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AUGUST 1990

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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SIMPLE METRONOME

GAS RESERVE INDICATOR

CHOOSING & USING TEST EQUIPMENT

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ISSN 0262-3617

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The Magazine for Electronic & Computer Projects

ONE POUND PACKS

All packs are £1 each. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD9 2 6V 1A mains transformers upright mounting with fixing clamps.
BD11 1 6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
BD13 12 30 watt reed switches, it's surprising what you can make with these – burglar alarms, secret switches, relay, etc., etc.
BD22 2 25 watt loudspeaker two unit crossovers.
BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day, original cost £40 each.
BD49 5 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
BD139 6 Microphone inserts – magnetic 400 ohm also act as speakers.
BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149 6 Safety cover for 13A sockets – prevent those inquisitive little fingers getting nasty shocks.
BD180 6 Neon indicators in panel mounting holders with lens.
BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201 8 Keyboard switches – made for computers but have many other applications.
BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD252 1 Panostat, controls output of boiling ring from simmer up boil.
BD259 50 Leads with push-on ¼in tags – a must for hook-ups – mains connections etc.
BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
BD305 1 Tubular dynamic mic with optional table rest.
BD653 2 Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.
BD548 2 3.5V relays each with 2 pairs changeover contacts.
BD667 2 4.7 µf non-polarised block capacitors, pcb mounting.

There are over 1,000 items in our Catalogue. If you want a complete copy please request this when ordering.

METAL PROJECT BOX Ideal for battery charger, power supply etc. Sprayed grey size 8" x 4" x 4½". Louvred for ventilation. Price £3.00. Ref. 3P75.

FLOPPY DISCS 5¼" pack of 10 £5.00. Ref. 5P168. 3½" pack of 10 £10.00. Ref. 10P88.

PERSONAL STEREOS Again customer returns but complete and with stereo head phones. A bargain at only £3.00 each. Our ref 3P83.

MICROWAVE CONTROL PANEL Mains operated, with touch switches. This unit has a 4 digit display with a built in clock and 2 relay outputs — one for power and one for pulsed power level. Could be used for all sorts of timer control applications. Only £6.00. Our ref 6P18.

EQUIPMENT WALL MOUNT Multi adjustable metal bracket ideal for speakers, lights, etc. 2 for £5.00. Our ref 5P152.

NEW MAINS MOTORS 25 watt 3000 rpm made by Framco. Approx 6" x 3" x 4". Priced at only £4.00 each. Our ref 4P54.

SHADED POLE MOTORS Approx 3" square. Available in 24V and 240V AC. Both with threaded output shaft and 2 fixing bolts. Price is £2.00 each. 24V Ref 2P65, 240V Ref 2P66.

SUB-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly fixing nuts. 3 for £1. Order ref BD649.

COPPER CLAD PANEL for making PCB. Size approx 12in long × 8½in wide. Double sided on fibreglass middle which is quite thick (about 1/16in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

POWERFUL IONISER

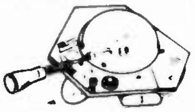
Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder – a complete mains operated kit, case included. £18. Our ref 18P2.

REAL POWER AMPLIFIER for your car, it has 150 watts output. Frequency response 20hz to 20Khz and signal to noise ratio better than 60dB. Has built in short circuit protection and adjustable input level to suit your existing car stereo, so needs no pre-amp. Works into speakers ref. 30P7 described below. A real bargain at only £57.00. Order ref: 57P1.

REAL POWER CAR SPEAKERS. Stereo pair output 100W each. 4Ohm impedance and consisting of 6½" woofer, 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00. Order ref: 30P7.

STEREO CAR SPEAKERS. Not quite so powerful – 70w per channel. 3" woofer, 2" mid range and 1" tweeter. Again, in a super purpose built shelf mounting unit. Price per pair £30.00. Order ref: 28P1.

VIDEO TAPES These are three hour tapes of superior quality, made under licence from the famous JVC Company. Offered at only £3 each. Our ref 3P63. Or 5 for £11. Our ref 11P3. Or for the really big user 10 for £20. Our ref 20P20.



ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with really detailed instructions. Ideal present for budding young electrician. A youngster should be able to assemble but you may have to help with the soldering of the components on the pcb. Complete kit £10. Our ref. 10P81

COMPUTER KEYBOARDS Brand new, uncased £3.00 each. ref 3P89.

12" HIGH RESOLUTION MONITOR Amber screen, beautifully cased for free standing, needs only a 12v 1.5 amp supply. Technical data is on its way but we understand these are TTL input. Brand new in makers' cartons. Price: £22.00. Order ref: 22P2.

SINCLAIR C5 WHEELS
Including inner tubes and tyres. 13" and 16" diameter spoked poly carbonate wheels. Finished in black. Only £6.00 each. 13" Ref 6P10, 16" Ref 6P11

COMPOSITE VIDEO KITS These convert composite video into separate H sync, V sync and video. Price £8.00. Our ref 8P39.

LINEAR POWER SUPPLY. Brand new +5v 3A, +/−12v 1A. Complete with circuit diagram. Short circuit protected. Our price £12.00 Ref. 12 P21

3½in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £60.00, reference 60P2. Both are brand new.

10 MEMORY PUSHBUTTON TELEPHONES These are customer returns and "sold as seen". They are complete and may need slight attention. Price £6.00. Ref. 6P16 or 2 for £10.00. Ref. 10P77. BT approved.

INDUCTIVE PROXIMITY SWITCHES These will detect ferrous or nonferrous metals at approx. 10mm and are 10-36V operation. Ideal for alarms position sensors, etc. RS price is £64.00 each! Ours £12.00. Ref. 12P19.

RETROFLECTIVE MODULATED INFRARED 5M BEAMS IR transmitter and receiver housed in the same case. Ideal for beam alarms, counting, etc. RS price if £95.00 each! Ours £25.00. Ref. 25P15.

ASTEC PSU. Mains operated switch mode, so very compact. Outputs +12v 2.5A, +5v 6A, ±5v .5A, ±12v .5A. Size 7½in long x 4³⁄₄ wide x 2¼in high. Cased ready for use. Brand new. Normal price £30+, our price only £13.00. Order ref 13P2.

VERY POWERFUL 12 VOLT MOTORS. ⅓rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £20. Our ref 20P22.

ALSO AVAILABLE WITH GEARBOX A 4:1 reduction giving 800rpm. Our ref 40P8. Price £40.

PHILIPS LASER
This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £35. Our ref. 35P1. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15.

PANEL METERS 270 deg movement. New, £3.00 each. Our ref 3P87.

SURFACE MOUNT KIT Makes a super high gain snooping amplifier on a PCB less than an inch square! £7.00. Our ref 7P15.

CB CONVERTERS Converts a car radio into an AM CB receiver. £4.00. Our ref 4P48.

GEIGER COUNTER KIT Includes PCB, tube, loudspeaker, and all components to build a 9v battery operated geiger counter. Only £39. Our ref 39P1.

12V TO 220V INVERTER KIT This kit will convert 12v DC to 220v AC. It will supply up to 130 watts by using a larger transformer. As supplied it will handle about 15 watts. Price is £. Our ref 12P17.

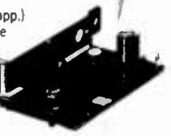
SINCLAIR GEARBOXES These are the original gearboxes and give about 50% reduction in speed and a toothed pulley output. Price for the gearbox AND motor is £40.00. Ref. 40P8.

SPECTRUM AND COMMODORE SOFTWARE Pack of 5 different tapes only £3.00. Ref. 3P96 for Spectrum and 3P97 for Commodore 64.

HIGH RESOLUTION MONITOR 9in black and white, used Philips tube M24/360W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. £20. Our ref 20P26.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape (4½in x 4½in x 1¾in). The electronically run fans not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc., or for a caravan. £8 each. Our ref 8P26.

MINI MONO AMP on p.c.b. size 4" x 2" (app.) Fitted Volume control. The amplifier has three transistors and we estimate the output to be 2W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.



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Phone (0273) 203500. Fax No. (0273) 23077

POPULAR ITEMS — MANY NEW THIS MONTH

MAINS FANS Snail type construction. Approx. 5" x 4" mounted on a metal plate for easy fixing. New. £5.00 each. Our ref 5P166.

MICROWAVE TURNTABLE MOTOR Complete with weight sensing electronics that would have varied the cooking time. Ideal for window displays, etc. Only £5.00. Our ref 5P165.

JOYSTICKS for BBC Atari, Dragon Commodore, etc. All £5.00 each. All brand new, state which required.

TELEPHONE TYPE KEYPAD. Really first class rear mounting unit. White lettering on black buttons. Has conductive rubber contacts with soft click operation. Circuit arranged in telephone type array. Requires 70mm by 55mm cutout and has a 10 IDC connector. Price £2.00. Ref. 2P251.

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole PCB mounting. 3 for £1.00. Our ref BD688.

AA CELLS Probably the most popular of the rechargeable NICAD types. 4 for £4.00. Our ref. 4P44.

20 WATT 4 OHM SPEAKER With built in tweeter. Really well made unit which has the power and the quality for hifi 6½" dia. Price £5.00. Our ref. 5P155 or 10 for £40.00 ref. 40P7.

MINI RADIO MODULE Only 2in square with ferrite aerial and solid dia. tuner with own knob. It is superhet and operates from a PP3 battery and would drive a crystal headphone. Price £1.00. Our ref. BD716.

BULGIN MAINS PLUG AND SOCKET The old and faithful 3 pin with screw terminals. The plug is panel mounted and the socket is cable mounted. 2 pairs for £1.00 or 4 plugs or 4 sockets for £1.00. Our ref. BD715, BD715P, or BD715S.

MICROPHONE Low cost hand held dynamic microphone with on/off switch in handle. Lead terminates in 1 3.5mm and 1 2.5mm plug. Only £1.00. Ref. BD711.

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140V 100 watt pair made by Hitachi. Ref.2SJ99 and its complement 2SK343. Only £4.00 a pair. Our ref 4P51.

TIME AND TEMPERATURE LCD MODULE A 12 hour clock a Celsius and Fahrenheit thermometer a too hot alarm and a too cold alarm. Approx 50×20mm with 12.7mm digits. Requires 1AA battery and a few switches. Comes with full data and diagram. Price £9.00. Our ref. 9P5.

REMOTE TEMPERATURE PROBE FOR ABOVE. £3.00. Our ref. 3P60.

PAPST fan 80 x 80mm 230V. Our ref 9P7. Price £9.
PAPST fan 120 x 120mm 230V. Our ref 6P6. Price £6.

600 WATT AIR OR LIQUID MAINS HEATER Small coil heater made for heating air or liquids. Will not corrode, lasts for years. Coil size 3" x 2" mounted on a metal plate for easy fixing. 4" dia. Price £3.00. Ref. 3P78 or 4 for £10.00. Our ref. 10P76.

EX-EQUIPMENT POWER SUPPLIES Various makes and specs, ideal bench supply. Only £8.00. Our ref. 8P36.

ACORN DATA RECORDER Made for the Electron or BBC computer but suitable for others. Includes mains adaptor, leads and book. £12.00. Ref. 12P15.

PTFE COATED SILVER PLATED CABLE 19 strands of .45mm copper will carry up to 30A and is virtually indestructible. Available in red or black. Regular price is over £120 per reel. Our price only £20.00 for 100m reel. Ref. 20P21 or 1 of each for £35.00. Ref 35P2. Makes absolutely superb speaker cable!

NEW PIR SENSORS Infra red movement sensors will switch up to 1000W mains. UK made. 12 months manufacturers warranty. 15-20m range with a 0-10mm timer, adjustable wall bracket. Our ref 25P16. Price £25.

GEARBOX KITS Ideal for models, etc. Contains 18 gears (2 of each size), 4 x 50mm axles and a powerful adjustable speed motor. 9-12V operation. All the gears, etc. are 2mm push fit. £3.00 for the complete kit. Ref. 3P93.

MINI HIFI SPEAKERS Made for televisions, etc. Two sizes available. 70mm x 57mm 3W 8 ohm, 2 for £3.00. Ref 3P99. 127mm x 57mm 5W 8 ohm, 2 for £3.00. Ref. 3P100.

SPECTRUM SOUND BOX Add sound to your Spectrum with this device. Just plug in. Complete with speaker, volume control and nicely boxed. A snip at only £4.00. Our ref. 4P53.

BBC JOYSTICK INTERFACE Converts a BBC joystick port to an Atari type port. Price £2.00. Our ref. 2P261.

TELEPHONE EXTENSION LEAD 5m phone extension lead with plug on one end, socket on the other. White. Price £3.00. Our ref. 3P70 or 10 leads for only £19.00! Ref. 19P2.

LCD DISPLAY 4½" digits supplied with connection data £3.00. Ref. 3P77 or 5 for £10. Ref. 10P78.

CROSS OVER NETWORK 8 Ohm 3 way for tweeter midrange and woofer nicely cased with connections marked. Only £2.00. Our ref. 2P255 or 10 for £15.00. Ref. 15P32.

BASE STATION MICROPHONE Top quality uni-directional electret condenser mic 600r impedence sensitivity 16-18KHz – 68db built in chime complete with mic stand bracket. £15.00. Ref. 15P28.

MICROPHONE STAND Very heavy chromed mic stand, magnetic base 4" high. £3.00 if ordered with above mic. Our ref. 3P80.

SOLAR POWERED NICAD CHARGER 4 Nicad AA battery charger. Charges 4 batteries in 8 hours. Price £6.00. Our ref. 6P3.

SOLDERING IRON STAND Price £3.00. Our ref. 3P66.

INCAR GRAPHIC EQUALIZER/BOOSTER Slimline 7 band with built in 30 watts per channel amplifier. 12V operation, twin 5 LED power indicators, 20-21KHz with front and rear fader plus headphone output! Brand new and guaranteed. Only £25.00. Ref. 25P14.

SHARP PLOTTER PRINTER. New 4 colour printer originally intended for Sharp computers but may be adaptable for other machines. Complete with pens, paper, etc. Price £16.00. Our ref. 16P3.

CENTRONICS ADAPTER KIT Converts the above plotter/printer to Centronics compatible. Price £4.00. Our ref. 4P57.

CAR IONIZER KIT Improve the air in your car, clears smoke and helps prevent fatigue. Case req. Price £12.00. Our ref. 12P8.

NEW FM BUG KIT New design with PCB embedded coil 9v operation. Priced at £5.00. Our ref. 5P158.

NEW PANEL METERS 50UA movement with three different scales that are brought into view with a lever. Price only £3.00. Ref. 3P81.

STROBE LIGHTS Fit a standard edison screw light fitting 240V 40/min. flash rate available in yellow, blue, green and red. Complete with socket. Price £10 each. Ref. 10p80 (state colour required).

ELECTRONIC SPEED CONTROL KIT Suitable for controlling our powerful 12v motors. Price £17.00. Ref. 17P3 (heatsink required).

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and look tidy. 4 core, suitable for alarms, phones etc. Our price only £5.00 for 50m reel. Ref. 5P153.

VOL. 19 No. 8 AUGUST 1990

EVERYDAY
ELECTRONICS

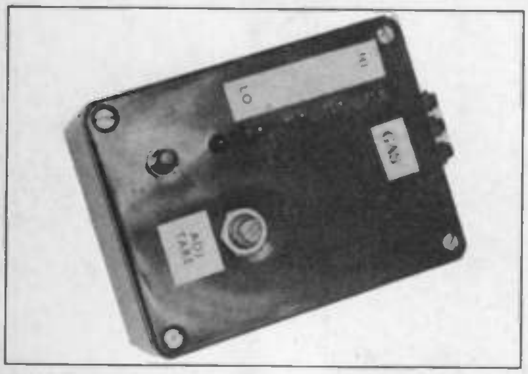
INCORPORATING ELECTRONICS MONTHLY

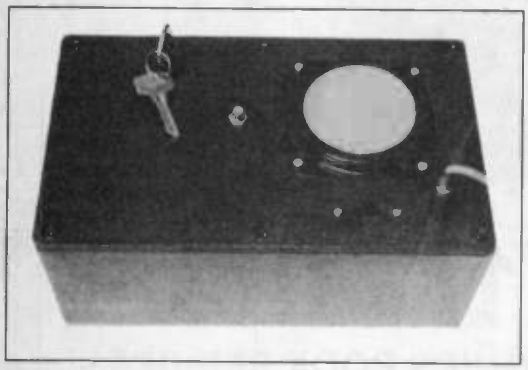
ABC

The Magazine for Electronic & Computer Projects

ISBN 0262 3617

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





Cover photograph by Reflections of Bournemouth

Our September '90 Issue will be published on Friday, 3 August 1990. See page 499 for details.

Projects

GAS RESERVE INDICATOR by T. R. de Vaux-Balbirnie **508**
Simple "weigh machine" that gives a visual indication on the contents of your camping gas cylinder. Has many other possible applications

SIMPLE METRONOME by Andy Flind **512**
Variable from 40 to 200 beats

MAINS APPLIANCE REMOTE CONTROL SYSTEM – 3 by Chris Walker **526**
Control household apliances from the comfort of your armchair

PRESSURE PAD ALARM by T. R. de Vaux-Balbirnie **534**
Protect your valuables with this portable anti-theft system

PHONEY PHONE by Owen N. Bishop **546**
Fool your friends with this warbler – it does have serious applications too!

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The place for Spectrum and Sam micro owners

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The 6502 microprocessor

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Novice Licence; USA Experience; Royal Contact

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Investigating the world of robotics

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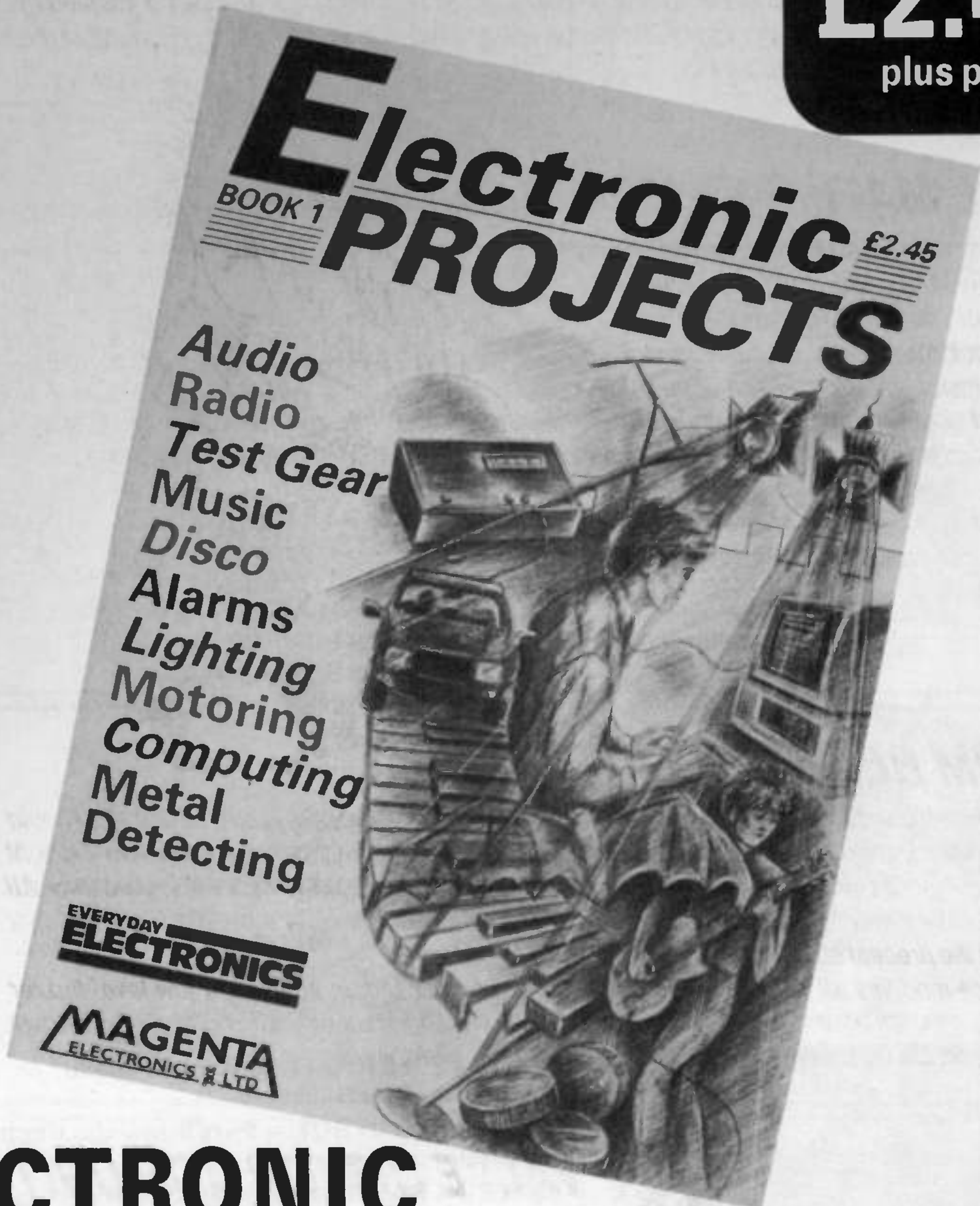


ELECTRONIC PROJECTS BOOK 1

AVAILABLE FROM THE EVERYDAY ELECTRONICS BOOK SERVICE

This book contains 128 pages A4 size packed with projects for you to build. Electronic Projects is published by EE in association with Magenta Electronics who can supply kits of parts for all the projects.

The projects are:
Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepping Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Door-bell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

ORDER CODE EP1

For full ordering details see the Direct Book Service pages

NEXT MONTH

INTERFACING THE RML NIMBUS

The Nimbus PC is a standard in the ILEA and other London boroughs, it is also being adopted by many local authorities as an upgrade for their now ageing BBC micros. We take a good look at this micro and some interface circuits for it.

METAL MATE

Great care must be taken when drilling holes in walls to avoid an unexpected encounter with a water pipe or live wire. The Metal Mate is first used to check the area of wall before drilling. As well as metal water pipes and objects such as nails and screws, it will detect mains wiring (whether switched on or not).

A further interesting application is to distinguish between sound car bodywork and that which has been made to look good by the extensive use of filler.

ALARM BELL TIMEOUT

Current British standard legislation requires that buglar alarm sounders (bells, sirens etc) should be shut off after a maximum of 20 minutes rather than sounding continuously. This was brought about by the high incidence of false alarms causing great annoyance to those living nearby. All alarms presently manufactured have this facility built in but there are many older models in use that do not meet the present standard.

This device modifies all 12 volt alarms to the required level and, in addition, a low level buzzer continues to operate after the main sounder has been shut off, thus indicating that the alarm has been triggered. Construction and installation are very straightforward.

VALVE DISTORTION UNIT

Despite the obvious drawbacks of valve equipment, it is often still used because of it's distinctive mellow sound. Many guitarists use valve equipment because of the "unsurpassed warmth, depth and soul" –the "fat, creamy, brassy, punchy or raunchy" sound.

Some people would deny that any difference between valve and transistor sound exists; but, when overdriven, they have two very different sounds. This device will produce that distinctive valve sound on overdrive.

EVERYDAY ELECTRONICS

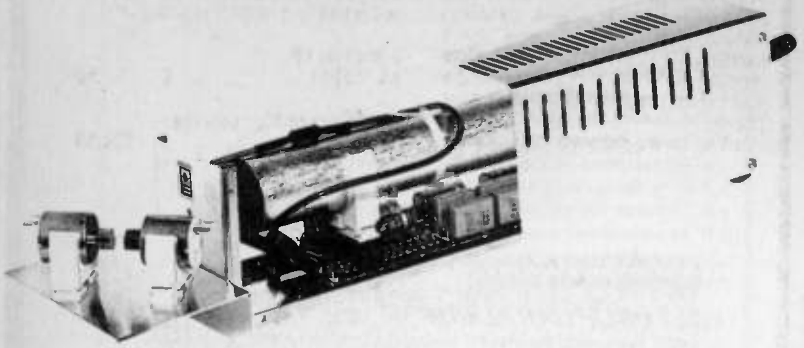
SEPTEMBER ISSUE ON SALE FRIDAY 3 AUGUST 1990

Technik für Kenner - Made in Germany ELV

We deliver from stock - The fastest way to order Is a fax !

LPS 8000 / LC 7000 Low Cost Show Laser

(Electronics The Maplin Magazine Dec 88 + Feb-Mar 90)



An almost infinite number of circular patterns can be projected onto a wall or ceiling with this super laser show equipment.
The complete project includes a laser tube and accompanying power supply, housed in a metal case, and a laser controller, LC 7000. The laser controller drives the accompanying deflection unit, fixed onto the laser power supply case, which produces the numerous configurations.
Naturally the laser tube, together with the power supply, can produce beams without the laser controller and the controller can be used with other, similar lasers.

LPS 8000 Laser Power Supply, complete kit
Version 240 Volts AC
44.428BKL220 .... £ 86.90
Version 220 Volts AC
44.428BKL240 .... £ 86.90

LC 7000 Laser Controller, complete kit
Version 12 Volts DC
44.427BKL .... £ 60.80

H-N Laser Tube 2 mW
44.428LR .... £ 60.80

LPS 8000 Laser Power Supply, ready assembled module
Version 240 Volts AC
44.428F240............. £ 156.50
Version 220 Volts AC
44.428F220............. £ 156.50

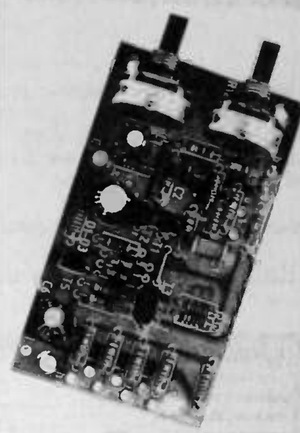
LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F.................... £ 104.30

Laser Motor-Mirror Set, complete kit
44.506M .... £ 22.95

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

Losses can easily occur when copying video tapes resulting in a distinct reduction in quality. By using this video recording amplifier, with no less than four (!) outputs, the modulation range is enlarged and the contrast range of the copy increases.
Two level controllers for edge definition (contour) and amplification (contrast range) allow individual and precise adaptation.

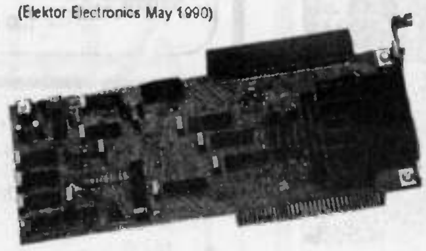


Complete Kit
(including Box, PCB and all parts
44.324BKL .... £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

This card was developed for assistance in the field of service, development and test. The card is used as a bus-extension to reach the measurement points very easy. It is also possible to change cards without having a "hanging computer".



Complete kit
44.517BKL .... £ 77.95

Ready assembled module
44.517F.................... £ 137.95

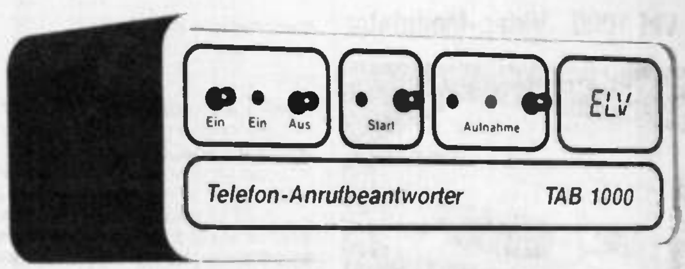
TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

This automatical telephone answering unit uses a 256-kbit voice recording circuit to store and replay your spoken message of uo to 15 seconds. Noteworthy features are that it is available as a complete kit, providesd a battery back-up facility and does not require alignment. No provision is made, however, to record incoming calls.

Complete kit
44.433BKL .... £ 45.65

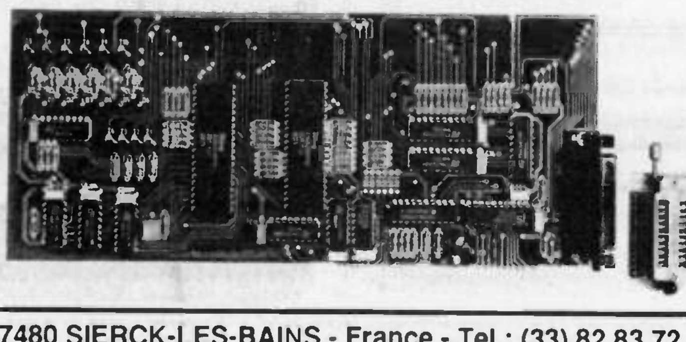
Ready assembled module
44.433F.................... £ 87.25



IC TESTER for IBM-PC-XT/AT

(Electronics The Maplin Magazine Jun-Jul 89 + Elektor Electronics December 89)

With the ELV IC tester logic function tests can be carried out on nearly all CMOS and TTL standard components, accommodated in DIL packages up to 20 pin. The tester is designed as an insertion card for IBM-PC-XT/AT and compatibles. A small ZIF test socket PCB is connected via a flat band cable. Over 500 standard components can be tested using the accompanying comprehensive test software.



Complete Kit including Textool sokket, connectors, sockets, Flat band cable, PCB, Software
44.474BKL .... £ 60.85

Ready Assembled Module
4.474F........................ £ 113.00

Software, single
44.474SW .... £ 17.85

ELV France - B.P. 40 - F-57480 SIERCK-LES-BAINS - France - Tel.: (33) 82.83.72.13 - Fax: (33) 82.83.81.80

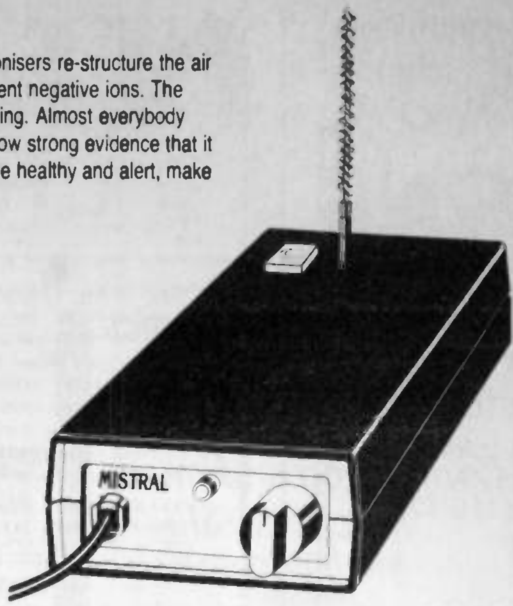
AIR IONISERS

By means of points raised to a very high voltage, ionisers re-structure the air you breathe, turning ordinary air molecules into potent negative ions. The effects of breathing in these ions can be quite startling. Almost everybody reports that it makes them feel good, and there is now strong evidence that it can also improve your concentration, make you more healthy and alert, make you sleep better, and even raise your IQ.

THE MISTRAL AIR ▷ IONISER

The ultimate air ioniser. The Mistral has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters with ease. Its nine main drive stages, five secondary drives and four booster stages give an immense 15 billion ions per minute output – enough to fill the largest room in a matter of seconds.

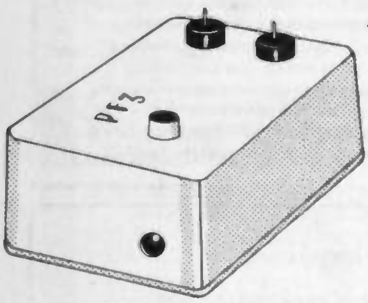
The parts set contains everything you need to build the Mistral: components, PCB, case, emitter and full instructions. If you're keen to increase the output still further, there's an optional eight-point internal emitter set to give extra ionising capability, and an almost silent piezo-electric ion fan to drive the ions away from the emitter and into the room.



