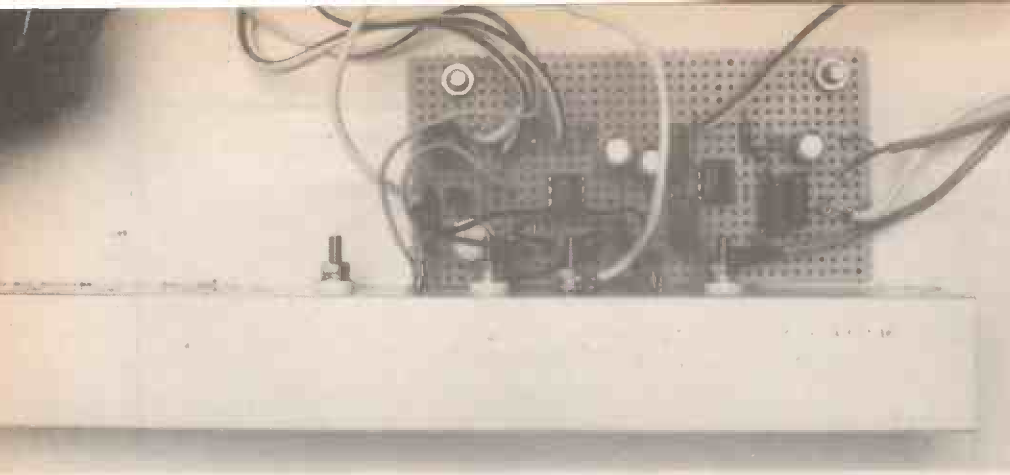


Fig. 4. Speaker surround, this is completely covered with grille cloth stretched over the top and sides.

Fig. 3. Dimensions and layout of the prototype enclosure.





above the enclosure, some readers might like to surround this with a "skirt" and cover it with some speaker grille cloth. This can be accomplished by making a surround to cover the 'speaker, with grille cloth stretched across for a more cosmetic appearance, see Fig. 4. This can be fastened to the main enclosure with 6mm (¼in.) dowels.

EQUALISER CIRCUIT BOARD

Most of the electronic components are mounted on a piece of 0.1in. matrix stripboard, size 16 strips by 34 holes. The component layout and details of breaks required in the underside copper tracks are shown in Fig. 5.

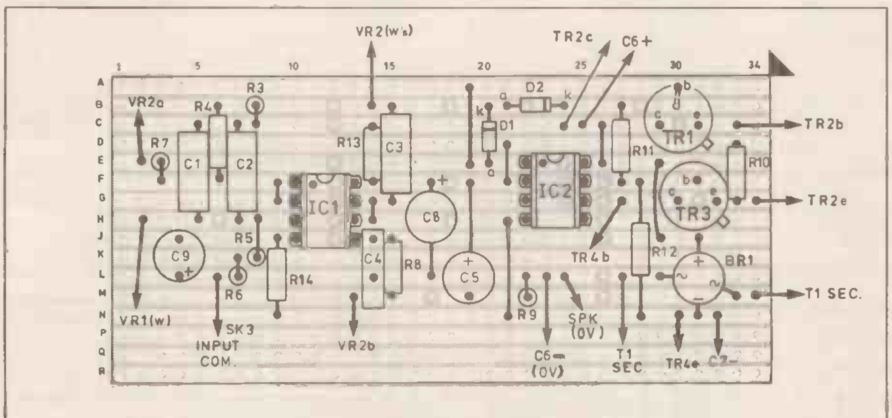


Fig. 5. Stripboard layout of the Sub-Woofer "equalising" circuit.

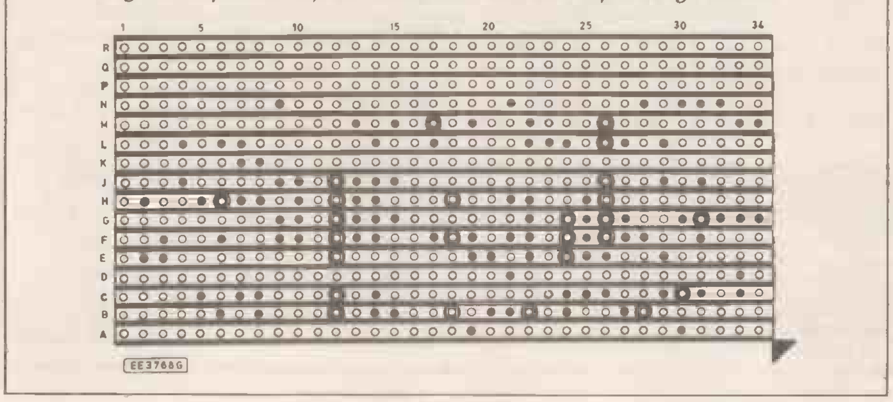
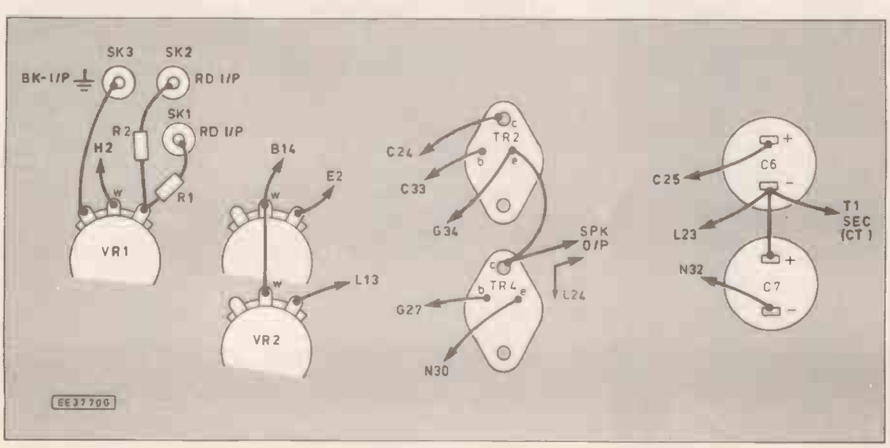


Fig. 6. Connections to the sockets, controls and off-board components. The metal casing of transistors TR2 and TR4 form the collector (c) connections and the usual insulating kit must be used when mounting them on the heatsink.



As long as the usual precautions are taken over the orientation of the transistors, capacitors and active components no problems should be experienced when making up the circuit board. In this regard special attention should be given to diodes D1 and D2.

Once you have completed the circuit board check and double-check for unwanted solder blobs and that the track breaks are complete and in the correct places. Connect flying leads to the board where indicated leaving these 305mm (12in.) long to facilitate easy interconnection.

Now mount the power transistors TR2 and TR4 on the specified heatsink. These *must* be *insulated* from the heatsink and each other in the normal manner using the washers and plastic bushes supplied. This can be checked with a multimeter switched to resistance. This should read an "open circuit".

INTERWIRING

At this stage the circuit board, mains transformer, heatsink and the two large supply smoothing capacitors C6, C7 should be mounted in the cabinet. The other components, potentiometers and input sockets are mounted on the terminal recess dish – see photographs. Now the interwiring can be commenced.

Terminate the flying leads from the circuit board at their respective destinations. Some interwiring between off-board components will also need to be made and these can be seen in Fig. 6.

Finally, *temporarily* connect two 100 ohm resistors in series with the secondary leads from the transformer. This will protect your circuit in the event of an undetected error. Check your work for errors. When you are satisfied that all is well the circuit can be tried out.

TESTING

Commence testing by gingerly switching on the power and standing back. You should be greeted with silence. If you get a loud hum or one or other of the two temporary resistors starts smoking you have a fault. Switch off immediately and rectify matters.

Assuming all is well, advance the Volume control VR1. Touching either of the input sockets SK1, SK2 should produce a buzz from the 'speakers. Now remove the two "protection" resistors, reconnect the transformer secondary leads and attach the front baffle to the rest of the cabinet, remembering to seal along the seams with filler.

The project is now complete.

IN USE

All that remains is to connect the Sub-Woofer to your system and adjust the relative output levels.

The Sub-Woofer is designed to be driven from the speaker outputs of your existing speaker system. This provides the input signal.

Similarly most amplifiers have a switched auxiliary mains socket on the rear panel. The Sub-Woofer can be powered directly from this socket or alternatively connected directly to the mains.

As with any speaker system the best room placement is best found by experience. Avoid corners as this will excite the resonant modes of your room. □

INTERFACE

Robert Penfold

IN LAST month's *Interface* article we considered the subject of barcodes. We continue on the same topic this month, with some ideas for a do-it-yourself barcode system. For those who missed last month's article it has to be pointed out that hardware and software featured here is not intended to be compatible with commercial barcodes. This system enables you to print out and read back your own barcodes, and it is in no way compatible with any commercial barcode systems.

Code Writing

Clearly the first requirement of a barcode system is the ability to actually produce the barcodes. It would be possible to work out the codes and produce them using practically any computer drawing program, but this would be a slow and inconvenient way of handling things. What is needed is a program that can be fed with a decimal number, and which will then print out the corresponding barcode.

The program provided in the accompanying listing is for Microsoft QBasic or QuickBasic. It will print a barcode of any number which can be expressed in 8 binary bits, i.e. 0 to 255. The printed barcode has 10 bars, a narrow start bar, the 8 digit bars, and a broad stop bar. In the 8 bit codes broad bars are used to represent 1s, and 0s are represented by narrow bars. The decimal number symbolised by the code is printed under the barcode.

The program is suitable for either 24-pin or 9-pin Epson (or compatible) printers. Triple density is used for 24-pin printers, and quad density for 9-pin types. These high densities are necessary to ensure a reliably readable code of good contrast. For good results the printer should still be fitted with a reasonably fresh ribbon. The program defaults to the 24-pin settings, but this could be easily changed if required.

Basic Program

The width of the barcode (not including the start and stop bars) is set by two constants declared at the beginning of the program. TD.DOTS sets the width for 24-pin printers, and QD.DOTS sets the width for 9-pin printers. The value entered here is the number of dot positions which will be printed minus 1. The values given, 175 and 239 respectively, give a width of approximately 25mm (not including stop and start bars, as mentioned above).

The 24-pin printer actually prints at 180 dots per inch, but the value given has been rounded down from 179 to 175, to give a number of positions (176) which is exactly divisible by 8. This is important. If you want to change the width of the barcode, you just need to alter these values. All other values are derived from them.

Normally, the barcode is printed with the least significant bit represented by the left-most bar. This is not normally of any great significance, as the barcode will be machine-read. In case it offends anyone, however, provision has been included to reverse the direction of printing so the MSB is the left-most.

The program is menu-driven. Selecting the options is simply a case of pressing the highlighted initial letters. The select printer option presents a submenu which is used in the same way. Swapping the MSB acts immediately. When you select the Enter value option, you have simply to enter the value to be printed and press return. Out of range values and nonsense input are trapped. The barcode is printed immediately, so you should be sure the printer is on line and ready to print before selecting this option.

With a little ingenuity it should be possible to adapt the program to suit individual needs. It could probably be modified to print longer barcodes having more bits, to print "x" number of each barcode, etc.

Hardware

As pointed out last month, the special high resolution sensors for use in barcode reader "pens" are very expensive, and there would seem to be no current source of supply for the home constructor anyway. My first attempts at reading barcodes used a passive sensor plus a fibre-optic cable. The cable was used as a simple means of giving a narrow angle of "view", and it seems to be possible to obtain quite good resolution in this way. The problem with the simple circuits I tried was a lack of sensitivity, and poor reliability (which probably stemmed from the poor sensitivity).

Better results were obtained using a reflective infra-red sensor. This consists basically of an infra-red l.e.d. and a photo-transistor mounted side-by-side, and "looking" in the same direction. If something fairly reflective is placed in front of and very close to the sensor, the infra-red light from the l.e.d. will be reflected back to the photo-transistor, and the latter will be switched on.

When choosing a photo-sensor of this type you are not exactly spoilt for choice. I mainly experimented with the OPB706B sold by Maplins, which would seem to be the same as the RS "miniature diffuse scan opto-switch sensor". There is also an RS "standard" type which is somewhat larger. This seems to give quite good results despite its larger size, but as it is more expensive and less widely available, I opted to use the smaller device for the final system.

Resolution

Looking at one of these sensors you would probably not expect the resolution to be very high, but they can read barcodes accurately provided they are not printed out using very narrow lines or spaces. With the fine lines at about 1.5 millimetres and the smallest gap between lines no smaller than this, one of these low cost reflective sensors seems to work perfectly well.

By getting everything setup just right, and using an aperture to restrict the field of view, it would probably be possible to obtain much finer resolution. However, unless you really need to use more compact barcodes, it is much easier just to settle for the natural resolution of the sensor.

In order to get good results at the natural resolution of the sensor it is still necessary for things to be setup reasonably accurately. There are two main points to watch, one of which is that the sensor is perpendicular to the barcode, and not keeled over at an angle of significantly less than 90 degrees. The second point is that the distance between the sensor and the barcode is critical. It is best to experiment a little to find the distance that gives optimum results, but the ideal gap between the barcode and the sensor is only about one to two millimetres.

In order to get good results the sensor really needs to be recessed slightly into a pen type case, so that the reader can be operated by running it over the barcode, with the case actually rubbing the barcode. Simply waving the reader above the barcode will not provide good results using one of these simple sensors.

Next month we will conclude this look at barcodes with a barcode reader circuit and matching software.

102 Decimal

Example of the type of barcode generated.

BARCODE PRINTING PROGRAMME (QBASIC)

```
DECLARE SUB printbar (bardat$(), all$, none$, mode%, first%,
last%, barwidth%)
DECLARE SUB selectprinter (all$, none$, mode%, printer$, first%,
last%, barwidth%, bardat$())
DECLARE SUB setscreen (printer$, direc$)
DECLARE SUB setdat (bardat$(), all$, none$, num%, first%, last%,
barwidth%)

WIDTH LPRINT 255
'You can change the next two constants to change the width of the
barcode.
'The values here give a width of 1 inch plus start and end bars.
'The value (CONST + 1 ) should be exactly divisible by 1,
' and the ratio TD.DOTS/QD.DOTS should be approx. 3/4.
CONST TD.DOTS = 175
CONST QD.DOTS = 239

'set defaults for Epson 24-pin, triple density.
REDIM bardat$(0 TO TD.DOTS)
mode% = 39
all$ = STRING$(3, CHR$(255))
none$ = STRING$(3, CHR$(0))
printer$ = "Epson 24 – Triple density."
direction$(1) = " as leftmost bar"
direction$(2) = " as rightmost bar"
first% = 0
last% = TD.DOTS
barwidth% = (TD.DOTS + 1)\ 8

SCREEN 0, 1
CLS
setscreen printer$, direction$(1)
DO UNTIL UCASE$(choice$) = "Q"
   choice$ = INKEY$
   SELECT CASE UCASE$(choice$)
      CASE "S"
         LOCATE 10, 6
         COLOR 7
         PRINT "elect Printer"
         selectprinter all$, none$, mode%, printer$, first%, last%,
barwidth%, bardat$()
         setscreen printer$, direction$(1)
      CASE "E"
         LOCATE 12, 6
         COLOR 7
         PRINT "nter value and print barcode"
         setdat bardat$(), all$, none$, num%, first%, last%,
barwidth%
         LPRINT CHR$(27); "3"; CHR$(24); 'set line spacing
         FOR lines = 1 TO 4
            printbar bardat$(), all$, none$, mode%, first%, last%,
barwidth%
         NEXT lines
         LPRINT CHR$(27); "2";  'Reset printer line spacing
         LPRINT num%
         LPRINT           'Print line space
         setscreen printer$, direction$(1)
      CASE "M"
         SWAP first%, last%
         SWAP direction$(1), direction$(2)
         setscreen printer$, direction$(1)
      CASE "Q"
         LOCATE 16, 6
         COLOR 7
         PRINT "uit"
   END SELECT
LOOP

END

SUB printbar (bardat$(), all$, none$, mode%, first%, last%,
barwidth%)
   IF last% < first% THEN
      st% = -1
      limit% = first% + barwidth% + 3 * (barwidth%\ 3)
   ELSE
      st% = 1
      limit% = last% + barwidth% + 3 * (barwidth%\ 3)
   END IF

   LPRINT CHR$(27); CHR$(42); CHR$(mode%); CHR$(limit%
MOD 256); CHR$(limit%\ 256);
   FOR dat = 1 TO barwidth%\ 3
      LPRINT all$;
   NEXT dat
   FOR dat = 1 TO barwidth%\ 3
      LPRINT none$;
   NEXT dat
   FOR dat = first% TO last% STEP st%
      LPRINT bardat$(dat);
   NEXT dat
   FOR dat = 1 TO barwidth%\ 3
      LPRINT none$;
   NEXT dat
   FOR dat = 1 TO barwidth%
```

```
      LPRINT all$;
   NEXT dat
   LPRINT
END SUB

SUB selectprinter (all$, none$, mode%, printer$, first%, last%,
barwidth%, bardat$())

LOCATE 18, 5: COLOR 2: PRINT "Epson 24-pin, ";
COLOR 7: PRINT "T"; : COLOR 2: PRINT "riple density"
LOCATE 20, 5: PRINT "Epson 9-pin, ";
COLOR 7: PRINT "Q"; : COLOR 2: PRINT "uad density"

ERASE bardat$

DO
   choice$ = INKEY$
   SELECT CASE UCASE$(choice$)
      CASE "T"
         mode% = 39
         printer$ = "Epson 24 – Triple density"
         all$ = STRING$(3, CHR$(255))
         none$ = STRING$(3, CHR$(0))
         REDIM bardat$(0 TO TD.DOTS)
         barwidth% = (TD.DOTS + 1)\ 8
         IF first% > last% THEN first% = TD.DOTS ELSE last%
= TD.DOTS
         done = -1
      CASE "Q"
         mode% = 3
         printer$ = "Epson 9 – Quad density"
         all$ = CHR$(255)
         none$ = CHR$(0)
         REDIM bardat$(0 TO QD.DOTS)
         barwidth% = (QD.DOTS + 1)\ 8
         IF first% > last% THEN first% = QD.DOTS ELSE last%
= QD.DOTS
         done = -1
      CASE CHR$(27)
         EXIT SUB
   END SELECT
LOOP UNTIL done
END SUB

SUB setdat (bardat$(), all$, none$, num%, first%, last%, barwidth%)
IF first% > last% THEN limit% = first% ELSE limit% = last%
getnumber:
   LOCATE 18, 5
   INPUT "Please enter a number 0 – 255 inclusive: ", num$
   IF num$ = "" THEN num$ = " "
   IF (ASC(num$) < 48) OR (ASC(num$) > 57) THEN
      num% = 256
   ELSE
      num% = VAL(num$)
   END IF
   IF (num% < 0) OR (num% > 255) THEN
      LOCATE 20, 5
      PRINT CHR$(7); "DO AS YOU ARE TOLD!"
      GOTO getnumber
   END IF
   FOR dotpos = 0 TO limit%
      IF num% AND (2 ^ (dotpos\ barwidth%)) THEN
         IF dotpos MOD barwidth% < (barwidth% *2\ 3) THEN
            bardat$(dotpos) = all$
         ELSE
            bardat$(dotpos) = none$
         END IF
      ELSE
         IF dotpos MOD barwidth% < (barwidth%\ 3) THEN
            bardat$(dotpos) = all$
         ELSE
            bardat$(dotpos) = none$
         END IF
      END IF
   NEXT dotpos

   LOCATE 18, 5
   PRINT SPACE$(45)
   LOCATE 20, 5
   PRINT SPACE$(20)
END SUB

SUB setscreen (printer$, direc$)
   CLS
   COLOR 2: LOCATE 5, 10: PRINT "Please select:"
   LOCATE 10, 5: COLOR 7: PRINT "S";
   COLOR 2: PRINT "elect Printer ("; printer$; ")"
   LOCATE 12, 5: COLOR 7: PRINT "E";
   COLOR 2: PRINT "enter value and print barcode"
   LOCATE 14, 5: COLOR 7: PRINT "M";
   COLOR 2: PRINT "SB"; direc$
   LOCATE 16, 5: COLOR 7: PRINT "Q";
   COLOR 2: PRINT "uit"

END SUB
```

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ARTWORK LIGHT BOX

ALAN WINSTANLEY

Make light work of producing your own printed circuit board masters

THIS Light Box has been specially designed to be of help when originating and drafting p.c.b. (printed circuit board) artwork. It permits the constructor to view the artwork positive very clearly and he can also obtain a "see-through" view of any artwork (if it is drawn on standard translucent or transparent media), so that the designer sees both the component layout on top of the proposed artwork, plus an X-Ray view of the copper track "through" the board – see photographs.

This ability to see the copper track layout with the component layout superimposed on top can be of great assistance when drawing up artwork. It is rather like designing a transparent printed circuit board!

Light Box

The Artwork Light Box has a sloping front panel made from white acrylic plastic (e.g. 3mm Perspex) and is illuminated from inside by a fluorescent light. The cabinet itself is made from readily-available "Conti-Board" which has a white melamine finish. The white surface reflects light around the inside of the box and helps to diffuse it.

Rather than use miniature fluorescent tubes, which require control units, starters etc., a compact "2D"-type tube was employed on the prototype, making the light very simple to install, just like a normal light bulb. Because of the convoluted shape of the tube, this contributes to giving a relatively diffused light in the box, unlike short compact tubes (e.g. Osram types).

The tube clips onto an electronic adaptor which fits a standard BC socket. Unlike some compact fluorescent tubes, the 2D-type bulb can be replaced when it fails without having to change the whole unit, thus being cheaper to run.

It is claimed that the tube is good for some 8,000 hours, however, which is equivalent to three years usage at six hours per day. That's a lot of p.c.b. designing.

Construction

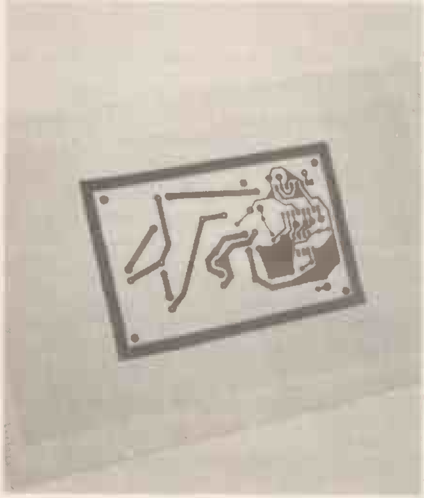
The general sizes of the parts used, and a cutting list is shown in Fig. 1. It should be pointed out that the prototype was partly designed to fit a piece of Perspex which happened to be available.

It should be possible for readers to obtain Perspex or polycarbonate (perhaps offcuts) from either plastics suppliers or shop sign makers, see *Yellow Pages*. Clear plastic could be used, perhaps sandpapering it down to diffuse the light.

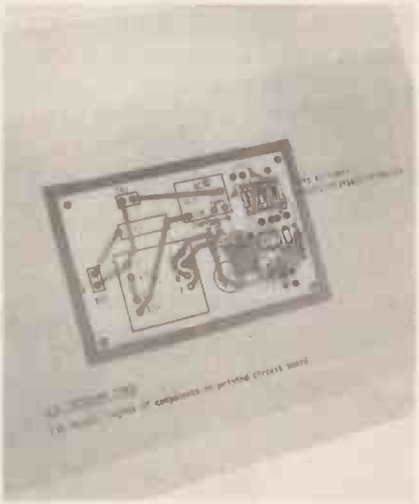
Standard Conti-Board is 15mm (0·6in.) thick and is readily available from all D.I.Y. stores. Buy a white finish 1800mm length × 305mm wide (6ft. × 1ft. nominal) – the product is very cheap and a length can be bought for under £4.

The board can be cut to size with a handsaw or a medium-speed jigsaw. Special jigsaw blades are available to give a smooth cut and prevent the melamine coating from splintering away (e.g. Black & Decker Ref. No 5194).

When making the two sloping end pieces, cut them out and clamp them firmly in a vice. Use a Surform, for example, to file the cut edges together till smooth – both ends will then be the same size.



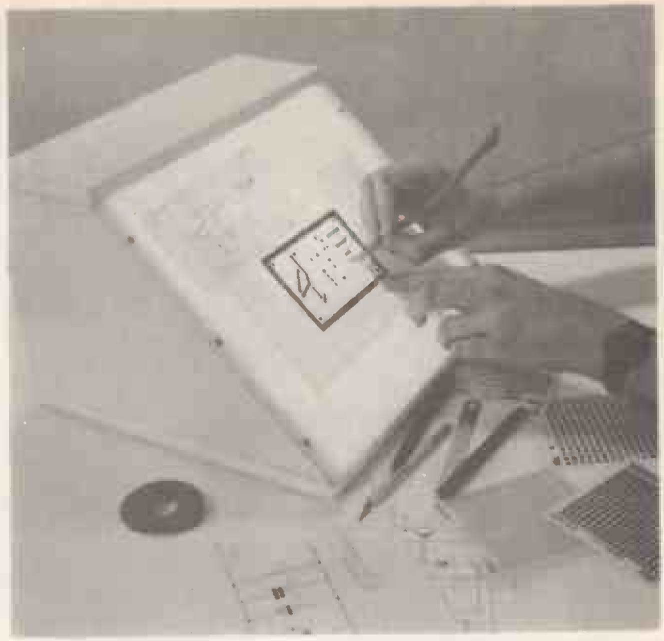
The completed artwork on the light box–the precision 0·1in. matrix grid is also visible. This view is actually equivalent to seeing the copper track pattern "through" the board from the component side.



The artwork with the finalised component layout superimposed on it. This stage can be used for double-checking your copper track design for errors or omissions.

The artwork is turned over and clearly labelled "Copper Track View Side" – this is your first sight of the actual copper foil pattern which will be etched into your p.c.b.!

Using the "light box" to draft a rough component layout diagram, referring to the circuit diagram and manufacturer's data as required.



Preparing the "master" artwork using rub-down transfers and tape. The proposed copper track layout shows through the paper so that an X-ray view is seen

ARTWORK LIGHT BOX – CUTTING LIST

Approx cost **£20**

Base: 345mm × 305mm – Qty. 1
End Piece: 195mm × 305mm/105mm – Qty. 2

All above made from standard white Conti-Board 15mm thick. Buy a length measuring 305mm wide × 1800mm approx (available from every DIY store, £4 approx.)
Conti Edging Strip, white

Rear Panel: 195mm × 315mm – Qty. 1
Top Ledge: 105mm × 345mm – Qty. 1

White Perspex (acrylic): 3mm thick, 345mm × 282mm
Available from plastics stockists or shop sign makers (see *Yellow Pages*). A different size could be used if required, and the dimensions of the Conti-Board parts would then need amending.

Other Parts

Chipboard Corner joint blocks (e.g. Plasplugs) – Qty. 8

No.6 × 19mm (¾in.) countersunk chipboard screws – Qty. 38

Thorn 2D Fluorescent Light Fitting (2D Tube + BC Adaptor). Part NO. 2DA10.BC

45° BC batten mounting light socket

6A twin-core mains flex, as required

p-clip, screws, 3A fused mains plug, etc

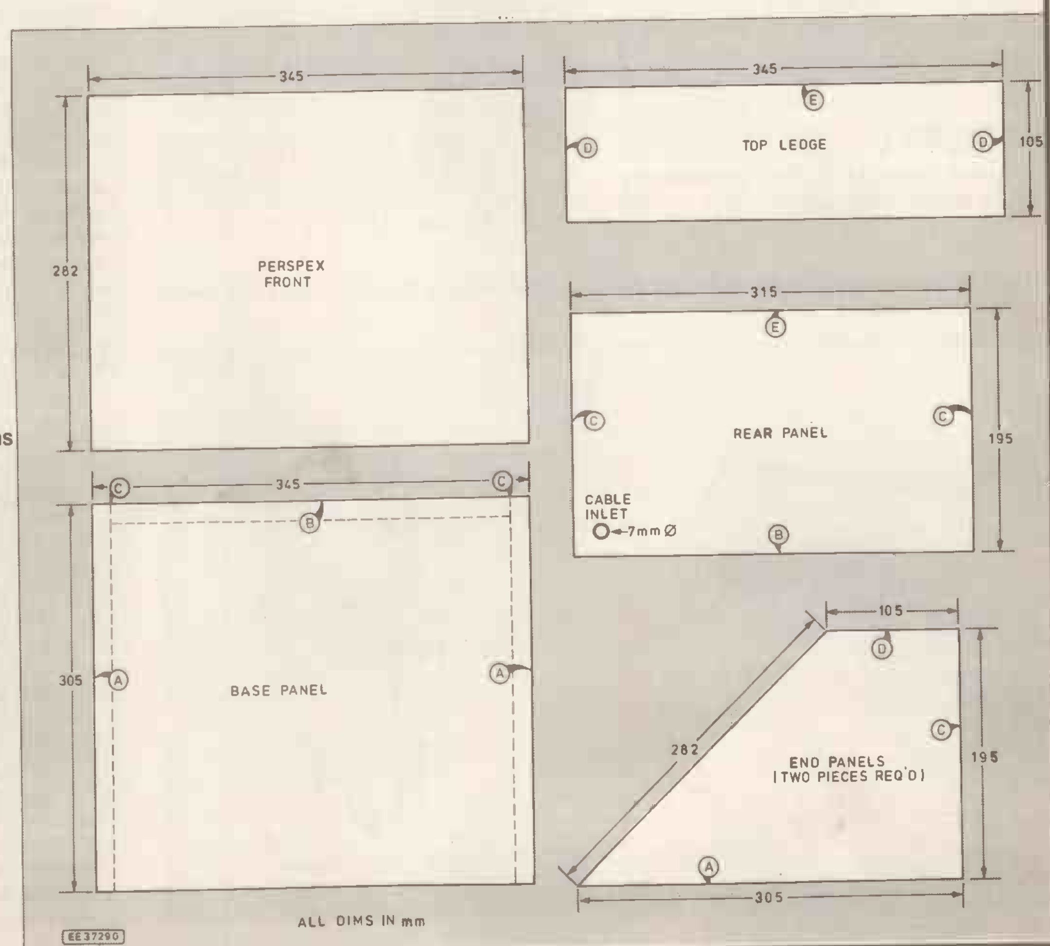
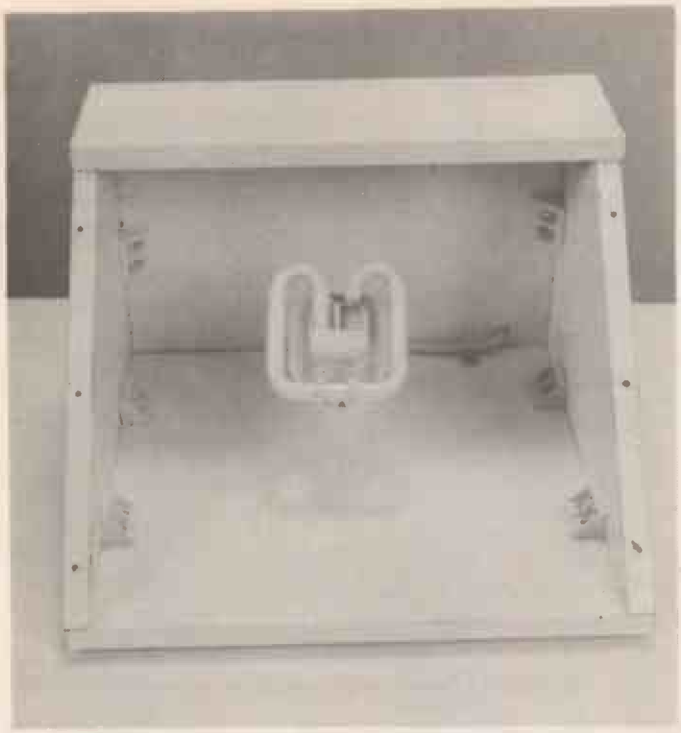


Fig. 1. Cutting details and dimensions for the Light Box. Dimensions can be altered as required, but if a 2D-tube is used the minimum depth of 305mm must be adhered to.
Join like letters (A-to-A) together to realise the complete unit.



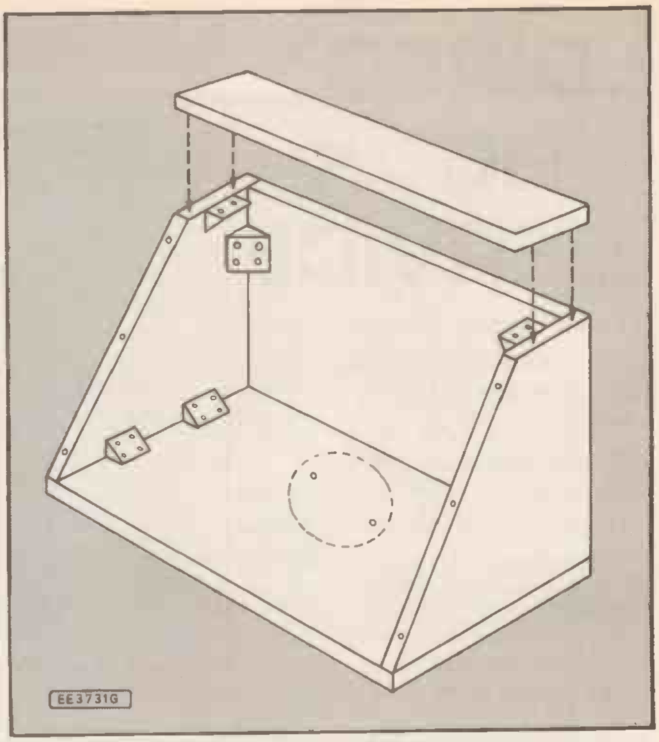


Fig. 2. (right). Three-quarter view without the Perspex front. The dotted area represents the location of the 45 degree batten bulb holder. The interior of the Light Box, with Perspex cover removed, the fluorescent 2D-type tube can be seen clearly in the photograph.

On The Block

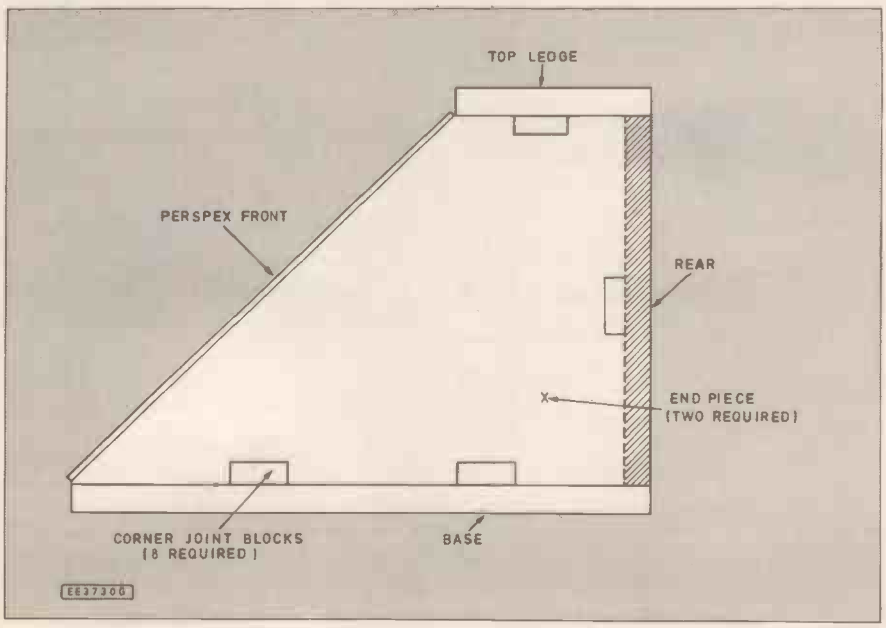
The Conti-Board is joined together using right-angle plastic blocks which themselves are screwed to the board, Fig. 2 and Fig. 3. Preferably use only chipboard screws for this (see Parts List).

Start off screw holes by drilling a pilot hole or use a bradawl first before driving the screws home. In fact, if ever there was a job for a rechargeable screwdriver, this is it! If necessary, do not tighten the screws until you are happy with the joint fit and alignment – it is possible to juggle the joints to a limited extent to obtain a reasonable finish before tightening the joints together for good.

The dimensions are not critical, although the cabinet must have sufficient depth to accommodate the 2D fluorescent tube. The constructor must maintain at least the same depth as per the prototype – this is very important, or the tube will not fit.

The 2D fluorescent tube is connected via a sloping batten-mounted BC socket, with the result that the tube is parallel with the Perspex front panel. It is connected via twin-core 6A flex which passes through a hole in the rear panel, and the wire is secured with a suitable p-clip inside to prevent it from pulling out. Connect the other end to a plug with a 3A fuse.

Fig. 3. End view of the Light Box showing the rough positioning of the corner blocks and sloping front opaque screen.



Finishing Off

All cut edges can be finished off with iron-on edging. This is white melamine strip on a roll, with a hot-melt glue backing. A heat gun or an iron can be used to fix this down, and it can be trimmed with a knife afterwards as the strip becomes brittle after application.

After assembling all of the woodwork, plug the 2D light into the BC socket and check that it illuminates properly (it should start immediately, but will take a couple of minutes to reach full intensity). *IT CANNOT BE USED ON ANY TYPE OF DIMMER CIRCUIT.*

If the lamp operates, the final step is to screw on the perspex front panel using the same countersunk chipboard screws as before, having made countersunk recesses in the panel. Fit four adhesive cabinet feet at the bottom, and the Light Box is then ready to use.

Light Options

One option which readers may wish to explore is the use of normal filament light bulbs in place of the fluorescent tube; this will very substantially reduce construction costs.

There is no reason why this cannot be done, but it will be best to use two sloping BC bulb holders, of the same type as used in the prototype. Employ two 15W Pygmy bulbs *only*, and this will give adequate illumination although, having used both systems, the author much prefers the fluorescent tube.

If using light bulbs, it might also be a good idea to allow a little ventilation through the box. Do this by reducing the height of the rear panel by say 13mm (½in.), so that there is a gap along the top.

You will soon find your Light Box an indispensable aid when drafting both rough layout diagrams and master artwork for p.c.b. designs. □

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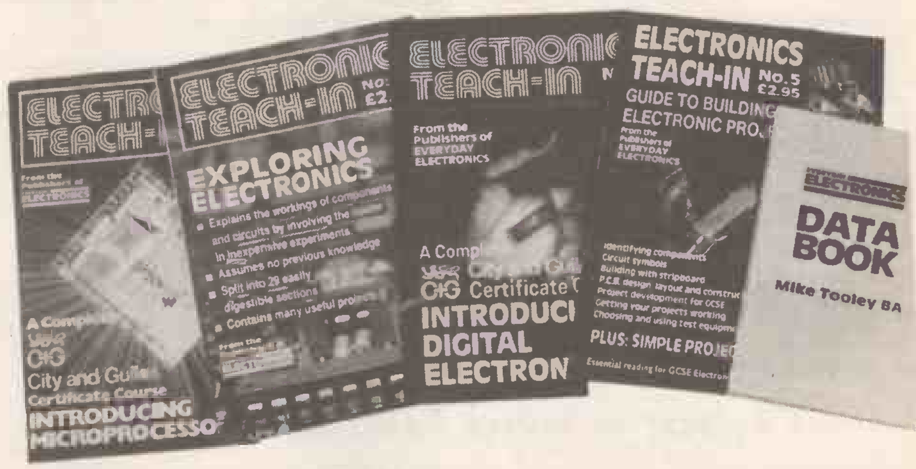

Computers and Computing

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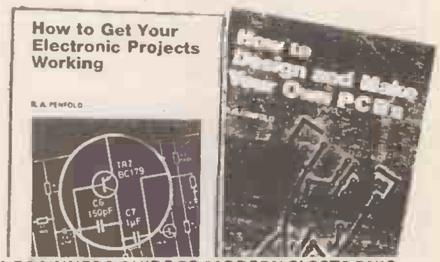

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F. A. Wilson
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A. Pickford
Communications and broadcast satellites are normally inaccessible to individuals unless they are actively involved in their technicalities by working for organisations such as British Telecom, the various space agencies or military bodies, even those who possess a satellite television receiver system do not participate in the technical aspects of these highly technological systems.
There are a large number of amateur communications satellites in orbit around the world, traversing the globe continuously and they can be tracked and their signals received with relatively inexpensive equipment. This equipment can be connected to a home computer such as the BBC Micro or IBM compatible PCs, for the decoding of received signals.
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R. A. Penfold
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NOTE: While 95% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Please check price and availability in the latest issue.

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Fridge Alarm	MAY'87	565	£3.00
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Relay/Decoder		601	£4.86
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Phasor		631	£5.64
Continuity Tester	FEB'89	619	£2.67
Mini PSU		636	£3.23
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Midi Pedal		639	£7.00
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See opposite page for ordering details.

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Weather Stn: Anemom. – Freq./Volt Board		670	£3.94
Optional Display		669	£3.73
Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
Weather Stn: Display Driver	MAR '90	672 & 678	£4.22
Display and Sensor		671	£4.47
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver/Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR '90	681	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
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Amstrad Speech Synthesiser	MAY '90	689	£4.68
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(5 or more 697's ordered *together* £3.25 each)			
Simple Metronome		698	£3.94
Hand Tally: Main Bd and Display Bd	SEP '90	699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
Mains Appliance Remote Control			
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REPORTING AMATEUR RADIO

Tony Smith G4FAI

CLASSES RE-START

A press release received from Huntingdonshire College reminds me that September sees the annual re-commencement of evening classes for the Radio Amateur's examination throughout the UK. This is the traditional means of entry into the hobby as opposed to the recently introduced more informal training arrangements for the new Novice licence.

The classes normally last for one academic year and cover basic radio and electronics theory plus radio regulations relating to the amateur transmitting licence. The classes are sometimes linked with a local radio club which provides practical examples of radio operating and an introduction into the local amateur scene. Morse courses are also available nationwide but are usually separate from the RAE courses.

Full details of examinations and courses near you can be obtained from the Radio Society of Great Britain, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE. For the benefit of readers near Huntingdon, the College course there starts on 16th September from 1900 to 2100 hours, and is taught by Barry Street G3MSU. Ring him on 0480 52346, extension 159, for more information.

VHF PROPAGATION

To those who might be put off by the idea of learning Morse initially, I should mention that the radio amateur "B" licence for v.h.f. and u.h.f. operation does not require a Morse test and that a wide range of activities take place on these frequencies with most not requiring a knowledge of the code.

In my March column I described these activities. I also mentioned that although v.h.f. is conventionally considered to provide "line of sight" communications, "lift" conditions enable stations many hundreds of kilometres away to be heard and worked, often with modest equipment and antennas.

Even in flat conditions v.h.f. signals do, in fact, extend well beyond line of sight due to changes in the radio refractive index of the air relative to height. The densest air, with the highest refractive index, is that nearest the ground. The v.h.f. radio waves bend towards the area of highest refractive index, thus tending to follow the curvature of the earth and to increase the range of a transmitter.

The following simplified notes describe how radio amateurs take advantage of seasonal and other phenomena to make v.h.f. operation a most interesting, and at times quite exciting, area of activity.

TROPO

A major cause of lift conditions is tropospheric ducting, popularly known as "tropo", which occurs most frequently when atmospheric pressure is high or just beginning to fall. Warm air heated by the ground rises, leaving the air close to the ground cooler than the higher air. Cool air is denser than warm air and the refractive index near the ground becomes higher than normal resulting in increased refraction of radio signals on both the 144MHz (two metre) and 430MHz (70cms u.h.f.) bands. Contacts in these circumstances can cover up to several hundred km.

The same effect arises when a mass of warm air meets a mass of cooled air in a cold front. The warm air rises over the cold air with a defined boundary between the two but this type of temperature inversion may only last a few hours compared with the high pressure lifts which can last for several days.

SPORADIC E

Also known as Es, sporadic E normally affects signals between 28 and 80MHz but in the summer months can extend rapidly up to 150 MHz, providing exciting conditions in the 50 (6m), 70 (4m) and 144MHz (2m) v.h.f. bands, with contacts possible on occasions up to 2000 kilometres away. This phenomenon occurs when highly ionised clouds form in the E layer of the ionosphere and signals beamed at the cloud are reflected back to earth.

As the clouds are affected by air currents in the upper atmosphere, beam headings may have to be altered and the area to which signals are reflected may change. These "openings" may last anything from a few minutes to a few hours followed by a rapid fade out. Generally speaking, sporadic E occurs on two metres from May to July, with a longer summer season on the lower frequencies.

AURORA

Auroral propagation occurs when a solar flare releases energy from the sun and charged particles are carried to the earth by the solar wind. These ionise the E layer in the auroral zones around the poles and the aurora created act as reflecting layers for v.h.f. signals aimed at them. Apart from the radio effect, of course, this phenomena is sometimes visible in the UK as the Northern Lights or Aurora Borealis.

In the UK, amateurs aim their beams northwards to make contact with distant stations who are also beaming to the north. Those in northern locations have the greatest success but when there is a major aurora stations in the south of England, and in Europe as far south as Italy, can make exceptionally long distance contacts.

Auroral propagation follows a seasonal pattern, peaking around March and September, although it can occur at any time of the year. It offers the possibility of contacts with stations up to 2,000 km away but it does require some dedication and access to various early warning arrangements to take full advantage of this fascinating activity. Next month I will describe the even more specialised activities of moonbounce and meteor scatter to conclude this roundup of v.h.f. propagation.

WARM SHACK PREFERRED IN RUSSIA

In a recent letter to *Morsum Magnificat*, the Morse magazine, Andy Troubachov UA3PIP, a Russian amateur, explains why there are so many radio amateurs in the former Soviet Union still using CW (Morse code) often at professional speeds.

"For a long time" he says, "the USSR was a military state. Many special schools were opened where you could be trained (absolutely free) for any technical specialty, including radio operating and Morse code, in preparation for army service.

"All young men reaching 18 years of age had to serve in the army for two years and most of the future soldiers wanted to be radio operators as they much preferred to sit in a warm shack rather than crawl in the snow with a gun! That's why there are so many high-speed CW operators in Russia with rude habits picked up in the army! Nevertheless, many Russians are very skilful on the key.