MISTRAL IONISER PARTS SET **£32.66** ☐

INTERNAL EMITTER PARTS SET (optional) **£3.22** ☐

ION FAN (optional) **£11.27** ☐



◁ PROPHET PF3

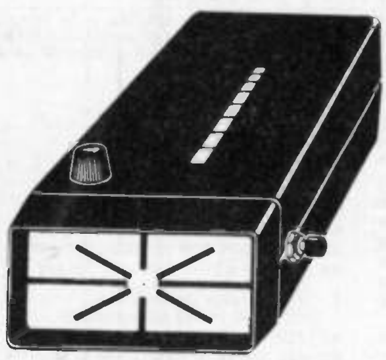
The Prophet performs its own special miracle on the dashboard of your car. First reports are most impressive: driving becomes a positive pleasure, easier to stay alert on long motorway journeys, a child cured of travel sickness. The ion effect is not to be underestimated. Don't forget the experiments either: there's the smoke trick, triffids, the living emitter, and more. The Prophet can be used anywhere with a supply of 9V to 12V DC, so don't restrict it to the car alone!

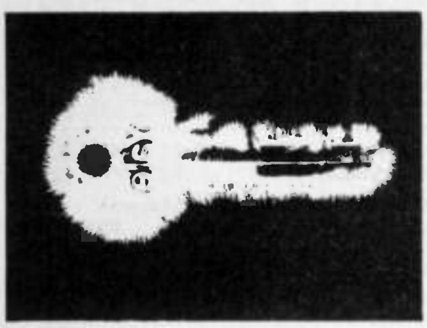
PROPHET PF3 PARTS SET **£21.39** ☐

THE Q-ION ▷

Check out the ion levels around your house. The Q-Ion will measure the output of any ioniser, test the air to see where the ions are concentrating, help you set up fans and position your ioniser for best effect, and generally tell you anything you want to know about ion levels in the air. The readout is in the form of a bar graph which moves up and down as the Q-Ion sniffs the air in different parts of the room. Readings up to 10^{10} ions per second, positive or negative.

Q-ION COMPLETE PARTS SET **£21.16** ☐





◁ KIRLIAN CAMERA

Bioplasmic fields, auras, or just plain corona discharge? No matter how you explain them, the effects are strange and spectacular. Can you really photograph the missing portion of a torn leaf? Can you really see energy radiating from your finger tips? Most researchers would answer 'yes' to both questions.

Our Kirlian photography set contains everything you need to turn the Mistral into a Kirlian camera, your bedroom or spare room into a darkroom, and to expose, develop and print Kirlian photographs (photographs made with high voltage electricity instead of light). The set includes exposure bed, safelight bulb, developing and fixing chemicals, trays, imaging paper and full instructions. A Mistral ioniser parts set is also required.

KIRLIAN CAMERA SET **£19.78** ☐

IONISER EXPERIMENTS

* The Vanishing Smoke Trick

Light up a cigarette and gently puff smoke into a glass jar until the air inside is a thick, grey smog. Carefully invert the jar over the ioniser so that the emitter is inside. Within seconds the smoke will vanish! This is one of the best demonstrations of an ioniser's air cleaning action and with a large jar the effect is quite dramatic.

* Triffids

Connect a length of wire from the ioniser emitter to the soil in the pot of a houseplant. One with sharp, pointy leaves is best. Hold your hand close to the plant and the leaves will reach out to touch you! In the dark you may see a faint blue glow around the leaf tips – this works better with some plants than with others, so try several different types. The plants don't object to this treatment at all, by the way, and often seem to thrive on it.

* The Electric Handshake

Wear rubber soled shoes. Touch the ioniser emitter for a few seconds until your body is thoroughly charged up. When your hair stands on end, that's just about enough. Then give everyone you meet a jolly electric handshake. Just think, you could lose all your friends in a single evening! (A meaner trick still is to charge up a glass of water or a pint of beer. Even your family won't speak to you after that!)

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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

£21.89

PET SCARER

EE MAY 89

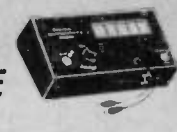
Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V–12V or via Mains Adaptor).

KIT REF 812

Mains Adaptor £1.98

£14.49

DIGITAL CAPACITANCE METER

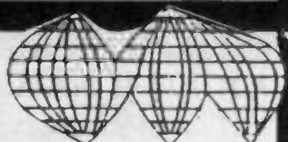


EE DEC 85

Simple and accurate (1%) measurement of capacitors from a few pF up to 1,000 μF. Clear 5-digit LED display indicates exact value. Three ranges – pF, nF, and μF. Just connect the capacitor, press the button and read the value.

KIT REF 493

£46.46



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

£29.66

DIGITAL FREQUENCY 200 MHz METER

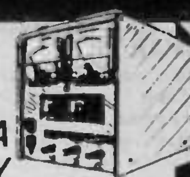
EE NOV 86

An 8 digit meter reading from AF up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.

KIT REF 563

£69.95

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

£55.61

MINI STROBE

EE MAY '86

A hand held stroboscope which uses 6 "ultra bright" LEDs as the light source. Designed to demonstrate the principles of stroboscope examination, the unit is also suitable for measuring the speed of moving shafts etc. The flash rate control covers 170–20,000 RPM in two ranges.

KIT REF 529

£15.50

ACOUSTIC PROBE

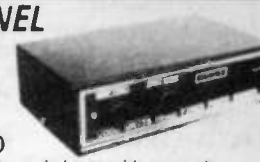
EE NOV '87

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

£19.58

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

£31.45

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

£17.37

MUSICAL DOORBELL

EE JAN '86

This project uses a special I.C. pre-programmed with 25 tunes and 3 chimes. A Magenta design, the circuit is battery powered and only draws current whilst producing sounds. Two rotary switches select the tune required. Provision is made for three bell pushes, each of which sounds a different tune, so that three points of entry can be identified.

KIT REF 497

£20.95

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

£27.90

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	£15.25
KIT REF 560 DISCO LIGHTS	£21.93
KIT REF 561 LAPEL BADGE	£11.40

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 £41.95

Headphones £1.99

STEPPING MOTOR INTERFACE

EE AUG '85

This interface enables 4 phase unipolar stepping motors to be driven from four output lines of any computer user port. The circuit is especially suitable for the ID35 motor and our MD200 which are commonly used in buggies and robot arms. Supplied complete with ribbon cable and connector for the BBC user port.

KIT REF 464

£9.40

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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BORING

One of the best things about editing EE is that there is always something happening. I sometimes say that we would be better off without our readers, when the 'phone rings ten times in quick succession with people asking if we have ever published "a thing for detecting when your wallet is empty?" or "do we know who makes the chip for the voice synthesiser in an electronic toothbrush?", etc. However, we do know that without you life would be very boring and that we would not have a magazine!

AVERAGE

Today is an average Monday in June and so far I've met two reps, one selling some excellent books from McGraw Hill (and very nice she was too) and one selling postal services. The new books will be appearing in our book pages soon and, with the way the Post Office treat us, we will probably be using the mailing company next month. I've had a 'phone call from one of our regular authors asking if I can buy an interesting antique his wife saw on a recent visit to Wimborne.

A Fax came in from a reader in San Francisco asking for information on a *Robot Roundup* item. The post contained two interesting project suggestions plus a constructional article from another regular contributor, along with the normal crop of new and renewed subscriptions, some technical queries and a couple of *Market Place* items (one of which will not get into print because someone did not read the rules!).

EXCITING

Finally, I received a letter from the author of our MARC series (*Mains Appliance Remote Control* by Chris Walker). I had put Chris in touch with a company who produce various commercial remote control systems and who are interested in a tie-up with us to add a telephone remote control unit to the MARC system. Chris informs me that this is now a very strong possibility as an add-on for MARC. The problem of BT approval has been overcome by the company involved and we should soon be able to bring you this exciting extension to our project.

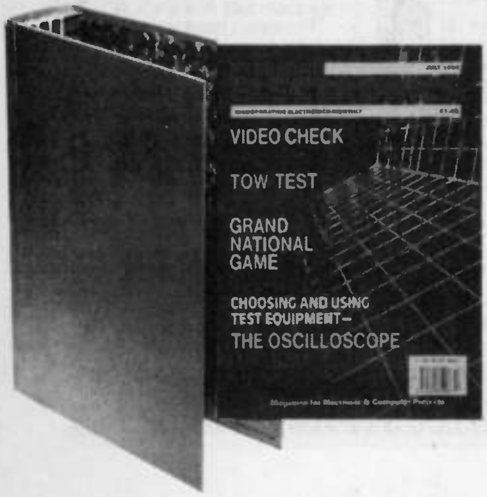
The MARC system has proved to be an outstanding success with readers and the facility of being able to easily control any appliance from virtually anywhere via a 'phone link will no doubt make it even more interesting.

I wonder what this afternoon will bring!

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £16.00. Overseas: £19.50 (£37 airmail). Cheques or bank drafts **(in £ sterling only)** payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. **Subscriptions can only start with the next available issue.** For back numbers see below.



BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available price £1.50 (£2.00 overseas surface mail) – **£ sterling only please** – inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability **one** article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery.* **We have sold out of Sept., Oct. and Dec. 85, April, May, Oct. & Dec. 86, Jan., April, May & Nov. 87, Jan., March, April, June & Oct. 88.**

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Binders to hold one volume (12 issues) are available from the above address for £4.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of post and packing. *Normally sent within seven days but please allow 28 days for delivery.* **Payment in £ sterling only please.**

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We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope** or a **self addressed envelope and international reply coupons.**

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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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We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the U.K. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use. The laws vary from country to country; overseas readers should check local laws.

Constructional Project

GAS RESERVE INDICATOR

T. R. de VAUX-BALBIRNIE

Make sure your camping gas supply does not let you down

THE GAS supply in a caravan is vital to maintain the refrigerator and cooking facilities. Failure is always inconvenient and can be disastrous where no back-up supply is available. Motor caravanners – due to shortage of space – often carry only one small (6lb) butane cylinder. This device will therefore be of particular interest to them.

The Gas Reserve Indicator displays the cylinder contents on a five-point scale – thermometer fashion – using a row of l.e.d's. Four green and one red one are provided. When the last green one (LOW) goes off, the red one illuminates to signal the near-empty state.

The main unit housing circuit panel, l.e.d's, battery, push-button switch and terminal block for the sensor connections, may be placed in any convenient position – in a locker, for example. A coin-adjusted control (ADJUST TARE) is used each time a fresh container is fitted to take account of the differing weights of empty cylinders. The circuit operates only when the "push-to-test" switch is used so the battery will have a very long life.

No doubt, readers will find other uses for this circuit where changes of weight need to be signalled at a distance. The sensor may be sited any reasonable distance from the main unit and connected to it using light duty 3-core wire.

WEIGHING PLATFORM

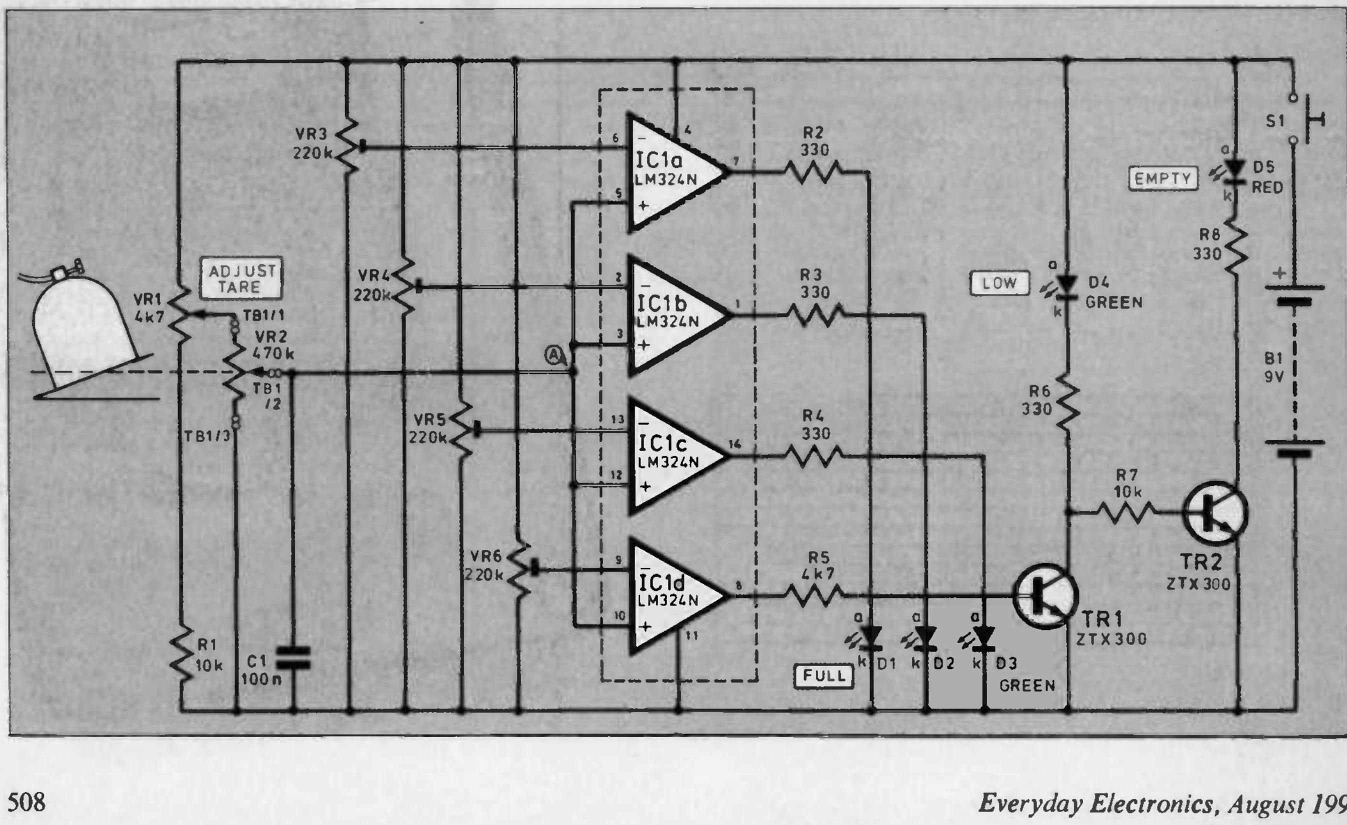
The only satisfactory way of monitoring gas cylinder contents is by weight. In this system, the cylinder is placed on a hinged wooden platform where springs compress by an amount proportional to the total weight of gas and container. This movement rotates the sliding contact of a potentiometer to provide an electrical signal. This lights the display in the correct sequence.

Construction of the wooden platform and potentiometer linkage is straightforward. However, readers who are uncertain of their ability to make this part should refer to Fig. 4 before proceeding. The dimensions apply to blue 907 "Camping Gaz" cylinders and may need to be altered when other types of containers are used.

CIRCUIT DESCRIPTION

The complete circuit for the Gas Reserve Indicator is shown in Fig. 1. Potentiometer VR1 (Adjust Tare), in conjunction with fixed resistor R1, form a potential divider connected across the supply derived from battery, B1. VR1 forms the adjustment for differing weights of empty cylinders. Thus, the voltage appearing at its sliding contact can be varied by a small amount according to the degree of rotation. Resistor R1 has a relatively high value compared with VR1 and this has the effect of narrowing the range of adjustment.

Fig. 1. Complete circuit diagram for the Gas Reserve Indicator. The sensor potentiometer VR2 is mounted on the side of the weighing platform and connected to the display unit via a screw terminal block.



VR2 is the potentiometer whose spindle rotates as weight is placed on the sensor platform. The full range of operation is not obtained but the circuit responds correctly with only a small degree of rotation.

As VR2 turns under decreasing load, its resistance decreases. Thus, a falling voltage is developed between Point A and supply negative. The voltage at Point A is connected to all four non-inverting inputs of quadruple operational amplifier IC1,

The op-amps are used in comparator mode each one (IC1a to IC1d) being responsible for one particular weight, IC1a for the highest one and so on. Each inverting input receives an individual adjustable voltage using presets VR3 to VR6.

With a full gas cylinder on the platform and VR3 to VR6 correctly adjusted, the voltage applied to the non-inverting inputs exceeds that at all inverting ones. All op-amps will then be on and the green l.e.d's, D1, D2 and D3 connected to their outputs (pins 7, 1 and 14 respectively) operate. In the case of op-amp (IC1d) the output, pin 8, operates transistor TR1 and hence green l.e.d. D4, in its collector circuit.

As the gas is used up, VR2 applies ever decreasing voltage to the op-amp non-inverting inputs. The non-inverting input voltage will now fall below each inverting one in turn so the op-amps, hence D1-D4, switch off in sequence.

When op-amp (IC1d) switches off, TR1 and D4 also switch off. The collector of TR1 now goes high and operates transistor TR2 hence D5, the red "EMPTY" l.e.d. Since the op-amps respond to the relative voltage levels applied to their inputs, the circuit is practically immune from changes in supply voltage such as will occur when the battery ages.

CONSTRUCTION

Construction of the Gas Reserve Indicator is based on a main circuit panel made from 0.1in matrix stripboard, size 13 strips × 28 holes. The component layout and details of the breaks required in the underside copper tracks is shown in Fig. 2.

Begin by cutting the board to size and making the track breaks and inter-strip links as indicated. Follow with the soldered on-board components and complete assembly by soldering 10cm pieces of light-duty stranded wire to the points indicated.

Note that resistor R1 is not mounted on the circuit panel but is externally connected. Do not insert IC1 into its socket until the end of construction.

Drill holes in the box for the l.e.d's (these were made a tight push fit and secured with

COMPONENTS

Resistors

R1, R7	10k (2 off)	
R2, R3, R4, R6, R8	330 (5 off)	
R5	4k7	
All 0.25W 5% carbon		

See SHOP TALK Page

Potentiometers

VR1	4k7 rotary, lin.
VR2	470k rotary, lin.
VR3 - VR6	220k sub-min. skeleton preset, horiz. (4 off)

Capacitor

C1	100n polyester

Semiconductors

D1 - D4	5mm green l.e.d's (4 off)
D5	5mm red l.e.d.
TR1, TR2	ZTX300 *npn* silicon (2 off)
IC1	LM324N quad op.amp

Miscellaneous

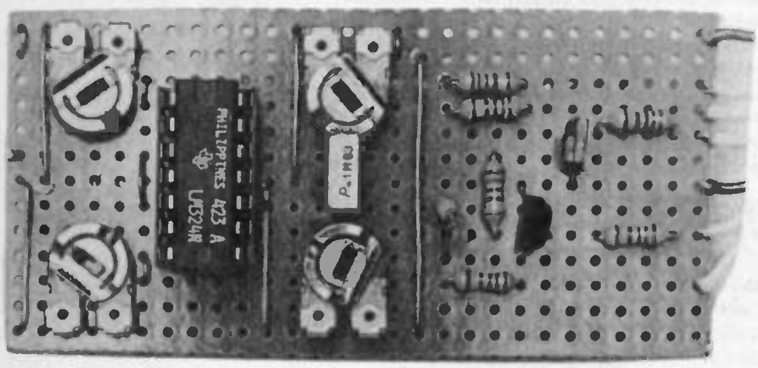
S1	Miniature push-to-make switch
B1	PP3 battery and battery connector

Stripboard, 0.1in. matrix size 13 strips × 28 holes; 14-pin i.c. socket; plastic case (MB2 box), size 100mm × 76mm × 41mm external; 3A 3-way terminal block; dial cord drum, approx. 55mm dia; connecting wire; solder etc.

Sensor Materials

5mm plywood (see Fig. 4); sheet aluminium; compression springs (see text); hinges; woodscrews etc.

Approx cost guidance only **£12** *(excl. Springs)*



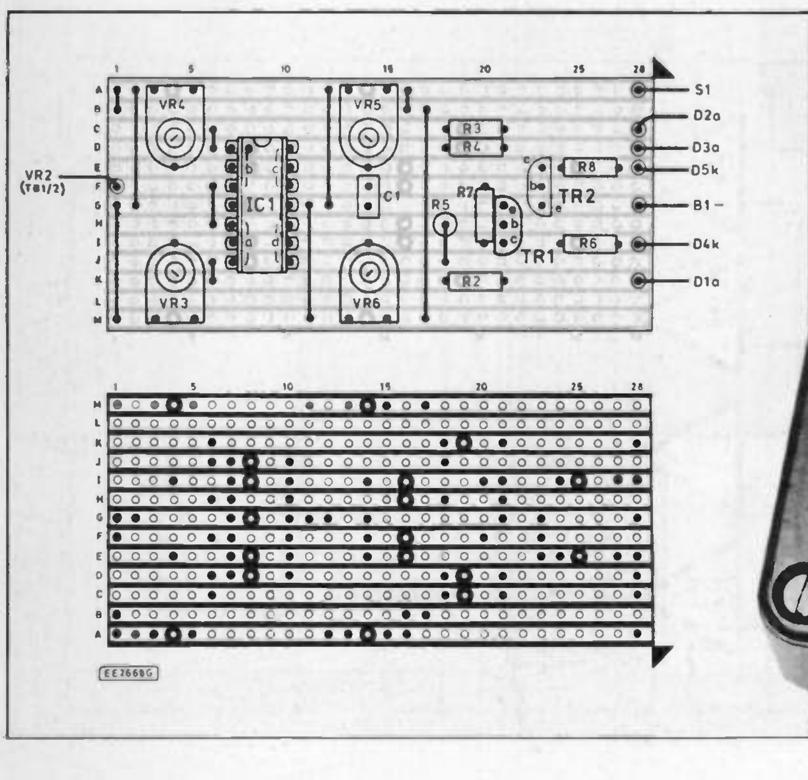
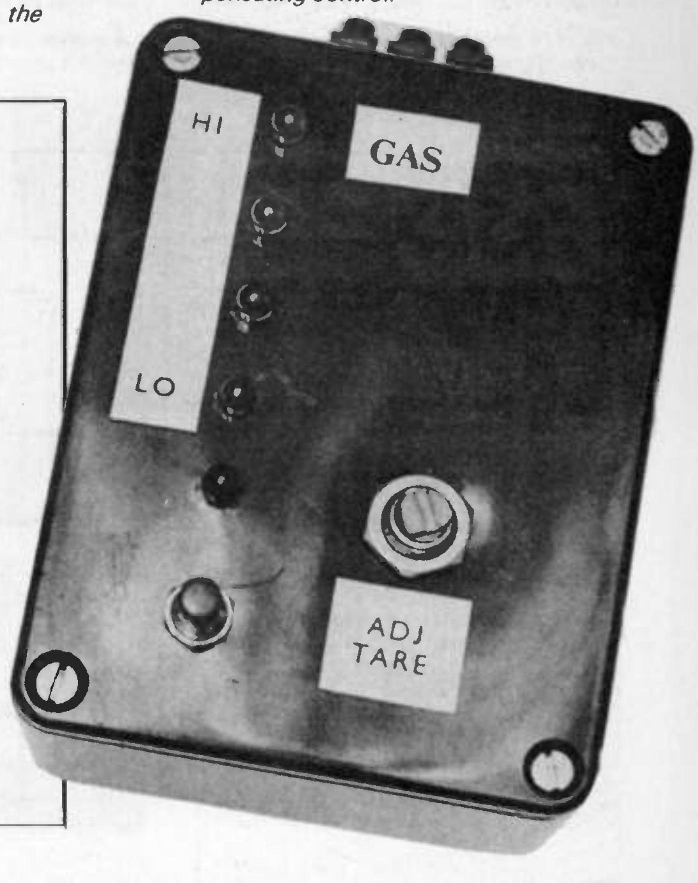


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. The completed circuit board is shown in the photograph above.



The completed unit showing the l.e.d. display and the coin-operated compensating control.

a little glue in the prototype unit), potentiometer VR1, switch S1 and the terminal block TB1 mounting. Drill a small hole near TB1 position for the wires to pass through. Cut VR1 spindle to a length of 5mm and gently saw a cross cut in the end so that a coin can be used to adjust it (see photograph on the previous page).

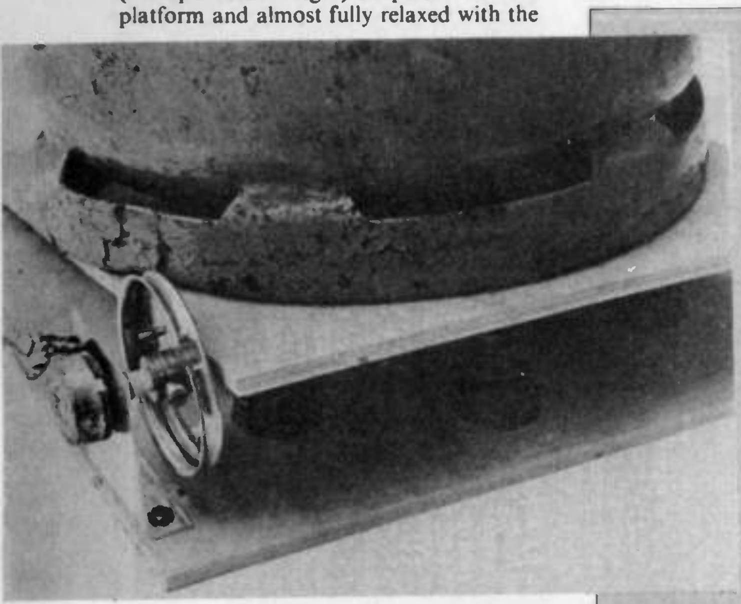
Referring to Fig. 3, mount remaining components and complete all interwiring. Note that the common cathode (k) connection of diodes D1, D2 and D3 forms an anchorage point for several other wires – make these connections carefully to avoid failure in service. Also note the manner in which resistor R1 is connected.

SENSOR UNIT

Details of the sensor "platform" construction is given in Fig. 4. The sensor comprises two sections – a spring-loaded platform on which the gas cylinder is placed and the potentiometer (VR2) assembly. The platform consists of two pieces of 5mm thick plywood cut to the dimensions shown. These dimensions apply to a 6lb Camping Gaz cylinder and should be altered to suit the application.

The pieces of plywood are hinged together along one of the shorter edges. Springs are then placed between the two pieces of wood. In the prototype unit, three suspension springs removed from an old record player deck proved suitable. However, any of a wide variety of small compression springs could be used.

The number and position of the springs will be determined by their strength and the weight of the gas cylinder. The springs should be arranged so that they are almost fully compressed when a full gas cylinder (or equivalent weight) is placed on the platform and almost fully relaxed with the



The spring-loaded platform showing the suggested method of mounting VR2.

weight of an empty cylinder. To locate the springs in the lower part of the platform, shallow holes may be drilled of a slightly smaller diameter than that of the springs.

The potentiometer assembly consists of VR2 mounted on an aluminium bracket together with a dial cord drum and linkage to the upper section of the wooden platform (see photograph). The bracket is made from 18s.w.g. sheet aluminium cut and bent as indicated. Drill holes for VR2 mounting and for attaching the bracket to the lower section of the wooden platform.

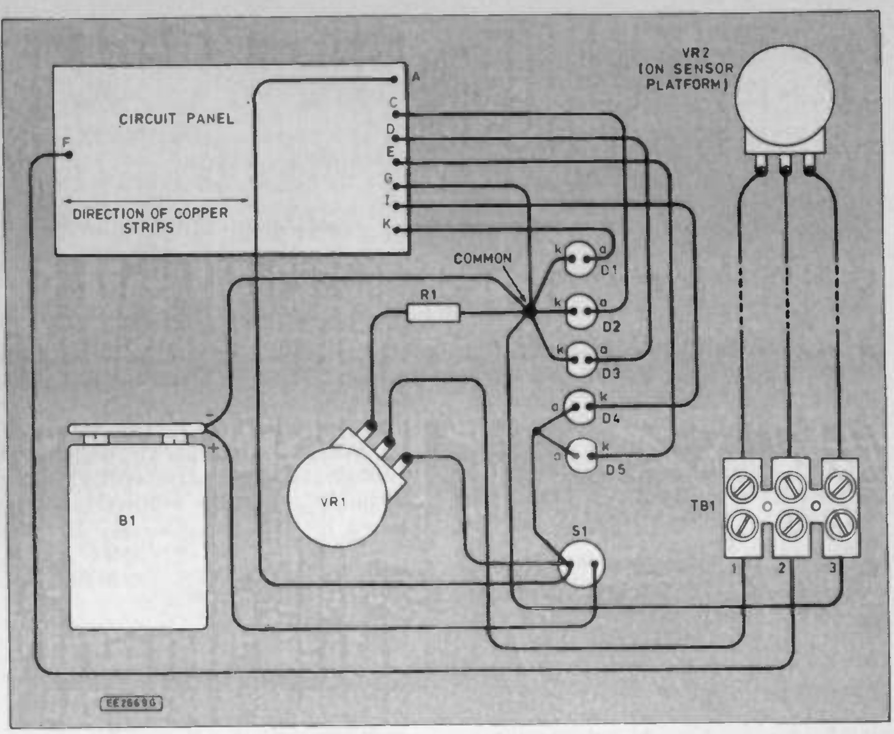
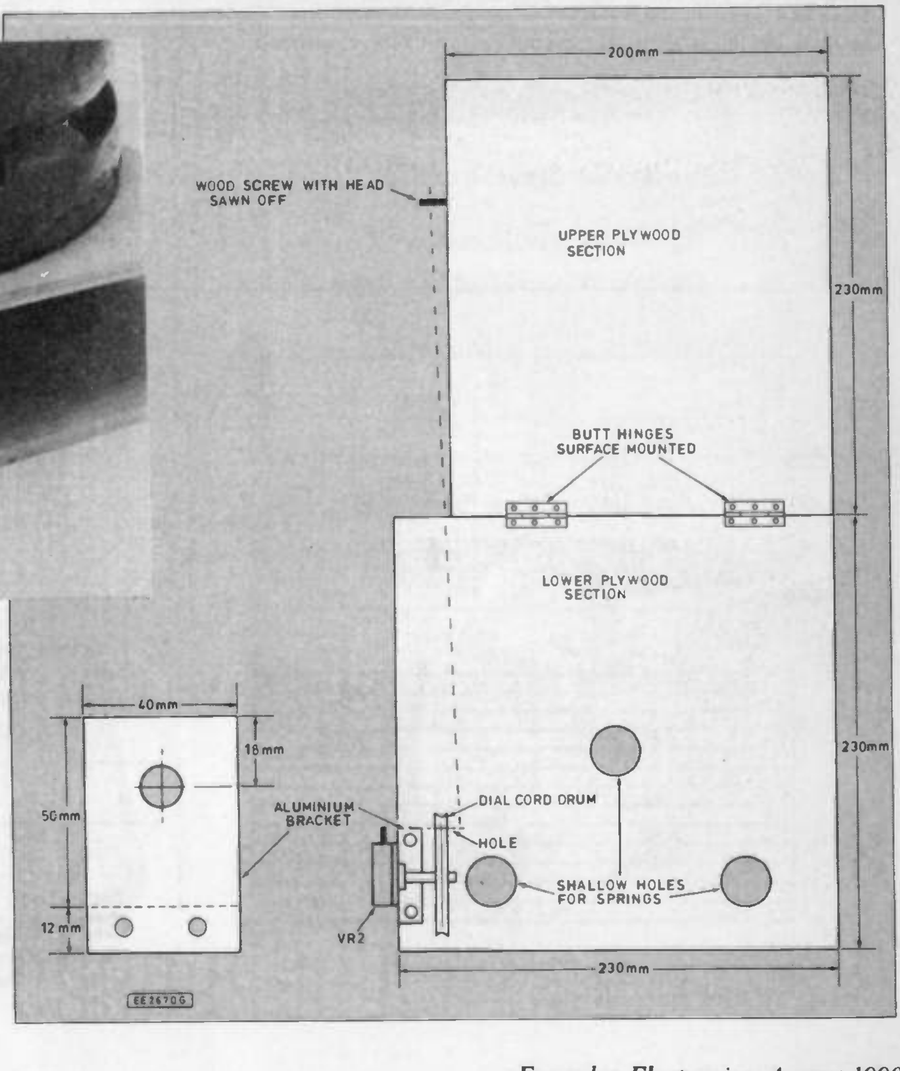


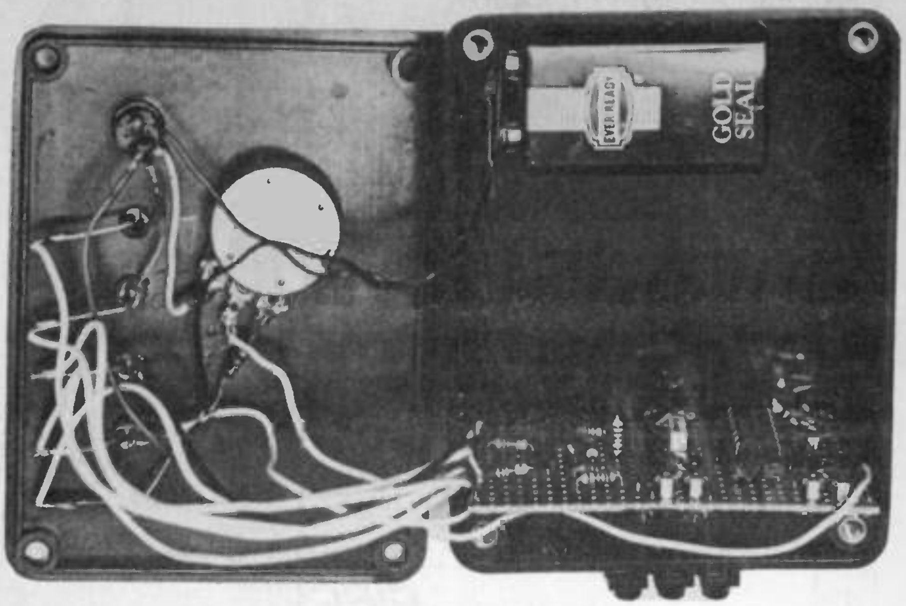
Fig. 3. Interwiring from the circuit board to all off-board components. The terminal block TB1 is mounted on the outside of the case.

Cut VR2 spindle to a length of 20mm and mount this component on the prepared bracket. Drill a 2mm hole in the dial cord drum in the position shown in the photograph and attach the drum to VR2 spindle.

Mark the position of the 2mm hole on the edge of the upper piece of plywood, remove the potentiometer assembly temporarily and insert a thin woodscrew in the position marked. Cut off the head of the screw, file it smooth and re-attach VR2

Fig. 4. Construction details for the plywood sensor platform and the small aluminium potentiometer mounting bracket.





The completed Gas Reserve Indicator showing layout of components inside the case and on the case lid.

bracket with the screw protruding through the hole in the drum drilled for the purpose.

Adjustments will now need to be made to ensure the smoothest action. Check that the potentiometer turns freely when weight is applied and removed from the platform. Adjust VR2 if necessary so that it rotates around its mid-track position.

The hole in the dial cord drum must be slightly larger than the diameter of the woodscrew to allow for smooth operation – the two parts do not "track" accurately. There will inevitably be a small amount of backlash but this is of no consequence.

Adjustments should be made so that between "full" and "empty" states VR2 spindle rotates by approximately 30 degrees (about 15mm measured at the rim of the drum). Make suitable stops so that the cylinder always takes up the same position on the platform and cannot move about in operation – this would cause inconsistent readings.

Using 3-core light-duty stranded wire, connect TB1/1, TB1/2 and TB1/3 to VR2 on the sensor unit. Note that if the two outer connections are made to VR2 in the wrong sense, the l.e.d's will operate in reverse sequence.

Insert IC1 into its holder. Connect the battery and secure it to the bottom of the box using an adhesive fixing pad. Do not attach the circuit panel yet or the preset potentiometer may be difficult to adjust.

TESTING

Initial setting-up may be carried out conveniently using an empty gas cylinder with sand or water-filled bags on top to represent the weight of the contents. Place the equivalent of a full gas cylinder on the platform and adjust VR1 to approximately mid-track position. Press switch S1 and adjust preset VR3 sliding contact so that l.e.d. D1 is just on.

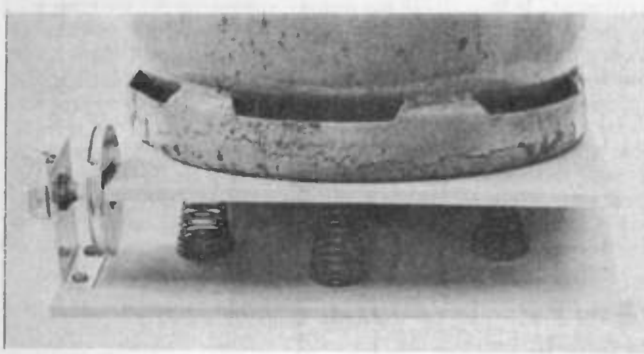
With the equivalent weight of about $\frac{3}{4}$ total gas contents, adjust preset VR4 so that l.e.d. D2 is just on. With about $\frac{1}{2}$ contents similarly adjust VR5 and with about $\frac{1}{4}$ contents adjust VR6 in the same way. With any less weight, all green l.e.d's should be off but the red l.e.d. D5 (EMPTY) should now be on.

If all is well, the circuit panel may be attached in its case, using a little adhesive in the position shown in the photograph. The device may then be put into permanent use.

When a fresh gas cylinder is installed, VR1 should be adjusted with a coin so that l.e.d. D1 is comfortably on. This will allow for some loss of gas before this l.e.d. goes off.

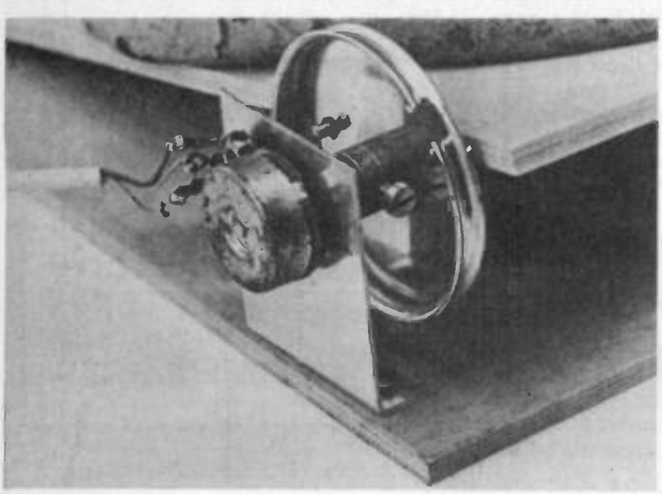
Adjustments may be made over a trial period to give indications at the chosen gas levels. Final adjustments will, of course, take account of the weight of the gas tap and regulator as well as any unsupported connecting tube.

It is **NOT** intended that the gas cylinder should remain on the sensor platform while the vehicle is *moving*. It should only be in the working position when *stationary* and *on-site*. □



The platform support springs recessed into the baseboard.

Close-up of the dial cord drum linkage to the upper platform.



Constructional Project

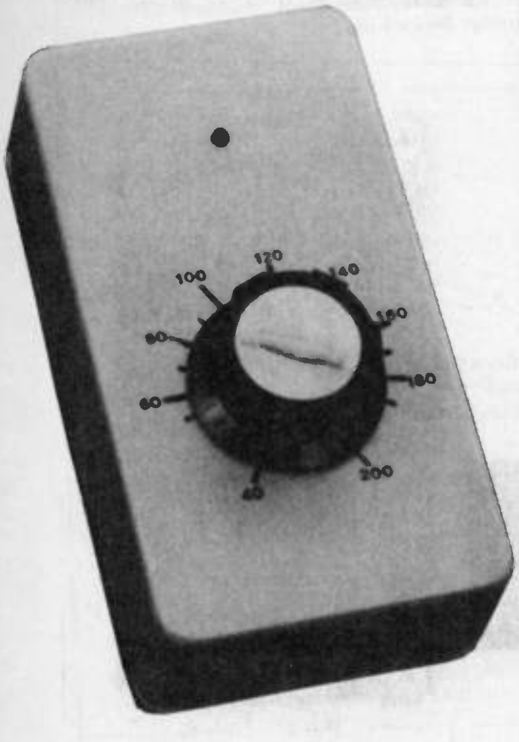
SIMPLE METRONOME

ANDY FLIND

A simple easy to build metronome with just a flashing output or with a "flash" and a "tick"!

As happens so often, this project was started following an apparently innocuous request from a friend. The circuit diagram of a simple relaxation oscillator was produced, showing three small wire-ended neons in a sort of triangular configuration. With a ninety-volt h.t. battery supply, these were supposed to flash in rotation. Would it be possible, asked the friend, for one of these to be built?

After explaining gently that the h.t. battery would by now be either horribly expensive or unobtainable, and that in these technically advanced times there are better ways to flash lamps, it was not long before the author found himself landed with the design and construction of a suitable new circuit.



SIMPLE TASK

At first the task appeared simple, especially as only the light was required (the usual ticking was offered, but firmly rejected). An astable circuit with a CMOS 4011B and transistor output was lashed together on a scrap of stripboard and boxed up with an l.e.d. and PP3 battery. This was handed over with the suggestion that the user, a retired gentleman with, presumably, time to spare, might like to amuse himself with the task of calibration.

Like the proverbial bad penny, the device soon returned. It was, it seemed, too difficult to calibrate, partly because of an over-wide range of possible speeds, but also because the control was seriously non-linear and the cramped end of the range was in the area of most interest to him. Could some simple improvement be made to it?

IMPROVEMENT?

Improvement was indeed possible, but simple it was not! The "modification" involved complete circuit redesign. An arrangement combining linear control with excellent stability and presettable top and bottom limits was required. Since a more complex metronome was under development at the time there was ample reason to design such a circuit, so work began.

The final version was a considerable advance over the original, combining all the above advantages in a circuit that was still reasonably cheap and uncomplicated. Since by this time the stripboard had been abandoned in favour of a printed circuit, the design had also taken on the appearance of a useful project for other enthusiasts, including those of limited experience.

Of course, many users of metronomes will prefer them to tick as well as flash, but this feature is easily added. A couple of ideas for this will be given later, both of which have been tested successfully on the prototype.

OSCILLATOR CIRCUIT

Much thought went into the production of an oscillator with a linear frequency control. A simplified diagram of the circuit eventually arrived at appears in Fig. 1. In this it will be seen that the first amplifier, A1, is connected as an inverting integrator, whilst the second, A2, is a "Schmitt trigger", with positive feedback providing hysteresis.

If it is assumed that the output of A2 is negative, the output of A1 will be ramping towards positive at a rate set by the position of the pot VR. When the output of A1 is high enough, the output of A2 will switch to positive and the output of A1 will commence ramping downwards until it is low enough for A2 to switch negative again. This action will, of course, repeat indefinitely.

If the output voltage of A2 switches all the way to both supply rail potentials, some simple mathematics will show that the frequency is independent of the supply voltage, useful where a battery is to provide the power. Also, if the value of 'R' is high compared to VR then the frequency is almost linearly related to the position of this pot; if the pot is linear then the scale of calibration will be too. A1 must have a high input impedance of course, if it is not to have an adverse effect on the operation.

FULL CIRCUIT

In the full circuit diagram of the Simple Metronome, Fig. 2, A1 is IC1, a 3130 op-amp. The MOSFET input devices of this provide the high input impedance required. The "Schmitt trigger" is made up from two of the four "NAND" gates

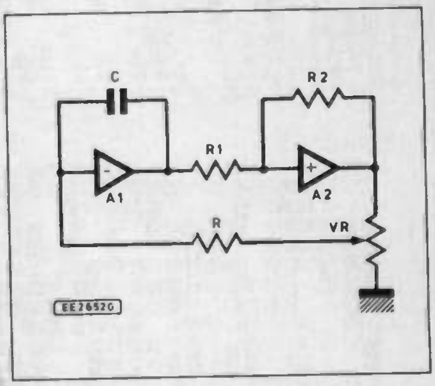


Fig. 1. Simplified oscillator diagram.

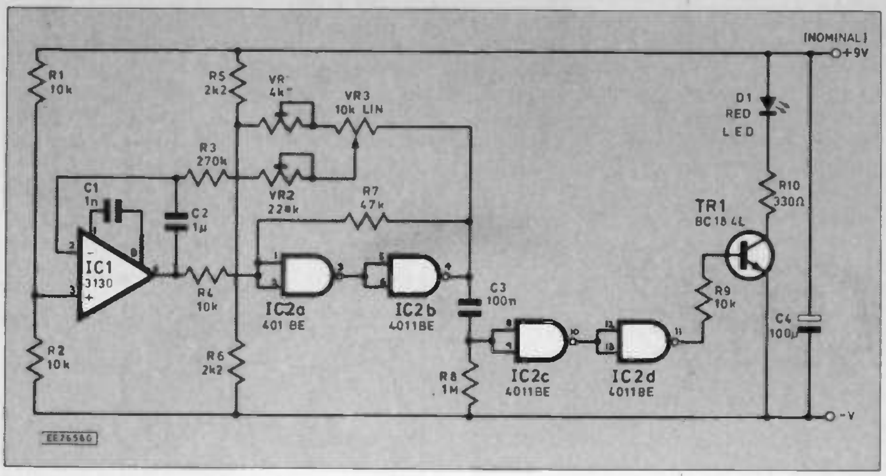


Fig. 2. Simple Metronome circuit diagram.

COMPONENTS

Resistors

R1, R2, R4, R9	10k (4 off)	
R3	270k	
R5, R6	2k2 (2 off)	
R7	47k	
R8	1M	
R10	330	

All 0.6W metal oxide, 1%

See SHOP TALK Page

Potentiometers

VR1	4k7 vertical sub-min preset
VR2	220k vertical sub-min preset
VR3	10k lin. rotary carbon

Capacitors

C1	1n miniature ceramic plate
C2	1µ polyester layer
C3	100n polyester layer
C4	100µ axial elect. 10V

Semiconductors

D1	(3mm) red l.e.d. high-brightness
TR1	BC184L *npn* silicon transistor
IC1	3130 CMOS op-amp.
IC2	4011 CMOS quad "NAND" gate

Miscellaneous

Printed circuit board, available from the *EE PCB Service*, order code EE698; case, ABS box 2004, 120 × 65 × 40mm; knob; PP3 battery connector, wire, etc.

Approx cost guidance only **£10**

in IC2, a CMOS 4011B chip, together with resistors R4 and R7. CMOS outputs can of course swing all the way to either supply rail. These components form the main oscillator for the circuit.

The adjustment range is given by VR3, and the top and bottom frequency limits can be adjusted with internal presets VR2 and VR1 respectively. As the circuit is intended to flash a light, a brief pulse to an l.e.d. is needed so the other two gates in IC2 are used to generate this.

The output from IC2b is fed to IC2c through the differentiator C3-R8, producing a pulse of about 100mS at each positive transition. This is buffered (and inverted) by IC2d and used to drive TR1, which flashes the l.e.d. D1. D1 should be a high-brightness type for the most easily visible flash from the current provided. C4 is the battery decoupling capacitor.

CONSTRUCTION

The circuit is constructed on a compact p.c.b., the component layout of which is shown in Fig. 3. There should be no problems in building this simple layout, though it is suggested that the resistors are fitted first to make things easy. Sockets are advised for the i.c.s, as this reduces the amount of handling required for the CMOS components and greatly eases trouble-shooting should this later prove necessary.

To test, just connect up the l.e.d., control and battery as shown (Fig. 4) and try it out. The l.e.d. is connected with a few centimetres of flexible wire to allow positioning in the case. Check that the control and presets all vary the flash rate as they should, VR2 will have some effect at any setting of the control, but VR1 is intended for low end adjustment and VR3 will have to be turned some way towards this end to see its effect.

TESTING

If for some reason the project does not work, then the best procedure is to work through the circuit with a meter, checking the various points in turn. The operation is fairly logical; if it isn't running then most of the outputs will usually be locked up towards one of the supply rails and some careful thought will usually reveal at least the area of the trouble, if not the fault itself.

If all seems well, the project can be assembled into the case. An ABS box 120 × 65 × 40mm is specified as the p.c.b. is designed to fit into the internal moulded slots in this. A small slide switch gives on-off battery control, and the battery fits into a compartment made with a piece of sheet plastic or metal placed across the box, with some foam plastic to prevent it from rattling. The general layout of the unit can be seen from the photograph. A large knob is suggested for VR3 to allow clear calibration.

SETTING UP

Setting up should begin with adjustment of the two presets. The normal range of a metronome is from 40 to 200 beats

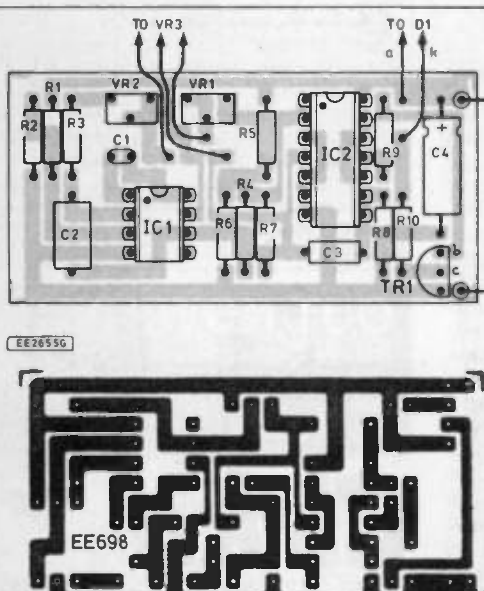
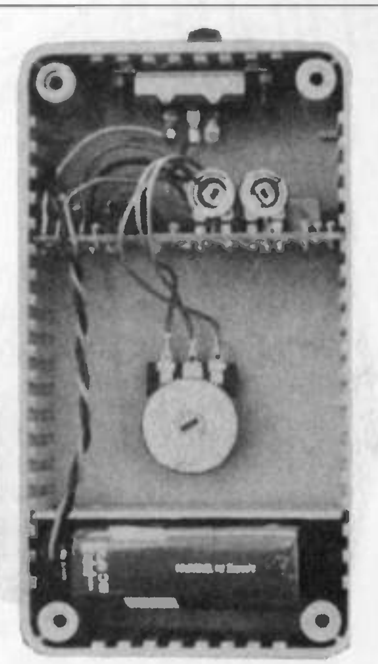


Fig. 3. P.C.B. layout and wiring.



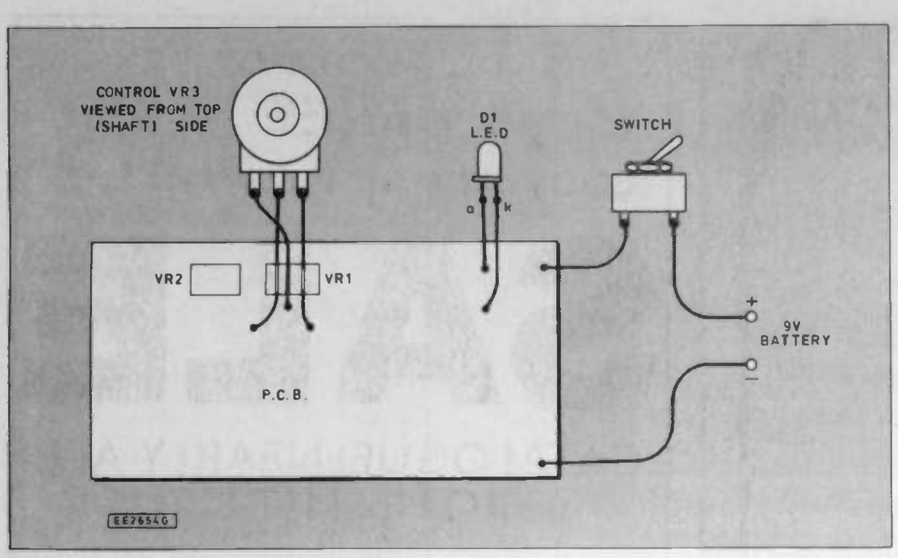


Fig. 4. Connections to the p.c.b. and controls.

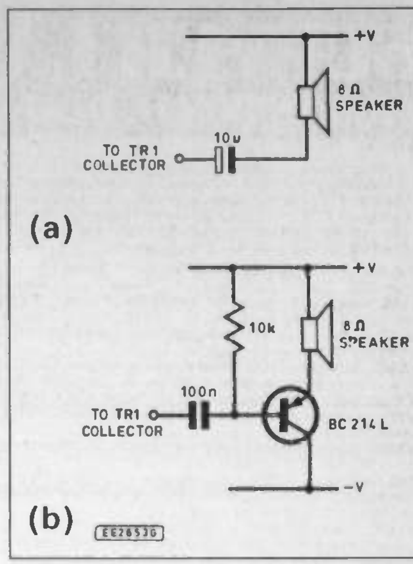


Fig. 5. Two ways of adding a "tick" (a) "tick", (b) louder "tick".

per minute, these limits being adjusted after moving the control to the correct position with VR1 and VR2 respectively.

Turn the control to the "high" end and adjust VR2 first, as this pot affects the entire range. Then turn the control to the low end and adjust VR1. Having set the limits, the control can be calibrated. A counter-timer was used for the prototype, using the "period" of each flash for the measurement and some sleight of hand with a calculator to determine the correct value. Where such equipment is not available a watch with "seconds" indication and a little patience will do just as well. As the calibration is linear, only a few cardinal points will need to be found anyway.

TICK, TICK, TICK

Although the prototype for this project was designed to have an output consisting only of a flashing light, there will probably be many constructors who would prefer it to tick in the accustomed manner. This presents no special difficulties as there is room in the box, with a little repositioning, to fit a small loudspeaker. This can be glued into place after drilling a pattern of holes to allow the sound to emerge.

To operate the speaker without using too much battery power, a short pulse is needed; Fig. 5(a) and (b) show two ways of doing this. The first works quite well and has the virtue of simplicity, but may not be loud enough for some applications. The second uses an extra transistor to raise the power and should be quite sufficient for all normal purposes. No layouts are given for these additions, as they are so simple it should be possible to construct them directly onto the terminals of the speaker, or at most on a very small piece of stripboard. □

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month we deal with testing and calibrating our 8-Channel Analogue to Digital Converter (ADC) for the SAM Coupé. To give readers some idea of how easy it is to program this module, we include a sample program which shows how the Coupé can function as an Eight Channel Analogue/Digital Multimeter. We begin, however, by attempting to explain the illogical behaviour of the Spectrum's logical operators.

Illogical Logic

In May's *On Spec* I mentioned a query sent in by Tony Preston from Cardiff. Tony was wondering whether his Plus-Two had a faulty ROM as it did not always generate the expected results when he made use of the logical operators AND and OR.

Unfortunately, ZX-BASIC handles the logical operators in a somewhat different manner form that which is employed in several other popular microcomputers. The Spectrum (and also the SAM Coupé) produces the following results:

Logical operation	Result	Comment
1 AND 1	1	OK
1 AND 0	0	OK
2 AND 2	2	OK
2 AND 1	2	Should be 0?
2 AND 0	0	OK

The surprising outcome (in the case of 2 AND 1) is attributable to the fact that the ZX-BASIC's AND function operates in a different manner from that of the "bitwise-AND" function provided in other versions of BASIC (such as GW-BASIC, Microsoft QuickBASIC, etc).

In the case of the Spectrum, the rule is simply that the function returns the first value if the second value is not equal to zero and returns zero if the second value *is* zero. Thus:

2 AND 1 produces 2 (the second value is not zero and thus the first value is returned

In the case of the more conventional bitwise-AND, **2 AND 1** would return 0, as shown below:

	Bit 1	Bit 2
First variable (2):	1	0
Second variable (1):	0	1
Result (ANDing each bit):	0	0 (=0)

Let's hope that this finally puts the subject of "illogical logic" to rest!

Testing the Sam ADC

Having completed the ADC construction (described last month), the next stage is to connect the module to the 64-way SAM expansion socket. Before doing so, it is important to disconnect the power from the computer (this precaution **MUST be observed** whenever connecting or disconnecting modules to/from the SAM expansion connector). After re-connecting the power, the computer should initialise in the normal way. If this is not the case, it is likely that there is a fault in the wiring of the ADC module!

Now measure the voltage at TPA which should typically be in the range −2V to −4V. If this is not the case, check IC4 and associated components. If the voltage at TPA is in the correct range, VR1 should be adjusted until the voltage at TPA reads exactly −2.55V (this procedure will be more easily carried out using a digital multimeter!).

Finally, the following program should be entered:

```
10 FOR p=120 TO 127
20 PRINT IN (p)
30 NEXT p
```

The result should be a column showing eight zeros (the voltage returned from each input channel in the absence of any input signal). If this is not the case (e.g. any one, or more, values appears as 255) check IC1, IC2, IC3 and associated wiring.

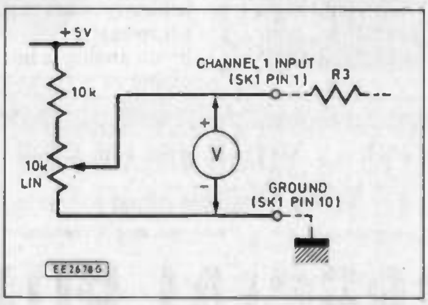


Fig. 1. Circuit arrangement for calibrating the ADC.

Calibration

The circuit shown in Fig. 1 should be used to calibrate the ADC. The variable resistor can be connected to the Sam's +5V supply rail (pin 10C on the expansion connector) or, alternatively, an external 5V supply (or even a 4.5V battery!) may be employed. A multimeter (preferably a digital type) should be switched to the 20V d.c. range and connected so as to measure the input voltage applied to Channel 1 of the ADC.

The following short test program should be entered and RUN:

```
10 LET v=IN(120)
20 IF v=255 THEN BEEP 0.1,0.1
30 PAUSE 5
40 CLS
50 PRINT AT 0,0;"Vin="
60 PRINT AT 0,6;v/100;"V"
70 GO TO 10
```

The program will continuously display the voltage measured by the ADC. If this voltage exceeds 2.55V, the Sam will issue a BEEP. The variable resistor should be adjusted for a reading of exactly 1V on the multimeter and then VR1 should be adjusted so that the screen display reads:

Vin=1V

Using the ADC

The 7581-based eight channel analogue to digital converter described last month is delightfully easy to use. The converter continuously samples each of the eight input channels without the need for any start conversion commands from the host CPU.

Values returned from the input channels are stored in the 7581's internal RAM. In order to read the state of a particular channel it is only necessary to include a command of the form:

100 LET v=IN(p)

where "p" is the decimal port address in the range 120 to 127 decimal (see last month for the port address table).

The value returned in the variable, v, will be in the range 0 to 255, i.e. when 0V is applied v takes the value 0 whereas, when a full-scale value equal, but of opposite polarity, to the reference voltage present at TPA is applied, v will take the value 255. It is important to note that any value in *excess* of the reference value (but of opposite polarity) will also produce a value of 255.

Since our reference voltage is −2.55V, a reading of 100 will be produced by a voltage of +1.00V. In other words, the ADC operates in increments of 10mV (see Fig. 2) such that the value of v is equivalent to "millivolts × 10". When v equals 100, the input voltage is (100 × 10mV) or 1000mV (i.e. 1V).

Note that, by dividing the value of v by 10, a result will be produced in volts. Alternatively, the value of v may be multiplied by 10 in order to produce a result in millivolts.

By changing the port address, we can read the voltage present on any one of the eight ADC inputs. As an example, suppose that we need to continuously read and display the voltages present on Channels 1, 2 and 8 and display the result in units of millivolts. The following lines of BASIC could be used:

```
10 LET x=IN(120): REM Read Channel 1 voltage
20 LET y=IN(121): REM Read Channel 2 voltage
30 LET z=IN(127): REM Read Channel 8 voltage
40 PRINT AT 0,0; "Channel 1 voltage =";x*10;"mV"
50 PRINT AT 2,0; "Channel 2 voltage =";y*10;"mV"
60 PRINT AT 4,0; "Channel 8 voltage =";z*10;"mV"
70 PAUSE 20
80 CLS
90 GO TO 10
```

Fig. 2. ADC characteristic (note that the step size is 10mV).

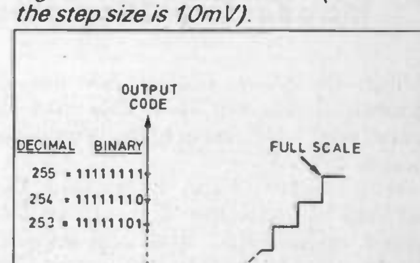


Table 1. Complete listing for an Eight-Channel Digital/Analogue Voltmeter.

```
  1>REM ******************************************
  2 REM *                                        *
  3 REM *      SAM Eight Channel Voltmeter       *
  4 REM *                                        *
  5 REM *   Everyday Electronics August 1990     *
  6 REM *                                        *
  7 REM ******************************************
  9 REM
 10 REM *** Initialise ***
 11 REM
 15 MODE 1
 20 LET ch=1
 30 LET z1=0: LET z2=0
 99 REM
100 REM *** Print scale ***
101 REM
110 BORDER 1: PAPER 1: PEN 6: CLS
115 PRINT AT 5,11;"E.E. SAM ADC"
120 PRINT AT 11,8; INVERSE 1;"Channel   selected"
130 PLOT 110,46
140 DRAW 0,11: DRAW 43,0: DRAW 0,-11: DRAW -43,0
150 PRINT AT 19,0;"0    0.5   1.0   1.5   2.0   2.5"
160 PRINT AT 21,14; INVERSE 1;"VOLTS"
170 FOR i=0 TO 255 STEP 50
180 PLOT i,32
190 NEXT i
499 REM
500 REM *** Main loop ***
501 REM
502 PRINT AT 11,16; INVERSE 1;ch
505 LET z2=z1
510 LET r$=INKEY$
520 IF r$="q" THEN NEW
530 LET cs=CODE r$-48
540 IF cs>=1 AND cs<=8 THEN LET ch=cs
550 LET z1=IN (ch+119)
555 PAUSE 2
560 LET z1=IN (ch+119)
565 PAUSE 2
570 IF z1<0.98*z2 OR z1>1.02*z2 THEN GO SUB 1000
580 GO TO 500
999 REM
1000 REM *** Print the value ***
1001 REM
1010 LET x=z1/100: REM Calibrate digital display
1015 LET w$=STR$ x
1020 IF LEN w$<=4 THEN GO TO 1030
1025 LET w$=w$( TO 4)
1030 PRINT AT 15,14; INVERSE 1;STRING$(5," ")
1040 PRINT AT 15,15; INVERSE 1;w$
1050 PRINT AT 18,0;STRING$(32," ")
1055 FOR y=26 TO 30
1060 PLOT 0,y
1065 DRAW z1*1.0,0: REM Calibrate bar display
1070 NEXT y
1080 RETURN
```

Voltmeter Software

Whilst this simple program has some obvious limitations it does serve to illustrate how easy it is to write software to operate the analogue to digital converter. The Listing Table. 1 is provided for readers requiring a "ready-made" eight-channel voltmeter program. This program can be used to display any one of the eight channels (selected simply by pressing the appropriate channel number on the SAM keyboard) in both digital and analogue bar form.

The program should be reasonably self explanatory and assumes a −2.55V reference. Lines 1015 to 1025 are used to strip the digital display voltage string to a sensible length. Calibration may be performed by simply making changes to two lines; 1010 and 1065 for the digital and analogue display respectively.