"Very few amateurs here can speak English but they do want to work foreign stations. This is easy on CW where all you have to know is just a few codes."

The "rude habits" he mentions refer of course to radio operating! He really means bad operating habits such as transmitting on a particular frequency without checking first to see if it is already in use.

In a later letter he mentions the awful quality of some Russian signals which cause interference to other stations on the bands. In the west we have often put up with this in the past, knowing that they did not always have access to decent amateur equipment or components.

This is the first time I have seen a reference to the problem from within the area, however, and interestingly the writer says to foreign stations experiencing such interference, "for goodness sake please tell the offender about it and long-suffering local hams working nearby will bless you!" He even goes on to provide a few appropriate Russian phrases to be transmitted in such circumstances. How times have changed!

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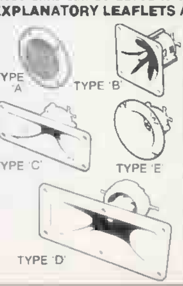

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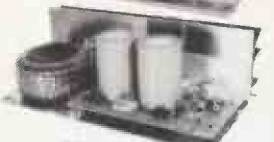

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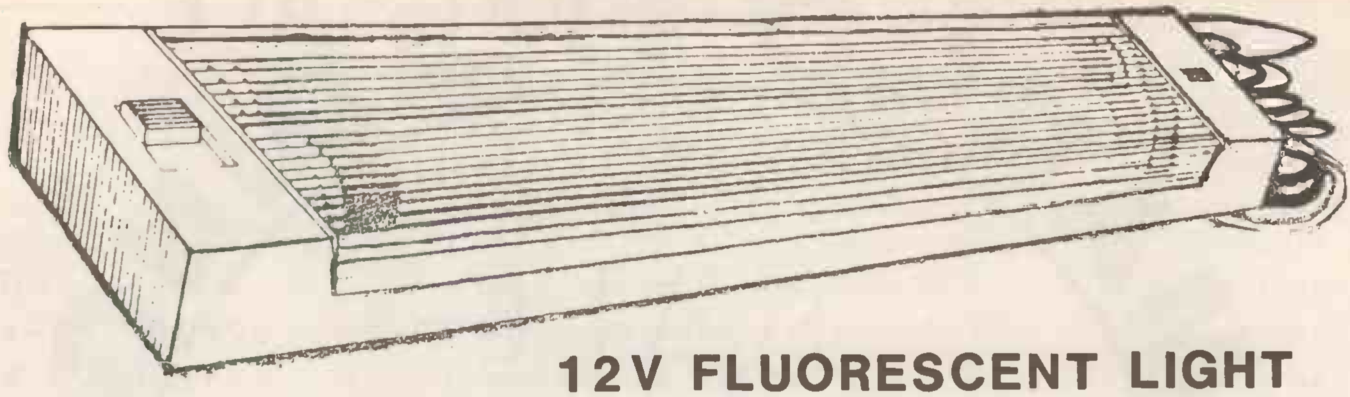

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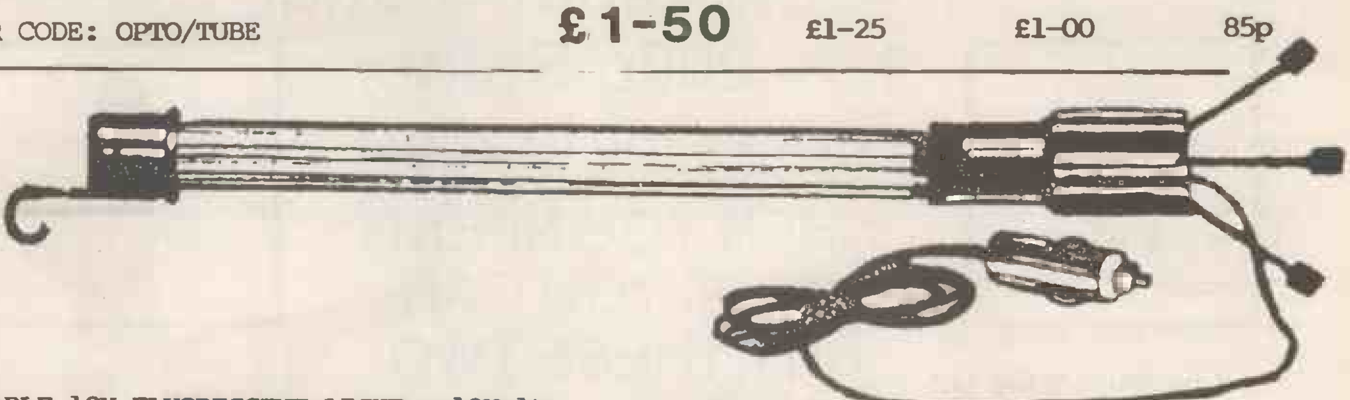

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Suitable for use with **ANTEX** and most other leading makes of soldering irons. The heavy base makes it very stable. Supplied complete with sponge

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WHOLESALE PRICES AND EX-STOCK NOW!!

EXTERNAL HALOGEN FLOODLIGHT & P.I.R.

A high power security floodlight with built-in PIR detector which reacts to body heat switching on the floodlight whenever somebody approaches within the detection zone. The PIR is adjustable for horizontal and vertical angle and contains a photo detector to prevent daylight operation.
Power: 220-240Vac.

* Choice of 200W, 300W or 500W lamp.
* Adjustable range up to 15 Metres.
* Adjustable 'Time On' 9 secs to 10 mins.
* Twilight setting is adjustable.

If you don't state a lamp wattage preference 500Watt will be sent.

SALE PRICE £29-99 (Incl. Lamp)

Access

VISA

PROTECT YOUR HOME NOW!

SECURITY SYSTEMS

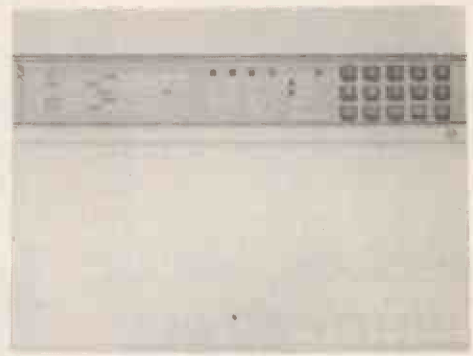
LOGIC 4
3 zones each with its own individual function, built in bell timer and keyswitch operation provide effective security with absolute ease of operation. Simple to install & full fitting instructions supplied. Available on its own or as complete Home Alarm Package, see below for special package price.

FEATURES
* Keyswitch operated security control unit
* Selectable part guard zone
* Selectable PA and tamper loops.
* Adjustable entry-exit timers.
* Integral 20 minute bell timer & auto set
* Latching strobe output.
* Simple 4 terminal wiring to each zone

ORDER CODE - SEC/LGC4 £39-99

OPTIMA XM
Latest updated version of the leading UK selling 'Optima' panel. Rubber keypad, fully selectable 4 digit customer code allows the system to be switched on or off, with the option of omitting zones, quick setting at night and performing simple tests.
Very simple to install supplied complete with full fitting instructions etc. Ideal for either office or home. This panel is also available below as a complete Alarm Package saving even more money.
We have sold hundreds of this truly versatile alarm panel. Our number 1 seller

FEATURES
* Keypad operated
* 4 zones & PA & tamper
* Built in internal sounder
* User may omit any zone.
* Memory recall for last alarm
* Programmable timers including bell cut off.
* Quick set feature.
* Intelligent auto reset and re-arm.

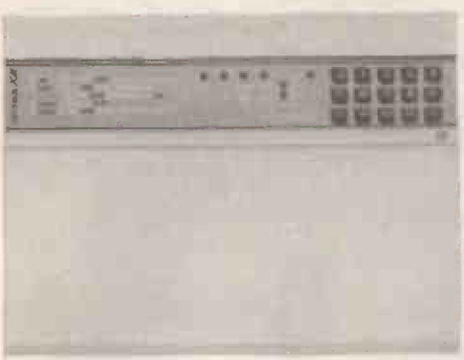


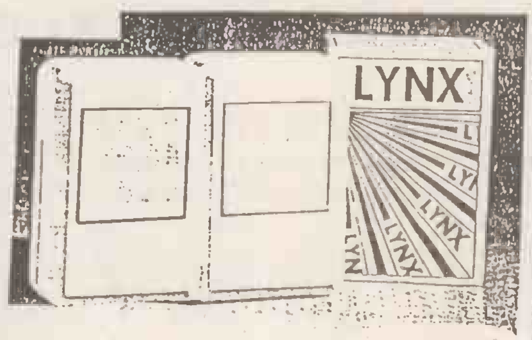
ORDER CODE: SEC/OPT/XM £49-00

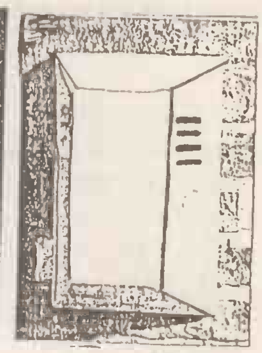
OPTIMA PLUS
As per the Optima XM but also has two communicator outputs thus enabling connection to a British Telecom telephone line. Further technical information is available.

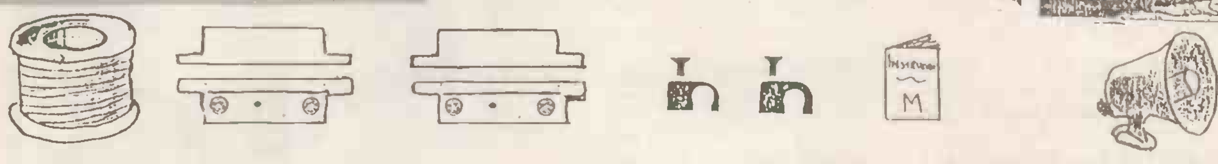
ORDER CODE SEC/OPT/PLUS £75-00

PROTECT YOUR HOME NOW!









We have sold hundreds of these Home Alarm Packages. They represent truly excellent value for money. It is becoming, sadly, a necessity to protect your home and office with a security system and most important of all, one that can be relied upon!
OK, and now for the contents of your package:

* OPTIMA XM or LOGIC 4 Panel
* External Bell Box
* Siren for Bell Box
* 2 X Lynx Internal P.I.R.'s
* 2 X Sets Door Contacts
* 100mts Cable & Clips

***************************************FULL FITTING INSTRUCTIONS***

SEC/PACK/LOG £115-00

SEC/PACK/OPT £130-00

* Should you require extra P.I.R.'s for your installation they are available : ORDER CODE: SEC/LYNX PRICE: £29-00 each

COMDEK HOBBY KITS

WE ARE PLEASED TO INTRODUCE A NEW RANGE OF UK DESIGNED KITS. ALL THESE KITS REQUIRE THE USE OF A SOLDERING IRON. ALL CONTAIN FULL ASSEMBLY INSTRUCTIONS AND ALL PCB'S HAVE COMPONENT LOCATION'S MARKED.
THE GOLDEN RULE FOR KIT ASSEMBLY IS SIMPLE.....READ THE INSTRUCTIONS 'BEFORE' YOU START..!!!!!!

TWIN ALTERNATE LED FLASHING UNIT

Two LED's of different colours which flash alternately at a fully adjustable rate operating on an operating voltage from 3V up to 15Volts, at approx 25mA depending on voltage.
Ideal for battery use using either AA, C, D or PP3's. Very simple to construct making it ideal for beginners.

Applications: Burglar deterrent, model construction, name badge, sign, jewellery etc.

ORDER CODE: COM/KIT/01 **£5-99**

CABLE/METAL DETECTOR

Super device using a ferrite antenna.Detection range up to approx. 6cm. LED indicator. Operates using **2XAA (3V)** Simple to construct.

Applications: Detecting cables in walls, under floors etc.

ORDER CODE: COM/KIT/002 **£5-99**

ALL THE COM/KIT's ARE DESIGNED IN THE UK AND ALL PCB's ARE UK MADE & SILK-SCREENED. ALL THESE KITS ARE PACKED IN THE UK!

FM MINI-TRANSMITTER

A super, very small mini-bug, ideal for baby alarm etc!!! Simply runs off a AA 1.5V battery, which we have had lasting a week or more! Whilst range is difficult to quote because it depends on siting conditions and the quality of the receiver, we have achieved over half a mile.
Simple to construct.

ORDER CODE: COM/KIT/003 **£7-50** **(AVAILABLE READY BUILT-SEE BELOW)**

ATTENTION: SCHOOLS & EDUCATIONAL ESTABLISHMENTS DISCOUNT AVAILABLE ON 10 KITS OR MORE.

ATTENTION: RETAILERS....WHOLESALE PRICES AVAILABLE WITH YOUR OWN NAME HEADER CARD..CONTACT US NOW!

FM MINI TRANSMITTER - Made in UK - COMDEK

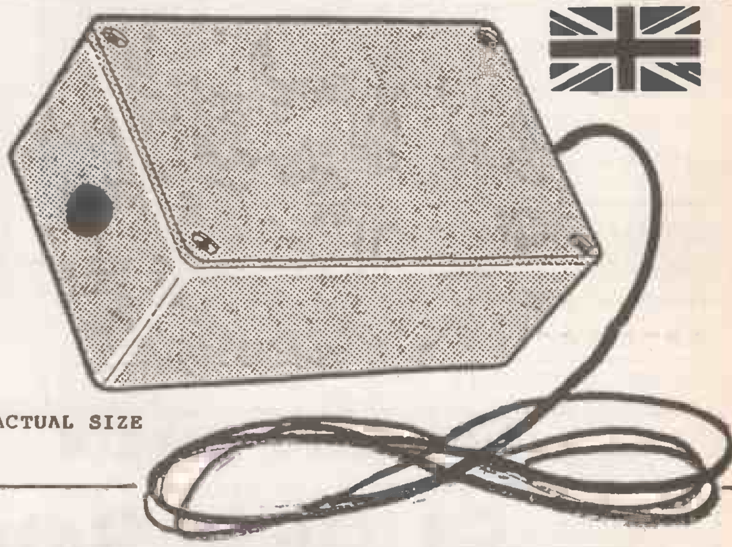
Very high quality Mini-bug, ideal for baby alarms etc!!

These units are well tried and tested. They may be the best on the market!

Range is difficult to quote because it depends on conditions, but we have acheived almost ½ a mile.

Simply remove cover, insert AA battery (not included) - and you're ready to go.

Reception can be obtained on any FM radio.
Adjustable frequency.
One AA battery can last 5 days continuous!
Frequency range.................95-110MHz FM
Power........................AA 1.5V Battery
Dimensions....................72 x 46 x 22mm

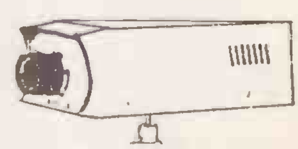


ACTUAL SIZE

ORDER CODE: SEC/FMB1 1+ **£9-99** 10+ **£7-50**

C.C.T.V.

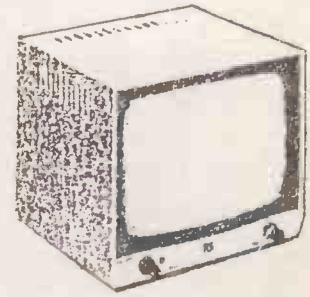
C.C.T.V. CAMERA - (USED)



A steel cased, closed-circuit monochrome TV camera. Ideal for internal or outside (using the weatherproof housing) security and for industrial surveillance.
All camera's are supplied with lens fitted - normally **16MM**
These units are secondhand the style and overall design may change to the illustration shown. All camera's are thoroughly tested before despatch and should give very long trouble free service. Never mount the camera facing a window or bright light as this wilburn the camera tube. Voltage generally 240V, if lower we will supply a suitable PSU

SEC/CAMERA/USED PRICE: **£120-00**

C.C.T.V. MONITOR - (USED)

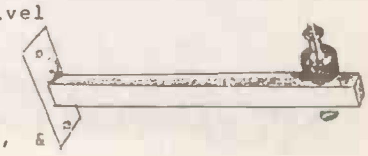


Steel cased, good quality black & white monitors. Depending on availability we can offer sizes from 9" up to 17". State your preferred size and we will send nearest size available.
Voltage: 240V

SEC/MON/USED PRICE: **£70-00**

C.C.T.V. CAMERA BRACKET - (NEW)

Quality, British made mounting bracket to suit not only our camera's but any standard CCTV camera.
White, plastic coated steel with standard ¼"-20 mount. Locking swivel allows camera to be adjusted and fixed in any position.



SEC/CB PRICE: **£7-75**

SPECIAL OFFER

BUY THE COMPLETE PACKAGE ABOVE i.e. 1 x Camera, 1 x Monitor, & 1 x Bracket

AND PAY ONLY ------ **£185-00** (Extra Carr. £10-00)

ALL PRICES INCLUDE V.A.T.

ADD £2.25 P & P PER ORDER

BATTERIES & POWER SUPPLIES

RECHARGEABLE BATTERIES - NI-CADS

At time of printing our Ni-Cads are **Hitachi** with the exception of the PP3. Should the Hitachi be unavailable we will supply a suitable alternative brand.
We guarantee our batteries may be charges 1000 times!

Type	Volt	Ah	Order Code	1+	10+
AAA	1.2V	180mAh	BAT/AAA	£1-50	£1-30
AA	1.2V	500mAh	BAT/AA	95p	85p
C	1.2V	1.2Ah	BAT/C	£1-95	£1-80
C	1.2V	2.0Ah	BAT/CI	£3-40	£3-20
D	1.2V	1.2Ah	BAT/D	£2-00	£1-85
D	1.2V	4.0Ah	BAT/DI	£4-75	£4-50
PP3	9V	110mAh	BAT/PP3	£3-90	£3-75

PPS1205

P001 **£19-99**

Regulated power supply for use with CB rigs, auto equipment. High stability circuitry with high surge current capability. Overload protection. Manufactured according to the requirements of the Electrical Safety Regulations for domestic use.

Input voltage 220/240Vac 50Hz
Output voltage 13.8Vdc
Output current ....5A continuous, 7A max.
Stability 1%
Ripple 25mV
Connections.....4mm banana socket(screw terminals)
Dims ....195 x 140 x 90mm

13.8Vdc - 5A Regulated output

NI-CAD BATTERY CHARGER

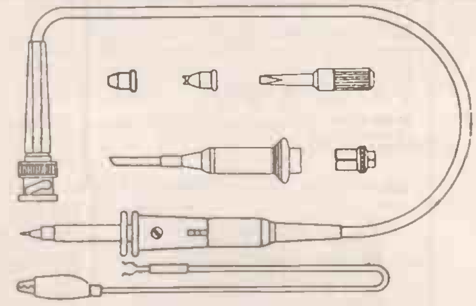
Capable of charging all the above sizes i.e.

4 X AAA, AA, C or D sizes
2 X PP3

White in colour, free-standing unit with LED 'charging' indicators. A built in tester is provided for 1.5V batteries.
Power: 240Vac
Dims: 180 X 85 X 50mm

	1+	10+
BAT/CHARGE/UNIB	£4-99	£4-75

JUST ARRIVED!!
Telequipment DM63
50MHz Storage
4 Trace.
£225-00!!!



A set of very high quality 'scope probes.
Switched X1 & X10
Supplied in neat storage pack & full instructions.

TEST/BS110 PRICE - £15-50

Hewlett Packard — 100MHz

SUPER SCOPE SALE

HP-1740A 100MHZ DUAL TRACE
DELAY SWEEP £350

HP-1744A 100MHZ DUAL TRACE
DELAY SWEEP & STORAGE..... £399

Supplied with full Operating Instructions & Mains leads.

Although secondhand, fully tested before despatch.

If we obtain service manuals they will also be supplied with the scopes Free of Charge.

REMEMBER: OUR PRICES INCLUDE VAT

BUYING NEW? WHY PAY OVER £600 FOR 50MHZ

PROFESSIONAL – METEX DIGITAL MULTIMETERS

Y123HD £83 M4650

- ★ 4½ digit 15mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Frequency counter
- ★ Capacitance ranges with zero adjust
- ★ Transistor and diode test
- ★ Continuity test with LED and buzzer
- ★ Data hold switch

AC volts	0-200m-2-20-200-750Vac ±0.5%
DC volts	0-200m-2-20-200-1000Vdc ±0.05%
AC current	0-2m-200m-20Aac ±1.0%
DC current	0-200µ-2m-200m-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.15%
Capacitance	0-2000pF-200n-20µF ±2.0%
Frequency	0-20k-200kHz ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	178 x 90 x 36mm

Y122HM £94 M4650B

As above but with 40 point analog bargraph display

Y123HB £78 M4630

- ★ 4½ digit 15mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Capacitance ranges with zero adjust
- ★ Transistor and diode test
- ★ Continuity test with LED and buzzer
- ★ Data hold switch

AC volts	0-200m-2-20-200-750Vac ±5%
DC volts	0-200m-2-20-200-1000Vdc ±0.05%
AC current	0-2m-200m-20Aac ±1.0%
DC current	0-200µ-2m-200m-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.15%
Capacitance	0-2n-20n-200n-2µ-20µF ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

Y122HK £88 M4630B

As above but with 40 point analog bargraph display

Y122HN £57 M818

- ★ 3¾ digit 17mm LCD display
- ★ Autoranging voltage and resistance
- ★ High and low frequency ranges
- ★ True RMS AC voltage and current
- ★ Diode and continuity test
- ★ Data hold switch

AC volts	0-40-400-750Vac ±1.5%
DC volts	0-400m-4-40-400-1000Vdc ±0.5%
AC current	0-4m-40m-400m-2-10A ac ±1.5%
DC current	0-4m-40m-400m-2-10A dc ±1.2%
Resistance	0-4k-40k-400k-4M-20MΩ ±0.8%
Frequency	0-4k-40k-400kHz ±2%
Dims	187 x 87 x 34mm

Y122HP £65 M818B

As above but with 40 point analog bargraph display

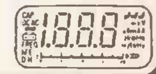
Y123HC £56 M3650

- ★ 3½ digit 17mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Frequency counter
- ★ Capacitance test with zero adjust
- ★ Continuity test with LED and buzzer
- ★ Transistor and diode test

AC volts	0-200m-2-20-200-750Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-2m-200m-20Aac ±1.8%
DC current	0-200µ-2m-200m-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Capacitance	0-2000pf-200n-20µF ±2.0%
Frequency	0-20k-200kHz ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

Y123HE £66 M3650B

As above but with 40 point analog bargraph display



Y123HA £52 M3630

- ★ 3½ digit 17mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Capacitance ranges with zero adjust
- ★ Transistor and diode test
- ★ Continuity test with LED and buzzer

AC volts	0-200m-2-20-200-750Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-2m-200m-20Aac ±1.0%
DC current	0-200µ-2m-200m-20Adc ±1.2%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Capacitance	0-2n-20n-200n-2µ-20µF ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	178 x 90 x 36mm

Y122G £46 M3610

- ★ 3½ digit 17mm LCD display
- ★ 30 ranges including 20A ac/dc
- ★ Transistor and diode test
- ★ Continuity test with LED and buzzer

AC volts	0-200m-2-20-200-750Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-200µ-2m-20m-200m-2A-20Aac ±1.0%
DC current	0-200µ-2m-20m-200m-2A-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

Y131 £55 M3900TD

- ★ 3½ digit 17mm LCD display
- ★ 20A ac/dc ranges
- ★ Dwell angle display
- ★ Low and high RPM ranges
- ★ Diode and continuity test
- ★ Rugged yellow case

AC volts	0-200-750Vac ±1.2%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-2-20Aac ±1.8%
DC current	0-2-20Adc ±1.2%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Low tach	4, 5, 6, 8 cylinders - reading RPM ±2%
High tach	4, 5, 6, 8 cylinders - reading x10RPM ±2%
Dwell	4, 5, 6, 8 cylinders - dwell angle ±2%
Dims:	176 x 90 x 36mm

Y123HF £57 M80

- ★ Large 3¾ digit 21mm LCD display
- ★ Autoranging volts, ohms, amps and frequency count
- ★ 20 Amp ac/dc ranges
- ★ Data hold function
- ★ Ruggedised, weatherproof case
- ★ Diode and continuity test
- ★ Auto polarity and zero

AC volts	0-400-700Vac ±1.8%
DC volts	0-400m-4-40-400Vdc ±0.5%
AC current	0-4m-40m-400m-2-20Aac ±1.8%
DC current	0-4m-40m-400m-2-20Adc ±1.2%
Resistance	0-4k-40k-400k-4MΩ ±1.2%
Frequency	0-4k-20kHz ±2.0%
Dims	182 x 85 x 34mm

ALL OUR METEX METERS ARE SUPPLIED COMPLETE WITH: PP3 Battery, CARRYING CASE, SHROUDED TEST LEADS AND COMPLETE INSTRUCTION MANUAL.
All METEX multimeters are built and tested to IEC348

5 SPEED BENCH DRILL

SAFETY GUARD SUPPLIED

POWER

- Drilling capacity 13mm
- 5 speed
- ¼ HP 240V motor

£149-99

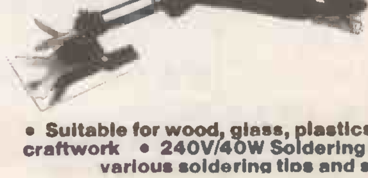
DESOLDER TOOL
High quality, fitted with **Teflon** micro nozzle.
LENGTH: 190mm
Dia: 20mm

PRICE: £2-99

SPARE NOZZLES

95p each

SOLDERING/ PYROGRAPHY KIT



- Suitable for wood, glass, plastics and craftwork
- 240V/40W Soldering Iron; various soldering tips and stand

£14-99

ALL PRICES INCLUDE V.A.T.