Readers should not forget to SAVE the program after entering it and BEFORE attempting to RUN it. When running, the program may be abandoned by pressing the 'q' key (note that this will perform a NEW command which ruthlessly clears the program from the SAM's memory!).

Finally, the 2.55V maximum analogue input voltage will be something of a limitation in a number of applications. The value can, however, be very easily increased by including a resistor in series with the appropriate input.

A 150k fixed resistor wired in series with a 100k pre-set resistor will, for example, increase the full-scale reading to approximately 25V. The pre-set resistor can then be used to calibrate the particular channel concerned. We shall develop this theme further next month with some practical examples of using the ADC interface.

Next month: We shall be taking a look at the latest version of ELECTRODRAW, BESofT's powerful Electronic CAD package for the Spectrum. In the meantime, if you have any queries or suggestions for inclusion in *On Spec*, please don't hesitate to drop me a line at the address below: Mike Tooley, Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey KT13 8TT.

Special Feature

CHOOSING AND USING TEST EQUIPMENT

Robert Penfold

A short series of self-contained articles looking at the various items of test gear available. How useful are they? How to use them! What to look for.

THE FIRST two articles in this series covered multimeters and oscilloscopes, which are the two main types of general purpose test equipment. There are many other items of test gear available though; some of general use and some of a specialisted nature.

We will consider some of these devices in this third and final article, paying particular attention to equipment that is likely to be of use to the electronics hobbyist. We will not be concerned with logic analysers having four figure price tags.

POWER SUPPLIES

A bench power supply is very much in the "general purpose" category, and it is a piece of equipment that I would suggest should be high on the "hit list" of any newcomer to the hobby. When testing battery powered equipment you can find yourself having to buy new sets of batteries at an alarming rate.

A good power supply might be quite expensive initially, but it could be quite cheap in the long term. If you progress to building equipment that has its own built-in mains power supply, it can be useful to check the main circuit board prior to fitting it into the case. This is not too difficult if you have a suitable bench power supply, but could otherwise be a bit awkward (or even dangerous if you are not very careful). If you start developing your own circuits, then a bench power supply could well be the piece of test equipment you will use the most.

The main ratings of a power supply are its voltage range and maximum output current. With so many modern circuits being digtal types that require a 5 volt supply, you would be well advised to choose a unit that has a minimum output potential of 5 volts or less. Many projects operate from a 9 volt battery supply, and this voltage should also be within the repertoire of the supply.

It is certainly useful to have a maximum output voltage as high as 20 or 30 volts so that the unit can be used with audio power amplifiers and other higher voltage equipment. However, the cost is inevitably that much greater, as are the size and weight of the supply.

CURRENT

For most purposes a maximum output current of about one amp is satisfactory. Again, a higher maximum rating is desirable and increases the scope of the unit, but higher ratings cost money. A unit covering a 0 to 15 or 0 to 18 volt range at a maximum output current of one amp should be adequate for most requirements. If you can find one that is within your budget and offers a 0 to 30 volt output at up to two amps, then this should be able to power all but the most unusual of projects, or those that require dual balanced supplies (mainly circuits based on operational amplifiers).

Most circuits these days seem to be designed in such a manner as to avoid the need for dual supplies. It is certainly something I avoid as much as possible. You can obtain bench supply units that offer dual outputs, but these are quite expensive. They generally offer an output of up to a couple of amps or more on each output, but most circuits that require dual supplies have quite modest current consumptions.

Probably the most practical solution is to buy a single rail supply, and to then build a small dual output low power type when you have gained the necessary experience. In fact it is not a bad idea to hold on until you have the necessary experience, and to then build your own single output bench supply. Designs for these in electronics publications are not exactly rare, and building your own can be a much cheaper way of doing things.

REGULATION AND NOISE

In power supply specifications you will normally find various regulation and noise figures. The regulation is simply the percentage change in the output voltage for a given change in operating conditions (increase in output current, reduction in mains voltage, etc.).

For most testing a change of a few percent will not be of any consequence, but a lot of modern power supplies keep the output voltage within about 0.2 percent of the selected output voltage. A noise level of one to two millivolts is tolerable, but many supplies now seem to comfortably better this. A figure of about 250μV (0.25mV) is not untypical.

A feature that I would consider to be absolutely essential is some form of electronic overload protection. Fortunately, this is a standard feature these days, usually in the form of output current limiting. In other words, no matter how heavily you try to load the output of the supply, the maximum output current will no more than marginally exceed the maximum output current rating of the supply. This avoids damage to the unit when the inevitable short circuits on the output occur – you do not even need to change a fuse.

Really you need a supply which has several preset limit currents, or a continuously variable limit level. Basic current limiting is there to protect the supply against overloads, but ideally the limit current should be one which is low enough to protect the circuit being checked, in the event of it developing a fault.

Using a bench power supply is not particularly high-tech, but avoid the two classic mistakes. The first of these is getting the supply polarity wrong. With a bench power supply there is no battery connector to ensure that the supply is connected correctly. Use output leads of different colours to minimise the risk of any confusion.

The second common mistake is to connect the power supply, switch on the power, and then adjust the output voltage. If you are testing a 5 volt logic circuit and the supply was left from the previous session with an output potential of about 12 or 15 volts, you could well destroy every semiconductor in the test circuit!

Always set the output voltage before applying power to the circuit. When you have finished using a power supply unit always set its output at minimum. There should then be no problems if you forget to adjust the output voltage next time you use the unit.

LOGIC PROBES

As pointed out in the first article in this series, a multimeter is of relatively limited value when testing digital circuits. The pulse signals in a logic circuit mean that the test voltages displayed by a multimeter are often ambiguous, and may not bring the nature of the fault to light. An oscilloscope is very much better, or as a low cost solution a logic probe is probably the best choice.

Logic probes vary somewhat in sophistication, and in their most simple form they simply indicate whether or not the test point is at a valid voltage. These are of limited value, and a probe which can detect brief pulses is a much more practical proposition. These usually have three l.e.d.s which indicate high, low, and pulsing signals. Some units have a seven segment display which indicates the logic level by displaying appropriate letters (e.g. "L", "H", and "P").

A useful feature provided by some units is where one of the l.e.d.s varies in intensity depending on the duty cycle of the input signal. In other words, a squarewave signal having a 1 to 1 mark-space ratio would give half intensity, brief and intermittent positive pulses would give a low intensity, and long positive pulses at high frequency would give a high intensity. This gives you some idea about the nature of the signal, other than simply knowing it is pulsing in some way. This is a factor which is crucial for many types of logic testing

Some units have an audio "bleep" of different pitch to indicate each logic state. This is a useful feature that aids quick testing (but could make you unpopular with anyone in the vicinity).

Testing a digital circuit using a logic probe. This one has high, low and pulse indication, plus a memory function.

CMOS AND TTL

A slight complication with this type of unit is that the valid voltages for CMOS and TTL circuits are not the same. A logic probe should therefore be switchable between CMOS and TTL modes. Furthermore, it should be capable of operating over the full 3 to 18 volt supply range of CMOS logic devices, or something close to it anyway.

In practice many logic probes are CMOS compatible, but are useable with most TTL circuits. The differences in valid logic voltages will usually be irrelevant as the actual test voltages will be well within the acceptable limits. Probably the main risk is that TTL circuits will be too fast for the CMOS logic probe, but probably few TTL circuits operate at a high enough speed for this to be a severe problem.

The more expensive probes have a TTL/CMOS switch, with largely separate circuits so that true compatibility with both logic families is possible. I would recommend the purchase of a CMOS/TTL switchable probe, since these guarantee reliable results, and are still not terribly expensive (typically about £15).

There have been dozens of logic probe designs published, and they are almost invariably quite simple devices. If the cost of a good ready-made unit is a bit too high then a do-it-yourself version makes an interesting project and will provide you with an invaluable tool.

PROBING

A logic probe can be used in a similar manner to an oscilloscope as far as digital testing is concerned. Logic probes are obviously less sophisticated and effective in some respects, but they also have one or two advantages. Perhaps the main one is that a good logic probe will detect and clearly indicate a single pulse as brief as about 25ns to 30ns, but many scopes will not produce a visible trace with such a short pulse, and may not even be triggered by one.

If we take a few examples of logic probe action, any points in the test circuit that should be at a static level can be checked to ensure that they are at the right level, and pulse-free. On a circuit that has a clock oscillator and divider chain, the pulse indication of the probe can be used to test for output pulses from the clock and each divider circuit.

If the probe gives some indication of the input signal's duty cycle, this will prove useful. The output from a divider stage is normally an accurate squarewave.

With a computer add-on that connects to the computer's buses, there is an address decoder circuit that provides an enable pulse each time the circuit is accessed. It is easy to check that this pulse is being produced properly by writing a simple test program to access the add-on about once every two seconds. You can then use the probe to check that the address decoder is producing pulses at the appropriate rate.

If the pulse is supposed to be a negative type, then the test point should be high for the majority of the time, and the appropriate l.e.d. on the probe should be activated. With brief and intermittent pulses this is a useful ploy for determining whether or not they are of the correct polarity.

BIT PATTERN CHECK

When testing something like a parallel printer port, the probe will detect the strobe pulses, if they are present, and can be used to check the bit pattern of the data lines. A value of 85 (01010101 in binary) is a good one to use when testing any sort of parallel port. This is the sort of testing where an oscilloscope is advantageous, since it can show the relative timing of the strobe, data, and handshake lines. This is not possible using a logic probe, and it can only be used to check that there is some form of pulse signal on the handshake lines each time a byte of data is output.

Some points in logic circuits carry complex pulsing signals. A logic probe cannot tell you a great deal about signals of this type. However, it will at least show whether or not a pulsing signal at valid logic levels is present, and with a suitable probe you will get some idea of the duty cycle. This will probably show up a fault if one is present, but you need to keep in mind that this type of testing is not necessarily conclusive.

If the signal is not at valid logic levels, or is not a pulsing type at all, then there is almost certainly a fault at that point. If the signal looks about right, it is still just possible that there is a fault at that point in the circuit.

D.F.M.

A Digital Frequency Meter (d.f.m.) is of most use to those who are involved in the building, testing, and design of radio equipment. Most units will accurately measure audio frequency signals, but it is not often necessary to do this. By contrast, when setting up and testing radio frequency equipment it is often necessary to make frequent checks on the output frequencies of oscillators.

Whether or not a d.f.m. will be a good buy is therefore very much dependent on the type of project building you will be undertaking. As d.f.m.s are not particularly cheap, generally costing around £70 to £200, it is probably not worthwhile buying one unless you are fairly deeply involved in radio projects.

The cost of a d.f.m. is largely governed by the number of digits in its display, and the maximum input frequency it can handle. An inexpensive instrument would typically offer something like a four digit display and a maximum input frequency of 50MHz. The resolution of these more simple d.f.m.s is often much better than the number of digits in their display would suggest. They normally have several measuring ranges, and by a method known as "over-ranging" it is possible to effectively add a few digits to their display.

As an example, assume that an input frequency of 45.67MHz is displayed when using the 99.99Mhz range, and that switching to the 9.999MHz and 999.9kHz ranges give readings of 5.673MHz and 673.8kHz respectively. The extra figures obtained from the second and third readings can be tagged on to the end of the original reading to give a frequency of 45.673MHz.

This gives six digit resolution from a four digit display. Note that while this technique works well with most simple d.f.m.s, it is **not** likely to work with any other test gear which has a digital readout.

BETTER RANGE

One of these low cost d.f.m.s is suitable for most radio frequency testing. If you are particularly interested in v.h.f. and u.h.f. projects it would be a definite advantage to have one with a much higher maximum frequency. Instruments that can measure signals at frequencies of up to 1GHz (1000MHz) are now readily available, but are quite expensive at around £150 to £200. They normally give a seven or eight digit display, giving excellent resolution without the need to resort to over-ranging.

Usually these up-market d.f.m.s operate using a device called a "prescaler". In effect the instrument consists of a conventional d.f.m. which has a highest range of 99.999999MHz, plus a divide by ten circuit (the prescaler) which can be switched in at the input of the unit. Dividing the input frequency by ten means that an input frequency of 999.99999MHz is reduced to 99.999999MHz before it is fed to the main d.f.m. circuit.

A simple adjustment to the position of the decimal point by the range switch gives a readout directly in MHz. External prescalers can be fitted to any d.f.m. incidentally, but it is then up to you to mentally adjust the decimal point one place when making measurements.

A d.f.m. is not difficult to use, but you need to be careful about the choice of test point when testing L-C oscillators, especially high frequency types. In general it is best to choose a low impedance part of the circuit, and as far as possible to avoid taking the signal from directly across the tuned circuit.

Remember that there will be a certain amount of capacitance in the test leads, and the d.f.m. itself will have a small amount of input capacitance. This could significantly reduce the operating frequency of the tuned circuit, and in an extreme case could damp the oscillator to the point where it ceases to function.

R.F. GENERATOR

The R.F. Generator is another piece of equipment that is invaluable to the radio enthusiast, but which is likely to be of little value to anyone else. Low cost r.f. signal generators cover from about 100kHz to a maximum frequency of around 50 to 200MHz. Harmonics provide higher frequencies, up to about 500MHz.

Most seem to have provision for a crystal to be plugged in so that accurate spot frequencies can be provided. The dial calibration is often not terribly accurate, and if highly accurate frequencies are needed, crystals offer one means of obtaining them. Alternatively, a d.f.m. can be used to act as a frequency readout so that the dial can be accurately adjusted for the required frequency.

There is normally provision for an external audio modulation source, or an internal 1kHz oscillator can be used. The modulation is usually of the amplitude (a.m.) type with no provision for frequency modulation (f.m.).

The main use for an r.f. signal generator is to provide signals at certain frequencies when aligning radio receivers. The exact alignment procedure varies somewhat from one receiver to another. The article describing the radio, or the service manual in the case of a ready made unit, should give detailed alignment information.

A.F. GENERATOR

If you are interested in audio circuits, then an Audio Frequency Signal Generator is a piece of equipment that you should obtain as soon as possible. These units are in two main categories; the traditional sinewave/squarewave type, and function generators. The traditional type has a high quality sinewave generator, usually based on a Wien oscillator with a thermistor to stabilise the oscillator. This gives a well stabilised output level and a low distortion sinewave signal.

The more simple circuits of this type generally have well under one percent distortion, while the better quality types have distortion levels of only about 0.01 percent or less at most frequencies. With a suitable filter, these high quality units are suitable for distortion testing on hi-fi equipment. The squarewave signal is usually derived from the sinewave signal by amplifying it to give severe clipping, or by feeding it to a trigger circuit.

FUNCTION GENERATOR

A Function Generator is based on a high quality triangular waveform generator. As in a Wien type signal generator, the squarewave signal is produced from this by feeding it to an amplifier or trigger circuit.

The sinewave signal is produced using a non-linear amplifier to process the triangular signal. The basic idea is to have an amplifier with a gain level that reduces as the positive or negative input voltage increases. This rounds off the triangular waveform to give something approximating to the required sinewave signal. Units of this type often produce quite high distortion levels, with two or three percent being quite typical. However, some of the better quality types can be set up to produce distortion levels of well under one percent.

For much testing even a two or three percent distortion level is satisfactory, including most frequency response testing. However, for audio testing my preference is for the traditional type of signal generator with its lower distortion, which makes it just that bit more versatile.

Most audio generators can provide a squarewave output at TTL logic levels, and this is a useful bonus. This is one respect in which some function generators are superior, as they often offer a variable pulse width TTL output signal.

SWEEP GENERATOR

In catalogues you will probably find a form of audio signal generator called a "sweep generator". This is a type that can be swept over a wide frequency range by an input voltage. This voltage is usually provided by an internal sawtooth oscillator, and the equipment is used in a setup of the type outlined in Fig. 1.

The basic idea is to have the oscillator swept upwards in frequency while the

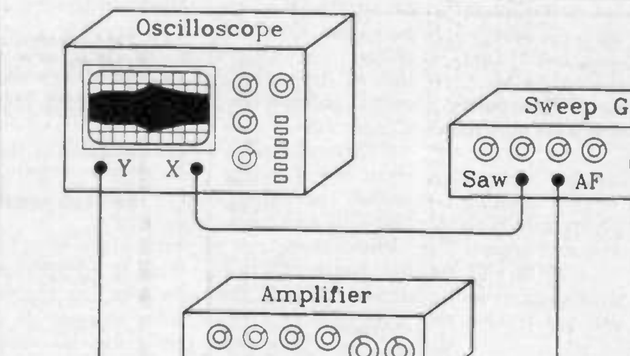


Fig. 1. Using a sweep generator and an oscilloscope to test frequency response.

oscilloscope's beam is swept across the screen. The output of the generator is fed through a piece of audio equipment and into the Y input of the oscilloscope. The X axis of the oscilloscope is effectively calibrated in frequency rather than time, and the height of the trace represents the gain of the audio device under test. In other words, the trace on the oscilloscope is drawing out the frequency response of the test circuit.

Results usually lack the precision of carefully measured and plotted results, but this represents a very quick way of frequency response testing. It will almost instantly show up any peaks or valleys in the response. Of course, a sweep generator is of little use unless you have an oscilloscope or chart recorder to monitor the output of the circuit under investigation.

USING AN AUDIO GENERATOR

The audio range extends from 20Hz to 20kHz, and so any audio signal generator must cover at least this range. In practice most units go well beyond 20kHz, with maximum frequencies often somewhere in the region of 200kHz to 2MHz. This is useful, but is not of crucial importance. At the other end of the range few units go much under 20Hz, but you are unlikely to need an infra-audio signal.

The controls of an audio signal generator are quite simple, with the main ones being a calibrated frequency control, the range switch, and the attenuator. The latter is usually in the form of a volume control style variable attenuator, plus a switch type which can reduce the output level by 20 or 40dB (i.e. by a factor of 10 or 100).

The switched attenuator should be used when very low output levels are needed, as it will otherwise be extremely difficult to accurately set the required output levels. The main use of a signal generator is to provide a sinewave input signal so that signal tracing techniques can be used, either with a signal tracer, or an oscilloscope.

SIGNAL TRACER

It should perhaps be explained that a signal tracer is a sensitive audio amplifier driving a loudspeaker or earphone. This can be used to detect audio signals at various points in a circuit, and can be used in a similar manner to an oscilloscope when testing linear circuits. It cannot be used to precisely measure signal levels, and it will not show waveforms.

On the other hand, with experience you can learn to gauge signal levels quite accurately, and if you use a sinewave test signal, any distortion should be quite apparent. A sinewave has a very pure and unmistakable sound, and even slight distortion can be readily detected by most people.

Signal tracers do not seem to appear in any of the electronics catalogues in my collection, but there have been plenty of designs for these published over the years. There is a very low cost solution to the problem, which is to use a crystal earphone. These have a fairly high input impedance, a very high input resistance, and enable signals down to a few millivolts peak to peak to be detected. Simply remove the 3.5 millimetre jack plug and connect one of the leads to a crocodile clip (which connects to earth) and the other to a test prod (which is connected to the test points).

With a signal generator and an oscilloscope you can measure the input and output levels to each stage in a circuit, which permits voltage gains to be accurately measured. By using a range of test frequencies you can check the frequency response of an audio unit, or even just test one of its stages.

With something like an audio compressor circuit, the voltage gain can be checked at a range of input levels. A graph showing the compression characteristic can then be drawn up, and this will show up any deficiencies in the unit's performance. With an audio signal generator and an oscilloscope there is very little testing that cannot be undertaken.

MILLIVOLT METER

As an alternative to using an oscilloscope for measuring signal levels, there is a device called an a.c. millivolt meter. This is rather like an analogue multimeter switched to a low a.c. voltage range, but a millivolt meter offers far higher sensitivity. Typically a unit of this type has an input impedance of one megohm, and ranges down to one millivolt r.m.s. The bandwidth usually extends from sub-audio to a few hundred kilohertz or more.

A unit of this type is excellent for frequency response testing, gain measurement, measuring the background noise level, etc. The problem with ready-made a.c. millivolt meters is that they tend to be very expensive, and for amatuer purposes are likely to be very over-specified. Once again, do-it-yourself designs are published from time to time, and these provide a low cost method of obtaining an a.c. millivolt meter of reasonable performance.

COMPONENT TESTER

In most electronics catalogues you will find a few component testers, particularly transistor checkers and capacitance meters. As I have pointed out before, unless there is a mechanical fault such as a solder splash, electronics testing usually ends up with some component tests. These ready-made testers are not necessarily a good buy for the electronics enthusiast though.

With many multimeters offering a transistor checking facility, plus what is in other respects a very respectable specification for the money, buying a separate transistor checker seems to be a relatively expensive means of obtaining this facility. Also, there have been many simple transistor tester designs published. These make interesting and useful projects which are within the capabilities of beginners.

A capacitance meter is a very useful piece of test equipment, but one which is likely to be quite expensive to buy ready-made. Once again, a do-it-yourself unit could be more economic, as well as providing you with an interesting project to construct.

Some digital multimeters now include capacitance ranges, and it is well worth seeking out a unit of this type if you are considering the purchase of a digital multimeter. The d.m.m. I use can measure capacitors from a few pF in value up to 20µF. It also includes a transistor gain measuring facility, plus an impressive range of resistance, voltage, and current ranges. A unit of this type is a tremendous asset when fault finding, and if you shop around it need not cost a fortune. □

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Fax of the Matter

It is interesting to watch Amstrad shake off its image as a purveyor of budget consumer electronics. With its profits and share prices down, Amstrad has stopped making audio equipment and is selling off video camcorders at a fraction of their original price - a full kit for £299 instead of the original, already low, price of £499.

Now Amstrad has launched a new facsimile machine which costs less than £600 (plus VAT) and incorporates clever technology so far found only on machines costing many times the price. The Amstrad FX9600T memorises a batch of commonly used numbers, automatically feeds up to 20 pages without manual assistance, chops received pages to length from a continuous roll, and (optionally) prints a red star on the original document to prove that it has been transmitted.

All standard features on upmarket machines, but the Amstrad fax is also Mercury-compatible. Users can enter their secret Mercury authorisation codes into the machine memory so that the code is automatically dialled ahead of any long distance number. This routes the call out of British Telecom's network, and via Mercury's network, to take advantage of the lower costs charged by Mercury.

Importantly the machine mutes the sound of dialling when the Mercury code is being transmitted and does not show it on the liquid crystal screen display. This prevents people looking at the screen, or analysing the telltale sound of the tones, to steal somebody else's Mercury code and thereby charge unauthorised calls.

Computer Control

The Amstrad fax also plays the very clever trick of relaying documents direct from a computer. Currently most office workers must type text into a computer, edit it on screen, print it onto paper, carry the paper to a fax machine and feed it through by hand. The FX9600T short-circuits this clumsy procedure with its own standard parallel Centronics printer socket.

If the printer output from the computer is plugged into the FX9600T socket instead of a printer, the fax machine memorises whatever text is sent by the computer, converts it into facsimile format and transmits it down the telephone line as a fax message. This message can then be received and printed out by a conventional fax machine in the usual way.

The advantage, apart from cutting out the step of printing before transmitting, is that text quality is better because there is none of the degradation inevitably caused by scanning paper text.

The operator can even add a personal signature to a text message sent direct from the computer. The FX9600T scans a signature on paper, and stores it in memory. Whenever a pre-set code signal is buried in the text being sent from the computer the fax machine retrieves the memorised signature and transmits it.

I tried the FX9600T with Mercury, and with a computer. It worked well, but only after I had given up on the instruction manual and found by trial and error that the secret Mercury authorisation code must be entered twice instead of once as indicated in the manual.

I also had to find by trial and error that an unmentioned switch on the fax machine must be set to "on line" before it will accept text from a computer. Without advice from a dealer, many users will end up completely flummoxed.

The Amstrad FX9600T has one further technological trick up its sleeve. It can in the future be used as a document scanner, for use with a desk top publishing system. When a document is fed through the fax machine without sending it down a telephone line, the machine either makes a photocopy or delivers the scanned signal from an unused socket on the rear.

With suitable interface electronics this socket will be able to connect with a computer to store and manipulate the scanned image. Amstrad says it has no plans to produce such an interface, but is happy for third parties to do so if they wish.

Static Charge

By the way, a few early machines showed a puzzling problem. For no apparent reason the LCD screen would show garbage and the machine lock up and refuse to operate. The cure was to unplug from the mains and remove the memory back-up batteries, to "cold start" the machine.

This did the trick, but lost all stored numbers and codes. Amstrad say they traced the fault to static electricity generated between some brands of paper and the plastic sheet feeder. The fix, says Amstrad, is an anti-static strip to be provided on the feeder tray in all future machines.

Amstrad buys in these machines from Hong Kong. Humidity is so high there that static electricity is never a problem. But when equipment is used in a centrally heated room or office, static rears its ugly head.

My advice; if you buy one of these good value fax machine units, is to check that it has the strip.

Hot Wire

I recently met a German electronics engineer whose hobby is collecting old radios. His prized possession is the first German portable sold off after the war. It ran on bulky batteries but as an option could be plugged into the mains, just like a modern portable radio with mains adaptor.

The wily Germans kept the price and size down with a neat trick. They left out the transformer normally needed to drop mains voltage to battery voltage.* Their trick was to put a string of high voltage resistors in the mains cable. So by the time the mains voltage had got from the wall socket to the radio, it had been dropped to the same level as a battery.

The inevitable side effect, of course, was that the mains cable got very hot. So in cold weather the radio doubled as a room heater.

**On no account should readers try this on their radios – we value your custom too much to loose you! – Ed.*

Secret Code

Hifi shops now often leave a compact disc player on demonstration, programmed to play the same record over and over again. Because the disc is being read by a laser light beam, there is no wear. The only trouble is that when shop staff are busy, some customers press the player's "drawer open" button, and steal the disc. It happens at hifi exhibitions, too.

Now Philips has come up with a neat solution. The Dutch company's latest CD player, the 840 (a very nice machine, incidentally) has all the usual control buttons on the front, plus some extra ones.

Shop keepers are told a secret combination code, which involves pressing three of these in order. After that, and until another secret code is entered, the disc plays but the drawer is electronically locked.

For obvious reasons, Philips do not put the secret code in the instruction manual and we are not going to publish it. But we will draw your attention to something else that is in the instruction book, and which no-one else yet seems to have spotted.

Like many Philips CD players the 840 has a feature called "favourite track selection", or FTS. This lets the user program the player to play only selected tracks from a disc, in any preferred order. The clever part of FTS is that the player recognizes the disc, by memorising its unique combination of music tracks and times. No two discs are ever likely to have exactly the same mix of musical items.

FTS on the 840 goes a lot further. In addition to memorising the user's favourite track selection, it also quietly notes and memorises the number of times any of these discs are played.

This information stays stored in the player's memory, even when it is switched off. So at any time the player can tell how many times a particular piece of music has been played.

Users have absolutely no use for this feature. But it provides a technological basis for the record industry's future plan to charge the public copyright fees for every home recording made.

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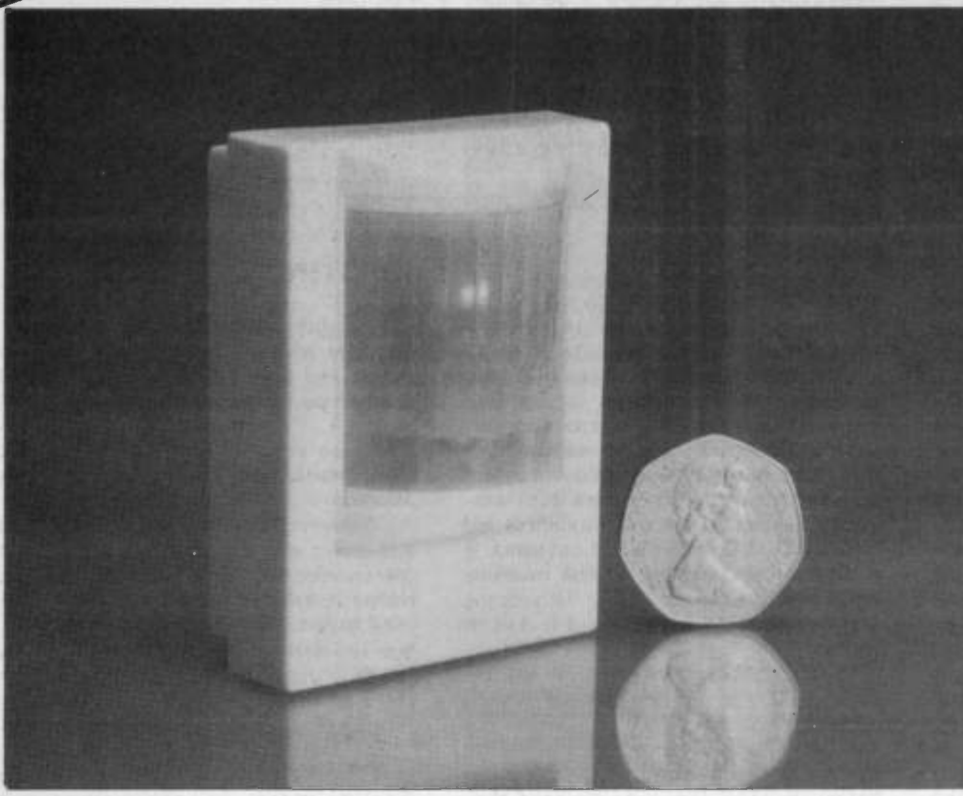
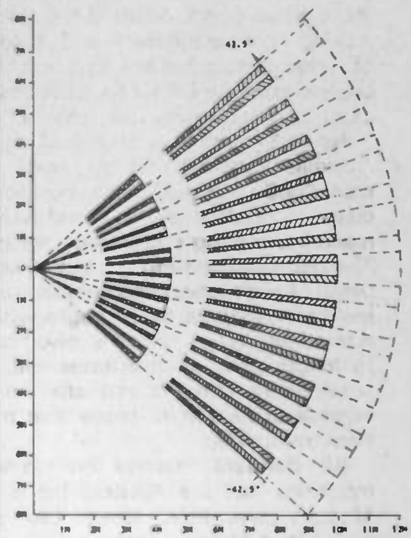
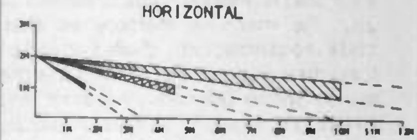
PASSIVE INFRA-RED INTRUDER DETECTOR



DETECTION PATTERN



HORIZONTAL



VERTICAL

THE RP33 Riscomp passive infra-red intrusion detector is designed for use in both residential and commercial security systems. It operates by detecting the body heat of an intruder moving across the detection field. The detector employs a dual element pyroelectric sensor which is designed to overcome the effect of changes in ambient temperatures, thus ensuring a stable and reliable performance, while the considerable filtering employed in the advanced circuitry ensures that the sensor is unaffected by RF interference and electrical transients.

Installation is easily carried out on a flat surface or in a corner location without the need for additional brackets, whilst the angled rear of the case permits the unit to be mounted in an off-set position as may be required in some locations to achieve optimum coverage. Vertical adjustment of the detection pattern over a 10° range is provided, whilst the dual range facility allows the installer to optimise coverage for the intended location.

The RP33 is suitable for use with the Riscomp control units type CA 1382 and CA 1250, or any equivalent high quality control unit.

SPECIFICATION

Operating voltage:	9-15V d.c.
Current consumption:	14mA at 12V.
Relay output:	Normally closed contacts rated at 0.5A with 22 ohm resistor in series.
Anti-tamper switch:	Normally closed rated at 1A.
Detection range:	Switchable between 7 and 12 metres.
Detection zones:	24 in 3 planes.
Maximum operating angle:	85°
Mounting height:	2-3 metres.
Walk test:	Red l.e.d. (with disable switch)
Dimensions:	80mm × 60mm × 40mm.
Sensor type:	Dual element ambient cancelling.

POST TO: EE Intruder Detector offer, Riscomp Ltd., 51 Poppy Rd., Princes Risborough, Bucks HP17 9DB

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Please suply:

Quantity	Product	Price
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... Interface ... Disk Interface ... Interface ...

THE standard BBC micro disk interface is something that was covered briefly in a previous *"Beeb Micro"* article. On that occasion we were mainly concerned with actually installing the disk interface components (which were an optional extra on the BBC model B), and getting the computer connected to a suitable disk drive.

The cost of fitting this type of interface is now quite high, with some of the components seeming to be in short supply (and long out of production). However, I believe that there is still a disk interface upgrade available at reasonable cost, although this would seem to involve fitting a daughter board of some kind onto the main board.

Anyway, a disk drive still represents one of the best upgrades for a basic BBC model B computer. The BBC computer's cassette interface is one of the best, but it falls well short of the disk system in terms of speed and convenience. Much of the best BBC software would only seem to be usable with disk based systems.

Disk Basics

In this month's article we will consider the basic way in which the BBC disk interface operates. Disk interfaces are probably less well understood than (say) RS232C or Centronics types, and are inevitably a bit more complex. The fundamentals of disk interfaces are not difficult to master though, and it is quite an interesting form of interface.

It is worth mentioning that the type of floppy disk interface used in the BBC computers is essentially the same as that used on many other computers, such as the IBMs and compatibles, Atari STs, etc. There are occasional differences between one "standard" disk interface and another, with some interfaces having the ability to detect whether or not the drive door is closed, for example, while others do not implement this feature. Much of the information given here applies equally to many other computers though.

Connection to the disk drive or drives is via a 34 way IDC connector and a 34 way cable. At the disk drive end of the system there is usually a 34 way edge connector, and the cable simply connects pin 1 to pin 1, pin 2 to pin 2, and so on. As can be seen from the pin identification diagram of Fig.1, many of the 34 wires are either left unused, or simply act as screens between the various control cables.

Parallel?

You may encounter references to disk drives being parallel data devices, and I have seen it stated that they achieve their relatively high operating speeds by using parallel data exchanges. This is a little misleading in that data is fed to and received from a disk drive in serial form.

The disk controller chip provides serial to parallel, and parallel to serial conversion so that, as far as the software writer is concerned, the disk drive appears to be a parallel device. It is not though, and data is written to and read from the disk on a bit-by-bit basis.

Control of the disk drive is really a three stage process. Working from the disk drive backwards, much of the control electronics is actually part of the disk drive itself. Thus, the drive can be controlled using a few simple digital outputs, plus a few digital inputs that are needed to monitor status output's of the drive's control electronics.

Next there is the disk controller chip, plus some supporting hardware, in the computer. The exact facilities the controller provides varies from one controller to another, but it at least provides the necessary inputs and outputs to interface to the disk drive, plus some electronics to keep track of the read/write head's position. It may also provide facilities such as aids to disk formatting and error detection.

Last, and by no means least, there is the operating system software. This is generally in ROM within the computer, or to some extent within ROM. With a disk based operating system such as MS/DOS it is not possible to have all the disk control routines on disk, as it would be impossible for the operating system to boot-up from disk at switch-on! Some disk control and reading routines must be present in firmware within the computer.

In the case of the BBC computers of course, the operating system program is contained entirely within the appropriate ROM. It would probably be an exaggeration to say that the disk interface is totally unusable without the correct disk operating system ROM installed in the computer, since it would presumably be possible to use your own routines to directly control the disk system. However, this would definitely be doing things the hard way, and normally the disk drive would only be accessed via the appropriate operating system calls.

Control Lines

If we now consider the important lines on the disk interface, there are separate read and write lines ("read data" and "write data"), and not a bidirectional data line. However, there is a single read/write head fitted in the disk drive (or two read/write heads in the case of a double-sided drive). The drive must be set to the read or write mode via the "write enable" input, and it will not be switched automatically simply by sending data on the "write data" line.

There are two drive select outputs, and this enables four disk drives to be controlled, as there are four possible logic state combinations for these outputs. Probably few BBC computer systems are equipped with more than two drives, and in most cases the second drive select line is superfluous. The BBC computer is compatible with double-sided disk drives, and when used with these it is the "side select" line that is used to select the desired side of the disk.

I suppose the easiest system of setting the drive to the desired track would be to have a number of parallel outputs, so that the desired track number could be written to the drive using the correct binary code. The system actually used is more crude than this, with the drive being stepped from one track to the next. The basic idea seems to be to have two outputs, with the "seek/step" one being used to step the drive from one track to the next, and the "direction" output being used to control whether the drive steps upwards or downwards.

The disk drive is a bit like a mechanical version of a binary up/down counter. Although this method of control may be a bit crude, the disk controller hardware plus software or firmware in the computer can make selection of the desired track an easy process, with the stepping procedure being "invisible" to the programmer.

Sectors

Selecting the right track is easy enough with the aid of the disk interface chip's hardware, but each track is divided into a number of sectors. The BBC disk interface uses ten sectors (numbered 0 to 9)

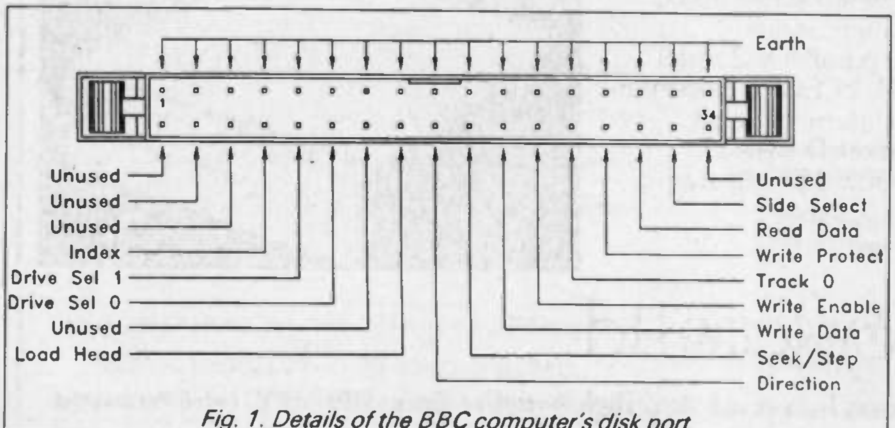


Fig. 1. Details of the BBC computer's disk port.

per track, and the disk drive system must be able to find the required sector of the selected track. The "index" input on the computer is an essential part of the disk system's navigation system. This operates in conjunction with the index hole in the disk, and a simple photo-electric circuit in the disk drive's electronics.

Each time the index hole in the disk passes the index window in the sleeve, a pulse is generated and sent to the computer via the "index" line. The disks and drives used with the BBC computer are of the "soft sectored" variety, which means that there is only one index hole per disk, not one per sector. This index system therefore does no more than mark out a single reference point on each track, which can be used as the starting point of one sector.

The starting points of other sectors can be located initially by a system of timing. This relies on the disk drive having a standard rotation speed which must be maintained with good accuracy. The disk controller chip includes facilities to aid the location of the beginnings of sectors. Once a disk has been formatted, there are marker signals on the disk which aid the disk system in its navigation around the disk.

Write Protect

The "write protect" line is an input, and it enables the computer to detect the presence of a write protect tab on the disk. I think I am correct in stating that this is just to enable the computer to display a suitable error message if its operating system is designed to do so.

The drive itself is designed so that it will not write to a disk that is equipped with a write protection tab, even if the computer should try to force it do so. The "load head" line is used to control whether the head is withdrawn, or in place against the disk.

The 8271 disk controller chip of the original BBC disk interface is at addresses from ?&FE80 to ?&FE84, but in practice it should never be necessary to read or write direct at any of these addresses. There are operating system commands and calls to aid control of the disk system. Also bear in mind that the more recent BBC disk interfaces are not actually based on the 8271 controller, and any direct control of the interface that assumes an 8271 is fitted will obviously be unsuccessful if tried with a more recent interface.

This covers the basic way in which the disk interface functions, but it little more than scratches the surface as far as the detailed operation of the BBC disk system is concerned. A more detailed discussion really goes beyond the scope of this series, but if you are keen to know more there is at least one book which covers this aspect of the computer in great detail.

Key To Success

Some time ago I appealed for any information about public domain ("PD") or shareware software for the BBC computers. Software of this type certainly exists for the Archimedes computers, and most other current machines (plus a few obsolete types come to that). The totally underwhelming response to my appeal for information would tend to suggest that my suspicions were correct, and that no significant amounts PD or shareware software is available for the BBC model B series of computers.

Some time ago I also mentioned that replacement keys and keyboards were available for the BBC computers, from the original models A/B through to the Master 128. A letter from a reader indicated that both of these were actually very difficult to obtain at that time. The situation might have improved by now, but it is probably worth mentioning that computer keyboard switches are listed in several of the larger electronic component catalogues. Although it is unlikely that the correct type of switch will be obtainable as an "off the peg" item in a components catalogue, you might be able to find something quite similar.

I once managed to repair the keyboard of an obsolete home computer by using a key switch that had the right "footprint" to fit the printed circuit board, but which did not fit the key correctly. A small amount of filing soon had the key nicely in place though. Even if you cannot find something that is suitable as a long term replacement, you might at least be able to produce a temporary fix that will enable the computer to be used to some extent until a proper replacement can be obtained.

There is an old service engineers "trick" that might be applicable to BBC keyboard problems. If a switch becomes faulty, and a replacement cannot be obtained, it is often possible to swop over the faulty switch with another one on the equipment that is little or never used.

Whether or not a key of the BBC keyboard could be successfully sacrificed in this way obviously depends on the applications in which it is used, but probably in most cases there is at least one key that is non-essential. As it is the keys that are used the most which tend to wear out first, a swap of this type would almost certainly render the computer a little more usable.

MARC

MAINS APPLIANCE REMOTE CONTROL SYSTEM

CHRIS WALKER

Part Three: Mains ON/OFF Decoder

Allows up to 15 different household mains appliances, placed anywhere in the house to be controlled form the safety of your armchair.
Can be linked to the home computer.

THE Mains Appliance Remote Control (MARC) system described in the last article is designed to facilitate easy remote control of mains operated appliances without running control wires to them. It works by sending encoded control data down the mains wires where it is received by a designated decoder unit into which the appliance is plugged.

The decoder, therefore, has control over the a.c. power entering the appliance allowing ON, OFF switching to be performed. Up to fifteen different decoders can be addressed.

The unit to be described in this article is an ON/OFF Decoder which, as its name implies, gives on/off control of appliances rated at up to 5A resistive (this rating can easily be increased). The power switch on the appliance is left permanently in the ON position and the decoder performs the switching under control of the Encoder Unit described previously. Although the prototype is fitted with a 13A plug and socket the unit can be permanently wired into the house electrical system (via suitable fusing) to control fitted devices such as ceiling lamps etc.

SYSTEM OPERATION

The Encoder unit, described last month, sends digital information along the house wiring by keyed carrier modulation of a 100kHz carrier wave.

The first requirement of the MARC Decoder unit is to separate the 100kHz pulsed carrier wave from the 50Hz mains a.c. waveform. This is performed by the 100kHz filter section on the block diagram of Fig. 3.1.

The amplitude of the receiver carrier will depend on a few factors, namely:

a) *The line length between encoder and decoder.*

b) *The loading on the line caused by appliances connected to it.*

c) *The loading on the line caused by other MARC decoders.*

In order to compensate for various transmission line conditions, the received signal undergoes a small amount of amplification (× 10) before entering the demodulator.

Demodulating a keyed carrier is a very simple task and it is primarily for this reason that keyed carrier modulation is employed in the MARC system. When no carrier is present the output of the demodulator is low. When receiving a carrier pulse, the demodulator output is high.

These digital pulses are fed to the data input of the decoder which waits to receive two consecutive and identical "words" before responding, thus greatly reducing the chance of receiving errors. Each data word transmitted by the encoder consists of two parts. Firstly the "receiver number" is encoded onto the line, this designates which decoder is to respond to the incoming data.

Four switches set which receiver number any one particular decoder should be, in a normal system all decoders will be set with different numbers but in certain situations two or more decoders may be required to respond simultaneously to the same command and thus be set with the same number. There are fifteen different combinations of the four switches (0000 not allowed).

FUNCTION CODE

The second part of the data word contains the "function code" which determines what action the chosen decoder unit should take on receipt of its command. The ON/OFF Decoder described here responds to function codes 0001 (ON) and 0010 (OFF). The output of the decoder drives a double-pole relay which switches mains power to the appliance.

Without the use of a dedicated integrated circuit to perform the decoding function it would be difficult to produce a design such as this. It is important, after all, to make the decoders relatively compact or else they become obtrusive and the advantages of a "wireless" control system are lost.

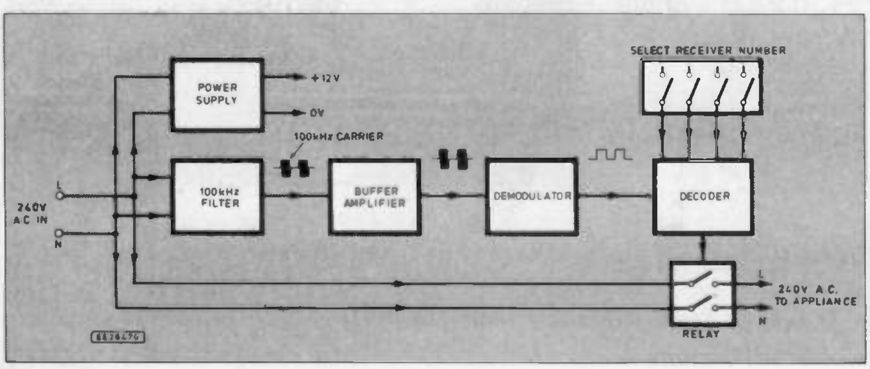
CIRCUIT DESCRIPTION

Readers familiar with the Encoder circuit will notice a very similar "front end" in Fig.3.2, between the low-voltage electronics and 240 volts mains. Capacitors C1 and C2 provide complete isolation of the circuit from mains live and neutral but present a low impedance to the 100kHz (actually 104kHz) carrier signal which thus flows through one winding of impedance matching transformer T1.

Capacitors C1 and C2 MUST be of "Class X" rating since they are connected directly between live and neutral. Cheaper capacitors, although of adequate working voltage, could fail explosively!

The signal is induced into the other winding of T1 which, together with capacitor C3, forms a parallel tuned circuit tuned to resonate at the carrier frequency. At resonance, a parallel tuned circuit has a high impedance and a large amplitude signal appears across it. Signals at different frequencies will appear at significantly lower amplitudes because the circuit has a lower impedance at these frequencies. A simple single-stage passive tuned circuit filter provides adequate filtering in this application.

Fig. 3.1. Block diagram for the ON/OFF Decoder.



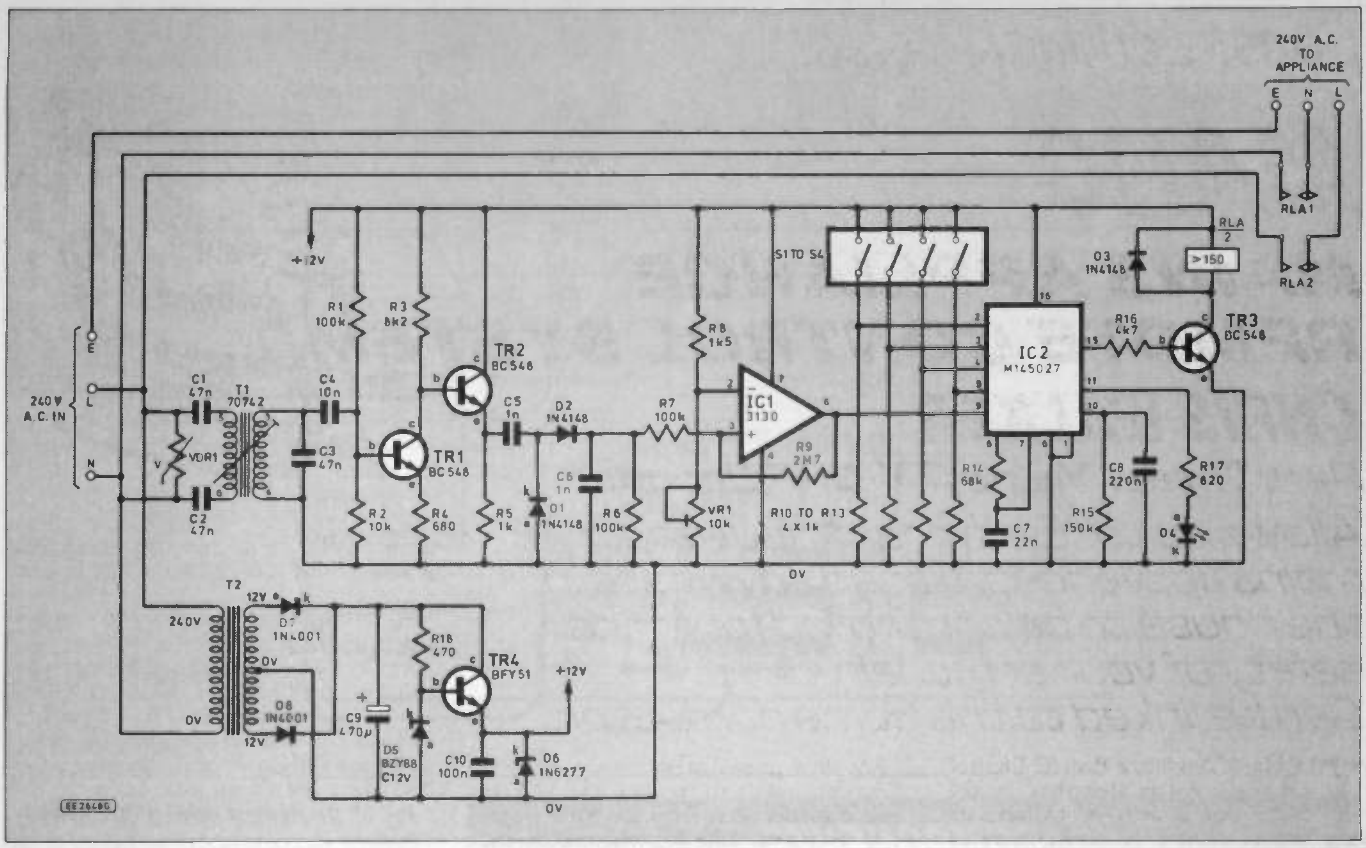


Fig. 3.2. Complete circuit diagram for the ON/OFF Decoder. It is most important that only the specified capacitors be used for C1 and C2.

The incoming signal is coupled through capacitor C4 to the base of transistor TR1 which is biased as an amplifier with a gain of about ten. Emitter follower TR2 buffers the output to drive a diode pump which demodulates the keyed carrier.

When a carrier signal is received the voltage at TR2 emitter oscillates up and down. The d.c. bias is removed by capacitor C5 and, during positive half-cycles, the charge is pumped via diode D2 into capacitor C6 which consequently develops a p.d. (potential difference) of about 10V across its terminals. When the carrier stops, the p.d. across C6 rapidly drops to zero as it discharges through resistor R6.

In order to "square up" the data pulses from the diode pump they are fed through the Schmitt trigger formed by IC1 and associated components. The positive feedback provided by resistor R9 provides a small amount of hysteresis, about 0.4V.

Resistor R8 and preset potentiometer VR1 provide a reference voltage which sets the switching points of the Schmitt trigger. Preset VR1 is adjusted so that the voltage at the inverting input of IC1 is *just below* the "high" output from the diode pump. This way, the pulse lengthening effect discussed in the previous article is reduced to a minimum.

DECODER

Pin 9 of IC2 is the data input of the decoder. The d.i.l. switches S1 to S4 set the binary code on pins 2 to 5 which determines the "receiver number" of this decoder. As in the Encoder unit, pin 1 is tied to 0V.

Resistor R14 and capacitor C7 are timing components which enable the decoder to distinguish between a long or short data pulse whilst R15 and C8 are used to detect the space between "words". All these components should have a tolerance of ±5 percent or better.

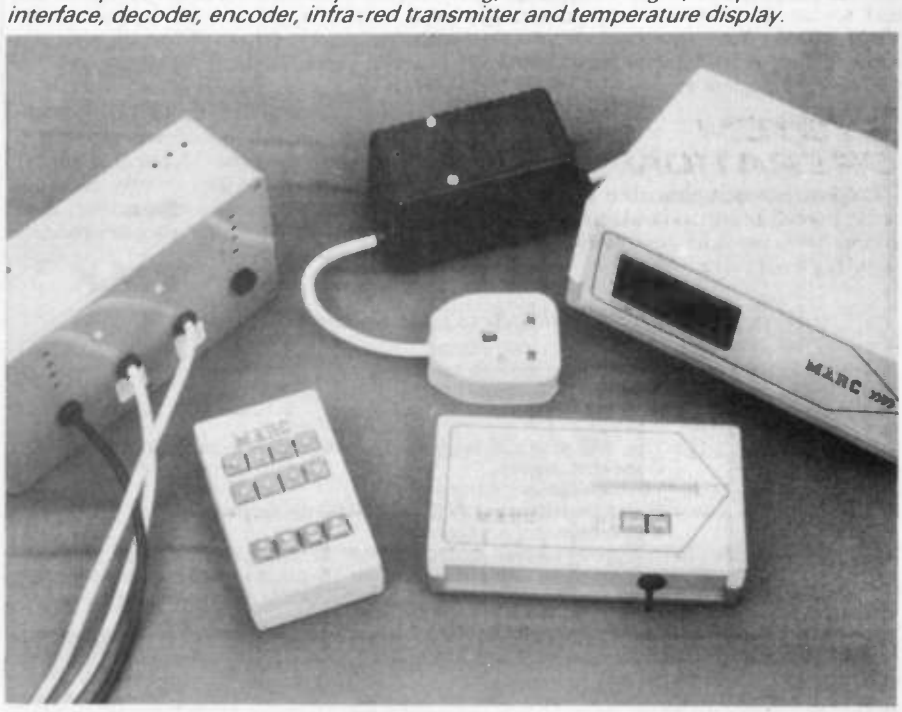
Pin 11 of IC2 is the "valid transmission" output which briefly goes high if the received data matches the code set on pins 1 to 5. It is used to light l.e.d. D4 which is useful during setting-up to determine when a decoder has been addressed properly.

The received "function code" is latched onto pins 12 to 15 of IC2. Pin 15 is the least significant bit, therefore, when the "ON" code (0001) is sent this pin goes high and switches on transistor TR3 which energises relay coil RLA, closing the contacts and switching on the appliance. Code 0010 (OFF) relaxes pin 15 to zero and switches off the relay.

Transformer T2 derives 12V a.c. from the 240V mains which is then rectified by diodes D7 and D8 and smoothed by capacitor C9. There is a stable 12V present across Zener diode D5 and, allowing for the 0.6V base-emitter voltage drop, about 11.4V exists at transistor TR4 emitter which supplies the rest of the circuit. Capacitor C10 decouples the supply rails.

Components VDR1 and transient suppressor "diode" D6 are protection devices which prevent high-voltage spikes on the mains from entering the circuit and damaging the electronic components. The mains transient suppressor VDR1 presents a low

The complete MARC control system showing, from left to right, temperature mains interface, decoder, encoder, infra-red transmitter and temperature display.



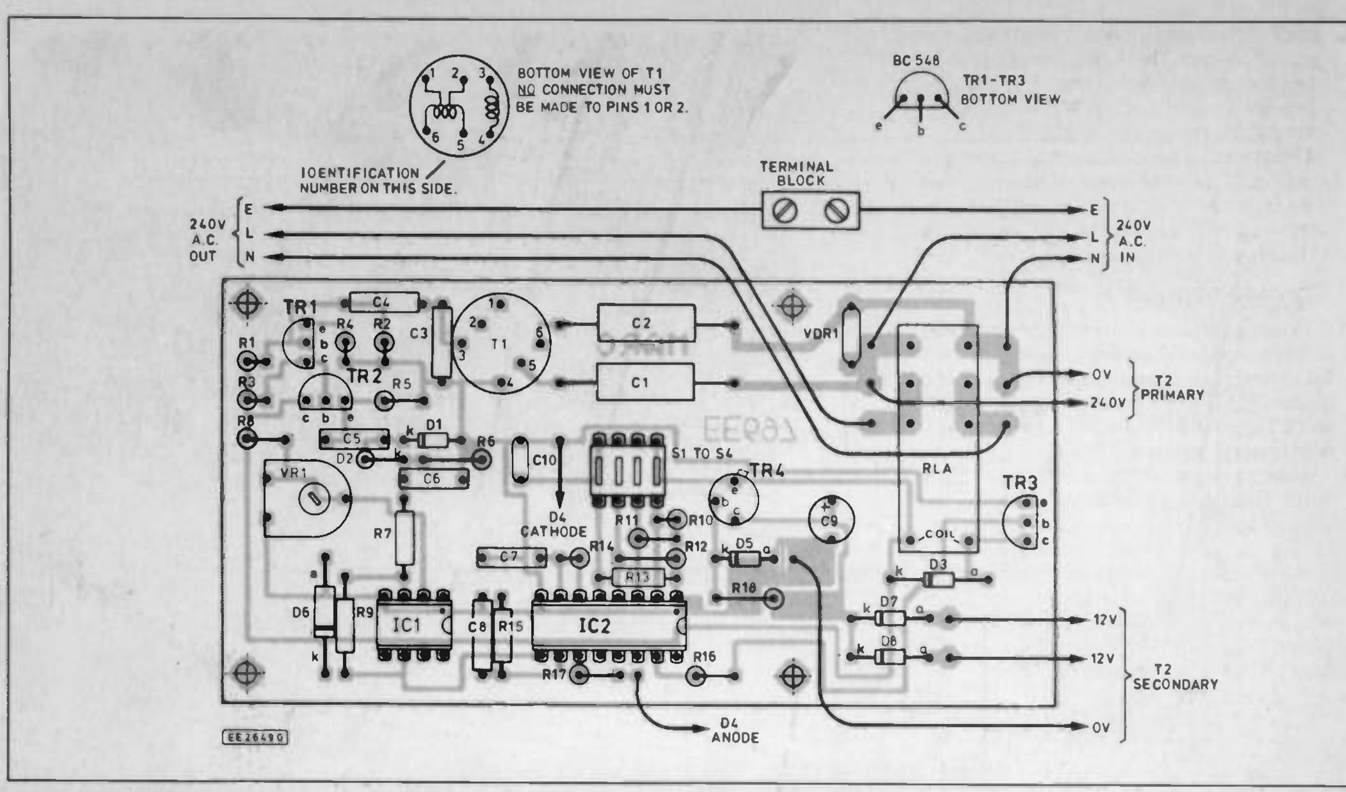


Fig. 3.3. Printed circuit board component layout and full size copper foil master pattern.

COMPONENTS

Resistors

R1, R6, R7	100k (3 off)
R2	10k
R3	8k2
R4	680
R5, R10-R13	1k (5 off)
R8	1k5
R9	2M7
R14	68k
R15	150k
R16	4k7
R17	820
R18	470

All 0.25W ±5% carbon

Potentiometer

VR1	10k min. skeleton preset, horiz.

Capacitors

C1, C2	47n	metallised PETP (Class X) (2 off)
C3	47n	metallised polyester film
C4	10n	polyester layer
C5, C6	1n	polyester layer (2 off)
C7	22n	polyester layer
C8	220n	polyester layer
C9	470µ	radial elec. 35V
C10	100n	monolithic ceramic

Semiconductors

D1-D3	1N4148	signal diode (3 off)
D4	any small light emitting diode	
D5	BZY88C12V	12V Zener diode
D6	1N6277	transient suppressor
D7, D8	1N4001	rec. diode (2 off)
TR1-TR3	BC548	*npn* silicon (3 off)
TR4	BFY51	*npn* silicon
IC1	CA3130	CMOS op-amp
IC2	M145027	remote control decoder

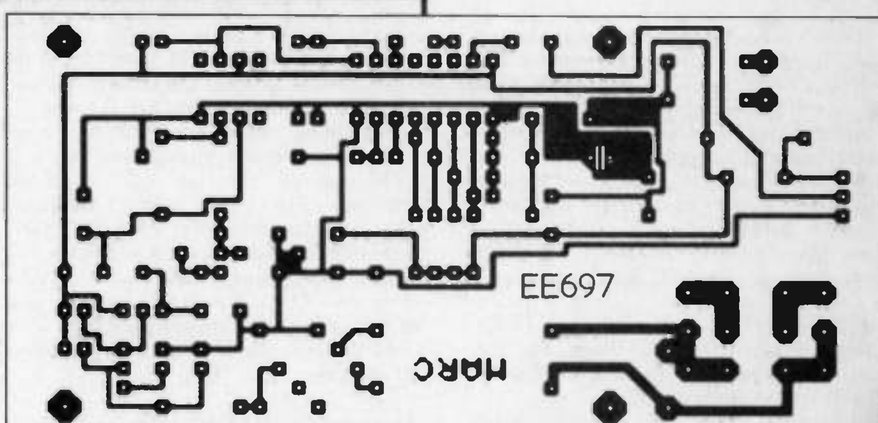
See SHOP TALK Page

Miscellaneous

RLA	12V, 150 ohm coil, relay with 5A 240V a.c. contacts (see text)
S1 to S4	Quad d.i.l. switch
T1	707VXA0242YUK transformer
T2	Mains transformer 12V-0V-12V 100mA secondary
VDR1	Mains transient suppressor

Single-sided printed circuit board available from *EE PCB Service*, code EE697; 3-core mains cable; plastic case; 8-pin d.i.l. socket; 16-pin d.i.l. socket; strain relief grommets (2 off); 13A plug and trailing socket; terminal block; nylon nuts and bolts.

Approx cost guidance only **£18**



impedance to incoming spikes whilst D6 acts as a very fast switch which prevents the positive supply rail from rising above about 18V.

CONSTRUCTION

Since this project involves direct connection to the 240 volt mains precautions must be taken to reduce the possibility of accidental contact with live connections. Insulate ALL exposed mains conductors and stick a layer of insulating tape over the high-voltage copper tracks of the printed circuit board. Also, although transformer T1 appears to isolate most of the circuit from the mains, this device is NOT guaranteed to give total isolation in the event of an insulation failure. So, be on the safe side and treat the whole circuit as though it were live.

All components except transformer T2 and l.e.d. D4 are mounted on a single-sided printed circuit board. The component layout and full size copper master pattern is shown in Fig. 3.3 This board is available through the *EE PCB Service*, code EE697.