ADD £2.25 P & P PER ORDER

£37-50

VIDEO HEAD TESTER Y139M

A VHS video head tester for determining whether a video head is in good condition by detecting the wear state and displaying it on a meter. Complete with carrying case and leads.

Measuring frequency	1MHz
Measuring system	Bridge measuring Circuit
Power	9Vdc(PP3 Battery)
Dims	142 X 95 X 30mm

Y122AA ALT26

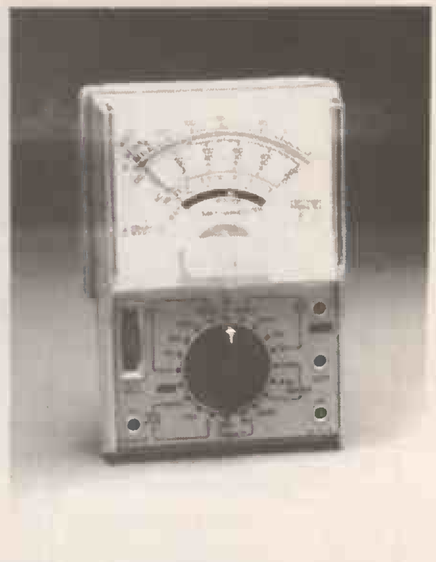
£15-75

1MΩ

- ★ 7 ranges including 10Adc
- ★ 3.5 digit 12mm LCD display
- ★ Diode test
- ★ Auto polarity and zero
- ★ Low battery and over range indication
- ★ Test leads with fully shrouded 4mm plugs

Battery and instruction manual included.

AC volts	0-500-Vac ± 1.2%
DC volts	0-20-200Vdc ± 0.7%
DC current	0-10Adc ± 1.5%
Resistance	0-2k-2MΩ ± 0.75%
Dims	148 x 73 x 32mm



Y105A **£14-95** HM102BZ

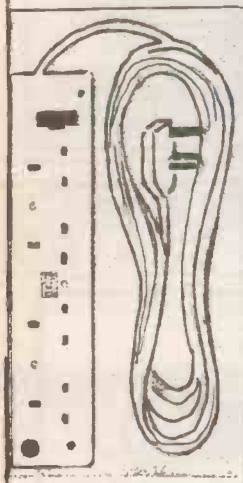
20kΩ/V

- ★ 19 ranges (including 10Adc)
- ★ Fuse and diode protection
- ★ Battery test
- ★ Continuity buzzer
- ★ Audio output test
- ★ Ohms zero
- ★ Mirrored scale
- ★ Leads with 4mm plugs.

Battery and instruction manual included.

AC volts	0-10-50-250-1000V ± 5%
DC volts	0-2.5-10-50-250-1000V ± 4%
DC current	0-5m-50m-500m-10A ± 5%
Resistance	0-10k-100k-10MΩ ± 4%
Battery check	1.5V75Ω. 9V450Ω
Decibels	-8 to +62dB
Audio power	-8 to +22dB
Protection	fuse and diodes
Dims	135 x 89 x 40mm

WHOLESALE PRICES ARE AVAILABLE



4-WAY EXTENSION
3 MTR LEAD
13A PLUG

£5-99

SALE PRICE £5-99

Y057

HELPING HANDS

Top quality "Made in Japan" version with glass 2.5" dia. magnifier in steel frame. (Magnification x 2.5).

SALE PRICE

£19-99

MOBILE UHF/VHF/FM ANTENNA WITH BUILT IN AMPLIFIER

A mesh dish antenna designed primarily for use with caravans, homes, mobile homes, commercial vehicles etc. The dish can be rotated left or right to pick up the best signal which can then be boosted using the built in amplifier and gain control. The amplifier may also be used to boost the signal from an external aerial. The integral LED's indicate which aerial is in use. Supplied complete with mains adaptor enabling aerial to be used on 240Vac.

GAIN	20dBVHF, 30dBVHF
GAIN CONTROL	0-30dB
MAX. OUTPUT LEVEL	100dBuV
POWER	12 or 24Vdc or 240Vac
DIMENSIONS	230 X 110 X 340mm(approx.)

SUPPLIED COMPLETE WITH ADAPTOR FOR 240Vac USE!!!!

WIRELESS MIC.

SALE PRICE

£155-00

G200 WMS202

PROFESSIONAL WIRELESS MICROPHONE SYSTEM

A complete wireless microphone system comprising a G201 receiver with matching G202 microphone, windshield, 1.4m patch lead for connection of receiver to amp/mixer and one pair of racking brackets for the receiver. All packed in a tough vinyl case.

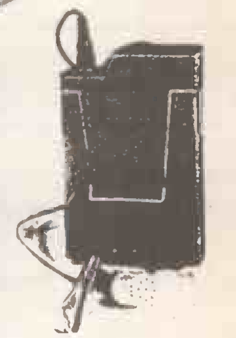
Receiver:

Receiving frequencies	173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz or 175.0MHz
Receiving system	Single super heterodyne conversion FM detector
Intermediate frequency	10.7MHz
Antenna Impedance	75Ω
RF sensitivity	0.7µV
S/N ratio	Better than 90dB
Squelch threshold	Adjustable from 10dBµV to 40dBµV
Image and spurious rejection	At least -80dB
De-emphasis	75µS
Audio output level	250mV at 600Ω
Audio harmonic distortion	Less than 0.5%
Power	220/240Vac 50Hz or 12Vdc
	via external adaptor (not supplied)
Dims	190 x 54 x 200mm

Packed: BOX

Transmitter:

Transmitting frequencies	173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz or 175.0MHz
Frequency stability	0.0[illegible]5%
Modulation system	Crystal controlle[illegible] FM
Harmonic and spurious output power	Less than -45dB below carrier [illegible]vel
Pre-emphasis	[illegible]5µS
Max frequency deviation	± 50kHz
Frequency response	70Hz - 12000Hz
Distortion	Less than 0.5%
S/N ratio	Better than 87dB
Ambient temperature range	0°C - 40°C
Operating voltage range	3.8V to 4.5Vdc



G203 £59-99 PT300

TIE CLIP MIC

Tie clip wireless mic. High quality electret insert connected to transmitter pack by 1.6m lightweight screened lead. Lightweight transmitter pack (125g with batteries) with belt clip and on/off switch. Powered by 3 x AA batteries (not included). Transmitter specification same as G200 (WMS202)

LIST PRICE £45-99

SALE PRICE £35-99

G210

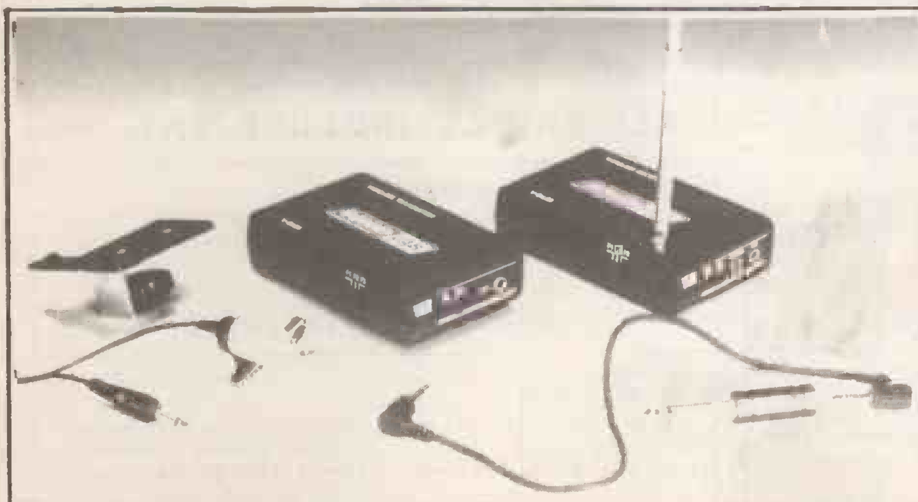
WIRELESS MICROPHONE

2-part wireless microphone system designed for use with video cameras. The hand-held microphone has a high/low power switch to select the transmission range (up to 200ft). The receiver has a video camera mounting shoe, volume control and integral output lead to 3.5mm mono plug. The system allows for greater flexibility with the microphone than can be achieved with a conventional microphone. Complete with vinyl carrying case.

SAVE £10-00

Packed: BOX

WITH VINYL CARRYING CASE



LIST PRICE £49-50

SALE PRICE £39-50

G211

WIRELESS MICROPHONE

A 3-channel 2-part wireless microphone system designed for use with video cameras. The tie-clip mic has a remote belt clip transmitter with on/off switch. The receiver has a hot shoe for mounting on the video camera. The system allows greater mobility with a microphone than can be achieved with the camcorder mic.

SAVE £10-00

Packed: BOX ★

WITH VINYL CARRYING CASE

COMPONENT PACK SALE

Due to popular demand we are pleased to introduce our new range of component packs. Only new unused components are used. Many of the components are to the highest specifications not normally available to the hobby market. The range is being introduced at SALE PRICES so hurry hurry, and take advantage of the low prises before they go up after the sale.
We are currently working on more packs, these will be introduced later this year. "Watch this Space"!

KNOB PACK
A pack containing an assortment of knobs, both rotary and slider. Some push On and some are screw fixing.
Total Pack Qty: 50 Assorted
ORDER CODE: PACK/018 **SALE PRICE: £4-50**

SEVEN SEGMENT DISPLAY PACK
A most useful pack of assorted displays, may contain Red, Green, Single digit, double digit large & small. A very mixed pack.
Total Pack Qty: 20 Assorted
ORDER CODE: PACK/019 **SALE PRICE: £3-00**

0.5W Resistor Pack
A good assortment of good quality 0.5W Carbon Film resistors mainly 5% tolerance. Many preferred values included. A super buy.
Total Pack Qty: 1000 assorted
ORDER CODE: PACK/020 **SALE PRICE: £2-00**

ZENER DIODE PACK
A good selection of assorted voltages, from 3.0v to 180v and wattages 250mW to 5Watt.
Total Pack Qty: 100 Assorted
ORDER CODE: PACK/024 **SALE PRICE: £2-75**

VOLTAGE REGULATOR PACK
A most useful pack containing a good selection of assorted fixed and maybe variable regulators. Both +ve and -ve, from 100mA to 5A. Plastic and metal. Excellent value foe money.
Total Pack Qty: 25 Assorted.
ORDER CODE: PACK/025 **SALE PRICE: £5-00**

PLUG TOP MAINS FUSE PACK
A pack of assorted 1" mains fuses. Anything from 3A to 13A. Super value for money.
Total Pack Qty: 40 assorted
ORDER CODE: PACK/029 **SALE PRICE: £4-25**

SLIDER POT PACK
A pack of metal and plastic mono and stereo sliders, Log and Lin.
Values may range from 250 ohms to 1Meg
Total Pack Qty: 25pcs
ORDER CODE: PACK/030 **SALE PRICE: £2-50**

TUBULAR CERAMIC PACK
A good mixture of capacitors, anything from 1pF up to 10,000 pf. Radial leads ideal for PCB mounting.
Total Pack Qty: 100pcs
ORDER CODE: PACK/031 **SALE PRICE: £1-50**

TUNGSTEN DRILL BIT PACK
A mixed pack of metric solid tungsten carbide drill bits suitable for drilling glass fibre based pcb's and general hobby use.
Original price was £4-20 each bit!!
Mixed sizes, anything from 0.4mm up to 3.0mm.
Total Pack Qty: 10 pcs
ORDER CODE: PACK/033 **SALE PRICE: £3-50**

ELECTROLYTIC PACK
A good assortment of both axial & radial capacitors. Some radial's are already pre-cropped for PCB mounting. These packs contain a good selection of voltages from 10V to 1000V and values anything from 1.0uF to 1000uF.
This pack is excellent value for money.
Total Pack Qty: 100 Assorted
ORDER CODE: PACK/021 **SALE PRICE: £2-50**

DISC CERAMIC PACK
A super selection of assorted values and voltages. Many popular values are included.
Voltages, anything from 5 to 1KV, Values, anything from 1.0pF to 0.1uF.
Great value for money.
Total Pack Qty: 100 assorted
ORDER CODE: PACK/022 **SALE PRICE: £1-50**

POLYSTYRENE PACK
A very useful range of assorted values and voltages of polystyrene capacitors. Many preferred values included.
Values range from 10pF to 0.01uF, and voltages up to 400V.
Total Pack Qty: 100 assorted
ORDER CODE: PACK/023 **SALE PRICE: £1-50**

BRIDGE RECTIFIER PACK
A very mixed pack, excellent value for money. May contain voltages from 50 to 1000v and up to 10 Amps.
Total Pack Qty: 25pcs
ORDER CODE: PACK/026 **SALE PRICE: £5-50**

CABLE TIE PACK
A mixed pack of assorted length cable ties and maybe black ones.
Total Pack Qty: 100pcs
ORDER CODE: PACK/027 **SALE PRICE: £2-00**

HEATSHRINK PACK
A super pack, very high quality heatshrink sleeving. Much of it is British made.
A very good assortment of both colours and sizes.
Total Pack Qty: 10 Lengths approx 12" in length.
ORDER CODE: PACK/028 **SALE PRICE: £1-25**

— ALL PRICES INCLUDE VAT —

500V SINGLE LAYER-CERAMIC PACK
A useful assorted pack of these very high quality capacitors. Very small, 8-16mm dia.
Normal price over 50p each! Super value.
Total Pack Qty: 50pcs
ORDER CODE: PACK/032 **SALE PRICE: £2-00**

CALCULATOR PACK
A mixed pack of calculators! Hand held, mains desk type, printers, non-printers, cased, uncased, damaged cases, bits missing! You name it - this pack has it! Lots of useful bits. Sold by weight. Total Pack Weight: 10Kg
ORDER CODE: PACK/034 **SALE PRICE: £5-00**

PRE-SET PACK

A mixed pack of various pre-sets. Miniature, standard, 0.1W, 0.25W, vertical, horizontal.
Assorted values from 100R to 1Meg.
Total Pack Qty: 100 pcs
ORDER CODE: PACK/001
SALE PRICE: £3-00

POTENTIOMETER PACK

A mixed pack of pots single, dual, slider, convergance - in fact almost every kind of pot. Assorted values ranging from 10R to 1Meg. These really are super value.
Total Pack Qty: 100 Assorted
ORDER CODE: PACK/002
SALE PRICE: £4-50

VOLTAGE DEPENDANT RESISTOR PACK

A good mix of different types of V.D.R's 50-500V Super Value
Total Pack Qty: 50 Assorted
ORDER CODE: PACK/003
SALE PRICE: £4-00

WIREWOUND RESISTOR PACK

A very mixed pack of assorted wirewound resistors. Mixed wattages and values, many popular values. A really good value pack.
Total Pack Qty: 100 assorted
ORDER CODE: PACK/004
SALE PRICE: £2-50

DIL SOCKET PACK

A good assortment of various IC sockets which may range from 8 pin to 64 pin!
Generally low profile. May also include gold plated, turned pin, wirewrap etc.
Total Pack Qty: 100 pcs
ORDER CODE: PACK/009
SALE PRICE: £8-00

SUPADRIV. Self Tapping Pack HARDWARE

A super pack of a mixture of No4 X ½ and No6 X ½. All Pan head hardened steel type AB bright zinc.
Total Pack Qty: 100 assorted
ORDER CODE: PACK/010
SALE PRICE: £1-00

MIXED SELF-TAPPING SCREW PACK HARDWARE

A good mixture of various self-tapping screws of assorted types, lengths etc. All top quality. Length's 5-10mm
Total Pack Qty: 200 assorted
ORDER CODE: PACK/011
SALE PRICE: £1-50

PRE-SET PACK 0.25W

A super selection of 0.25W Pre-sets mainly Piher enclosed, AB etc.
Both vertical & horizontal and many popular values. Values may range from 100R to 10Meg!
Total Pack Qty: 100 pcs Assorted
ORDER CODE: PACK/016
SALE PRICE: £2-50

POLYESTER PACK

A good assortment of various polyester capacitors. Both Radial and Axial styles, values ranging from 0.01uF up to 2.2uF and voltages from 63V to anything up to 1000V!
This pack is very good value for money.
Total Pack Qty: 100 Assorted
ORDER CODE: PACK/017
SALE PRICE: £2-50

TANTALUM BEAD CAPACITOR PACK

A random selection of tantalum bead capacitors of assorted voltages and values. Many popular values.
Total Pack Qty: 50 pcs
ORDER CODE: PACK/005
SALE PRICE: £2-50

TRANSISTOR PACK

A mixed pack of various transistors. many popular types including:
AC169, BC107, BC125, BC147, BC148, BC158, BC182A, BC237, BC328, BC558, BCY72, 2N2907A, TIP126, TIP141, TIS90, 2N2222A, etc etc.
Over £17-00 value at current catalogue prices!!
Total Pack Qty: 100 pcs
ORDER CODE: PACK/006
SALE PRICE: £4-99

INTEGRATED CIRCUIT PACK

A super value pack containing all types of I.C's many popular types included.
All are new and full spec.
Total Pack Qty: 100 pcs
ORDER CODE: PACK/007
SALE PRICE: £5-00

TRIMMER PACK

A useful kit containing a selection of 'ceramic' trimmers.
Values include: 2-7pF, 4-15pF, 6-25pF, 8-30pF.
Working voltage: 250Vac
Total Pack Qty: 50 Assorted
ORDER CODE: PACK/008
SALE PRICE: £2-99

M5 & M6 Pack

A mixed pack of steel screws, a mixture of Pan Head Supadriv and Allen type. Length's 20-30mm
All super quality and a real bargain!
Total Pack Qty: 50 Assorted
ORDER CODE: PACK/012
SALE PRICE: £1-00

M4 Mixed Pack

A mixed pack of small M4 bolts - various lengths and types, pan, cross etc.
All the highest quality. Length's 5-20mm
Total Pack Qty: 100 Assorted
ORDER CODE: PACK/013
SALE PRICE: £1-50

MIXED HARDWARE JUMBO PACK

A super Jumbo pack containing all types of bolts, screws, washers. All mainly small types and high quality. Also nuts etc. Length's 10-45mm
This pack is really super value for money.
We are selling this pack by weight: 1Kg.
This is up to 1000 pcs depending on sizes.
Pack Size: 1Kg
ORDER CODE: PACK/014
SALE PRICE: £2-50

FUSE PACK

A super pack containing an assortment of fuses which could include 20mm 32mm 1", fast blow, slow blow, in fact any type of fuse. Man popular sizes and values.
Total Pack Qty: 100 pcs
ORDER CODE: PACK/015
SALE PRICE: £2-50

— SURPLUS STOCK WANTED —

EDDYSTONE DIECAST BOXES

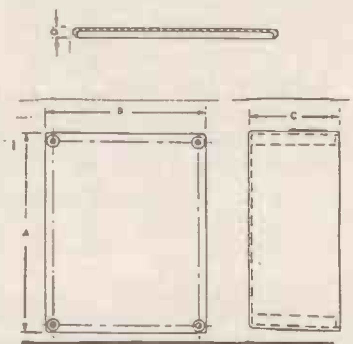
WE HAVE NOW BEEN OFFICIALLY APPOINTED SOLE U.K. MAIL ORDER & RETAIL SUPPLIER.

EDDYSTONE DIECAST BOXES - Manufactured in the U.K. by Eddystone Radio - need no introduction. Respected Worldwide as the highest quality aluminium diecast enclosure available - until now only available to the professional buyers.

We have been appointed sole mail order and retail supplier of this range of boxes to the hobbyist market.

Aluminium diecast boxes with close fitting lids secured by four or six countersunk screws depending on the size of the box.

Supplied complete with screws.



ORDER CODE	EXTERNAL DIEMSNIONS MM (APPROX.) A	B	C	D	PRICE EACH 1+	10+
BOX/11451P	52	38	31	4	£2-05	£1-85
BOX/27969P	92	38	27	4	£2-25	£2-02
BOX/27134PSL	111	60	31	4	£2-45	£2-20
BOX/29830PSL	120	95	34	4	£3-65	£3-28
BOX/26908PSL	120	95	53	4	£4-80	£4-32
BOX/26357P	188	120	78	4	£8-40	£7-55

ABS MULTIPURPOSE BOXES - STANDARD

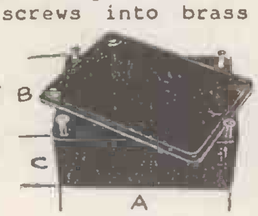
A range of professional quality boxes, offering a high quality finish at a very realistic price.

Moulded in high impact ABS to give maximum strength, they are easily punched or drilled to produce a professional looking end-product.

Printed circuit board slots are provided on this range except for MB6.

All the lids are retained by 4 or 6BA countersunk posidrive screws into brass inserts.

Colour available: Black.



INTERNAL DIMENSIONS mm A	B	C	ORDER CODE	PRICE 1+	10+
76	58	35	BOX/MB1	£1.25	£1.18
95	71	35	BOX/MB2	£1.35	£1.26
115	95	37	BOX/MB3	£1.58	£1.50
145	95	55	BOX/MB5	£2.20	£2.05
165	119	75	BOX/MB7	£3.20	£3.05
207	122	77	BOX/MB4	£4.96	£4.80
213	142	57	BOX/MB6	£3.78	£3.63
174	117	80	BOX/MB7	£3.20	£2.95
147	77	47	BOX/MB8	£2.15	£1.99

Dimensions B.4.1/2"xH.2.3/8"xW.2.1/4"

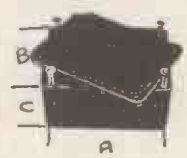
Colour available: Black

ORDER CODE
BOX/PSU-2

	1+	10+
PRICE -	£1.26	£1.16

ABS MULTIPURPOSE BOXES - MINIATURE

Colour available: Black



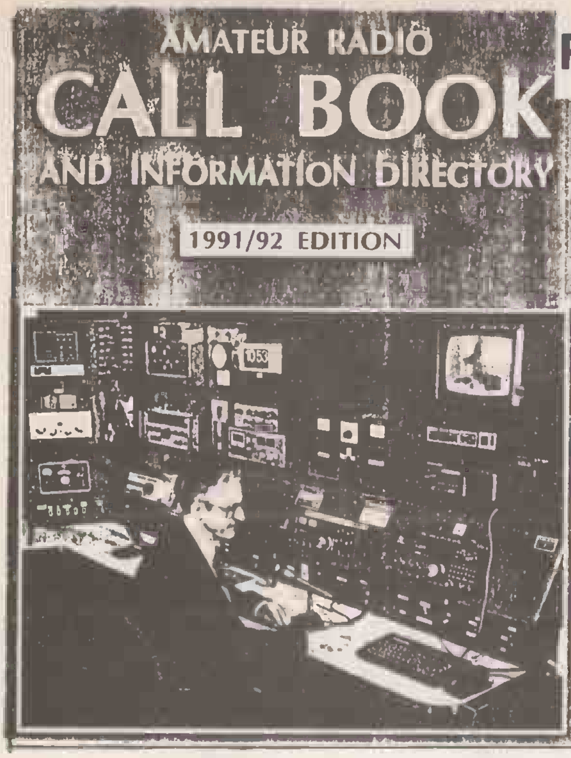
INTERNAL DIMENSIONS mm A	B	C	WALL THICKNESS mm	ORDER CODE	PRICE 1+	10+
72	46	22	1.5	BOX/T3	75p	67p
107	53	18	2.0	BOX/T4	90p	82p

PANEL METERS

Good quality range of panel meters. Plastic with moving coil. Dims: 45x51x34mm Deep. Cut Out: 38mm Dia.

F.S.D.	INTERNAL RESISTANCE	
0.50uA	3500ohm	PANEL/164
0-100uA	3500ohm	PANEL/165
0-500uA	430ohm	PANEL/166
0-1mA	200ohm	PANEL/169
0-5mA	8ohm	PANEL/170
0-10mA	3ohm	PANEL/171
0-50mA	1.5ohm	PANEL/172
0-100mA	0.8ohm	PANEL/173
0-500mA	0.2ohm	PANEL/174
0-1A	0.1ohm	PANEL/175
0.2A	0.4ohm	PANEL/176
0-3A	0.3ohm	PANEL/176A
0-5A	0.02ohm	PANEL/177
0-10A	0.01ohm	PANEL/177A
0-25V d.c.	1000ohm/V	PANEL/178
0-30V d.c.	1000ohm/V	PANEL/179

PRICE: £5-95



RSGB 1991/92 CALL BOOK

(LESS THAN HALF PRICE)

SUPER SALE

The Official RSGB Call Book & Information directory. This publication is a must for anybody interested in Amateur Radio. **430 PAGES!** Lists all UK & EIRE Call Signs and is packed with information including:
Abbreviations, Awards, Band Plans, Beacons, Clubs, Contests, EMC, Licensing Info., Locators, Morse info., News, Packet nodes, Propagation , QSL, Planning permission, RAE, Raynet, Repeaters, RSGB info., Safety, Satellites, Special Event Stations Etc etc.

CURRENT PRICE: £6-75!!

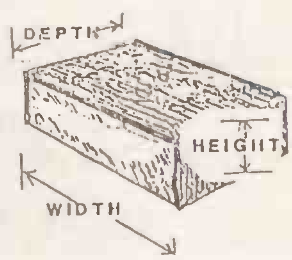
DIMS: 200 X 270MM

SALE PRICE £2-99

BOXES

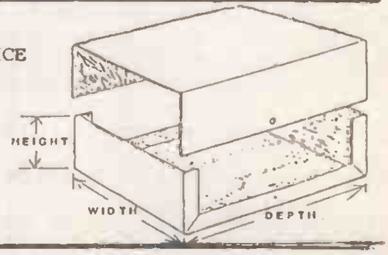
LEATHER-GRAIN P.V.C. COVERED ALUMINIUM A very attractive range of British Made aluminium boxes covered with a leather-grainPVC. These boxes will add that finishing touch to any DIY or professional circuit.
THESE BOXES ARE EXTREMELY GOOD VALUE FOR MONEY.

WIDTH	DEPTH	HEIGHT	ORDER CODE	PRICE	WIDTH	DEPTH	HEIGHT	ORDER CODE	PRICE
MILLIMETRES									
NEW LINE									
73	50	32	BOX/L10	£1.50	433	190	90	BOX/J46	£11.25
114	57	51	BOX/J2	£2.37	153	102	102	BOX/J10	£4.25
153	102	51	BOX/J6	£3.15	153	153	102	BOX/J15	£5.08
204	140	51	BOX/J9	£4.25	153	230	102	BOX/J22	£6.60
280	280	51	BOX/J26	£7.38	204	178	102	BOX/J23	£6.75
102	76	64	BOX/J3	£2.75	204	153	127	BOX/J24	£6.70
153	76	64	BOX/J5	£3.32	280	153	127	BOX/J33	£8.10
204	102	64	BOX/J8	£4.15	380	153	127	BOX/J45	£9.75
230	134	64	BOX/J12	£4.68	204	280	127	BOX/J44	£9.30
127	153	76	BOX/J11	£4.25	280	280	127	BOX/J60	£11.95
204	153	76	BOX/J14	£5.08	380	280	127	BOX/J83	£14.95
204	204	76	BOX/J19	£6.05	178	254	178	BOX/J49	£10.70
280	153	76	BOX/J20	£6.62	254	254	178	BOX/J70	£13.15
280	190	90	BOX/J29	£7.65	433	254	178	BOX/J119	£18.60



PLAIN ALUMINIUM

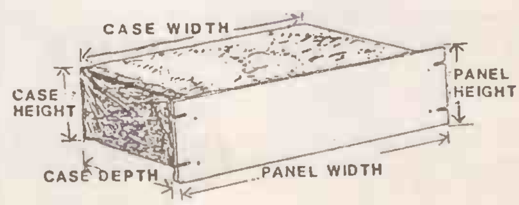
WIDTH	DEPTH	HEIGHT	ORDER CODE	PRICE	WIDTH	DEPTH	HEIGHT	ORDER CODE	PRICE
51	76	26	BOX/A6	£1.16	102	102	51	BOX/A32	£2.15
51	102	26	BOX/A8	£1.32	102	153	51	BOX/A48	£2.50
51	127	26	BOX/A10	£1.55	76	127	76	BOX/A45	£2.55
76	102	26	BOX/A12	£1.60	102	153	76	BOX/A72	£3.10
51	76	38	BOX/A9	£1.45	127	178	76	BOX/A105	£3.75
76	114	38	BOX/A20	£1.78	102	254	76	BOX/A120	£4.42
76	140	38	BOX/A25	£2.10	127	171	102	BOX/A140	£4.48
51	102	51	BOX/A16	£1.65					



19" RACK CASES

7 Piece construction with 3mm aluminium front panel. Top & bottom covers are removable for easy access. Supplied in kit form for easy drilling etc.

PANEL DEMENSIONS WIDTH	HEIGHT	CASE DIMENSIONS WIDTH	DEPTH	HEIGHT	ORDER CODE	PRICE
INCHES		INCHES				
19.0	1.75	16.75	6.0	1.375	BOX/U106	£15.30
19.0	1.75	16.75	9.0	1.375	BOX/U109	£17.00
19.0	1.75	16.75	12.0	1.375	BOX/U112	£18.90
19.0	3.5	16.75	6.0	3.125	BOX/U206	£18.50
19.0	3.5	16.75	9.0	3.125	BOX/U209	£20.80
19.0	3.5	16.75	12.0	3.125	BOX/U212	£23.00
19.0	5.25	16.75	6.0	4.875	BOX/U306	£24.30
19.0	5.25	16.75	9.0	4.875	BOX/U309	£26.85
19.0	5.25	16.75	12.0	4.875	BOX/U312	£29.35
19.0	7.0	16.75	6.0	6.625	BOX/U406	£28.20
19.0	7.0	16.75	9.0	6.625	BOX/U409	£32.20
19.0	7.0	16.75	12.0	6.625	BOX/U412	£35.20



COMPONENT KIT SALE

SALE PRICES ANY QUANTITY

Resistor Kit - 0.25W (5 off)

A pack containing 305 resistors. Values as listed below. Each value individually packed and each bag marked with the values enclosed.

Contents: 5 off each value:

10R, 12R, 15R, 18R, 22R. 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M.

Order Code:	1+	5+
KIT/RES/25/5	~~£3.75~~	~~£3.25~~

SALE PRICE £2-99

Resistor Kit - 0.25W (10 off)

A pack containing 610 resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

Contents: 10 off each value:

10R, 12R, 15R, 18R, 22R, 27R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M.

Order Code:	1+	5+
KIT/RES/25/10	~~£5.10~~	~~£4.60~~

SALE PRICE £4-00

Resistor Kit - 0.25W POPULAR

A pack containing a total of 1,000 of 1,000¼W 5% carbon film resistors ranging in value from 10R to 10M.

In this pack we have included larger quantities of the more popular values.

Each value individually packed.

Contents:

No.	VALUE	NO.	VALUE	NO.	VALUE
10 x	10R	10 x	82R	10 x	390R
10 x	12R	20 x	100R	30 x	470R
10 x	18R	10 x	120R	20 x	560R
10 x	22R	10 x	150R	20 x	680R
10 x	33R	10 x	180R	10 x	820R
20 x	47R	20 x	220R	40 x	1K
10 x	56R	20 x	270R	15 x	1K2
10 x	68R	20 x	330R	15 x	1K5
10 x	1K8	10 x	8K2	10 x	39K
25 x	2K2	30 x	10K	30 x	47K
20 x	2K7	15 x	12K	20 x	56K
20 x	3K3	15 x	15K	15 x	68K
15 x	3K9	15 x	18K	10 x	82K
25 x	3K7	20 x	22K	30 x	100K
20 x	5K6	15 x	27K	20 x	120K
15 x	6K8	20 x	33K	15 x	150K
15 x	180K	5 x	820K		
20 x	220K	20 x	1M		
15 x	270K	10 x	2M2		
15 x	330K	5 x	3M3		
10 x	390K	10 x	4M7		
20 x	470K	5 x	6M8		
10 x	560K	20 x	10M		
10 x	680K.				

SALE PRICE

£5-50

Order Code	1+	5+
KIT/RES/25/POP	~~£6.99~~	~~£5.99~~

Resistor Kit - 0.5 POPULAR

A pack containing a total of 1,000 ½W 5% carbon film resistors ranging in value from 2R2 to 10M.

In this pack we have included larger quantities of the more popular values. Each value individually packed.

Contents:

NO.	VALUE	NO.	VALUE	NO.	VALUE
5 x	2R2	10 x	12R	10 x	120R
5 x	2R7	10 x	18R	10 x	150R
5 x	3R3	10 x	22R	10 x	180R
5 x	3R9	10 x	33R	20 x	220R
10 x	4R7	20 x	47R	20 x	270R
5 x	5R6	10 x	56R	20 x	330R
5 x	6R8	10 x	68R	10 x	390R
5 x	8R2	10 x	82R	30 x	470R
10 x	10R	20 x	100R	20 x	560R
20 x	680R	10 x	3K9	20 x	22K
10 x	820R	25 x	4K7	10 x	27K
40 x	1K	20 x	5K6	20 x	33K
10 x	1K2	10 x	6K8	10 x	39K
10 x	1K5	10 x	8K2	30 x	47K
10 x	1K8	30 x	10K	20 x	56K
25 x	2K2	15 x	12K	10 x	68K
20 x	2K7	15 x	15K	10 x	82K
20 x	3K3	30 x	18K	30 x	100K
20 x	120K	10 x	680K		
10 x	150K	5 x	820K		
10 x	180K	20 x	1M		
20 x	220K	10 x	2M2		
15 x	270K	5 x	3M3		
15 x	330K	10 x	4M7		
10 x	390K	5 x	6M8		
20 x	470K	20 x	10M		
10 x	560K				

SALE PRICE

£9-00

Order Code:	1+	5+
KIT/RES/5/POP	~~£10.75~~	~~£9.75~~

Resistor Kit - 0.5W (5 off)

A pack containing 365 resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

Contents: 5 off each value:

2K2, 2R7, 3R9, 4R7, 5R6, 6R8, 8R2, 10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M8, 2M2.

Oder Code:	1+	5+
KIT/RES/5/5	~~£5.40~~	~~£5.00~~

£4-50

Resistor Kit - 0.5W (10 Off)

A pack containing 730 Resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

Contents: 10 off each value:

2R2, 2R7, 3R3, 3R9, 4R7, 5R6, 6R8, 8R2, 10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 1M8, 2M2.

Order Code:	1+	5+
KIT/RES/5/10	~~£8.75~~	~~£7.75~~

£7-00

COMPONENT KIT SALE

SALE PRICES ANY QUANTITY

Resistor Kit - 1W (5 off)

A pack containing 365 1W resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

Contents: 5 off each value:

10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 22K, 27K, 33K, 39K, 47K, 56K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 1M8, 2M2, 2M7, 3M3, 3M9, 4N7, 5M6, 6M8, 8M2, 10M.

Order Code:	1+	5+
KIT/RES/1/5	~~£15.25~~	~~£14.00~~

SALE PRICE £13-00

Ceramic Kit - 50V - Over £9.70 worth at catalogue prices -

A pack containing 125 50V disc and plate ceramics - ranging in value from 1pF to 10nF (0.01mF).

Each value individually packed and each bag markes with the value enclosed.

Contents: 5 off each value:

1,0pF, 1.8pF, 2.7pF, 3.3pF, 4.7pF, 5.6pF, 6.8pF, 8.2pF, 10pF, 12pF, 22pF, 27pF, 47pF, 68pF, 82pF, 100pF, 150pF, 180pF, 270pF, 470pF, 560pF, 1000pF, 2200pF, 4700pF, 10nF.

Order Code:	1+	5+	
KIT/CER/50V	~~3.99~~	~~£3.50~~	**£3-00**

Electrolytic Kit - Radial - Over £11.00 worth at calalogue prices -

A pack containing 100 miniature radial lead electrolytic capacitors. 12 different values. Each value individually packed.

Contents:

No.	VALUE	VOLTAGE	NO.	VALUE	VOLTAGE
10	1mF	63V	15	10mF	25V
10	2.2mF	63V	10	22mF	25V
10	4.7mF	63V	10	47mF	25V
15	100mF	16V	5	1000mF	16V
5	220mF	16V	2	1000mF	25V
5	470mF	16V	3	2200mF	16V

Oder Code	1+	5+
KIT/ELECT/RAD	£8.50	£7.50

SALE PRICE £7-00

Fuse Kit - 20mm Quick Blow

A pack containing 80 Quick-Blow 20mm Fuses.

Each value individually packed.

Contents:

No.	VALUE	NO.	VALUE	NO.	VALUE
5	x 100mA	10	x 500mA	10	x 3.15A
5	x 250mA	20	x 1A	5	x 5A
5	x 315mA	5	x 1.6A	5	x 6.3A
		10	x 2A		

Order Code:	1+	5+	
KIT/FUSE/QB2	~~£4.75~~	~~£4.25~~	**£3-50**

Fuse Kit - 20mm Anti-Surge

A pack containing 80 Anti-Surge 20mm Fuses.

Each value individually packed.

Contents:

No.	VALUE	NO.	VALUE	NO.	VALUE
5	x 100mA	10	x 500mA	10	x 3.15A
5	x 250mA	20	x 1A	5	x 5A
5	x 315mA	5	x 1.6A	5	x 6.3A
		10	x 2A		

Oder Code:	1+	5+	
KIT/FUSE/AS2	~~£8.50~~	~~£7.50~~	**£7-00**

A pack containing a total of 120 miniature horizontal mounting pre-set potentiometers. A total of 13 different values. Each value individually packed.

Contents:

No.	VALUE	No.	VALUE	No.	VALUE
5	x 100R	5	x 2K2	10	x 47K
5	x 220R	15	x 2K7	20	x 100K
5	x 470R	20	x 10K	5	x 220K
15	x 1K	5	x 22K	5	x 470K
		5	x 1M		

Order Code:	1+	5+	
KIT/POT/HORIZ	~~£7.75~~	~~£7.25~~	**£6-50**

A pack containing a total of 120 miniature vertical mounting pre-set potentiometers. A total of 13 different values. Each value individually packed.

Contents:

No.	VALUE	No.	VALUE	NO.	VALUE
5	x 100R	5	x 2K2	10	x 47K
5	x 220R	15	x 4K7	20	x 100K
5	x 470R	20	x 10K	5	x 220K
15	x 1K	5	x 22K	5	x 470K
		5	x 1M		

Order Code:	1+	5+	
KIT/POT/VERT	~~£7.75~~	~~£7.25~~	**£6-50**

Zener Diode Kit - 400 M/W

A pack containing 55 zener diodes. 400m/w. Ranging from 3V6 to 30V. Each value individually packed and each bag marked with the value enclosed.

Contents: 5 off each value:

3V3, 4V7, 7V5, 8V2, 11V, 12V, 13V, 15V, 16V, 20V, 24V.

Order Code:	1+	5+	
KIT/ZEN/400	~~£3.99~~	~~£3.50~~	**£3-00**

Polyester Capacitor Kit

ITT PMT type 100V miniature or similar. Pack contains 110 capacitors. Each value individually packed and each bag marked with the value.

Contents: 10 off each value:

0.01uF, 0.015uF, 0.022uF, 0.033uF, 0.047uF, 0.068uF, 0.1uF, 0.15uF, 0.22uF, 0.33uF, 0.47uF.

Order Code:

KIT/POLY Price £ ~~5.00~~ **£4-00**

KIT SALE

500V Ceramic Kit

Very high quality, single layer type.

These capacitors are normally very expensive and there not available to the hobbyist. We priced this kit up at current trade prices, the price manufacturers pay, and it was over £60.00!!! You really cannot afford to miss this super offer.

Physical sizes: 3.3pF to 3N3 8mm Dia.
4.7nF tol0N 10mm Dia.
20nF to 220N 16mm Dia.

Each Kit contains 5 off each value. Total Quantity 125 pcs.

Values: 3.3pF, 3.9pF. 10pF, 15pF, 22pF, 27pF, 33pF, 47pF, 56pF, 68pF, 82pF, 100pF, 120pF, 180pF, 220pF, 270pF, 680pF, 1N2, 1N5, 3N3, 4N7, 8N2, 10nF, 20nF, 47nF, 220nF.

Order Code: SO/HVKIT Price: £6.00

CABLE KITS SPECIAL OFFERS

A choice of two packs of British Made equipment wire. 10/0.1mm and 7/0.2mm.
We also offer this cable in 100mtr.reels. See below.

10/0.1mm Pack
Dia. approx 1.05mm. Max voltage RMS 1000V. Nominal current is 0.5Amps.

Each pack contains 10 Metres of each of the following colours: RED, BLACK, BLUE, BROWN, GREEN.

A total pack of 50 metres.

Order Code: SO/CBL/P1 Price:£1.50
(Price per 100mtr reel is £1.95)

7/0.2mm Pack

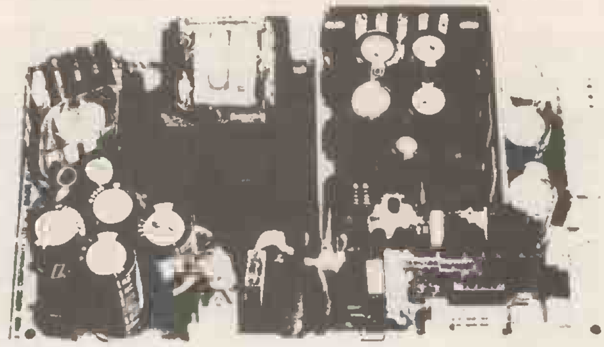
Dia. approx. 1.2mm. Max voltage 1000Volts RMS. Nominal current 1.4Amps.

Each pack contains 10 Metre of each of the following colours: RED, BLUE, GREEN, WHITE, GREEN/YELLOW.
A total pack of 60 metres.

Order Code: SO/CBL/P2 Price: £1.80

(Price per 100Metre Reel is £2.00)

SWITCH MODE PSU Astec AC-9355 65 WATTS



Super quality, ex-equipment but ALL tested guaranteed.
Input: 240Vac OUTPUT:

V1 +5V @ 6A V2..+12V @ 1.5A

V2 +12V @ 1.5A

V3 +12V @ 2.1A

V4 -12V @ 0.25A

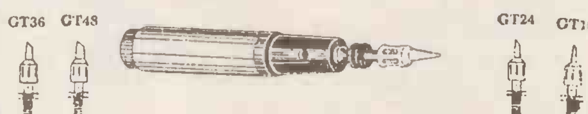
DIMS: 195X10.5MM
ORDER CODE: SO/ASTEC/9355

SALE PRICE: £15-00 each

BUTANE GAS SOLDERING IRON

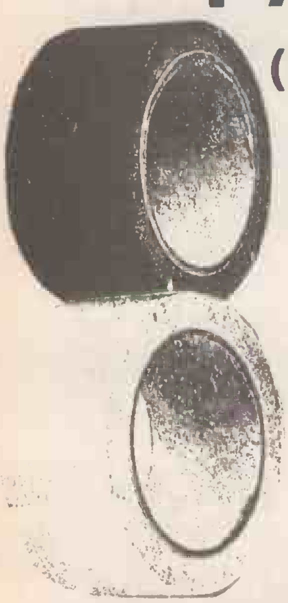
Uses ordinary butane 'cigarette lighter gas. Internal tank holds sufficient gas for one hours use. Ideal for: field service engineers, motor mechanics etc. supplied with 2.4mm soldering tip as standard.