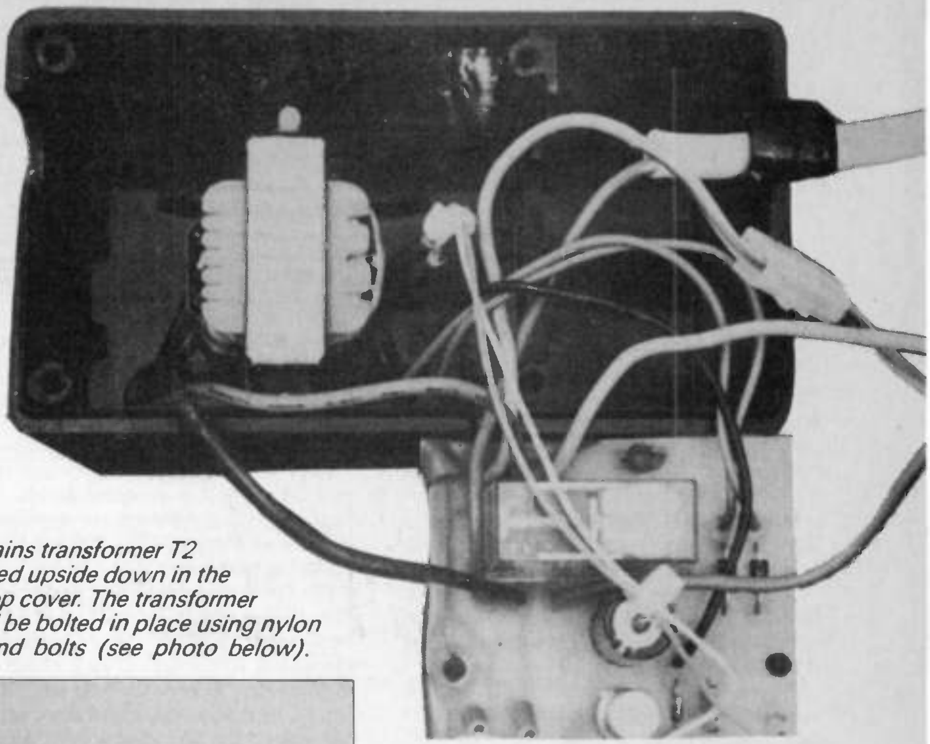
This board has been designed to fit inside a plastic "power supply" case measuring 117mm × 63mm × 62mm (tapering slightly) which provides a cheap, neat and compact enclosure. The mains transformer is mounted upside down, bolted to the top of the box and l.e.d. D4 also protrudes through this face as shown in Fig. 3.4.

The boxes purchased for the prototype units required four holes drilling in their base to allow it to be fastened to the top using self-tapping screws. Of course, any suitably sized box can be used.

TESTING

It is a good idea to build and test the circuit in stages as described below. Start off by inserting the power supply components; diodes D5, D6, D7 and D8, capacitors C9 and C10, resistor R18 and transistor TR4. Also insert suppressor VDR1.

Solder the leads from transformer T2 to the printed circuit board and then connect a 3-core mains power supply lead as shown in Fig. 3.3 (the Earth connection is not made at this stage). Terminate this lead in a 13A plug *fitted with 5A fuse*. Insulate the board as described earlier and then apply power and check for approximately 12V between the power rails on the board.



The mains transformer T2 mounted upside down in the case top cover. The transformer should be bolted in place using nylon nuts and bolts (see photo below).

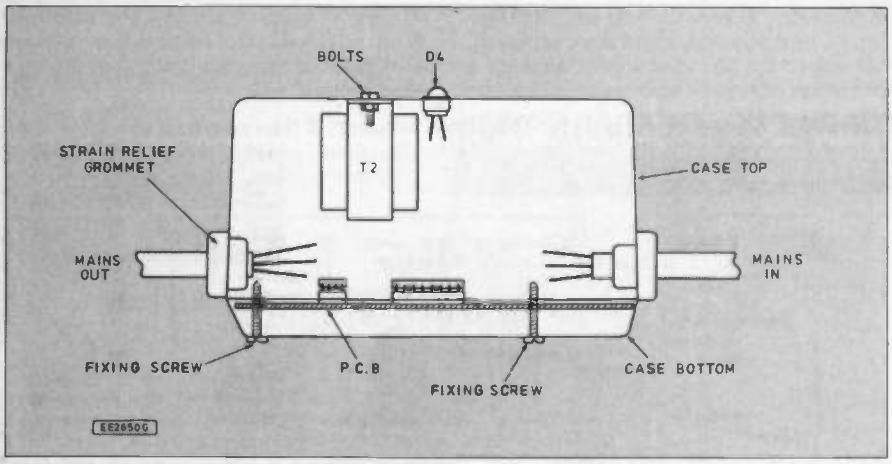
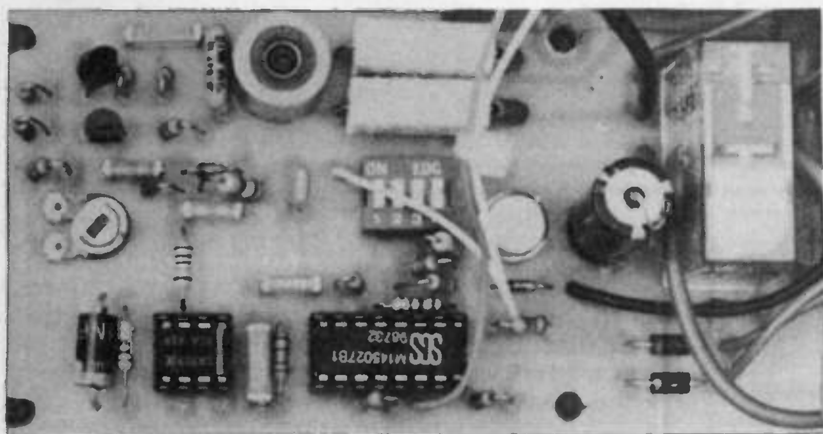


Fig. 3.4. Layout of components within the recommended case.



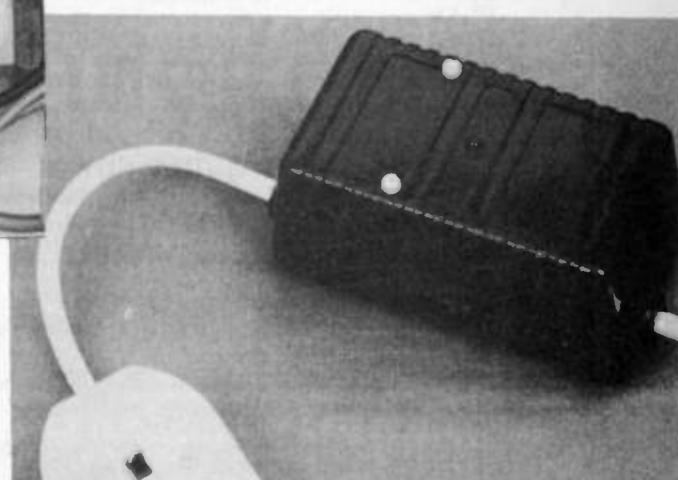
(above) The completed circuit board showing the d.i.l. switch and relay.

Now insert IC1 in its socket (CMOS device, static sensitive) and re-insulate the p.c.b. with adhesive tape. Set preset potentiometer VR1 fully anticlockwise and apply mains power to the board.

If you are fortunate enough to own an oscilloscope, connect it across capacitor C3 and set the temporary link in the Encoder Unit to generate a permanent carrier wave. The received carrier should be visible on the 'scope display and the tuning slug in the core of transformer T1 is adjusted (using a *plastic* tool) for maximum amplitude, this brings the tuned circuit into resonance.

If a 'scope is not available, the best you can do is to set the slug in a similar position to that in the Encoder unit transformer, it is not a very critical adjustment.

Now connect a voltmeter between the output of IC1 (pin 6) and 0V. It should read about zero volts. With the carrier wave still present, slowly turn preset VR1 wiper clockwise until IC1 output just goes high (about 11V). This output should now



(right) The completed ON/OFF Decoder and the "appliance" 13A trailing socket.

If all appears well, switch off and continue construction by inserting all the components relating to the 100kHz filter, amplifier, diode pump and Schmitt trigger, i.e. up to and including IC1 on the circuit diagram. An i.c. socket is recommended for IC1.

It is essential that transformer T1 is inserted correctly. Refer to the pinout details in Fig. 3.3 and check continuity with a multimeter. When soldered in place there should be NO continuity between the pins connecting to capacitors C1 and C2 and those connected to C3.

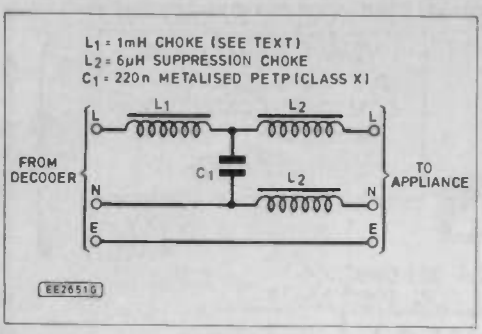
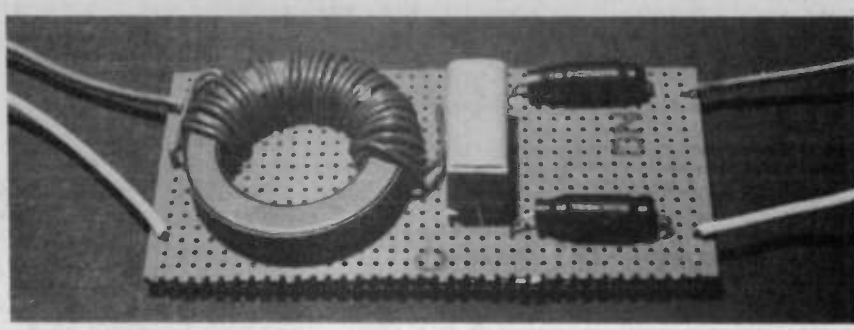


Fig. 3.5. Simple filter for "noisy" appliances.



Completed noise filter. All components should be rated well above expected load currents.

"follow" the carrier wave, it must be low when the carrier is off, high when the carrier is on. Check this.

Disconnect the power, remove IC1 from its socket and insert the rest of the components. Solder the "mains out" 3-core lead to the board and terminate it with a 13A trailing socket if required. The "receiver number" is set in binary on d.i.l. switches S1 to S4, pin 2 is the least significant bit. Closing a switch sets the input to binary 1.

When the unit is addressed by the Encoder l.e.d. D4 should flash. Notice that any odd numbered function code will switch the relay on since this will always make the least significant data bit (pin 15 IC2) high. Complete decoding of all 15 "function codes" can be achieved using a 4 to 16 line decoder/demultiplexer chip but this is not necessary when such simple control is required.

If it is required to control high power mains appliances rated above 5A then a relay with stronger contacts is needed. This will probably not fit the space provided on the p.c.b. so some modification is called for. Also, if the coil current is above about 80mA transistor TR3 will need up-rating along with power supply transformer T2. The printed circuit board tracks carrying high current should be reinforced by soldering pieces of stout wire along them.

JAMMING

It has been found, in some situations, that if the Decoder is used to switch on particularly "noisy" appliances the resulting mess placed on the mains line in such close proximity to the decoder swamps its front end and prevents it from receiving "switch off" signals!

Televisions and microwaves are the biggest offenders I have come across. Simple filtering *placed between the appliance and decoder* as shown in Fig. 3.5 has been successful in both cases.

The 6μH coils are sold as mains suppression chokes whilst the 1mH coil L1 is made by winding about 30 turns of insulated wire through a ferrite toroid ring about 38mm in diameter. Similar toriods are available from Cirkit although exact dimensions are not important, the idea is just to create a coil which presents a high impedance to the 100kHz carrier which would otherwise be "lost" through the 220nF capacitor.

When winding this coil be sure to use wire which can handle the current drawn by the appliance concerned and check that the edges of the toroid are smooth and not likely to "nick" the insulation. The suppression chokes are also available in different current ratings, choose a type with a rating well above the expected load current.

The capacitor should, once again, be a "Class X" type. The whole circuit can be built on a small piece of plain matrix board (see photograph) and safely housed in a suitable case.

Next Month: Digital Room Thermostat.

ACTUALLY DOING IT!

by Robert Penfold

THE SUBJECT of this month's *Actually Doing It* article is the perils and pleasures of stripboard. I suppose that there are few products that have had as much impact on the hobby of electronics as the humble stripboard (or "Veroboard" as it is popularly known, this being the proprietary name for the board manufactured by BICC Vero Ltd.). It is an "off the shelf" item that provides much of the convenience of a custom printed circuit board.

Unlike most other universal electronic construction systems, it is not restricted to producing prototype circuits, with some other form of construction being used for the final unit. Having built a circuit on stripboard, you can then use it as the final unit.

Others can also copy the design quite easily, without having to do a messy etching of custom printed circuit boards, or going to the expense of a ready made board. Provided your soldering is of good quality, finished boards should provide many years of trouble-free operation.

STRIPPED FOR ACTION

So what actually is this "miracle" product? Like most really good ideas, it is delightfully simple. A piece of board made from an insulating material is drilled with a matrix of holes. Various pitches of board are made, but the only type in common use these days has the holes spaced 2.54 millimetres (0.1 inches) apart. This pitch enables d.i.l. integrated circuits and most other components to fit straight onto the board with no difficulty.

There are "plain" stripboards, and with these the components are mounted on one side of the board, with their leadout wires connected together in the appropriate fashion on the other side of the board. This method of construction is little used these days, but it remains a good one if a quick and easy means of producing high frequency circuits is needed.

True stripboard has copper strips running along the rows of holes on its underside, as in Fig. 1. The idea is that the components are mounted on the top (non-copper) side of the board with their leadout wires threaded through the appropriate holes. The leads are then trimmed to length, and soldered to the copper strips.

This is very much like building a custom printed circuit board as far as the constructor is concerned, but it is more difficult for the board layout designer. With a custom board you can run tracks more or less where you like. With stripboard you have to arrange the layout to suit the regular pattern of strips.

MAKING A BREAK

In practice most circuits can not be accommodated on stripboard without resorting to a few cuts in the copper strips and the inclusion of some link wires. The breaks in the strips can be made with the special "spot face cutter" tool, or a handheld twist drill bit of around 4.5 to 5.5 millimetres in diameter will also do the job quite well.

Either way, make sure that the strips are fully cut through, with definite gaps being produced. On the other hand, do not get carried away and cut deeply into the board (or cut right through!). Where a long line of cuts is needed in the strips, you will often find that they are shown in a zigzag pattern on the layout diagram. This is done so as to minimise the weakening effect on the board.

MAKING A LINK

Link wires are normally made from about 22s.w.g. to 24s.w.g. tinned copper wire. In most cases you can simply use trimmings from resistor and capacitor leadout wires. Some link wires might be quite long though, and you will need a reel of suitable wire in order to deal with these (something that should be part of your standard kit anyway).

It is not normally necessary to insulate link wires, but they should be taken straight from one hole to the next. If they are something less than taut there is a risk of accidental short circuits occurring.

The best way to deal with link wires is to first cut a slightly over-length piece of wire from the reel. Next fit one end through the appropriate hole in the board and solder it in place. Then thread the wire through the other hole, pull it firmly with a pair of pliers to remove the slack, trim it to length, and then finally solder it in place.

Interpreting stripboard layout diagrams is not too difficult as they are generally quite close representations of the real thing. In the interest of clarity many of the holes are often not shown, but usually all those around the periphery of the board are included. Circles represent unused holes, while filled circles indicate the holes to which something actually connects.

Ideally the underside of the board should be shown separate from the top side, as this makes it easier to get any breaks in the strips in the right places. In order to save space in the magazine or book, the breaks in the copper strips are sometimes included on the component side diagram, with no underside view being included. Usually something like an "X" is used to mark the position of each break.

Remember that where the breaks are shown in a top-side view, what you see in the diagram is a mirror image of the underside of the board. Take due care when making the breaks. It is probably best to mark them all with a fibre-tip pen first, and then actually make the cuts once you have checked all the positions a couple of times.

DRAWBACKS

Stripboard is extremely good in most respects, but there are a few drawbacks that you should keep in mind. One of these is simply that stripboard layouts are generally less compact than those based on a well designed custom printed circuit board. However, it is not normally too difficult to keep the boards down to reasonable proportions, and most published designs are quite compact.

The original stripboard was extremely tough, and it was actually quite difficult to cut pieces down to size. Some of the boards that came later were very much less strong. In fact some of these boards were quite brittle, and had a definite tendency to shatter as they were sawn through.

At one stage I virtually gave up using stripboard. It was a bit like tiling a bathroom (where you generally reckon on three whole tiles being needed to make each half tile!).

I am glad to say that the boards I have used recently are very much tougher, and perfectly usable. They are not as tough as fibreglass printed circuit boards though, and mounting heavy components on them (such as medium to large size mains transformers) is probably not a good idea.

Although stripboards can accommodate virtually any circuit, they are better suited to some types than to others. Stripboard works well with most audio and simple digital circuits. With care, it can be used for very sensitive audio circuits and radio frequency types.

The problem in these last two cases is the stray capacitance between the copper strips. The layout has to be carefully designed to avoid problems with unwanted feedback through the routes this provides.

Probably the type of circuit which is least suited to this method of construction is the complex digital type having buses to route all over the board. Even custom printed circuit boards are stretched to the limit by this type of circuit, and matters are naturally that much more difficult with a "universal" construction method. Stripboard can be used for awkward digital circuits, but only with the aid of an inordinate number of link wires.

MISTAKES

The factor that many seem to regard as the main drawback of stripboard is that it is relatively easy to make mistakes. If you make an error when assembling a custom printed circuit board you will probably soon realise it, and it will probably be an easy matter to take corrective action.

Things are very different with stripboard, where there is not a nice and convenient relationship of one hole per leadout wire. In most stripboard layouts there are about ten unused holes for each one that takes a leadout wire or pin. You have to carefully follow the layout in order to get everything just right.

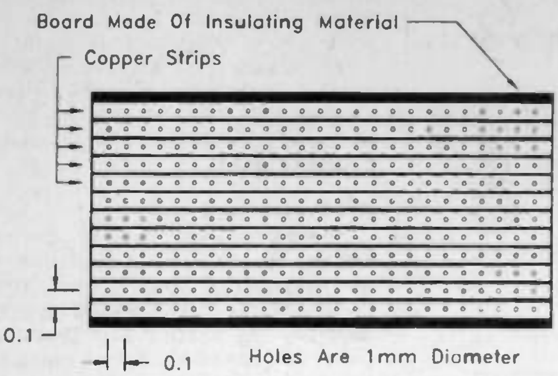


Fig. 1. Stripboard has 1mm holes drilled on a 0.1in. (2.54mm) matrix, plus copper strips along the underside.

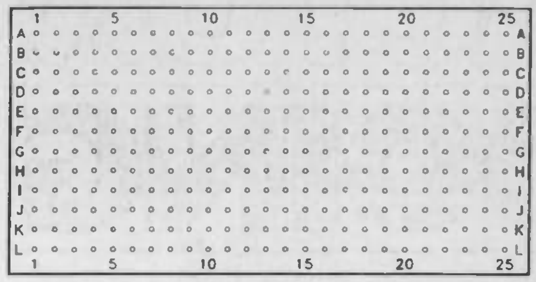


Fig. 2. Adding numbers (holes) and letters (strips) to a board and layout diagram can help you navigate your way around the board. This is the method used in EE together with a small key "triangle" for overlaying on the top side.

When making up a stripboard it is quicker to work out the component positions using relative rather than absolute positions. In other words, you work on the premise of having (say) a resistor's lead "x" number of holes to the right of another component already fitted to the board, rather than working on the basis of it being something like twenty holes from the left and six strips up.

This is a slightly risky way of doing things though, since if you should make a mistake with the position of one component, any others placed relative to it will also be wrong. Correcting the positions of one or two components is unlikely to be very difficult, but moving one or two dozen is a different matter. You might have to start from scratch with a new piece of board, and possibly a lot of new components as well.

A method that is used successfully by many people is to mark the layout diagram with letters to identify the copper strips, and numbers to identify the columns of holes (Fig. 2). On many stripboard layout diagrams this will already have been done for you. The board itself is then similarly marked using a fibre-tipped pen having a spirit based ink. You can then work in absolute mode without having to do a lot of counting.

Although I have given the problems of getting the layout right as a drawback of stripboard construction, I suppose this may not be an entirely fair way of viewing matters. After the initial novelty has worn off, many constructors find that assembling custom printed circuit boards becomes a bit boring at times.

Stripboard requires you to keep your mind on the job, and is more challenging (especially when building larger circuits). It could reasonably be regarded as a more interesting form of construction than a ready made custom printed circuit board.

SHORT CIRCUITS

The problem that I would regard as the main one when using stripboard is that of accidental short circuits between adjacent copper strips due to blobs of excess solder. The gap between strips of 0.1 inch matrix board are extremely narrow, and necessarily so. This makes it very easy to use too much solder and to bridge two strips.

The risk is especially high where there are rows of connections, such as where d.i.l. integrated circuits are fitted on the board. Using a soldering iron having a miniature bit of around 1 to 2 millimetres in diameter helps, but will not eliminate the problem.

Often it will be obvious that a short circuit has occurred, and remedial action can be taken at once. This will not always be the case though. The solder bridges can sometimes be minute, and very difficult to see. The ones that cause the greatest difficulty are pieces of solder that are buried out of sight under some excess flux.

Many people successfully combat solder blobs by using a high power magnifier to carefully examine the whole of the underside of the board. If this method is adopted it is advisable to clean the board first, using one of the proprietary board cleaners. Alternatively, methylated spirits can be used, but treat this highly inflammable liquid with due care.

I have never found any form of visual inspection to be fully effective. My preferred method of searching for short circuits is to use a continuity tester. Use a type of tester that will not damage any of the delicate semiconductors in the circuit, such as a multimeter set to a medium resistance range, or one of the continuity tester designs featured in *Everyday Electronics* from time to time.

If you find a short circuit between two tracks, but there is no obvious sign of a solder blob (and there is no link wire bridging the two tracks in question!), try repeatedly running the blade of a sharp knife along the board between the two tracks. This should cut through any solder bridge, wherever it is positioned along the tracks.

Constructional Project

PRESSURE-PAD ALARM

T. R. de VAUX-BALBIRNIE

Protect your valuables with this portable anti-theft system

This burglar alarm emits a loud tone when an intruder steps on a pressure pad placed under a window or other likely point of entry. The system is portable with self-contained batteries so could be found useful in many temporary or semi-permanent security applications such as for garden sheds or boats.

It can operate a wide variety of 12V audible warning devices including high-powered sirens of up to 3A rating. The pad may be situated any reasonable distance from the main unit – if the interconnecting wire is cut or the plug is pulled out, the alarm will sound.

The system may be operated in either *continuous* or *timed* mode. In the latter case, it can be adjusted to sound for between 30 seconds and 12 minutes approximately – it then resets automatically ready for further use.

The Pressure Pad Alarm has very low standby current consumption – less than 300µA in the prototype unit. The life of the batteries will therefore be long if the alarm is not required to sound very often.

The sensitivity of the circuit is adjusted so that pressure caused by small objects or animals walking on the pad will not trigger it. A key-operated switch is used to cancel operation and to switch the alarm off, a push-to-test switch is provided to check operation and to test the batteries at any time.

The basic material used for making the pad is 6mm (¼in.) thick electrically conductive foam. This is normally used as packing material to protect CMOS devices from the effects of static charge and is available in sheets 30cm (12in.) square. Very little work is needed to turn it into an effective pressure sensor and full details for this are given later.

CIRCUIT DESCRIPTION

The entire circuit for the Pressure Pad Alarm is shown in Fig. 1. IC1 is a CMOS operational amplifier of the type chosen for its very low standby current requirement. This is used as a comparator. Thus, if the voltage applied to its non-inverting input (pin 3) exceeds that at its inverting one (pin 2) the device switches on and its output, pin 6, goes high (supply positive voltage).

The non-inverting input receives a voltage dependent on the potential divider action of resistors R4, R5 and preset potentiometer VR1. With the values shown, VR1 provides an adjustment between 0V and 2.5V approximately.

The inverting input receives a voltage which depends on the potential divider consisting of resistor R2 (through the continuity loop) in the upper section and resistor R1 connected in series with R_X (the resistance of the pressure pad) in the lower one together with resistor R3 which appears in parallel with the pair. Resistor R3 has a high resistance compared with the other resistors in this section so has little effect – its purpose and that of the continuity loop will be explained later.

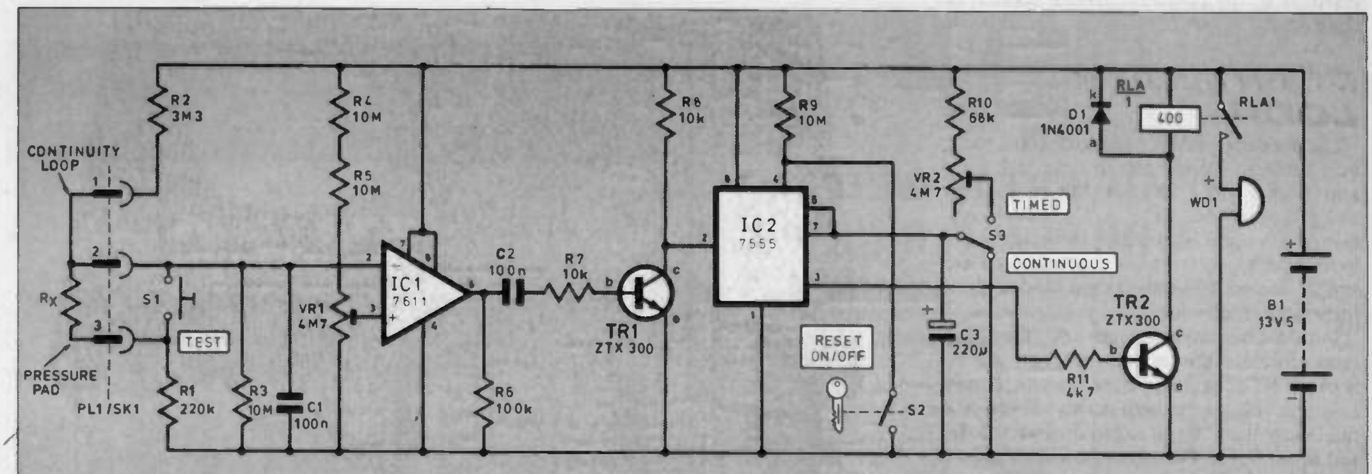
Preset VR1 is adjusted at the setting-up stage so that the voltage applied to pin 3 is less than that at pin 2 and the op-amp remains off with no pressure applied. With weight on the pad, its resistance and hence the voltage across it falls. At some point, this will become less than the voltage at the non-inverting input and the op-amp switches on.

With the op-amp on, capacitor C2 allows a positive pulse through resistor R7 to transistor TR1 base. This switches on, the collector goes low momentarily and IC2 is triggered at pin 2. IC2 is a CMOS timer connected as a monostable.

Thus, with the mode switch S3 set to Timed, the arrival of the trigger pulse will cause the output (pin 3) to go high for a time dependent of the values of preset VR2, resistor R10 and capacitor C3, then revert to low. Preset VR2 provides the time adjustment.

With IC2 pin 3 high, TR2 operates by base current entering through resistor R11. This energises relay, RLA/1 and hence

Fig. 1. Complete circuit diagram for the Pressure Pad Alarm. Details of the "pressure pad" and continuity loop arrangement are given in Fig. 4.



the audible warning device, WD1, through "make" contacts RLA1. Diode D1 bypasses the high-voltage "spike" which appears when the magnetic field in the relay coil collapses – this could otherwise damage components.

With mode switch S3 set to Continuous, capacitor C3 is bypassed and VR2/R10 disconnected. The voltage across C3, and hence at IC2 pins 6 and 7, remains zero and IC2 cannot cycle – once triggered, its output remains high and WD1 sounds until the alarm is reset. Switch S2 (Reset) connects IC2 reset input (pin 4) to the negative supply line and cancels operation – pin 4 is kept normally high through resistor R9 which prevents false resetting. S2 is also used to switch the alarm off by keeping pin 4 low continuously. For highest security this switch should be of the key-operated type.

CONSTRUCTION

The prototype unit was based on a circuit panel made from a piece of 0.1in. matrix stripboard, size 45 holes × 12 strips. Details of the component layout and breaks required in the underside copper tracks is shown in Fig. 2. Cut the material to size, drill the fixing holes and make the track breaks, solder all inter-strip link wires and mount the on-board components. Take care over the polarity of D1 and C3.

The moving contact connection of the sepecified relay does not fit directly into the 0.1in. matrix board – it will be necessary to drill a small hole for the connecting tag to pass through. This is linked using a short pieces of wire to strip *F* as indicated.

Check carefully for accidental solder bridging of adjacent copper tracks then solder 20cm. pieces of light-duty stranded connecting wire to strips *D, E, F, H, I* and *J* on the left-hand side and to strips *A, H* and *I* on the right-hand side as indicated. Leave preset VR1 adjusted fully clockwise and VR2 fully anticlockwise.

The size of the case will be determined to some extent by the choice of audible warning device and batteries so check this point before ordering components. Prepare the box by making holes for the three switches, SK1 and WD1. Drill holes in the base to align with the mounting holes already made in the circuit panel.

INTERWIRING

Make the power supply by soldering the three batteries in series as shown in Fig. 3. Mount all components and complete the internal wiring, shortening any wires as necessary. Make a bracket and secure the batteries to the base of the case.

The stereo jack plugs and sockets vary in construction so precise connection details cannot be given. However, in the prototype unit, the tip (contact 3) was used for the pad, the centre section (contact 1) for the loop and the sleeve for the common loop and pad connection (contact 2).

A simple battery and bulb circuit, or multitester, can be used to identify the connections. Note that some sockets have extra connections for internal switches

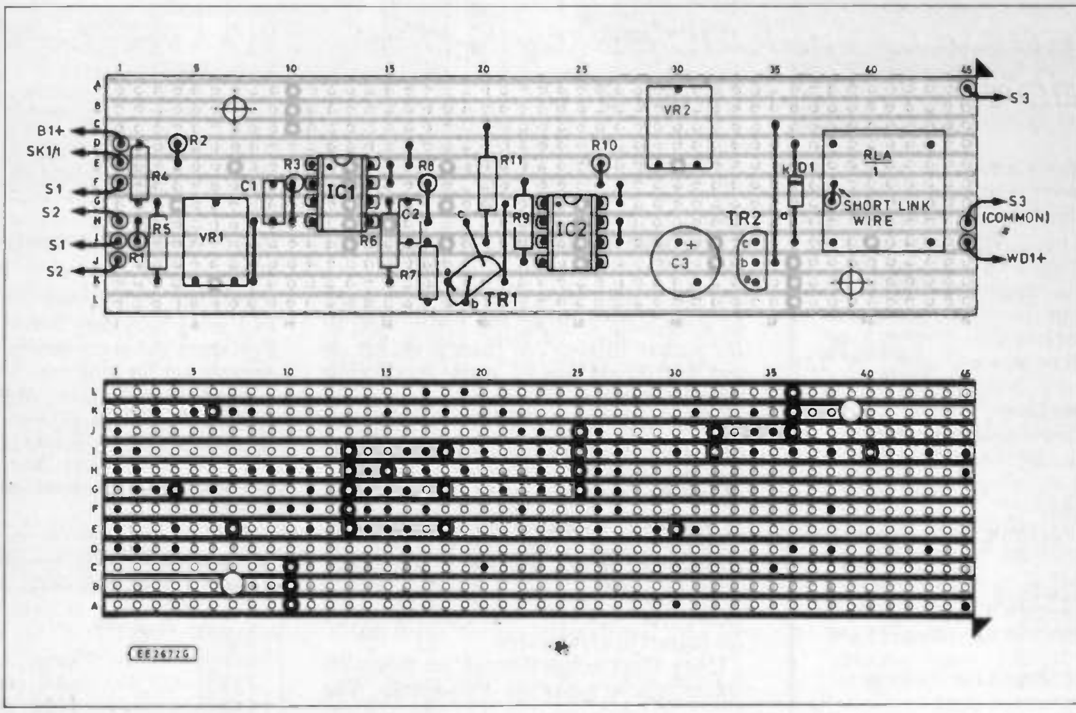


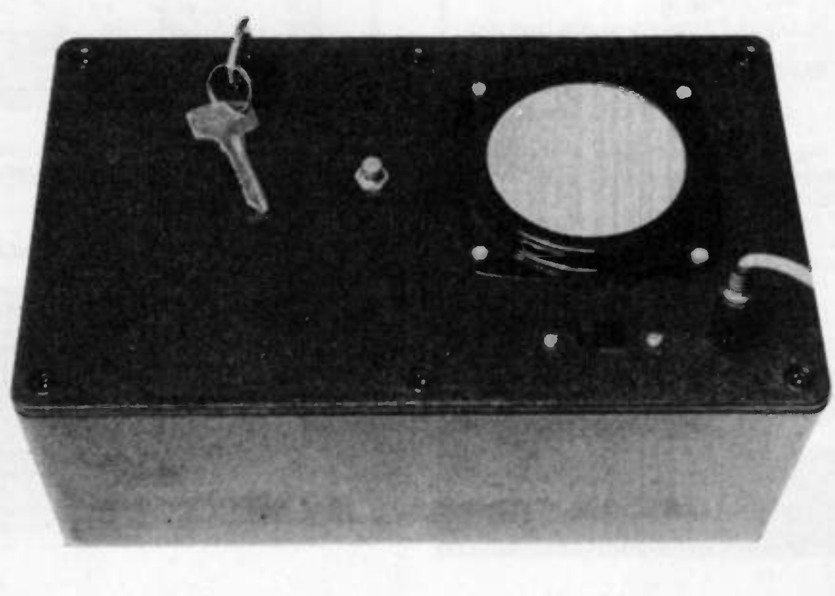
Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. Note the short link for the moving contact of the relay.