Order Code:
SOLD/GT06 £14-50



TIPS £4-00 EA

PARCEL TAPE SALE



(BUFF VINYL SEALING TAPE)

(YES, IT'S SELF ADHESIVE!)

Known by many titles, we simply call it brown parcel tape! It's the tape we have used for several years. It's the highest quality - not to be confused with the cheap & cheerful tape that's around.
We have just taken delivery of over 5,000 reels and although we use a lot we can spare a few rolls!!!

PLEASE REMEMBER: OUR PRICES INCLUDE VAT!!

Standard Length: 66 Metres. Standard width: 50mm
Colour: Buff (Brown)

	1+	10+	100+
SUPER SALE PRICE:	65P	55P	48P

HURRY HURRY, WE SOLD 200 ROLLS BEFORE WE HAD FINISHED UNLOADING OUR VAN!!

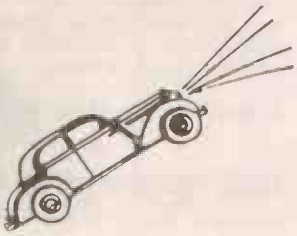
HOBBY KITS

A range of Economy Electronic Kits for hobbyists, schools etc. Each kit contains electronic components, which must be soldered to the P.C.B. provided. The modules are ready made units and most have connections brought out to screw terminals.

Many of the kits and modules require the purchase of additional items.

Car Light Warning (B001)

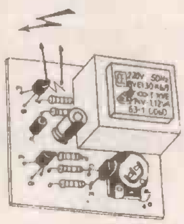
This circuit will attract your attention by producing a noisy 'Honk' signal should you turn off the car ignition but leave the lights on, and therefore should save you the problem of a drained battery. Works off the car battery, 6-12V.



KIT/B001 £7.50

Electrifying Apparatus (B007)

...generates a weak adjustable high tension of appros 80-300V out of 3-6V(Max 9V). May be used by anglers to catch worms. Maximum current 50-250 MA.



KIT/B007 £8.35

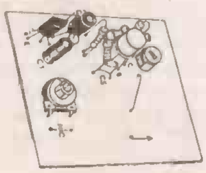
Fog Horn 5W(B015)

...generates a deep, noisy sound similar to the fog-horns of ships. Operating voltage 4.5-12V wattage:Max 5W depending on the voltage. For 8Ω-loudspeakers.

KIT/B015 £5.99

Test Oscillator (B018)

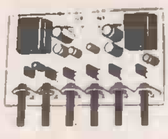
This is a close range test only transmitter, which can be tuned between 88 and 108 MHZ and used to service radio receivers by using the unmodulated carrier. this Kit must not be used to transmit over any distance.



KIT/B018 £6.85

Lighting Console (6 WAY),(B022)

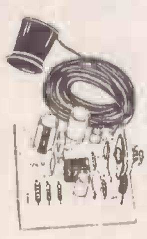
Each channel is independantly adjustable. Lamps up to Max.500W. 240V can be connected per channel. High input sensitivity: Adapts to stereo or mono equipment. For discotheques, party rooms and the like.



KIT/B022 £20.50

Telephone Amplifier (B105)

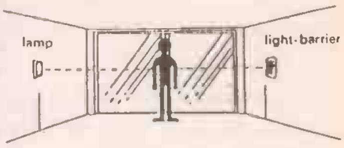
Suitable to monitor telephone conversations via the pick up coil. This kit requires a loudspeaker of 8^ and an operating voltage of 9V.



KIT/B105 £9.95

Light Barrier 12V (B045)

A light barrier Kit which uses an LDR(Light Dependant Resistor) to trigger the relay on. Can be used to switch on an alarm, open a door or as a twilight switch etc. A light source is required which shines onto the LDR of the kit, if this light source is interrupted the relay will pull on. Max. relay current is 5A. Requires a 12V supply.



KIT/B045 £9.75

Thermo Switch (B048)

Turns the relay on or off at a pre fixed temperature This instrument may be used as a thermostat, as an ice warning system, etc. Operating voltage: 12V. Temperatur range: approx -30 to +150 C. Relay switching capacity: 5A

KIT/B048 £9.85

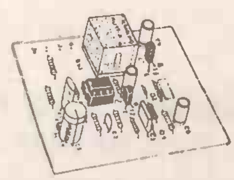
Siren Warship (B052)

'Decks clear for action' - warship siren. Creates a short swelling up sound (uiiit...uiiit...) in short intervals. Wattage 3-15W. depending on the operating voltage. For 6-12V. Loudspeaker impedance:8Ω

KIT/B052 £12.50

Infra-Red Light Barrier (B062)

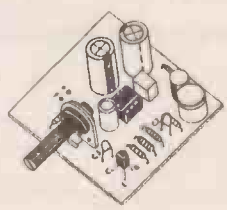
Light barrier with invisible infra-red light beam. Complete kit with transmitter and receiver. Range over 6M. Operating voltage: transmitter 9-12V receiver 12V. Relay contact: 3A switching capacity. Ideal for warning systems.



KIT/B062 £19.75

Parabolic Microphone (B085)

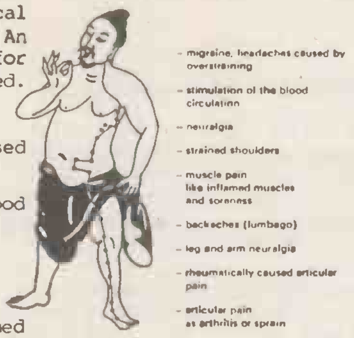
Highly sensitive microphone. If mounted into a semi-circular reflector (eg half of a plastic ball), noise and voices in a distance of several hundred metres may be recorded . Ideal for animal observance, for detectives etc. For headphone connection 80. Requires 9V supply.



KIT/B085 £10.35

Acupuncture Electronic (B136)

Electronical Acupuncture has an effect on many sicknesses. This kit operates in accordance with the electronical acupuncture - method. An illustrated description for the treatment is enclosed. 3-12V

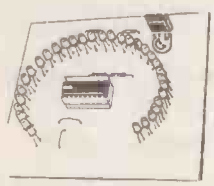


- migraine,headaches caused by overstraining.
- stimulation of the blood circulation.
- neuralgia
- strained shoulders
- muscle pain like inflamed muscles and soreness
- backaches (lumbago)
- leg and arm neuralgia
- rheumatically caused articular pain
- articular pain as arthritis or sprain.

KIT/B136 £9.85

LED VU Meter (30LEDs) (B160)

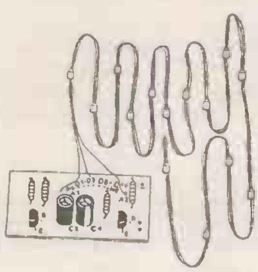
A thirty LED voltage display which uses the new U 1096B chip making it possible to construct an LED control display with 30 LEDs. The circuit can be connected directly to the loudspeaker output of an amplifier. A trimming pot allows exact setting within the required range. The display can also be used as a voltimeter etc.



KIT/B160 £19.25

LED Lightband (B173)

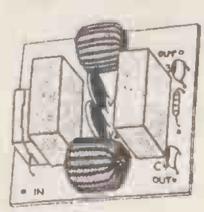
A decorative lighting band of approx.1.5m with 14 light emitting diodes, which light up alternately to give the appearance of movement. Ideal for decorations at parties,carnivals etc. Requires 18V power supply.



KIT/B173 £9.45

Filter Electronic (B176)

This highly effective anti-interference device has to be connected into the mains lead of you computer,telefax,video or TV set. The kit is overvoltage protected. Max load:750W 110-250V AC



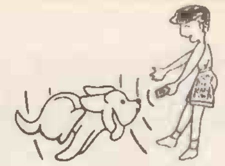
KIT/B176 £13.25

Dog Barking Electronics(B155)

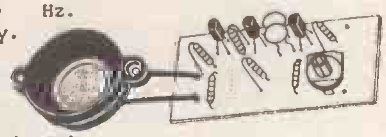
Generates a dog barking sound. Suitable for use with 8Ω speaker. Operating voltage 9-12V. The barking is stored on a special speech-synthesizer IC.

KIT/b155 £19.50

Ultrasonic Dog Whistle (B179)



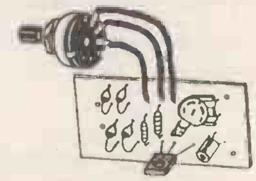
The ultrasonic dog whistle emits high powered ultrasonic sounds which are widely audible for dogs, but mostly undetectable by the human ear. The output frequency is through a special piezo lodspeaker and is adjustable between 8000 and 25,000 Hz. Requires a 9V battery.

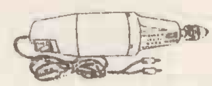


KIT/B179 £7.50

Speed Control 12-24V (B180)

Suitable for the operation of miniature drilling machines which have DC motors. A rectifier is fitted in the kit and only requires a transformer of 12-24V secondary depending on the required voltage. Suitable for use up to 3A current input.





KIT/B180 £6.45

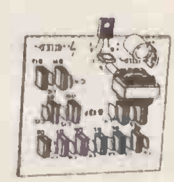
Alarm Motorbike (M073)

This waterproof and shakeproof module will automatically switch on a horn or siren if the motorbike is moved, can also be used to protect other objects from theft. Additional items required:power supply (bike battery),SPST switch,horn or siren. Max current 1A.

KIT/M073 £4.50

Ion Generator (B137)

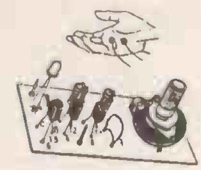
Regenerates negatively loaded air particles (air-ions) and helps to produce a healthy climate which can reduce troubled sleep.aggressiveness,headaches and weather related dispositions etc. Input 6-18V DC. Output 2-7kV. Current limit protection<200 A.



KIT/B137 £9.95

Lie Detector (B087)

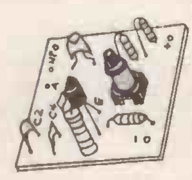
This lie detector will monitor changes of the skins resistance due to sweating caused by lies and fear etc., which is then indicated by an LED. Requires 4.5V



KIT/B087 £5.95

MW Testing Transmitter (B144)

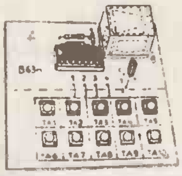
A close range test only oscillator which can be used as an unmodulated carrier to test radio receivers in the MW band. This kit must not be used to transmit over any distance.



KIT/B144 £4.99

Combination Digital Lock B(063)

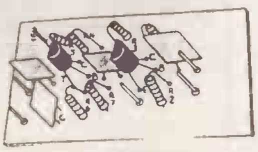
After keying-in a 4-digit number, the relay switches on. The code is independantly programmable and can be easily modified. Relay contact: 3A, 1xchange over. For 6V application: keyless door-lock, to switch on equipment (radio, TV-set etc.) which is not to be used by other people, for safe doors etc.



KIT/B063 £22.75

Car Antenna Amplifier (B068)

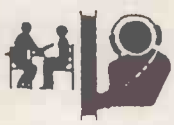
This amplifier is connected between the antenna and the radio, using co-axial cable 60-750. Gain max: 22 dB. Frequency range:0.5-150 MHZ (Approx).



KIT/B068 £5.99

Spy Stethoscope (B069)

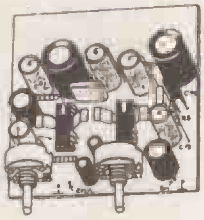
Using an earpiece the spy stethoscope allows you to listen through thin walls, doors, windows etc., due to a highly sensitive pre-amplifier and microphone. Suitable for monitoring animals etc.



KIT/B069 £20.50

Accoustic Water Detector (B070)

...raises a loud alarm signal on contact with water. This instrument signals broken water pipes, overflowing washing machines and bath tubs, etc. The sensor can be connected by a longer cable of up to 100m. Power supply: 9V battery.



KIT/B070 £5.99

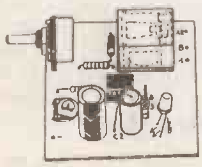
Microphone pre-Amp (B090)

The impedance load can be adapted for each microphone from 40 to 100kO. Input voltage 2-40mV. Output max. 1.8V. Adjustable gain. Frequency: approx. 20-40000Hz. Operating voltage: 6-20V.approx. 1mA

KIT/B090 £6.95

Interval Switch (Universal) (B098)

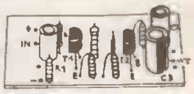
Interval time: approx. 1-140sec. interval length: approx. 0.2-12sec. adjustable. Operating voltage: 7.5-15V. Relay capacity: max.5A. Interval indication by LED. Application: Screen-wiper interval switch for cars, pulsator for lamps, motors etc. Delay switch for alarm systems,etc.



KIT/B098 £13.85

Pre-Amp Universal Mono (B073)

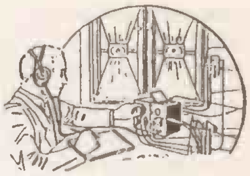
Frequency range 10Hz-150kHz. 2-step pre-amplifier for 9-30V, output:200mV-2V. Application: pre-amplifier for high-power amplifier,'headphones-amplifier', etc.



KIT/B073 £4.85

Diode Receiver MW and SW (B076)

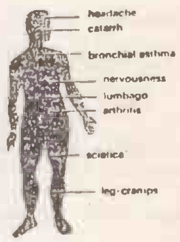
'Detector-receiver' for Middle-wave or short wave, approx 2-9 MHz. This radio operates on the same principle as the very first radio receivers. It does not require an operating voltage. This kit is educational for beginners.



KIT/B076 £10.75

Mesmeric Instrument (B078)

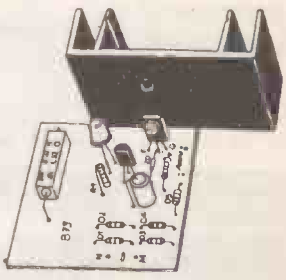
This magnetic field instrument operates on the same principle as curative instruments offered on the medical market. Alternating currents of magnetic fields are said to have a soothing effect on various kinds of sicknesses.



KIT/B078 £9.25

Battery charger, Ni-Cad (Universal) (B079)

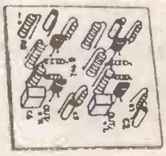
Automatic accu-charger for accumulators of 1.2-15V. The charging current will automatically adjust, to remain constant as the battery charges. Has a selection of seven settings. 5-600mA. Additional requirement: 1 transformer. Output capacity: 18-20V.0.6 A.



KIT/B079 £9.25

Pre-Amp Universal Stereo (B142)

2-step stereo universal pre-amplifer for operating voltages between 9-30V operating voltage. Input:2-20mV.output:200mV-2V:application pre-Amplifier for high-power amplifier,'Headphones-amplifier',etc.



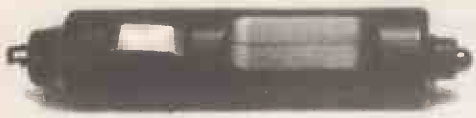
KIT/B142 £8.45

Robot Voice (B 107)

This kit modulates the human voice with an adjustable frequency to produce robot like sounds. This sound then requires amplification i.e. by an amplifer or a tape recorder. Requires 9-12V supply.

KIT/B107 £9.60

12V ACCESSORIES



PLUG-IN FLASHING LED

A flashing LED built into a car cigar plug to act as visual warning that alarm may be fitted. Simply plug into car cigar socket. Simple but may keep your car safe!

ORDER CODE: CAR/B200Z **PRICE: £1-95**

B118B

BROADBAND RADIO RECEIVER

A handheld broadband radio receiver with a range covering CB, FM radio, TV, Air and PB bands. Built-in telescopic aerial. Squelch, volume and tuning controls and band selector switch.

Frequency range:

Air	108 - 145MHz
PB	145 - 176MHz
WB	162.5MHz
TV	54 - 87MHz
FM	88 - 108MHz
CB	1 - 80 channels

Power 6Vdc
(4x "AA" batteries, not included)
Dims ....93 x 198 x 50

PRICE: £17-50

T081B **£69-99**

VIDEO LIGHT KIT

A semi-professional video light kit comprising 100W halogen lamp, remote 12Vdc 7Ah sealed lead acid battery in carrying case with shoulder strap, 220/240Vac operated battery charger and camcorder power supply adaptor.

CAR POWER LEAD

A handy lead, Fused 3A cigar plug connected to a moulded 2.2mm DC power plug. Lead length approx. 2m.
Colour: Black

	1+	10+
CAR/P.LEAD	**£1-50**	**£1-25**

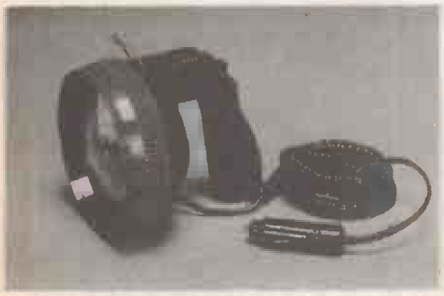
12VDC TRAVEL KETTLE

B049A

12Vdc kettle complete with mounting stand, cup and cup holder with a self-adhesive base. Plugs directly into a car cigar lighter socket for power. A power-on light is provided at the base of the kettle. Ideal for cars, vans, campers etc.

Capacity..0.5 pints (0.3lts
Power..12Vdc 9A, 14Vdc 11A
Dims..143 x 125 x 112mm (approx.

£12-99 4 FOR £46-00



QUARTZ HALOGEN SPOTLIGHT

Hand held spotlight with a 55Watt bulb, producing more than 250,000 candle power, directed by a concave, electro plated reflector Supplied complete with hanging loop and 3.6m coiled lead with cigar plug fitted.

POWER...................12Vdc 55w
DIMENSIONS..125X125X140mm(Approx)

ORDER CODE: OPTO/QHS **£5-75**

A 12 V car cigarette lighter socket connected to 2 × battery crocodile clips.

1+.....£2-99

ORDER CODE: CAR/JL

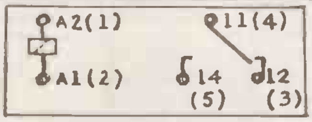
4 FOR £10-00

SPECIAL OFFERS

PHOTO-TRANSISTOR Siemens Type: SFH309-5
Case: T1 (3mm)
Sensitivity: 1.0-2.0 @ 0.5mW/cm²
Half Angle: 32°
Peak Response: 900nm
Response: 10 tr(US)
Short lead is connector.
Lead pitch: 2.54
We have large qty's in stock.

	1+	10+	100+	1000+
ORDER CODE: SO/601	38p	35p	25p	20p

SCHRACK RELAY TYPE:
RP-03 1 0 1 2



Internationally approved heavy duty PCB mounting relay in industry standard dimensions with 1 form C contact rated at 8Amps. Mounted on 0.1" grid.

Switching voltage: 380Vac max.
8A 250Vac Dims: 28 X 25 X 11mm

Nominal V DC: 12V 270 ohm

	1+	10+	100+	1000+
ORDER CODE: SO/602	£1-00	90p	65p	55p

(We still have approx 3,000 in stock!)

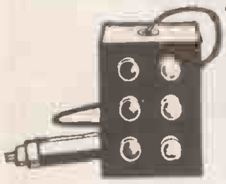
EPROM LABELS 16.5mm X 5.08mm
OK INDUSTRIES TYPE CODE: 1/100A/10
A dual purpose label designed for use on Eproms or similar devices where the chip requires protection from the effects of light. These labels are also handy for marking devices or junction identification. Supplied on roll sheets which have pin-feed holes along the edge thus allowing them to be printed on a computer printer.
Total qty. per full rel: 3350 Labels (Approx)

	QTY	PRICE
ORDER CODE: SO/600	60 Labels	50p
	180 Labels	£1-40
(Full reel)	3350 Labels	£22-50

IEC LEAD - CURLY
6A 240Vac Right Angle IEC plug fitted to 3core 0.75mm black curly cable. Stretches to approx. 2.5Metres.

	1+	10+
ORDER CODE: SO/604	£1-00	90p

TERMINAL BOX - 12Vdc



Terminal junction box for powering d.c. accessories. Gives three pairs of pillar screw terminals, colour coded Red & Black. 90cm lead with cigar plug fitted.
Current......3A max.
Dims: 84 x 55 x 32mm

ORDER CODE: SO/158	1+	10+
PRICE	£1-50	£1-25

TOROIDAL TRANSFORMER Made in UK
Manufacturer: St Ives Windings.

PRIMARY: 0-120V
0-120V

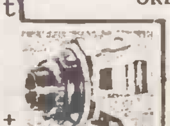
SECONDARIES: 9V at 4Amps
15-0-15v at 500mA

Dims: 75mm Dia 38mm Thick

Original Price in tens £24 each
ORDER CODE: SO/268 PRICE: £9-99

STEREO SOCKET SALE

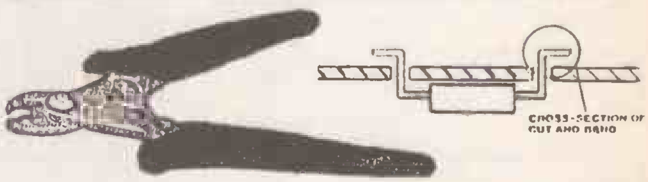
6.35mm (¼") Stereo chassis socket
Metal mounting nut. **Unswitched**
ORDER CODE: SO/661



	1+	10+	100+
PRICE:	30p	26p	20p

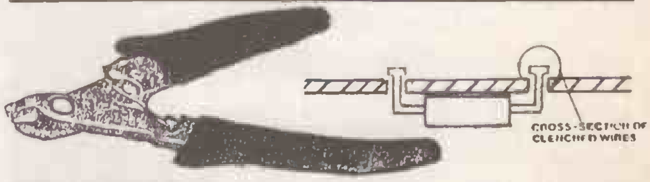
HI RES MONITOR Made in UK GREEN SCREEN
Very high quality monitor, complete apart from the case.
Resolution at Centre is 900 lines therefore ideal for computer applications.
Simply input 12V @ 1.2A.
COMPOSITE VIDEO!
Supplied complete with full handbook and circuit diagram and full parts list.
(Manual available seperately £2-00 each)
SPEC:
CRT Size ....7" (178mm)
Power...............................12V/1.2A
Line Frequency..................15-19KHz
Vertical Frequency.............50-60Hz
Resolution at Centre...........900 lines
Linearity...........................<2%
EHT Typical.......................12.0Kv
Line Blanking.....................12-7.5uS
Vertical Blanking................750uS
Video Input unterminated........12K
terminated..........75R
Video Response..................22MHz
Video Rise/Fall...................17nS
Video in for 35V output........1Vp-p

ORDER CODE: SO/MONITOR PRICE: £19-99
2 for £35-00



CUT AND BEND
Cuts & bends component leads in one action (see drawing). A quick & easy method of retaining mounted components. Ideal for development work. Components can be removed & reused after desoldering at a later time. Cutting capacity 1mm dia. copper wire. Special cushion grip handles. Very high quality, manufactured in Italy.
Length: 128mm Weight: 70gms
Normal Catalogue Price: £4-95

ORDER CODE: TOOL/SC/TP30 SALE PRICE: £2-99



CUT and CLENCH
A stepped edge provides a cutting & clenching action which will cut & splay copper leads out to approx. twice the original diameter.(See drawing). Provides a permanent & secure method of retaining components, particularly useful in production. Cutting capacity 1mm dia. copper wire.