The Test switch S1 triggers the alarm by short-circuiting the pressure pad. This creates a condition similar to that which exists when pressure is applied. IC2, like IC1, requires very little standby current. Note that continuous current drain has also been reduced by using very high value resistors in the potential divider section of the circuit.

CONTINUITY LOOP

The pressure pad is connected to the main unit through 3.5mm stereo-type jack plug and socket, PL1/SK1 at the main unit using 3-core wire. The pad itself is connected to contacts two and three while the wires leading to contacts one and two are simply joined together at the pad end to form a continuity loop.

Should the wire be cut or the plug removed from the socket, this loop will be broken. IC1 pin 2 will now assume supply negative voltage through resistor R3 so will fall below the voltage at pin 3 whatever the setting of VR1. The op-amp will therefore turn on and the alarm trigger in the manner already described.



which operate as the plug is inserted. Connections to the battery can be soldered as shown, after testing.

The specified batteries provide a 13.5V supply. This is suitable for 12V buzzers and sirens taking into account the voltage drop when current is drawn. These batteries are suitable for devices requiring up to 500mA approximately and which will be found to give sufficient sound for most purposes. For higher-powered devices, the batteries will need to be uprated. The 12V HP1 would be excellent but expensive. A cheaper solution would be to use two 6V PJ996's connected in series.

SENSOR

The constructional details for the pressure pad sensor are shown in Fig. 4. The base consists of a piece of thin plywood, or thick cardboard, 30cm. × 40cm. approximately. To this are attached (using Copydex or similar adhesive) strips of aluminium cooking foil 15mm wide in the pattern shown. The foam is placed on top but should not be stuck down until tests are complete.

When the foam is compressed the resistance between the aluminium strips is reduced. This resistance must be kept very high under non-compressed conditions and to help in this, most of the foil is covered with p.v.c. tape or sellotape with only the corners and centre exposed. If this procedure is not followed, it may be found difficult or impossible to adjust the circuit for correct operation later.

Using short fixings through the base with solder tags to make the connections. The completed pad should be connected to PL1 using light duty 3-core stranded wire. For short distances mains 3-core wire is suitable but for long runs it will be cheaper to use 4-core telephone cable with one wire ignored. Do not forget the continuity loop connection at the centre solder tag.

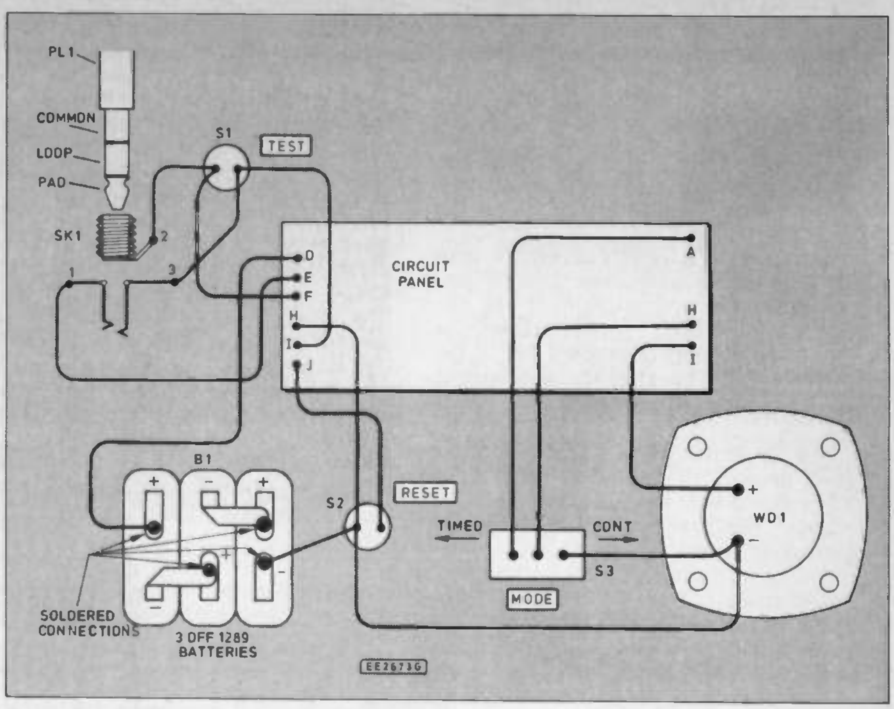


Fig. 3. Interwiring from the circuit board to the off-board components.

COMPONENTS

Resistors

R1	220k
R2	3M3
R3, R4, R5, R9	10M (4 off)
R6	100k
R7, R8	10k (2 off)
R10	68k
R11	4k7

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1, VR2 4M7 sub-min. preset, horiz. (2 off)

Capacitors

C1, C2	100n (2 off)
C3	220µ p.c.b. elect. 16V

Semiconductors

D1	1N4001 1A 50V rec.
TR1, TR2	ZTX300 *npn* silicon (2 off)
IC1	ICL7611 operational amp.
IC2	ICM7555 CMOS timer

Miscellaneous

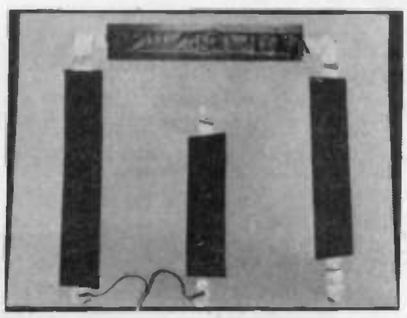
S1	Miniature push-to-make switch
S2	Key-operated switch with single-pole make or changeover contacts
S3	Miniature SPDT (or DPDT) slide switch
B1	4.5V "flat" batteries type 1289 (3 off – see text)
WD1	12V buzzer or siren up to 3A rating
PL1/SK1	3.5mm stereo jack plug and chassis socket
RLA/1	Min. 12V relay, with 400 ohm coil and 3A normally-open or changeover contacts

Plastic box, size 216mm × 130mm × 85mm external (see text); 0.1in. matrix stripboard, size 45 holes × 12 strips; 8-pin d.i.l. integrated circuit sockets (2 off); crocodile clip; connecting wire; solder etc.

Materials for Sensor

6mm thick conductive foam 300mm × 300mm; aluminium cooking foil; plywood or cardboard, size 30cm × 40cm; adhesive; solder tags (2 off); small fixings (2 off); 3- or 4-core wire (see text).

Approx cost guidance only **£21** *(excl. Bat.)*



The completed wiring for the pressure pad prior to covering with the conductive foam.

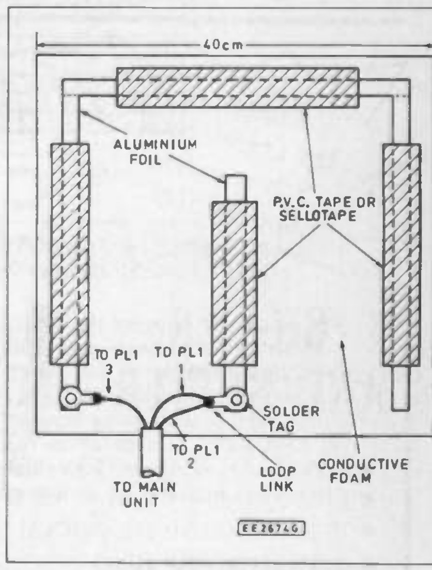
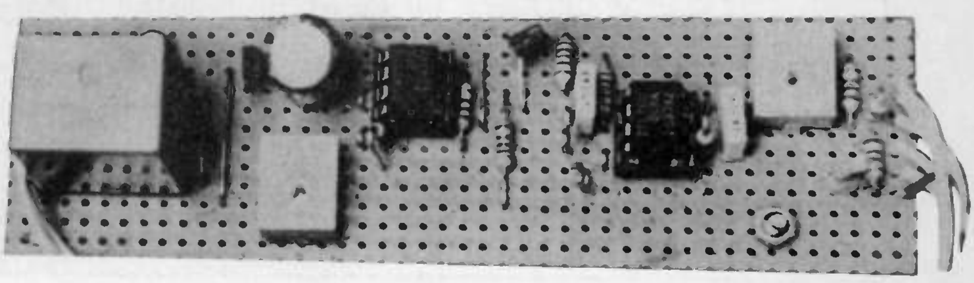


Fig. 4. Constructional details for the pressure pad sensor. The conductive foam is placed over the foil strips.

The completed circuit board for the Pressure Pad Alarm.



TESTING

To test the completed Pressure Pad Alarm, connect a small 12V bulb in place of WD1 – this is kinder on the ears during testing and adjustment. Switch S3 (Mode) to Continuous, plug in the sensor and make the positive battery connection. The circuit will probably self-trigger – cancel it using switch S2 momentarily. The lamp should now remain off.

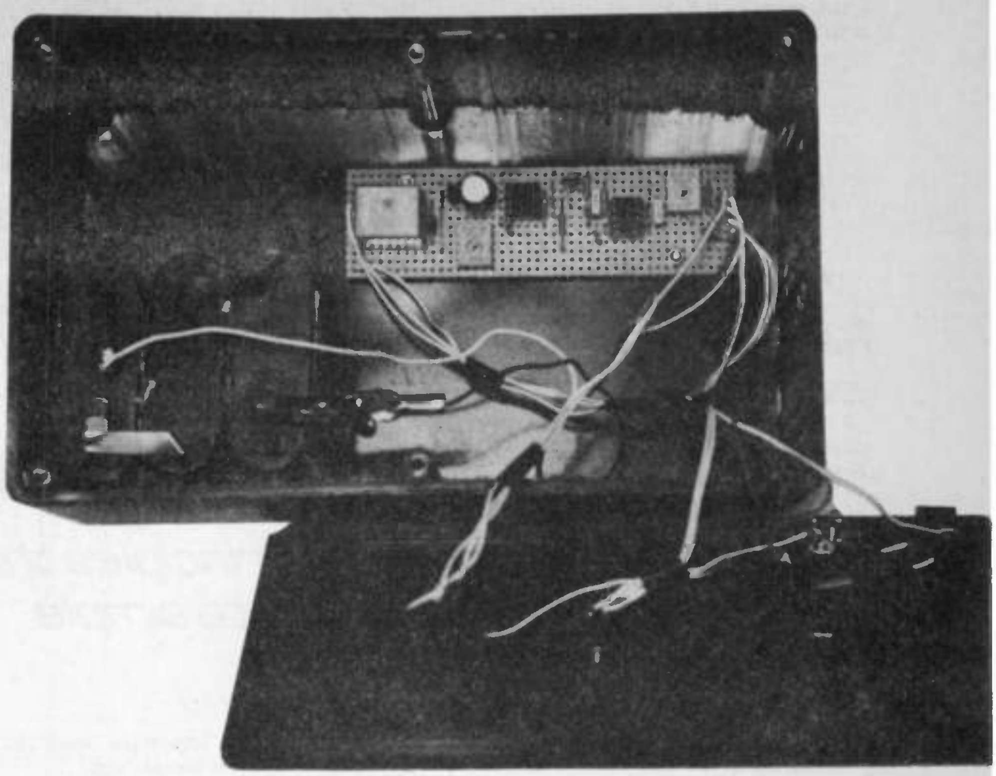
Turn preset VR1 gently anticlockwise to the point where hand pressure on the sensor causes the lamp to light. If any difficulty is found here, it may be necessary to adjust the amount of exposed foil in the pressure pad. This gives the approximate operating point. Again, cancel using switch S2.

Now set switch S3 to Timed and apply hand pressure to the pad as before. The lamp should light for 30 seconds approximately. The predicted time is very approximate depending as it does on the value of capacitor C3 which, being of the electrolytic type, is subject to wide tolerance and high leakage.

Check that the circuit triggers when the sensor is unplugged and also when switch S1 (Test) is operated. Note that the test switch will not work with the pressure pad disconnected from the unit. With tests complete, the audible warning device may be connected in place of the lamp observing polarity.

The foam may now be attached to the pad lower section using Copydex sparingly around the edges. The top surface of the foam should be protected by a thin plastic sheet, carpet or similar material – this should be light so as not to compress the foam appreciably. The pad should be situated where it will not become damp since this would reduce the resistance and possibly cause false triggering.

Once installed, VR1 should be adjusted as necessary for the correct degree of sensitivity and VR2 for the required operating time. Note that it is only necessary to disconnect the battery if the device is to be left unused for several weeks – temporary on-off switching is achieved using S2. □



The completed unit showing layout of components inside the case. The three switches, jack socket and buzzer are mounted on the lid.

Special Series

MICRO IN CONTROL

JOHN HUGHES

Part Nine

Starting from very basic principles this series quickly builds through logic to simple microprocessor control.

The 6502 Microprocessor

T This is one of the "6500" family, initially designed by MOS Technology, then taken up and extended by Rockwell International (among the "moon-shot" developers). You may well have used it without realising it, for not only has it been used for serious simulation and control but it can provide the "brains" of many arcade games. It was adopted by the designers of, among others, the Apple and the BBC micros.

As with all CPUs (Central Processing Units) of this kind, the 6502 requires a programme of instructions (stored in memory) to enable it to perform any task at all. The task it then carries out is determined by this programme, often referred to as "software". By the way, we may as well adopt the American spelling "program" as most computer programmers do.

S *Does it matter?*

T Not at all, really, and many experts use the "correct" English spelling. Please yourself!

S *I've heard, too, of "firmware". What's that?*

T You could say it's a kind of more permanent software. May I leave it until later on to explain more fully? As we shall see, there are various ways of storing programs and data, the most important being the memory circuits we've already met.

Now, the microprocessor (let's refer to it as the CPU for short) has to be able to "read" the contents of its memory store. Sometimes it has also to "write" (i.e. to store) the data into memory.

S *Someone has to write a book before anyone can read it.*

T That's it. Let's consider how a memory bistable could be written to and read from.

S *The WRITING could be done using SET and CLEAR pulses,*

S *(another) And the Q output can then be READ off.*

T Exactly. Remember that a memory LOCATION has several bits, though, and each would need to be dealt with.

S *So we'd need several input and output leads/for each location/no, we can direct signals to a particular location if we use its ADDRESS, like last time.*

T Good, we're getting there. The number of data lines (wires) can be reduced if we can use the SAME line for both reading and writing, as long as we send a signal to the CPU to "tell" it which. Here's a possible circuit (Fig. 9.1).

The Read/Not Write line is normally at logic 1 so that the memory Q output is connected to the data line, but if it is made logic 0 for a moment, then a data value (0 or 1) can be applied for that moment to the data line, and it will be "written" into the bistable.

S *And there will be a whole register of bistables/and many registers/ all connected to the Read/Not Write line.*

T Spot on. Incidentally the $R/\overline{W}$ line is sometimes called the "write-enable" line. So this is one of the signals we expect from the CPU, isn't it?

S *Yes, and the Data values as well/and the Address of the particular location.*

T That's right. The CPU also dishes out the clock pulses as well as one or two other special signals when necessary. It's a busy little bee!

S *Can we build the memory circuit we just discussed?*

T In your own time, if you wish to, though it's always a good idea to check that these circuits do behave as expected. But we'd better take a further look at the 6502.

It's really extremely complicated, but all we need for now is a "programmers' model" of the CPU. Here it is (Fig. 9.2). We'll list the items it shows:

1 – An 8-bit register called the ACCUMULATOR. This is where it all happens, so to speak. The name is taken from the old adding machines which totted up (accumulated) an account. The CPU can add, subtract, perform logic, and so on upon whatever number is in the accumulator. It can also read (copy) the contents of any memory location into it, and send a copy of the accumulator contents to a suitable location, as we'll see.

2 – Two 8-bit INDEX REGISTERS (X and Y), which we shall find useful for temporary storing of numbers to be worked on or referred to. (They are very similar to each other, but not quite so.)

3 – A STACK POINTER, whose use will be explained later. It has an extra ninth bit (always a 1) as shown.

4 – A 16-bit register called the PROGRAMME COUNTER, or PC for short. It keeps track of the sequence of events, and, because the 6502 is an 8-bit chip, it has to deal with the PC in two halves of eight bits each, PCH and PCL. Well? . . .

S *High and Low.*

T Sure. Now there's one register left.

5 – The STATUS REGISTER. This is

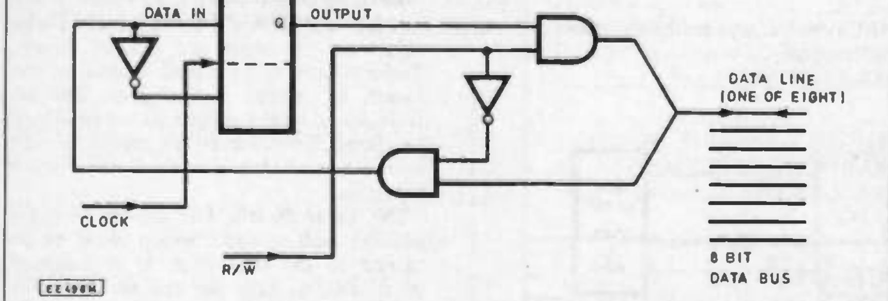


Fig. 9.1. Type of logic to allow some DATA lines to be used for both input and output signals (not both at the same time!). Note that reading (copying) does not alter memory contents.

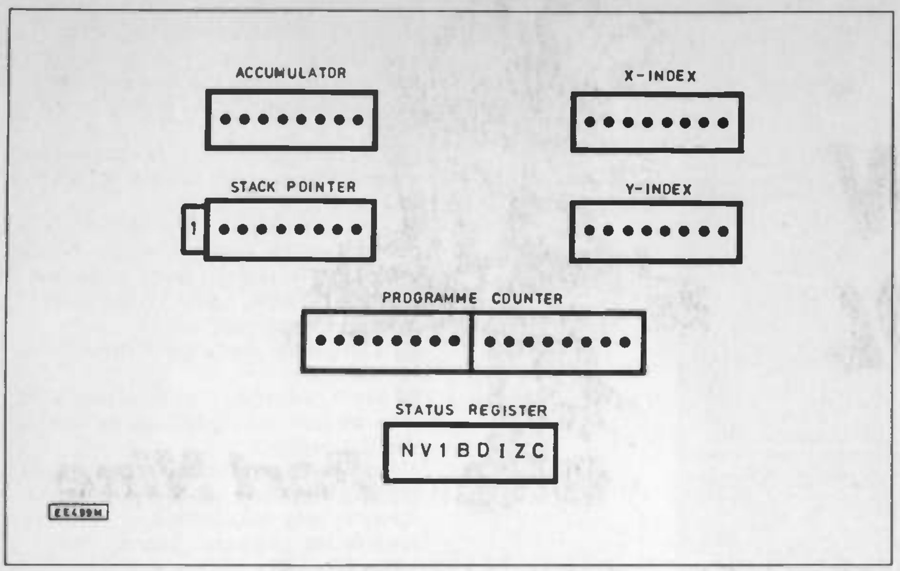


Fig. 9.2. Programmers' Model of 6502 micro.

really a collection of "flags" (single bits) each of which has a special part to play. Again we'll meet them and get to know them as we proceed, but they include, for example, a "carry flag" to show whether a 0 or 1 is to be carried over in a calculation and a "zero flag" which indicates zero in the accumulator or index register. Yet another shows a negative value, and another that a decimal (denary) calculation (as distinct from a pure binary one) is in hand.

S *Like the BCD counter we used some time ago?*

T Exactly so. As we proceed, these points will become clearer. It's not easy to grasp everything at once!

Perhaps we should now look at a typical small system and seek to follow its working in some simple programs.

A typical small 6502 system:

All micro systems will have the following sections (Fig. 9.3), usually in separate chips, though they can sometimes be found combined into fewer, or spread over extra ones:

1 – The CPU itself. This usually also contains the clock circuit, requiring just a couple of external items.

2 – Input and Output links of a suitable kind. No system is any use to us unless we can communicate with it!

3 – Adequate memory storage to accommodate the program and the necessary data. There is a certain minimum requirement, a "monitor" program without which the CPU can't even get started, and this has to be kept in store even when no power has yet been applied. It is stored beforehand in a "Read-Only" kind of memory where all the logic levels are fixed and cannot be set or reset.

S *Like wires permanently connected to 0V and 5V?*

T That's an excellent image of it. Just what it's like.

S *Is it called ROM/or is it RAM?*

T Read-only memory is of course ROM. The term RAM is generally used for "ordinary" memory which can be both read from and written to, but does anyone know what the letters stand for?

S *Random Access Memory?*

T Yes, so it should, strictly speaking, apply to ALL kinds of memory, for the CPU has access to any location in its range. But, as I said, we normally mean "read or write" memory.

S *Should be called RWM/better still "RUM"!*

T OK. Now, someone asked about "firmware" earlier. Well, firmware is the name we give to the "fixed" contents of a ROM, which cannot be altered as can ordinary "software".

S *What's an EPROM, then, please?*

T PROM stands for "Programmable Read-Only Memory", which is a chip containing fusible links which can be "blown" once and for all when the firmware is initially put into it. A useful development is the "Eraseable P.R.O.M.", which can be "burned" and will hold its contents for years, but which can be "repaired" (erased) by exposing it to ultra-violet light. You can recognise an EPROM by the little "window" on the top of the chip. It can be re-used, in other words, and mistakes can be rectified, which is useful.

There are also "EAROMS" and "EEROMS", and probably others for you to look up!

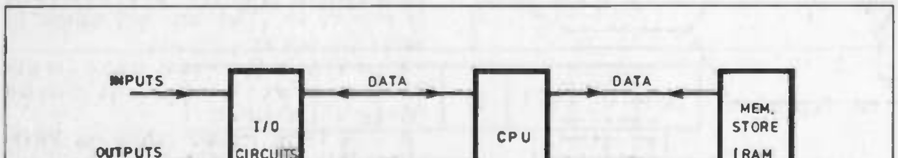


Fig. 9.3. Essentials of the micro system.

S *Is a microcomputer such a system as we are looking at?*

T Yes it is. Its input devices are a keyboard and a disc drive or cassette, its output going to a VDU (visual display unit, i.e. a TV type screen) and a printer.

S *And perhaps a modem/or a controller.*

T Quite. We may get on to these later. Now we need to do some practical Exercises on a real system. The one we shall use for our description was developed specially for you lot and your kind, for it has features designed to help you to understand just what goes on in a micro system. Unfortunately, this means that some of the "user-friendly" features of your home micro are missing.

S *In other words, we have to learn the hard way?*

T 'Fraid so! But I hope you'll agree later it was worthwhile. When you are running your models (your whole house?) from your armchair.

S *Or it's running itself!*

T We can dream about it, anyway. Let's press on. . . . As we discussed earlier, it's tricky to build a bread-board circuit for a micro, so I'll list some of the manufacturers of small systems similar to this one; it may be that some of you may be able to get your hands on one.

The general principles are the same for all such systems, though you'll appreciate that the codes will be different for another CPU. Even if another 6502 system is used the memory locations and circuit details may also vary a little from ours, so keep that in mind if you try to transfer a project to another system.

The MIDAS system is manufactured by E & L Instruments Ltd., of Rackery Lane, LLAY, WREXHAM, Clwyd. Other suppliers of development kits for the 6502 and alternative processors include: Tutorkits Ltd., LLAY, WREXHAM, Clwyd. Unilab Ltd. of BLACKBURN, Lancs. Flight Electronics, of SOUTHAMPTON.

The MIDAS system

T The MIDAS name stems from Microprocessor Instruction, Development and Application System, for, as I said, this unit was designed with folks like you in mind; wishing to see for themselves as far as possible how the micro operates and to put it to use in their own developments or practical control applications.

Look at the unit for a moment before we switch on (Fig. 9.4). It consists of two boards which can be plugged together:

The Controller Board. As its name implies, this is the heart of the system. It has on it the 6502 CPU, its monitor program (in an EPROM), some "empty" memory (RAM), and the necessary control logic, address decoding, and clock circuits. It also has a 5-volt stabiliser circuit, and an edge connector for input and output signals. There is only a single push-button on this board, to re-start if necessary. The annoyance of losing programs on switch-off has been eliminated by an ingenious data retention circuit which does not require batteries.

The Tutor Board. This is one of many possible add-on units which could be attached to the controller. It is designed, of course, to help the student to follow the passage of signals in and out of the system, and to indicate the contents of memory locations, of the CPU registers and of the status flags. It makes it possible to run a program one step at a time

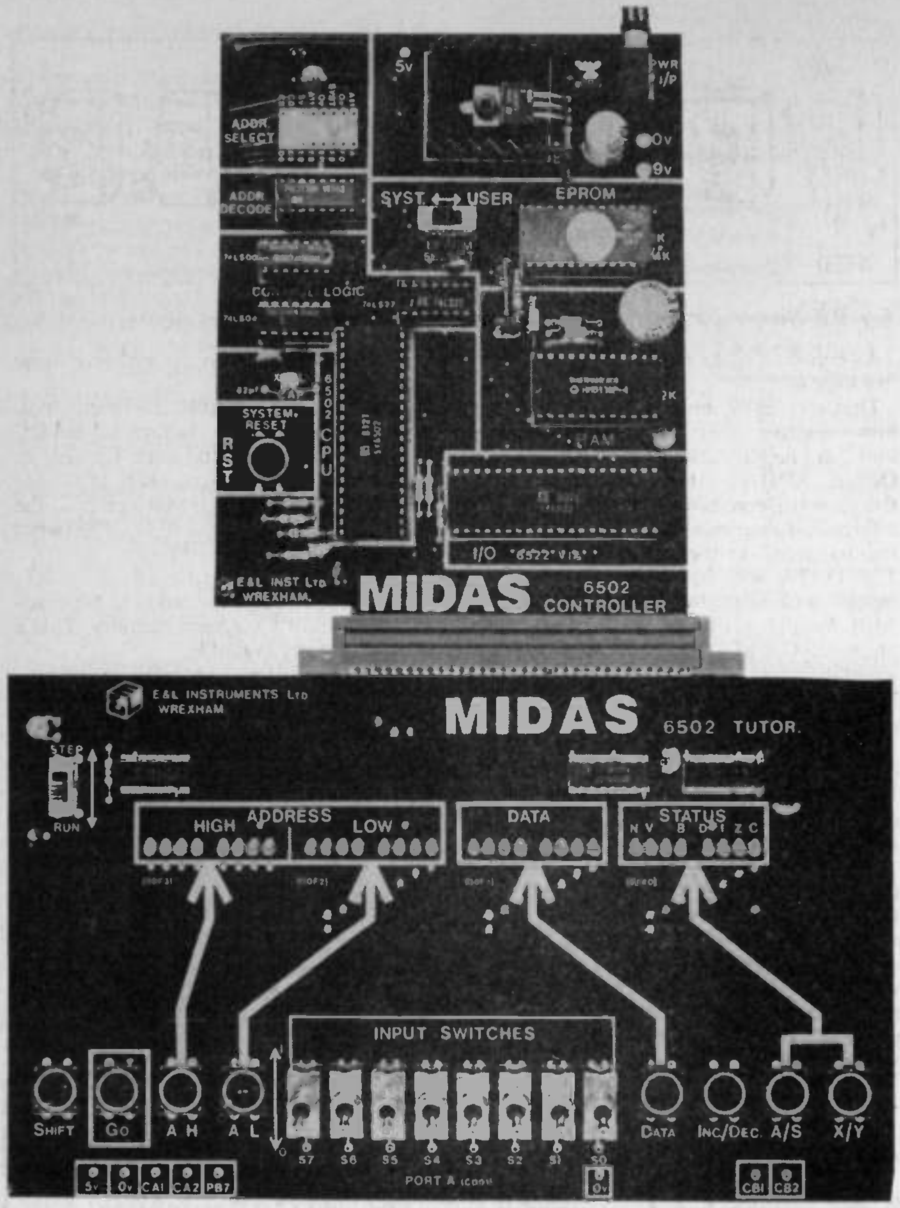


Fig. 9.4. The MIDAS Controller and Tutor boards connected together.

so that these quantities can, if necessary, be studied as a program proceeds, assisting both understanding and trouble-shooting.

Because the micro operates strictly with binary signals, the indicators and switches follow this pattern (though a hex keypad can be linked in at a later stage to facilitate the loading of longer and more ambitious programs).

The Master Board. At a more advanced stage, this can be used instead of the Tutor, as it offer many extra facilities and can allow the user to tackle real control design projects, including the burning of customised EPROMS after a program has been tested and revised. Duplicates can be made, cassette storage utilised, or links to a suitable computer, such as the BBC micro, can allow assembly programming to be undertaken.

S *I assume we'll be using the Tutor with the Controller.*

T That's right. Now we can plug in the power supply and switch on.

S *Nothing happens.*

T Not yet indeed. Now press the RST (reset) key.

S *Some of the l.e.d.s are alight/not all of them.*

T As expected. Let me explain. Pressing the RST key sends a signal to the reset pin of the 6502, which ALWAYS responds by starting to run a program from a special location in memory. The program is already there. Where, do you think?

S *In the EPROM.*

T Yes, in a particular part of the EPROM. Now this "built-in" program, called a "monitor" program, clearly causes the l.e.d.s (or some of them) to light up.

Look at the Tutor board labels. The 16 left-hand l.e.d.s are showing just ONE address of a location, which may or may not exist. How many possible addresses can you have with 16 bits.

S *(after some discussion) Well, with four we had sixteen, so with eight we'd have 16 ×* 16, which is 256. So for sixteen?

S *(others) Must be 256 × 256 . . . /65536.*

T Good. That, of course, is the denary (decimal) value of sixteen binary ones, 1111 1111 1111 1111. (The grouping into fours is just to make it easier to read and to represent as a hex number.) This will be FFFF, right?

S *I see. You just write the hex value of each group of four bits. And FFFF in hex is 65536 in decimal.*

T Spot on once more. You probably know that an eight-bit group of "words" is called a BYTE. The four-bit group is sometimes called a NYBBLE! Our system works in bytes, as we're using the 6502.

S *The address register is a two-byte one; high and low*

T Yes. You can see it on the Tutor board. Now we have it switched on, let's explain the l.e.d. patterns:

The two leftmost groups show an ADDRESS, High and Low bytes respectively. As we've only just switched on, it will be a random one, of no special significance.

The next eight bits (to the right of the address) shows the DATA stored in this address, and it, too, has no special importance to us yet.

Finally, we see eight more l.e.d.s, showing the flags of the STATUS REGISTER. We'll explain each one when we need it, but this diagram shows which is which (Fig. 9.5).