Length: 128mm Weight: 70gms

Special cushion grip handles . Made in Italy.
Normal catalogue Price: £4-99

ORDER CODE: TOOL/SC/TS30 SALE PRICE: £2-99

CAR STEREO KNOBS
A complete set of silver knobs for car stereo radio/cassette player. 4 knobs gives one each for volume, tuning, balance & tone. Serrated edges. Push On with anti-rotation spigots.

Max dia: 34mm Only a few hundred left.

ORDER CODE: SO/606	1+	10+
PRICE:	50p	42p

SURPLUS STOCK WANTED

SPECIAL OFFERS

MICROPROCESSOR BOARD

A very high quality PCB manufactured by Ferranti still in its original packaging.
All Microprocessors are 'plug-in'.
2 X Z0803006PSC (40pin) 1 X Z0801604PSC (48pin)
1 X Z8001B1 CPU (48pin) 4 X 27256-20 (28pin)
1 X AM8152ADC (48pin) 1 X AM27128A (28pin)
1 X AM8052-5LC (68pin PLCC) Dated 1984
Over 40 assorted IC's soldered plus numerous resistors, caps., crystals etc etc.
BOARD DIMS: 220 X 225mm
ORDER CODE: SO/648 PRICE: £15-00

SILVERED MICA 0.01uF 500V 1%
Type: RDM30FD103-F03 CDE
Super quality, good high voltage at a low price.
DIMS: Height 20mm Width 20mm Depth 7mm
Lead Pitch: 10mm (Lead length: 35mm)
The current distributor price for a 350V version is over £1-85 each plus VAT!!!
Several thousand avail.

ORDER CODE: SO/649	1+	10+	100+
PRICE:	50p	45p	35p

ANGLE SCREWDRIVER

USAG 340 Each end has flat blade 13mm tip.
Very high quality, marked Vanadium USAG Extra 2 X 13.

ORDER CODE: SO/650 PRICE: £1-00 each

POLYESTER 0.22uF 400V
ITT Made
Radial Lead. Lead Length: 15mm. Pitch: 22.5mm
Dims: H 19mm W25mm D 10mm

ORDER CODE: SO/651	1+	10+	100+
PRICE:	20p	18p	14p

COMMUNICATIONS INTERFACE PCB - Processor Board
Sorry, no further info. but board populated with several 6800, 6116, 2764, series chips (All plug-in).
Phono sockets, resistors, caps., etc etc.
Board Size: 465mm X 195mm
ORDER CODE: SO/652 PRICE: £5-00

IEC SOCKET - Snap Fit
10A 250V
A snap fit IEC socket providing a quick and easy installation option for IEC connector.
Chassis male.
Marked with all the approvals.
Panel Cut Out: 27 x 19.5mm

ORDER CODE: SO/653 PRICE: 50p

TANT BEAD SUPER SALE

We have just purchased over 150,000 tantalum bead capacitors and can offer very attractive prices while stocks last.

VALUE/Voltage	1+	10+	100+	1000+
1.0uF/35V	10p	8p	5p	3p
2.2uF/16V	11p	9p	6p	4p
4.7uF/35V	16p	12p	9p	7p
10uF/16V	20p	15p	10p	8p
10uF/35V	24p	18p	13p	10p

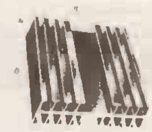
Lead Spacing: 5mm Approx Lead length: 5mm

TELEFUNKEN - Selection guide Transistors & Diodes.
38 pages, packed with full specifications, drawings, pin-outs and cross-references.
Contents: BA204-2N4036
A super booklet full of useful data.
Dims: 270mm X 210mm
ORDER CODE: SO/654 PRICE: £1-00

ANGLE SCREWDRIVER

USAG 341. Ideal where space is restricted. Two tips set at 90° to the shaft and heads for cross slot screws. Manufactured from Chrome vanadium steel, hardened, tempered and chrome plated for corrosion protection.
Blade Length: 6"(150mm)
One End: Cross Slot No. 3
Other end: Cross Slot NO. 4
ORDER CODE: SO/655 PRICE: £1-25

REDPOINT HEATSINK
Type: 4W-4
1.2°C/W
H=32mm W=130mm D=100mm



Pre-drilled to take 2 X TO3 devices.
List price £6-04 plus VAT! These really are top quality. Only a limited quality available.
ORDER CODE: SO/260A PRICE: £2-50

HEATSINK Type: SW50-4

High performance heatsink, designed for plastic power transistors, including TO-220, TO-3P, TO-126 etc. Fitted with solderable pins and may be vertically mounted.
Pre-drilled, Black anodised body.
Length: 50mm Width: 34.5mm Depth: 12.5mm
Thermal Rating: 8.6°C/W (Current Price 98p!)
ORDER CODE: SO/260 PRICE: 55p

AUDIO CASSETTES — AUDIO CASSETTES

Used once and bulk erased. ALL FULLY GUARANTEED
Over the last 12 months we have sold over 55,000 of these tapes and demand is still growing.
At time of printing we have two makes available.
MAXELL UDI-90 & SKC GX90 Ferro Position
Both tapes are supplied complete with inlay cards.
Both tapes are 90 Minutes.

ORDER CODE	1+	10+	100+
SO/MAX	85p	75p	60p
SO/SKC	65p	55p	40p

SPECIAL OFFERS

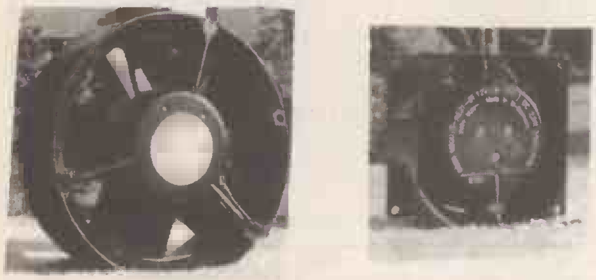
FARNELL SWITCH MODE PSU - 240Watts G Series

Model: G12 20A
They seem unused but no promises. Copy of manual available with orders upon request.
These units are in the curent Farnell catalogue at over £395 each!

INPUT: 115-120/240Vac

OUTPUT: 8 to 12.6V (Adjustable) 20 Amps

Dims: 88 X 160 X 194
SALE PRICE: £150-00 each



PAPST FAN - TYPE 6124 (172 X 55mm) 206CfM
Aluminium fan, impeller of fibreglass reinforced plastic. Electronically commutated dc motor.
Counterclockwise rotation viewed from rotor, air output over struts!! OK? (Supplied with FREE guard)
All brand new, still boxed, very high quality.
List price is over £85-00 each!!!

ORDER CODE: SO/256A **SALE PRICE: £10-00 each any qty.**

EBM FAN - Type W2G075-AE21
80mm X 80mm (Depth 38mm)
Super quality, latest model. Run at 12Vdc. (Will run on voltage between 8v and 16vdc.)
2.6Watts, 3450u/min. Made in Germany.
All aluminium construction. Trade price over £30 each!

ORDER CODE: SO/257 **SALE PRICE: £7-50 ea**

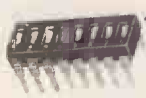
RAYCHEM MINIATURE CO-AX
75 ohm Type: 7528A1317-9(100)
Commercial quality. Stranded 7/0.127mm 28awg. Dia. 2.6mm
Colour: WHITE Reel Length: 100mtrs
Current trade price: £92 per reel!!

ORDER CODE: SO/446 **65p/mtr** **£45 per 100 mtr reel**

IEC FILTER PLUGS - Belling Lee
Operating Voltage: 240Vac. Line Frequency: 0-400Hz.
Inductance: 3mH per line. Trade Price £9-50 each!

Two ratings available: 2Amp and 6Amp.

2A Order Code: SO/262 SALE PRICE: £3-50 each
6A Order Code: SO/262A SALE PRICE: £3-50 each



DIL SWITCH - 10 Way - Low Profile
Alco Type: ADF10
Very high quality. 0.1" pitch. Black with white switches. Length: 27mm. DIL package. 20 pin
At time of printing we have over 20,000 pcs in stock.
15pcs per tube.

	1+	15+	90+	900+
ORDER CODE: SO/608	50p	45p	39p	30p

SIEMENS FILTER 0.33uF
Type: B84150-A-A110
Stud mounting, 4 solder tags.

0.33uF(X1) + 2 X 2500pF(Y) + 680K + 2X1.8mH

250Vac 10Amp 50/60Hz

Dims: 65mm X 35mm(Dia)

ORDER CODE: SO/SIE/A110 **SALE PRICE: £1-50**

SIEMENS FILTER 0.47uF
Type: B84150-A-A115
Stud mounting, 4 solder tags.

0.47uF(X1) + 2 X 5000pF(Y) + 680K + 2 X 1mH

250Vac 10A 50/60Hz

DIMS: 75mm X 35mm(Dia)

ORDER CODE: SO/SIE/A115 **SALE PRICE: £1-50**

SIMILAR TO ABOVE KEYBOARD

KEYBOARD - Clare BRAND NEW
Uncased Brand new keyboards manufactured by Clare General Instrument Corp.
Alphanumeric - seperate numeric keypad.
107 keys with a buzzer and several IC's on the rear:
1 X 8528, 1 X 2516JL-45, 1 X ET8035N-6, 1 X 6Mhz Crystal etc etc. Plus various resistors & capacitors.
Overall dims: 480 X 160mm.

ORDER CODE: SO/472 **SALE PRICE: £4-50 each**

ALLIBERT TRAYS

Capacity 6 litres
Ext LxWxHmm - 400x300x74
Int LxWxH - 355x255x64

P.C.B. STORAGE TRAYS - Made by ALLIBERT
General purpose, high quality trays. Ideal for many uses: PCB storage, component storage, desk in/out trays, seed trays etc. Very very strong & stackable.
Current price in KEYS catalogue: £3-50 ea plus VAT

Dims: 300 X 395mm Depth: 75mm

	1+	10+	100+
ORDER CODE: SO/TRAY	£1-50	£1-25	£1-00

SHUGART 8" DRIVE

DISK DRIVE - 8" BRAND NEW
Shugart Model: 801
Brand new, 240Vac drives still in original packaging. These really are a bargain!

ORDER CODE: SO/DRIVE SALE PRICE: £15-00

ALL PRICES INCLUDE V.A.T.

ADD £2.25 P & P PER ORDER

SPECIAL OFFERS

SECURITY KEYSWITCH

6A 240Vac 2 tag SPST Fixing hole: 19.2mm
Dimensions: 40 X 20mm dia.
Key may be removed in 'OFF' position only.

	1+	10+	100+
ORDER CODE: SO/605	£1-50	£1-25	£1-00

Keyswich Cover.
Strong plastic cover providing protection against the weather in external applications.
Colour: Grey

	1+	10+
ORDER CODE: SO/607	25p	20p

PHILIPS CCTV CO-AX LEADS
BRAND NEW - Leads, 10Mtr long.
Co-Ax plug to Right Angle Co-Ax plug.
(Moulded Plugs)
Colour: GREY

	1+	10+
ORDER CODE: SO/350	£1-75	£1-50

RESISTOR KIT - 1000pcs
Assorted values, including values that we have overstocks on. A minimum of 10 different values.
Absolute Bargain
1000 Resistors. All 0.25W Carbon 5%

ORDER CODE: SO/193 Price: £1-99

IEC MAINS LEADS

IEC LEAD 250V 10A Right Angle
Made By BELDEN
This may be the highest quality lead available. Fully screened cable, moulded IEC socket one end with USA plug on the other.
To use in UK, simply cut off the USA plug and wire up a standard 13A plug.
At time of printing we have over 12,000 of these leads and therefore able to offer very attractive quantity prices.
Markings on cable: 18-3 Type SJT E-3462 LL-7874 Shielded GE
Colour: BLACK
Length: 2 Mts

	1+	10+	100+
ORDER CODE: SO/307	£1-00	85p	60p

SIEMENS

Ideal for Radio, Computer etc which require an electrical noise free supply. Each filter is constructed using toroidal chokes and a combination of safety X2 and Y capacitors configured in a delta formation.
Very high quality, Brand New never been used.
These really are a bargain.

	1+	4+
ORDER CODE: SO/SIE/10A	£7-50	£7-00

SCOTCH DATA CARTRIDGE Type DC300A 3M
Standard length, all brand new and in original sealed packs. These really are a bargain.
Length: 450ft (137.2mtrs) 1600bpi/3200 ftpi

ORDER CODE: SO/436 SALE PRICE: £10-00!!

MEMOGUARD LITHIUM MEMORY RETENTION BATTERY
Saft Type: 40LH220

* DIL Package
* Hermetically sealed
* 10 year operating life.
* Voltage 3V

Dimensions: 28 X 25 X 8mm
Normal trade price is £2-75 plus VAT!

	1+	10+
ORDER CODE: SO/437	£1-50	£1-25

JUST ARRIVED! Limited quantity....Hurry hurry...

FARNELL SWITCH MODE PSU - 240Watts G Series G12 20A
Seem unused, but no promises. These are in the current Farnell Electronics catalogue at over £395 each!!

INPUT: 115-120/240Vac OUTPUT: 8 to 12.6V 20A

Dims: 88 X 160 X 194

ORDER CODE: SO/432

SALE PRICE: £150-00 each!!!!!!

BULGIN FUSED TEST PROBES Red & Black
Made in UK, very high quality. robust moulded plastic, complete with a 1A 1¼" fuse fitted.

Length: 144mm Sold as a pair

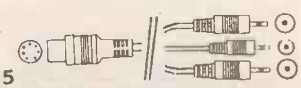
Normal price is more than £4-00 per pair!

	1+	10+
ORDER CODE: SO/139 (per pair)	£1-20	£1-00

COMPUTER LEAD
A 7 pin DIN plug to 1 X 2.5mm Jack plug (Yellow)
1 X 3.5mm Jack Plug (Red
1 X 3.5mm Jack plug (Black)

Lead length: Approx 2 metres.

	1+	10+
ORDR CODE: SO/194	£1-50	£1-25



SPEAKER GRILL - Chrome - 12"
Very attractive chrome speaker grill with black rubber surround.
Robust construction made from 1.1mm thick steel.
Grill pitch: 11 X 11mm approx.

	1+	4+
ORDER CODE: SO/026	£3-00	£2-50

EPSON - Intelligent Printer Interface Boards.
Type: 8148
Suits Epson printer models: EX-800, EX-1000, LQ-2500 and SQ-2500 (Maybe others)
Integral 8kB buffer and self-test which can be used to provide either RS-232C or current loop capability.

Currently being sold in trade cats. at over £80!

ORDER CODE: SO/EPSOM SALE PRICE: £25-00

EPROM SPECIAL - 27C256
Brand new, 250ns. Limited quantity, approx 800 pcs. First come first etc

	1+	10+
ORDER CODE: SO/EPROM	£3-00	£2-50

POWER SUPPLIES - EUROPEAN - 2 PIN

Manufactured by Commodore Business Machines (CBM) ltd. These power supplies are ideal for running radio's, cassette recorders, calculators etc etc. They fit the UK shaver adaptor (See our Electrical section). We have substantial quantities of these items and can offer attractive discounts for bulk buyers.

TYPE: EOB -DC
Input: 220/240V
Output: 4.5V @ 200mA
Plug: 2.5mm Jack
SO/POW/EOB

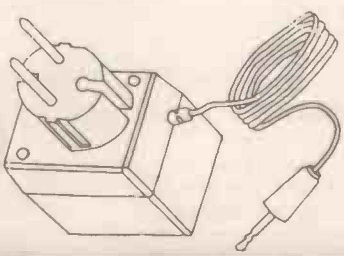
1+	10+	100+
70p	60p	50p

TYPE: MM3-AC
Input: 220/240V
Output: 6V @ 200mA
Plug: 3.5mm Jack
SO/POW/MM3

1+	10+	100+
95p	90p	75p

TYPE: EO9-DC
Input: 220/240V
Output: 6V @ 400mA
Plug: 3.5mm Jack
SO/POW/EO9

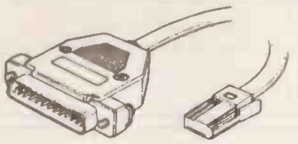
1+	10+	100+
£1-20	£1-10	90p



SPECIAL OFFERS

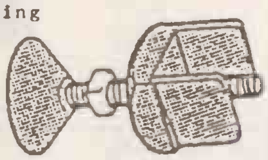
5¼" Computer Disks - 3M
Type: 744 D-O SS DD
Single sided double density soft sector.
Limited qty, only a few hundred boxes. First come first served!
ORDER CODE: SO/636 PRICE: £2-00 per box of 10

MODEM LEAD



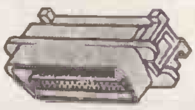
25 Way 'D' Plug connected to a BT 4 way plug.
Length: Approx. 3 Metres.
ORDER CODE: SO/637 PRICE: £3-50

Adjustable Feet for Tube Fitting



High quality feet for fitting to most makes of 25mm square tube. Each pack contains:
4 X Threaded Feet. 4 X Metal Cap. 4 X Tightening Nut. Current Trade price is £4-70 plus VAT per pack! Remember, all our prices include VAT.
ORDER CODE: SO/638 PRICE: £3-00 per pack

CENTRONICS PLUG - MALE - 50 Way
Amphenol Type: 226 B-50-U



50 Way plug (Without strain relief) Very high quality. Only a couple of hundred available.

	1+	10+
ORDER CODE: SO/639	£1-10	£1-00

0.1uF 63V 5% Metallised Polyester Capacitor
Very small capacitors, ideal where space is restricted. Overall width is only 7.5mm.
Lead pitch is 5mm.
We have a substanial quantity of these capacitors so if you use large quantities contact us now.

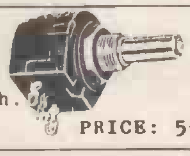
ORDER CODE: SO/640	1+	10+	100+	1000+
PRICE:	5p	4p	3.5p	2.5p

ITT- PLASTIC 25 WAY 'D' Cover with Jackscrews
ITT-CANNON Type: DC77762-25

Maybe the highest quality on the market at a very low price. Current Trade Price is £1-16 plus VAT!
Complete with integral Jackscrews and cable grip.

Colour: BLACK	1+	10+
ORDER CODE: SO/641	70p	65p

WIREWOUND POT 1Watt 2K5
AB Type: ABW1
Super quality,
Current price over £2-50 each.



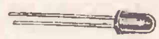
ORDER CODE: SO/642 PRICE: 50p each

Multi-channel Photodarlington Optocoupler
Siemens Type: ILD32 8 pin DIL
2 input opto-coupler with darlington output

This device can be used to replace 4N32's or 4N33's in applications calling for several single-channel couplers on a board.
Continuous Forward Current..................80mA
Peak Reverse Voltage..........................3V
Photodarlington Sensor (Load Circuit)
Power Dissipation @ 25°C Ambient............150mW
Derate Linearly from 25°C.................2.0mW/°C
Collector (Load) Current....................125mA
Collector-Emitter Breakdown Voltage (BVceo)....30V
Emitter-collector Breakdown Voltage (BVeco).....5V
8 pin DIL package.

ORDER CODE: SO/643	1+	10+
PRICE:	45p	40p

INFRA-RED EMITTERS Type: OP161SLA
T1 (3mm) Package.



Gallium arsenide infrared emitting diodes moulded in clear plastic, mini-axial package. The lensing effect of the package allows a radiation half angle of 8° measured from the optical axis to the half power point. Lead spacing is 0.100" (2.54mm) to allow mounting in standard sockets.
Continuous Forward Current...................50mA
Peak Forward Current (pulse width=1usec 300pps)..........3.0A
Reverse Voltage...........................2.0V
Power Dissipation........................100mW
At time of printing we have several thousand pcs of this item if you require large quantity's.

	1+	10+	100+
ORDER CODE: SO/644	45p	40p	25p

PAIR - INFRA-RED EMITTER & DETECTOR
T1 (3mm) Package.

No info on these pairs but we are fairly sure that the emitters are OP161SLA as detailed above with matching detector. But no promises!
Each pair is in a small holder.
ORDER CODE: SO/645 PRICE: £1-00 per pair

0.01uF 2000V Wima Type FKP-1
Tol: 5%

Width: 30mm Height: 20mm Depth: 11mm
Lead Pitch: 27.5mm
ORDER CODE: SO/646 PRICE: 50p each

2200uF 63V Electrolytic
PCB/Stud Fixing

Dimensions: Dia. 35mm Height. 50mm (Excluding thread)
Supplied complete with fixing nut and washer.

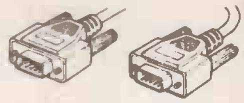
ORDER CODE: SO/647	1+	10+
PRICE:	50p	45p

2200uF 100V PCB Electrolytic
Miniaturized versions ensures a saving of space in compact power supply design.. PCB snap-in terminals on a 10mm pitch for direcr mounting into 2mm dia. holes. Super quality, super price!
ORDER CODE: SO/310
PRICE: £1-50 each

We may purchase your excess stock! Contact us now.

SPECIAL OFFERS

MONITOR EXTENSION LEAD

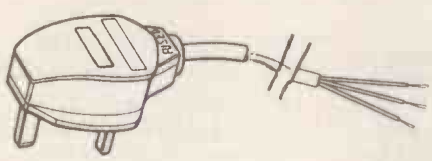


15 Way 'D' Male to 15 Way 'D' Male

Length: Approx 9.5Metres

ORDER CODE: SO/611 PRICE: £2-99

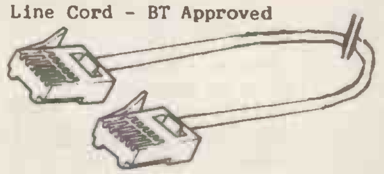
MOULDED 13A PLUG & LEAD



A non-rewireable standard VOLEX 13A plug fused with 3A fuse, moulded to a 2 Metre length of 3 core 0.5mm cable. The free cable end has stripped conductors ready for fiting to your equipment.
COLOUR: BLACK

		1+	10+
ORDER CODE: SO/612	PRICE:	£2-00	£1-75

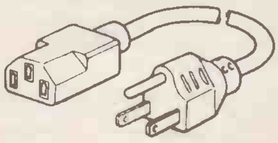
BT Type Line Cord - BT Approved



Line Cord, Plug to Plug. BT standard cord set used when modifying existing equipment. Plugs each end are 4 way.

LENGTH: 3 Metres		1+	10+	100+
SO/613	PRICE:	£1-25	£1-00	88p

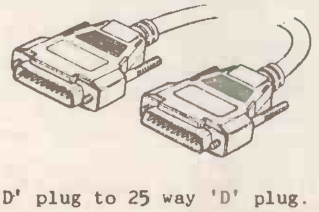
IEC MAINS LEAD Belling Lee UK 6A 250V



A non-rewireable IEC socket moulded to a 2M length of 3 core 0.75mm cable terminating with a USA plug. For UK use simply cut off USA plug and fit UK 13A plug.
Rating: 10A @ 115V. 6A @ 250V. Colour: GREY

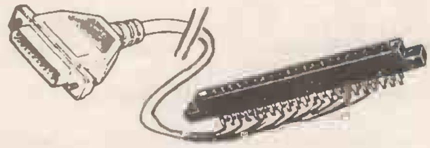
ORDER CODE: SO/614	1+	10+	25+
PRICE:	£1-50	£1-25	£1-10

COMPUTER MODEM LEAD



RS232 - RS232 25 way 'D' plug to 25 way 'D' plug.
9 pins connected.
Snap-fit covers allowing you to open and re-wire the pin configuration if required.
Length: 1.5 Metres (Approx)
ORDER CODE: SO/615 PRICE: £2-75

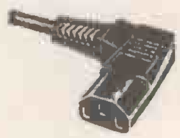
COMPUTER LEAD



Amphenol 15 way D plug fitted to approx 1 metre of 13 way cable terminating in a 24 way 0.15" pitch double sided edge connector. (Edge connector type: TRW 50 24A-30) Edge connector can simply be cut off if not required.

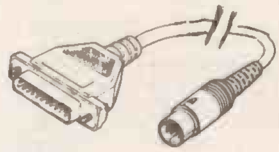
ORDER CODE: SO/617 PRICE: £1-50

IEC MAINS LEAD - Right Angle - Belling Lee 6A 250V



SO/618
A non-rewireable right angle socket moulded to approx. 2 metres of 3 core 0.75mm cable terminating in prepared ends ready for wiring to your equipment.
Length: 2 Metres PRICE: £1-00 each COLOUR: BLACK

COMPUTER LEAD



A 25 way 'D' plug fitted to approx. 1 metre of overall screened 9 way round cable with a metal 8 way DIN plug on the other end.
ORDER CODE: SO/619 PRICE: £1-00 each

COMPUTER CURLY LEAD

A 15 way 'D' plug fitted to approx. 1 metre of black 4 core curly lead with prepared ends on the other end.
Lead stretches to approx. 3-4 metres.
ORDER CODE: SO/620 PRICE: £1-00 each

CAPACITOR SALE

2200uF 35Volt Ideal for power supplies. Super quality, made by Matsushita (Panasonic) in Japan. Only available while stocks last. RADIAL LEAD
Dims: Length 30mm, Dia. 16mm. Lead length approx. 30mm.

		1+	10+	100+
ORDER CODE: SO/621	PRICE:	50p	45p	35p

L293B SGS Bridge Driver 16 pin DIL

Only a few hundred available at this once only price. 25 pcs to a tube.

	1+	25+	100+
ORDER CODE: SO/622	£1-50	£1-25	£1-00

EEPROM SALE (Yes EEPROM!)

General EEPROM characteristics include a minimum of 10,000 read/write cycles and data retention of 10 years.
NMC9346N National Semiconductor (Fairchild)
1K-Bit 1K(64 X 16) Serial NMOS EEPROM-byte erasable. 8 pin DIL. Vcc = 5V±10%
Normal trade price is £1-67 ea plus VAT!!

	1+	10+	100+
ORDER CODE: SO/623	£1-00	90p	75p

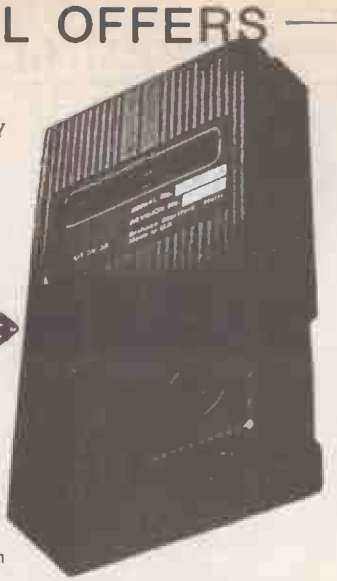
ALL PRICES INCLUDE V.A.T.

ADD £2.25 P & P PER ORDER

SPECIAL OFFERS

GOULD SWITCH MODE POWER SUPPLY 24V 1.4Amp
Type: MMg24-1.4
No promises but most seem to be unused. Very high quality and now limited quantity left. Curent list price is over £200 each.

INPUT: 110V-120V **OUTPUT:** 24V 1.4Amps
220V-240V
Dimensions: 160 X 35 X 85mm



Reduced from £90-00
ORDER CODE: SO/487 **SPECIAL PRICE: £45-00**

WEIR SWITCH MODE POWER SUPPLY 50Watts
MODEL: SMM 50/12 A24
Again, no promises but all these units seem unused. Still in original packaging.
Complete with full spec. sheet & circuit diagram.!!
(Available seperately send £1 plus SAE)

INPUT: 98-132V **OUTPUT:** OP1: 5V
196-264V OP2: +12V
OP3: -12V
(Fully cased) OP4: +24V
These units just arrived and regret we have no current ratings yet.

Dimensions: 200 X 150 X 60mm

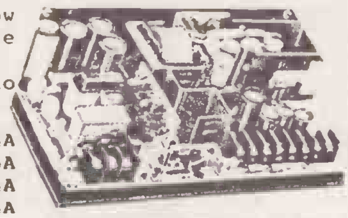
ORDER CODE: SO/WEIR/SMM **PRICE: £17-50**

GREENDALE Switch Mode Type 19A-BOE-M137-TG
53 Watts

A partially cased unit made to commercial standard. Very high quality.
Dimensions:195 X 125 X 60mm
Outputs are on flying leads.

INPUT: 120-240Vac **OUTPUT:** +5V @ 3A
+12V @ 1A
-12V @ 1A
+24V @ 0.5A

ORDER CODE: SO/434 **PRICE: £12-50**



GREENDALE

WEIR - 120V @ 60Hz 200Watts

Another custom built switch mode power supply manufactured by Weir UK. Again, made to the highest standard. Originally made for use in the USA hence the 120V input, however we know you have the technology to make use of these units!!!! So in return, a bargain price.
Units are fitted with a 4 way molex plug - no extra charge. These units are fully cased.

INPUT: 120V **OUTPUT:** V1 +5V @ 4A
V2 -5V @4.5A
V3 +16V @3.4A
V4 -16V @3.4A

The original cost of these units was over £200-00.

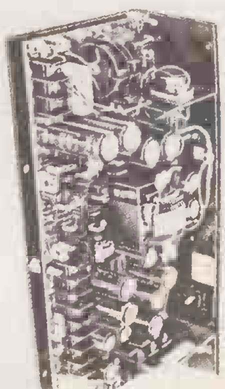
ORDER CODE: SO/WEIR/2 **PRICE: £12-50**

ASTEC Switch Mode Power Supply 110Watts
Model: BM-41001
Once again, a commercial standard PSU. All brand new, just received another delivery, (Sorry higher price) but they still represent a REAL bargain. To date we have sold nearly 700 units!!

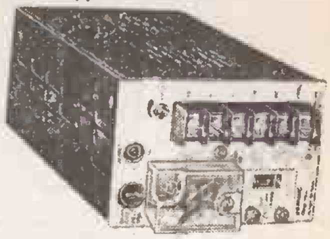
INPUT: 115-240Vac **OUTPUT:** V1 +5V @ 3A
V2 +38V @2.5A

Dimensions: 415 X 120mm

ORDER CODE: SO/ASTEC/BM4 **PRICE: £12-00**



FARNELL G-Series Switch Mode Power Supply 60Watts
Farnell Type: G12 5S



Mostly still in sealed boxes. Unused and complete with full manual. This unit is still in production. Catalogue price over £200-00!!

Input: 240Vac

OUTPUT: 8-12.6V 5Amps

Dims: 88 X 60 X 165mm

ORDER CODE: SO/431
PRICE: £55-00
(Reduced from our Special price of £85-00!!

CCTV MONITOR BOARD
Weir Type: M5009/1
Custom built board by Weir UK. Board seems complete, has EHT unit fitted etc. All boards seem brand new. These really are a bargain
DIMS: 200 X 160mm

ORDER CODE: SO/435

PRICE: £5-00

BRANDENBURG Power Supply
Type: 776AF
15KV @ 500uA
500Vdc out
Very high voltage, variable from 8.5Kv - 16Kv Made for REM & CRT application. 10 pins.
SORRY, NO INFO! Hence low price. Current model over £250 each!

ORDER CODE: SO/433

PRICE: £35-00

TRANSFORMER - 100VA
High quality at a very affordable price. Only a 100 left, over 500 sold!

PRIMARY: 0-120v 0-120v

Secondary: 0-24v, 28v, 32v
36v, 100VA

Dims: H 120mm, D 90mm
W 100mm
ORDER CODE: SO/470 1+ 10+
PRICE: £5-00 £5-00

TELECOM - Housing
Very smart, light tan in colour with dark brown base. Two 'quick fix' screws hold on cover. Many cut-outs both ends. Normal BT quality.

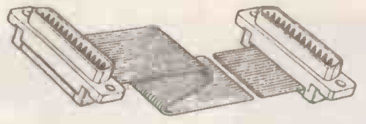
DIMS: 210 X 320 X 125mm

ORDER CODE: SO/462

PRICE: £3-50

SPECIAL OFFERS

SERIAL PRINTER CABLE



RS232 Ribbon cable. 25 way 'D' plug to 25 way 'D' plug.
Length: Approx. 1.8Metres.
ORDER CODE: SO/616 **PRICE: £3-50**

SUFLEX - Lacing Cord Type R88W

These cords are specifically designed for the lacing of cable forms. The core of nylon braid ensures high tensile strength with small extensibility, and yet has sufficient elasticity under low loads to make a neat cable form. The outer PVC acts as a cushion preventing the cord from cutting the cable insulation.
Colour: Black Reel Length: 500 Metres
O.D. 1.1mm Working Load: 6.8Kg
Current Trade Price: £13-11 per reel plus VAT!

ORDER CODE: SO/624 **PRICE: £6-50 per reel**

BT 4 Way plug to 25 way 'D' Socket Lead

A short lead, BT 4 way plug to 25 way 'D' socket using BT flat style cable. 4 core, pins 2,3,5 & 7 connected on the 25 way 'D'.
Lead Length: Approx 175mm

ORDER CODE: SO/625 **PRICE: 50p**

MULLARD TRIMMER CAPACITOR

Mullard type: 808 series. 2-40pF 250V
Super quality at a very special price while stocks last!
Mullard Code: 808-11409. Value: 2-40pF 250Vac
Distributor price is 24p ea + VAT on 100's!!

ORDER CODE: SO/626	1+	10+	100+
PRICE:	25p	23p	20p

MAINS SUPPRESSION CAPACITOR

ISKRA 0.1uF 250Vac X2
A radial lead boxed metallised polypropylene mains suppression capacitor. Approved to VDE-0565 Class 2. Epoxy resin encapsulated in flam retardent plastic case. Iskra Type: KNB1532
Dims: W 18mm. H 7mm. D 13mm Pitch: 15mm
Tolerance: ±20%

ORDER CODE: SO/627	1+	10+	100+
PRICE:	20p	18p	15p

AVO PANEL METERS Type T60/2481

Marked 50-0-50uA
Internal Resistance 400 ohm.
Dims: 70 X 60mm (Approx)
Zero adjustment on front of meter.
As you would expect from AVO, made to the highest quality. Limited qty. available.

ORDER CODE: SO/628 **PRICE: £6-50**

WANTED WANTED WANTED

We buy new surplus electronic components and equipment. Simply send your samples/list to our Head Office, attention The Managing Director.

TOROIDAL TRANSFORMER 50VA

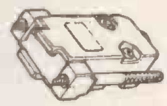
Avel-Lindberg Ltd UK. Type: 40/4556

Input: 120V - 240V
OUTPUT: 0-9v 0-15v Max. 25VA per winding.
A PCB mounting transformer with twin primary and twin secondary windings fitted with a wound screen for safety and electrostatic screening.The transformer is encapsulated in a rugged thermoplastic case. This provides protection against mechanical damage and enables secure PCB fixing via a threaded bush moulded into the centre of the case.
Dia: 95mm Height: 40mm. Mounting bush 2 X M4
Weight: 893gms. The current dist. price is around £25-00 each. ALL ARE BRAND NEW STILL BOXED ETC.
These really are a bargain. Hurry, only a couple of hundred available.

ORDER CODE: SO/629 **PRICE: £12-50**

ITT PLASTIC 9 WAY 'D' Cover with Jackscrews

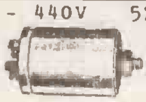
ITT-CANNON Type: DE77762-9



Maybe the highest quality on the market at a very low price! Current Trade price is £1-05 plus VAT
Complete with integrel Jackscrews and cable grip.

Colour: BLACK	1+	10+
ORDER CODE: SO/630	60p	55p

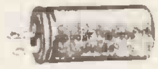
MOTOR RUN CAPACITORS - 440V 5% TOL.



Stud mounting capacitors suitable for motor start/run and other similar applications. Connections via double 6.35mm tabs. Manufactured to BS5267.
Curent list price is over £6 each plus VAT!
15uF 440V DIMS: 115mm X 45mm Dia.
20uF 440V DIMS: 135mm X 45mm Dia.

15uF 440V	ORDER CODE: SO/631	PRICE: £3-50 each
20uF 440V	ORDER CODE: SO/632	PRICE: £4-00 each

STC 47,000uF 40V Electrolytic



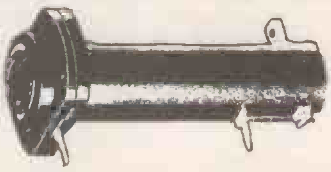
Tag end STC capacitor.
Date Code: 8512
Dims: 115 X 65mm
List price is over £8-50 ea plus VAT.
ORDER CODE: SO/633 **PRICE: £3-50**

8 pin DIN to 8 pin DIN Lead

All pins connected (Mirror Image) Plugs are Metal.Cable Colour is Black.
Cable is overall screened.
Length: Approx 1.5 Metre
ORDER CODE: SO/634 **PRICE: £1-00**

BULGIN Panel Mounting AA Battery Holder

Takes 3 AA Batteries (Bulgin Type: B13/1)



Panel mounting battery holder. Flush fitting bayonet cap with coin slot for tightening. Mounting is from rear of panel, fixing by screws through front flange.
ORDER CODE: SO/635 **PRICE: £1-00 each**

MARCO TRADING 1992 SUMMER SALE ORDER FORM

EE-TV

INCORPORATING 'EAST CORNWALL COMPONENTS'

The Maltings, High Street,
WEM, Shrewsbury, SY4 5EN.

TEL: 0939-232763 (3 lines)
0939-232689 (2 lines)

FAX: 0939-233800

CUSTOMER NAME & ADDRESS

DATE:

DESCRIPTION	QTY.	UNIT PRICE	TOTAL PRICE
MY ORDER IS OVER £10 PLEASE SEND MY FREE CATALOGUE ☐			
SUB.TOTAL FROM OVERLEAF			
MY ORDER IS OVER £15, PLEASE SEND MY SOLDER & STAND FOR £2-99			£2-99
ADD P & P			£2-25
SUB.TOTAL			
TOTAL			

IF PAYING BY CREDIT CARD, PLEASE STATE:

NO.:

EXPIRY DATE:

SIGNATURE:

PAYMENT ENCLOSED: VISA/ACCESS, CHEQUE, POSTAL ORDER, CASH, CREDIT NOTE. (Delete As Applicable.)

If any items are not available from stock, tick appropriate box for action required.

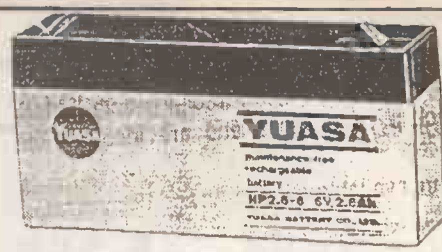
Send Order Balance To Follow A.S.A.P. ☐ Hold Order Until Complete ☐ Credit for Out of Stock Items ☐

DESCRIPTION	QTY.	UNIT PRICE	TOTAL PRICE
SUB.TOTAL			

SPECIAL OFFERS

We have a limited stock of Yuasa Sealed Lead Acid batteries which when checked at random found are not accepting a full charge. On the few that we have found to be like this we have found with patience, most eventually came up to full specification.
However, time is money as they say and so we are selling off these batteries at a very reduced price. We are selling these batteries with NO WARRANTY WHATSOEVER and therefore it is a case of taking a chance!
NO RETURNS WILL BE ACCEPTED!
The normal price of these batteries is approx. £16-95 each.

	1+	5+	10+
SO/656	£5-00	£4-50	£3-50



YUASA CODE: NP10-6 Dims: 101 X 151 X 50mm

Terminals: Spade Type.

Weight: 2.2Kg **6V 10Ah**

100VA Toroidal TRANSFORMER
100VA (Approx) transformer fitted into a smart metal case. Very attractive.
Input is selectable.

Multiple Primary: 100V-250Vac

Secondary Voltage: 110V, 12-0-12v, 0-9v with screening

Limited quantity.

ORDER CODE: SO/657 PRICE: £9-99

SHARP RADIO CASSETTE - Model QT-F10E
A super radio cassette Recorder offered at a fraction of the normal price.
Although some are refurbished they are all guaranteed by us for 3 months from date of purchase. In the unlikely event of any problem we would repair or exchange at our discretion.
Features include:
* Auto Stop
* Battery Operated (5 X AA) NOT Included
* Recording from Radio using Built-In Mic. is possible.
* Recording external sound is of course possible
* Earphone socket is fitted.
* FM Range: 87.6MHz - 108MHz
* AM Range: 526.5KHz - 1606.5KHz
* Some are complete with carrying case.

Limited quantity are available!

ORDER CODE: SO/658 PRICE: £12-50

B.T. MODEM UNIT
Brand new, still in sealed manufacturers packs.
Sorry, no info but we have listed the major components on the 2 sandwich style boards.
Plug In: 1 X C875 1H-11 Intel. 40 pin
3 X P8051AH-0121 Intel 40 pin
Soldered: 3 X LM348 1 X 74ALS74N
1 X ULN2033A, 1 X ULN2002A, 1 X LF353
1 X AD7528JN, 1 X AD7574KN
Assorted relays, BT Sockets, crystals switches.

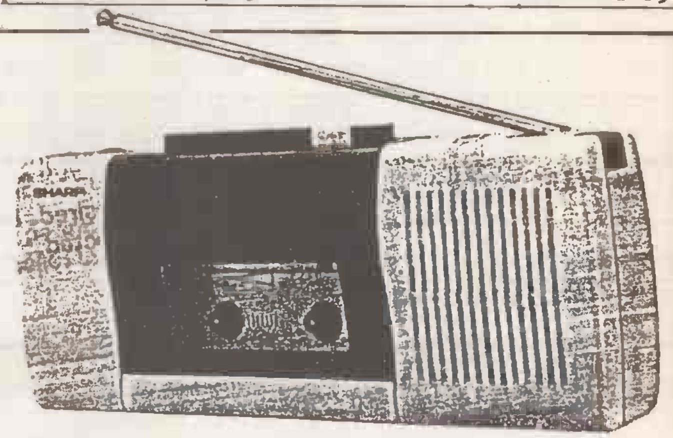
Both boards are the same size: 160 X 100 X 55mm
These really are made to the highest spec.
(Free prize to anyone who can supply original circuit info!)

ORDER CODE: SO/485 PRICE: £5-00 each

GOODY BAGS
Contains a random selection of very assorted components including:
Resistors, Capacitors, Connectors, IC's, Diodes, Potentiometers, etc etc.
Sold by weight. Each bag weighs over 1Kg.
ORDER CODE: SO/660 PRICE: £1-99

VIDEO/TV LEADS
A set of quality leads, originally manufactured for Granada.
5 pin DIN Plug to Phono Plug
BNC plug to Phono Plug.
Length: 2 Metres
ORDER CODE: SO/212 PRICE: £1-25

VIDEO/TV Lead
Another set of quality leads.
BNC plug to Phono Plug
5 pin DIN plug to Phono Plug
ORDER CODE: SO/213 PRICE: £1-25



COMMODORE (CBM) Charger/Power Supply
A good quality power supply offering the electronics hobbyist/enthusiast the opportunity to purchase a quality unit that is fairly simple to alter the specfcation of, at a very attractive price. Plenty of room in the case to add zener's, voltage regulators etc.

Input: 220V-240V (Switcheable)

Output: 7.2Vdc @ 225mA
7.0Vac @ 45mA

DIMS: 100 X 55 X 60mm

Mains Lead: Approx. 400mm

Output Lead: Approx 2.25 Metres. Fitted with a moulded plug (Non-standard)

Several thousand of these units at time of printing.

ORDER CODE: SO/659	1+	10+	100+
PRICE:	£2-99	£2-50	£1-99

ALL PRICES INCLUDE V.A.T.

ADD £2.25 P & P PER ORDER

STOP CAR THEFT NOW!

PROTECT YOUR CAR FOR ONLY £15-00!! **MADE IN UK**

COMDEK AT1 - CAR ANTI-THEFT UNIT

A brand new design, 100% designed in the Uk. A very clever device giving 100% peace of mind to the car owner and causing 100% frustration to the would be car thief! This unit may be used alongside an existing alarm or simply on its own.

Most alarms require the owner to activate them when you exit the vehicle, which can easily be overlooked or simply forgotten. The AT1 circuit overcomes this by activating the moment the ignition is switched on or the vehicle is 'Hot Wired' making it impossible to forget. From the moment the ignition is first switched on the AT1 circuit starts timing. When the engine has started the unit must be de-activated otherwise after a pre-set time the engine will simply cut out.
The method of de-activating the unit is set by the installer. We recommend either wiring up to one or more switches i.e. rear window de-mist, interior light, wipers etc. but you may of course wire it to a concealed switch. Therefore until the chosen switch/switches are 'switched' on/off, the AT1 will **NOT** de-activate and the engine will stop after the pre-set time!
Every AT1 is pre-set at approx. 21 seconds but this time may be shortened or lengthened to suit your requirements up to 130 seconds. This time governs how far your vehicle will travel before the engine cuts out.
Any car thief will then be faced with the problem of the engine cutting out and refusing to re-start. Simple. The thief will not wish to attempt to 'repair' the vehicle.
We also supply a red LED, which when installed in the car, remains lit all the time acting as a deterrent to any would be car thief.

		1+	10+
Supplied in Kit form, full instructions etc. supplied.			
ORDER CODE: CAR/COMDEK /KIT	PRICE:	£15-00	£12-00

NOW AVAILABLE READY BUILT & TESTED £24-99

MARCO TRADING

****************** INCORPORATING ******************

EAST CORNWALL COMPONENTS

THE MALTINGS, HIGH ST. WEM, SHREWSBURY, SY4 5EN

TEL: 0939 232763 TEL: 0939 232689 FAX: 0939 233800

BRANCHES

SUPERTRONICS, 65 HURST STREET, BIRMINGHAM. B5 4TE	WALTONS, 55A WORCESTER STREET, WOLVERHAMPTON. WV2 4LL
TEL: 021 666 6504	TEL: 0902 22039