S *I suppose the eight switches are for sending signals in to the system, but what does "Port A" mean?*

T You're right about the switches. We can set them to the pattern of 0s and 1s we require for an input, as we'll see in a moment. The term "Port" refers to a special register in another chip of the 6500 family. It's a very useful one called the 6522.

S *I can see it on the controller board. It's as big as the microprocessor.*

T It is, and it's quite clever, too. The makers call it a Versatile Inteface Adaptor (VIA to us), and we'll get to know it better as we proceed. It provides a convenient input and output link for the system.

Notice that each switch corresponds to a small socket, numbered from *right to left* (the way we count) S0 to S7. These are the eight bits of the input/output PORT we shall be using. The 6522 has another port (Port B) which is in use for the CPU itself in this system.

As with the memory registers, the ports can be READ FROM or WRITTEN TO; they are bi-directional.

S *So they, too, are controlled by the R/$\overline{W}$ line?*

T They are. Now let's put it to use.

S *Can we use it to run a programme?*

T Certainly. The system contains some ready-made programs just for you! Here goes:

EXERCISE 15
A demonstration program

Cover up with card or paper all the l.e.d.s except the extreme right-hand one. Then press SHIFT, then press GO, and watch

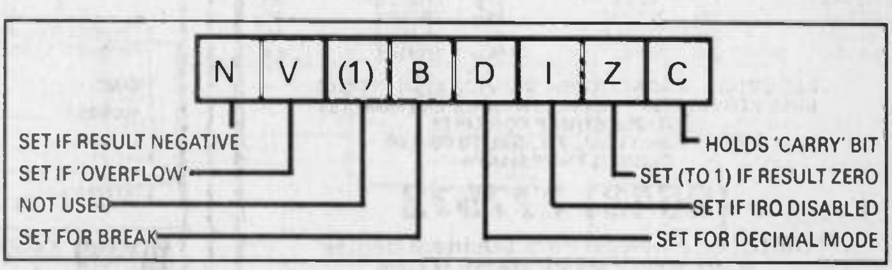


Fig. 9.5. The 6502 status flags.

the l.e.d. Gradually uncover the next l.e.d., then the next, until the FOUR rightmost l.e.d.s are clear.

S *The're counting in binary/but only to 9/it's a BCD counter like the 7490 chip.*

T Good, count with it for practice. To stop it, press RST. To re-start counting press GO again. OK? Now let's explore further:

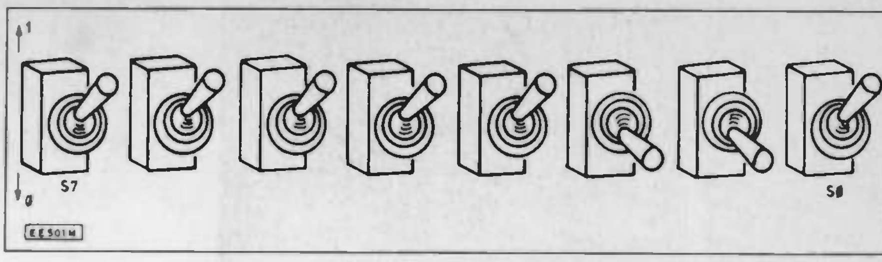


Fig. 9.6. Switch pattern for address high (F9). Entered by pressing AH key.

EXERCISE 16
Calling at an address

After switching on and pressing RESET, try this:

Step 1: Press the right-hand button, marked X/Y. Nothing will (should) happen to the display. The reason for doing this is that some of the buttons have been made "dual-purpose" by means of a SHIFT key (don't press it!), and pressing the right-hand key cancels the shift (the shift is more like a shift-lock on a typewriter). Anyway, press X/Y again to make sure.

Step 2: We'll inspect the location whose address, in binary, is:

1111 1001 0111 1100

Set up the "top half" i.e. 1111 1001, on the eight switches, by setting each one thus (Fig. 9.6), Up for 1, Down for 0, as usual.

Step 3: Now press the AH key, and see the pattern entered into the Address High l.e.d.s.

Step 4: Set the switches to the "low half" pattern, and enter them by pressing the AL key.

Step 5: After checking that the whole address is correct, look at the DATA l.e.d.s to see what is stored there. It should be (in binary, of course): 1010 1001.

As before, a lit l.e.d. is logic 1, an unlit one logic 0.

That's it, really, but we may as well see how another key can be used to look at neighbouring locations. Press, ONCE ONLY, the INC/DEC key (Increment/Decrement). Notice how the address has incremented (moved up by just one location), to the "house next door"! The DATA will be different, too, and should now show the binary value 0010 0010. Finally, press the SHIFT key, then press INC/DEC again, ONCE only, remember, and see the Tutor step BACK (decrement) to the original address, still containing 1010 1001.

You can, of course explore further up and down adjoining memory by pressing the INC/DEC key several times, with or without SHIFT. Remember to cancel SHIFT with X/Y at the end.

The address we used last time, is actually the START ADDRESS of a program. To RUN a program, assuming there's one already in memory, it's ESSENTIAL to start at exactly the right address, otherwise the codes may not make any sense to the micro, so make sure.

S *I don't recall doing so with my home computer.*

T No, because the BASIC interpreter built into it does it for you. In fact, all BASIC programs start from the same location in the home computer. Here, we're at the actual coal face! So, check that you're at the start address: 1111 1001 0111 1100 (what would it be in hex, by the way?)

S *(after some thought) F . . . 9 . . . 7 . . . C*

T Right F97C. It's a location in the read-only section of the system memory. That's why it's already available.

S *And why you knew what data to expect.*

T Yes. Now, to run this program, press GO, and watch the right-hand register (the "status" one which is borrowed for now as our display).

S *It's counting in binary, like our counter chip did.*

T Yes. This time, however, it won't stop at 9, but carry on, so watch it for a while. (It will revert to the BCD count after filling the eight bits; you can restore a full binary count by pressing RST then GO.

Next month: We explore further.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

NOVICE LICENCE

More details are now available on the DTI's proposed Novice Licence, briefly referred to last month. Two classes are proposed, a Novice B licence, permitting operation on v.h.f. frequencies above 30MHz, and a Novice A licence, requiring a Morse test of 5w.p.m., allowing additional frequencies in the h.f. range. These h.f. frequencies are not currently available to existing class B amateurs but B licensees of at least one year's standing will be allowed to use them if they pass the 5w.p.m. Novice Morse test.

The maximum power allowed will be five watts d.c. input (three watts r.f. output), using various modes as shown in the table. It is hoped that schools will be interested in taking on board the course of study leading to the novice exam. Some of the more exotic modes permitted, particularly at u.h.f., will be more suitable as classroom projects rather than day-to-day activities for the average novice at home.

Applicants for a novice licence will be required to complete a practical training course organised by the RSGB, and arrangements are in hand for these to be set up as part of Project YEAR (Youth into Electronics via Amateur radio) by local radio clubs. The Society is currently trying to locate all colleges and schools in the UK which are involved in amateur radio in any way, and would also like to hear from any schools which might be interested in using the Novice licence course as classwork or as an extra-curricular activity for its pupils.

Teacher/readers of EE interested in this possibility are asked to write to the RSGB Project Co-ordinator, *Hilary Claytonsmith G4JKS, 115 Marshalswick Lane, St Albans, Herts AL1 4UU.* Please mention that you read about Project YEAR in Everyday Electronics. I understand from Hilary that she has already collected interesting information about a number of existing amateur radio activities in UK schools and I hope to report on some of these in a future column.

PROPOSED UK NOVICE FREQUENCIES

MHz			*Novice Class*	*Permitted types of transmission*
1.950	–	2.000	A	Morse, telephony, RTTY, data
3.565	–	3.585	A	Morse
10.130	–	10.140	A	Morse
21.100	–	21.149	A	Morse
28.100	–	28.190	A	Morse, RTTY, data
28.225	–	28.300	A	Morse, RTTY, data
28.300	–	28.500	A	Morse, telephony
50.620	–	50.760	A,B	Data
51.250	–	51.750	A,B	Morse, telephony, data
433.000	–	435.000	A,B	Morse, telephony, data
1240.000	–	1325.000	A,B	Morse, telephony, RTTY, data, facsimile, SSTV, FSTV
10000.000	–	10500.000	A,B	Morse, telephony, RTTY, data, facsimile, SSTV, FSTV

USA EXPERIENCE

In the States there are already a good number of school projects associated with amateur radio and it has been found that, apart from gaining knowledge of electronics, children benefit in other areas of school work. Nine years ago, Carol Perry, WB2MGP, began teaching a course *"Introduction to Amateur Radio"* at Intermediate School 72 in Staten Island, New York. What began as a pilot programme is now taught to 700 students in the sixth, seventh and eighth grades with social studies, science, maths and language-arts skills all built into the curriculum.

Carol runs a station at the school which the students use under her supervision. As an example of the widening of horizons possible, Carol describes the occasion when radio contact was made with Father Mike Cronin, EL2BX/9L1, a missionary in Sierra Leone and principal of a high school. As a follow up to the contact the children wrote letters and sent pictures to Father Mike and later, during a visit to the US he came to the school to meet them.

In anticipation of the visit the students prepared reports on Sierra Leone and drew maps, charts and flags of the African continent. They learned a great deal about the climate and geography of their visitor's country in the process, and he described for them a typical school day in Sierra Leone. He also told them how lonely it can be in desolate areas of the world and how amateur radio can help to relieve this loneliness.

ROYAL CONTACT

On another occasion the class radio station contacted King Hussein of Jordan, callsign JY1, who subsequently wrote to the students congratulating them on their work in the Amateur Radio programme. This stimulated interest in Jordan and the Middle East generally so that it would be possible to speak intelligently to any station from that part of the world contacted by the school station.

Apart from straightforward radio contacts, the students participate in a 10 metres net with other schools across the USA, explore other amateur modes, and have received transmissions from astronauts via slow-scan TV.

A recent fillip to amateur radio in schools has been provided by the Uniden Corporation of America according to a recent W5Y1 REPORT. Uniden are making available to schools a quantity of their 10m HR-2510 transceivers which, apart from the ability to link in with the *"CQ All Schools"* activity each Tuesday and Thursday, are capable of worldwide communications in favourable conditions.

Each set comes complete with a ground plane antenna, co-axial cable and battery charger. The company "recognizes the urgent need to interest students in science and technology . . . it sees this programme as a way to use the Amateur Radio Hobby to revitalise an interest in mathematics, physics, chemistry and even foreign languages."

To qualify for one of the sets a school must have a licensed amateur operator on its staff and agree to install the radio where it can be observed and used by the greatest number of students under the supervision of the licensed amateur. A national committee, which includes Carol Perry, has been appointed to review applications which will undoubtedly outnumber the supply.

COMPLETE PACKAGE

Carol Perry's *"Introduction to Amateur Radio"* has been made available to other schools in the form of a complete package which includes a free video tape showing classroom use, a teacher's manual, Morse practice instruction and equipment, and access to a Ham Radio Hotline for assistance with any matter arising from the programme. The course can be used as a unit of study in a science curriculum, as a minor subject in its own right, or to specifically help students in passing the USA Novice examination.

It would not be of great assistance to schools in this country because of the differences between US and UK regulations, nomenclature and practice, but it is an interesting example of the place amateur radio can find in a school curriculum, especially now that a UK Novice licence is near reality.

Nearer home, West Germany has more than 200 schools with amateur radio activities. They are currently interested in establishing contact with similar groups in other countries. They suggest that skeds (regular contacts) could improve use of foreign languages and could lead to closer links including exchange visits.

DARC, the German national radio society, is compiling a list of schools interested in this idea, and those interested should write to *Wolfgang Lipps DL40AD, Sedanstr. 24, D-3207 Harsum, West Germany.*

DOWN TO EARTH

BY GEORGE HYLTON

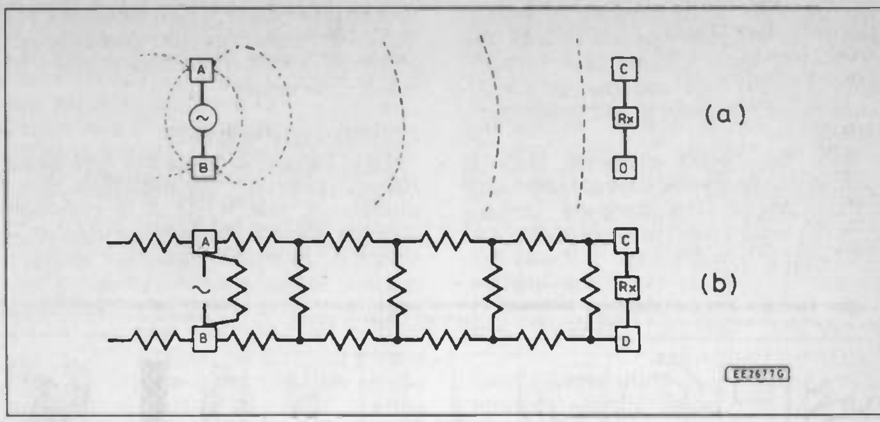


Fig. 3. (a) Receiver distant from transmitter. (b) Rough equivalent circuit of the transmission path.

COMMUNICATION BY EARTH CURRENTS

FROM time to time electronics magazines carry articles about using the ground as a transmission medium for audio or radio signals. The basic idea (Fig. 1a) is to drive currents from some sort of generator *G* into the earth via two buried metal contact plates *A* and *B*. The earth then forms the return path for the generator current.

Since there is resistance between any two points on the earth, the ground behaves rather like a network of interconnected resistances (Fig. 1b). Even though most of the current takes the shortest path between *A* and *B*, some current reaches all parts of the network.

In principle, it should be possible to apply a pair of earth contacts *C* and *D* to the ground and pick up some of the energy from the generator. By modulating the generator output a communication link could be established.

HISTORY

The idea has a long history. The first experiments on the subject go back at least as far as 1838, when a German physicist detected d.c. signals 50 feet from the primary (AB) connections.

In 1842, Samuel Morse (of Morse code fame) got interested, as the result of an accident. He had set up a submarine cable link to demonstrate his telegraphy system. A ship's anchor broke the cable. This led him to make experiments to find out whether signals could be sent across rivers without submarine cables, by using the conductivity of the water (Fig. 2).

Morse showed that they could, and found by experiment that for efficient communication the distance between *A* and *B* should be about three times the width of the river. This was an early hint of the greatest drawback of earth conductivity communication; short range.

Of course, there were no electronic amplifiers in Morse's day. With modern technology one can do better.

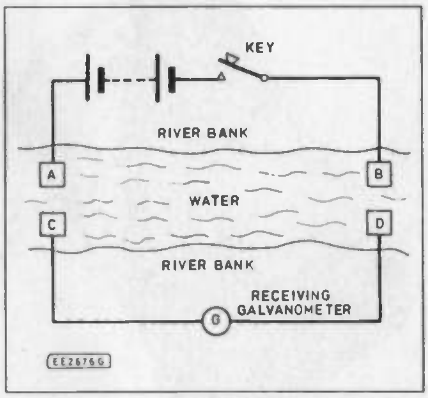
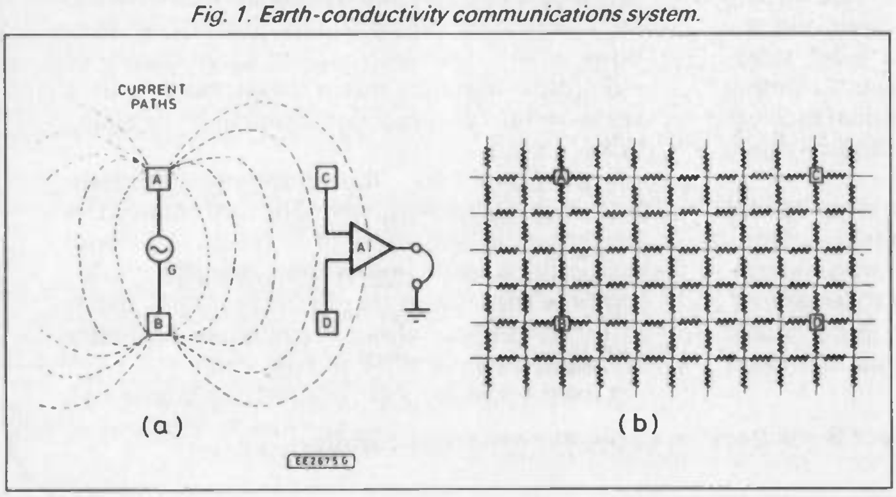


Fig. 2. Morse's broken-cable experiment.

ATTENUATION

How much better? If the receiving contacts are a very long way from the transmitter (Fig. 3a) we are concerned with signal levels along a narrow rectangular strip. Divide this into a series of squares. If the earth is uniform the resistance is the same along any side of a square. So in Fig. 3b all resistances are equal.

Fig. 1. Earth-conductivity communications system.



This is a crude, oversimplified two-dimensional model. But one thing is obvious. Each square is a section of a ladder attenuator. We know that if one section of an equal-resistance ladder gives an attenuation of 10dB, then two gives 20dB, three 30dB and so on.

If the attenuation at a range of 1 kilometre is 50dB then at 2km it is 100dB and at 3km, 150dB. Practical communication systems are limited by noise. It is a very good system indeed which can tolerate a path loss of 150dB.

Whatever the actual loss in the ground and the contact size and spacing, signal strength falls very rapidly with distance.

GROUND VERSUS RADIO

A ground communication system is quite different from a radio link. Radio contact can be maintained with space vehicles millions of miles away, because the only cause of reduced signal is its spreading-out, which limits the amount which can be intercepted by an aerial of practical size. The signal strength falls off with the square of the distance.

With an earth conduction system, attenuation must be worse. Not only does the signal spread out, but it is also absorbed by the earth, which has resistance.

Empty space, in contrast, is lossless. All the power transmitted by the space vehicle exists, spread out in space, whereas the power form the ground transmitter is used up in warming the soil.

EXPERIMENTING

This may rule out worldwide earth-conductivity communication but it doesn't mean that the idea is useless. There are times when limited range is all that's needed. Also, limited range can mean less interference, since unwanted distant transmissions never reach you.

TABLE-TOP MODEL

If you want to experiment, you can get the feel of conductive communication with the help of a model. Line a plastic tray with newspaper and moisten it with tap water. Put a pair of transmitting electrodes near one end and try different positions for a receiving pair.

An audio generator and a pair of high-sensitivity headphones can get you started. You'll find that signal strength is affected by the orientation of the pickup electrodes, rather as a ferrite rod aerial's orientation determines signal strength.

Tap water in Britain often has enough dissolved salts to provide the required conductivity. If for some reason you have to use pure water, add a pinch of salt.

OTHER USES

Real earth doesn't have uniform conductivity. Its electrical properties are affected by moisture content, mineral composition, and so on.

This raises the question whether ground communication techniques might be adapted for other uses. A contour map of signal strength could conceivably help to locate hidden water sources, the buried foundations of buildings, and so on.

Maps of simple ground conductivity are already used for similar purposes, but are tedious to make. By using the directional properties of a pair of signal-pickup contacts it might be possible to map the gradient of the signal strength without making any absolute measurements. Sudden changes of gradient may be significant indicators of hidden features.

On the plastic-tray model, a high-conductivity buried feature can be simulated roughly by putting a piece of aluminium foil between the pages of the newspaper, and a low-conductivity feature by cutting a hole or reducing the thickness of the wad at some point.

Further Reading

For information on early work see "*Wireless Telegraphy*" by Alfred T. Storey. My "revised edition" is undated but was probably printed in 1912, by Hodder & Stoughton, London. Some libraries may still have it.

SHOP TALK

with David Barrington

Please Take Note

We should like to apologise to constructors of the *MARC* system for causing confusion over the oscillator crystal specified in last months *Encoder* module. An extra three crept into the frequency figures during the design stage and was not picked up during all the checking processes. The correct crystal should be one operating at **3.2768MHz**.

The 3.2768MHz crystal is to be found in most catalogues under the "Timing Crystals" section for timekeeping purposes. It is quoted by **Maplin** as part number FY86T (Crystal 50HzX2.16).

In-Car Alarm

There are now numerous car alarms on the market with prices ranging to match. The latest car alarm from **Electronize** seems to answer the two main criticisms, namely cost and installation problems.

The Micro-Pressure Car Alarm comes as a kit (£12.95 plus £1 p&p) or ready assembled (£18.95 plus £1 p&p). Only three wires from the circuit board are needed to connect it to the vehicle, two into the horn circuit and one to the ignition or hidden switch if preferred.

This new design employs an air pressure sensing system to detect when a door is opened. As a door catch is released and the door begins to open, air is drawn out of the vehicle causing a minute but sudden drop in air pressure within the vehicle. This is converted into an electrical signal which triggers the alarm.

The system directly senses the movement of the doors. It can therefore be triggered by all doors and tailgate without the need to fit extra door switches. An adjustment is provided so you can set the sensitivity to your own preferences. At maximum sensitivity even a thump on the glass will trigger the alarm.

Further details and kits can be obtained from **Electronize Design, Dept EE, 2 Hillside Road, Four Oaks, Sutton Coldfield B74 4DQ.** ☎ *021 308 5877.*

Phone-In

We hear that **R&TV Components** have a stock of Pocket Tone Dialers which are proving very popular.

It is claimed that the "keypad dialer", which is just held over the mouthpiece, will control answer machines and video cassette recorders which will accept Dual-Tone Multi-Frequency (DTFM) signals over the telephone line. It is also claimed that you can quickly enter the DTMF Touch-Tone codes required by many computer based services, once you have reached the service number using a conventional rotary service phone.

The Telean PB881 Pocket Dialer costs £14.95 plus 60p p&p from **Radio & TV Components Acton Ltd, Dept EE, 21 High Street, Acton, London W3 6NG.**

Mains Appliance Remote Control

The *ON/OFF Decoder* for the *MARC* system, described this month, is another unit which is connected directly to the mains and, for personal safety, only first class quality components should be used.

The "impedance matching" transformer T1 (code 37-70742) and the optional ferrite ring for the "noise filter" were both purchased from **Cirkit** and are listed in their Inductor section.

The capacitors C1 and C2 are class X types designed to withstand continuous mains voltages, other types **must NOT** be used as replacements. This also applies to the X-class capacitor used in the optional mains noise filter. These capacitors were obtained from **Maplin**, codes JR33L (IS Cap 0.047μF) and JR35Q (IS Cap 0.22μF) respectively.

The remote control decoder i.c. M145027 (code UJ50E), VDR1 mains transient suppressor (code HW13P) and the moulded p.s.u. case (code YN38R) used to house the Decoder were all purchased from **Maplin**. The 12V double-pole mains relay, rated at 5A 240V a.c. (code YX98G (5A Main Rly)) also came form the same source. The coil resistance is listed as 200 ohm, the 150 ohm depicted on the circuit is a minimum figure.

The suppressor diode (D6) 1N6277 is an RS component and is available through **Electromail** (☎*0536 204555*), stock code 283 277.

The printed circuit board for the ON/OFF Decoder is obtainable through the *EE PCB Service*, code EE697 (see page 556).

Pressure Pad Alarm

We cannot foresee any component buying problems for readers undertaking the construction of the *Pressure Pad Alarm* project.

The dial cord drum is used for tuning dials in radios and may be stocked by some of our advertisers. If readers do have difficulties in finding a source, it is currently being listed by **Maplin**, code RX43W (Cord Drum Small).

Phoney Phone

There are no "special items" called for in the *Phoney Phone* project and all components should be available from local sources.

The stripboard is not a standard size and will have to be cut from a fairly large and expensive piece if it is to slot into the specified case. The off-cut need not be wasted as it will be plenty large enough to take a future project.

Simple Metronome

There should be no component purchasing problems for constructors building the *Simple Metronome* as they are all standard "off-the-shelf" items. However, when ordering the BC184L transistor it is most important to quote the suffix L as other 184 versions have a different pinout arrangement.

The small printed circuit board is available from the *EE PCB Service*, code EE698 (see page 556).

Gas Reserve Indicator

The conductive foam called for in the *Gas Reserve Indicator* is normally used to protect CMOS devices from the possible effects of static charge and is stocked by most semiconductor suppliers. The "pad" used in the prototype model was purchased from **Maplin** and is listed as: FA83E (Lodensty A/stat Foam).

Constructional Project

PHONEY PHONE

OWEN N. BISHOP

Fool your friends with this warbler — it has serious applications too!

THE IDEA for this project suggested itself one day when there was a particularly persistent and chatty caller at the door. We just could not get rid of him without appearing rude.

"If only the phone would ring," we thought to ourselves, "then we'd have an excuse to get away". Thus was born the Phoney Phone, a device that sounds like a ringing telephone and can be set to start ringing automatically after a given interval of time.

Such a device has many other uses, both for practical joking and more serious purposes. We leave it to the mischievous reader to devise the jokes, but some of the practical uses of this device are:

* A phone-bell repeater.
* A door alert.
* An alarm for use by an invalid or elderly person.
* A baby alarm.
* A security system alarm.
* A process timer, for example an egg timer.
* As a replacement for the buzzer used on an existing inter-com system.
* To lend added realism to a child's toy phone.

Readers may have already thought apprehensively of the chaos that will ensue with everyone rushing to answer the *real* phone every time an egg has finished cooking or someone comes to the door. This would soon become a bad joke indeed.

Fortunately, there are no problems of this kind – the Phoney Phone circuit is easily adaptable to make sounds quite unlike a phone warbler. We shall explain several ways of altering its sound output as the description of the circuit proceeds.

HOW IT WORKS

The heart of the circuit is the function generator shown in the block diagram Fig. 1. This is a single i.c. the 566, which has two outputs, giving a square wave and a triangular wave.

This project uses the triangular wave. The square-wave output could be used instead but it gives a much harsher sound. This would be suited to alarm applications, such as in a security system.

The central frequency of the output is determined by the values of a resistor and capacitor, as explained later. The frequency is also modulated by a signal from an astable multivibrator. This modulates the sound at about 25Hz, causing a warbling effect. The signal sent to the amplifier would produce a continuous warbling sound were it not for the action of the counter and detector, described next.

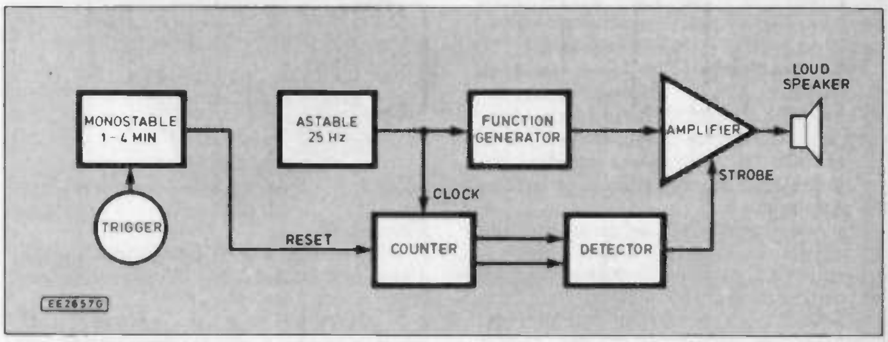


Fig. 1. System block diagram for the Phoney Phone.

The astable also drives a 14-stage binary counter. The output from this is tapped at stages four and six and fed to a detector circuit, consisting essentially of a 2-input NAND gate. The outputs of stages four and six go through the following sequences:

	Stages 6 5 4	Output of NAND
	0 0 0	1
	0 0 1	1
	0 1 0	1
	0 1 1	1
	1 0 0	1
	1 0 1	0
	1 1 0	1
	1 1 1	0
Repeating	0 0 0	1
	0 0 0	1
	etc	

As will be explained later, when the output is high ("1" in the table above), the amplifier is disabled and no sound is heard. When the gate output goes low ("0"), the amplifier is enabled and sound is heard. As the counter cycles through the stages in the table, sound is heard at every "0" stage, giving the familiar "burr-burr ... burr-burr ... burr-burr ... " of a ringing telephone.

Stage four of the counter has a frequency of 1/16 of the astable, approximately 1.5Hz. Stage six has a frequency of 1/64 of the astable, approximately 0.4Hz. Thus we obtain a tone burst lasting about 0.75 seconds, sounded twice and repeating every 2.5 seconds.

Other effects are produced in three ways:

1) By altering the frequency of the astable. This makes the sequence run faster or slower, but still gives a repeating "burr-burr ... " with gaps between. This also alters the warbling effect.
2) By tapping off other pairs of counter outputs. For example, tapping stages three and five gives the same sequence but twice as fast; tapping stages five and seven gives the same sequence at half the speed.
3) Other tappings can be selected to give a wide variety of sequences, ranging from a rapid series of "beeps" to "burr-burr-burr-burr ... once every 10 minutes. There is plenty of scope for experimentation.

The pin-out details of the 4020 i.c. to help you design your own sound sequences is given in Fig. 2. There are spare NAND gates that can be used when detecting outputs from more than two stages. The pinout of the 4011 NAND gate i.c. is shown in Fig. 3.

The monostable shown in Fig. 1 is an optional part of the design, when used in timing applications. When the trigger button is pressed, the output of the monostable goes high. This is connected to the reset input of the counter, and the effect is to hold the counter in the reset state.

After a period of one minute (or other length of time depending on the timing resistor and capacitor used) the output of the monostable goes low. The counter can now operate and the device begins to sound.

For other applications, the monostable can be replaced by a simple push-button or an interface to some other device such as a sound detector or security system. These options are explained later.

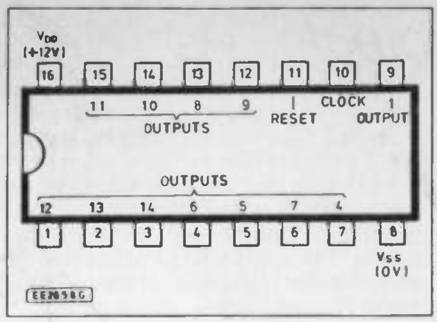


Fig. 2. Pin-out details for the 4020 counter (outputs from stages 2 and 3 not available).

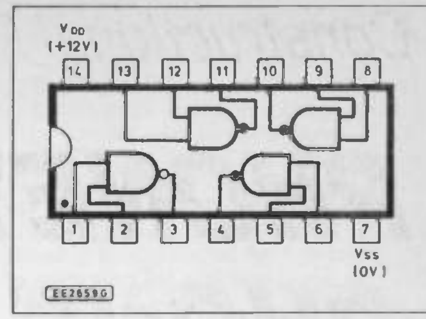


Fig. 3. Pin-out details for the 4011 i.c.

CIRCUIT DESCRIPTION

The full circuit diagram for the Phoney Phone is shown in Fig. 4. The circuit operates on a 12V supply, since it is battery-powered and the function generator i.c. requires a minimum of 10V.

When quiescent, the circuit takes 40mA. When sounding, the average current is 70mA. Thus eight alkaline AA cells should last for about 40 hours of continuous use. If you wish to economise in current, omit the two l.e.d.s and their resistors R1, R2.

capacitor C9. First of all the steady control voltage (V_c) at pin 5 is determined by the potential divider R10/R11. If the supply voltage is 12V, then $V_c = 12 \times R11/(R10 + R11)$.

In Fig. 4, $V_c = 12 \times 10/11.5 = 10.4V$. V_c must be between the supply voltage (12V) and three-quarters of the supply voltage (9V), so this voltage is just about middle of the range, allowing modulation in either direction.

The central frequency of the generator is given by:

$$f = \frac{2(V^+ - V_c)}{R12.C9V^+}$$

where V^+ is the supply voltage (12V). In this circuit,

$$f = \frac{2 \times 1.6}{6.8 \times 10^3 \times 47 \times 10^{-9} \times 12} = 834\text{Hz}$$

Frequency is varied by altering the values of R12 and C9 but R12 must be in the range 2k to 20k.

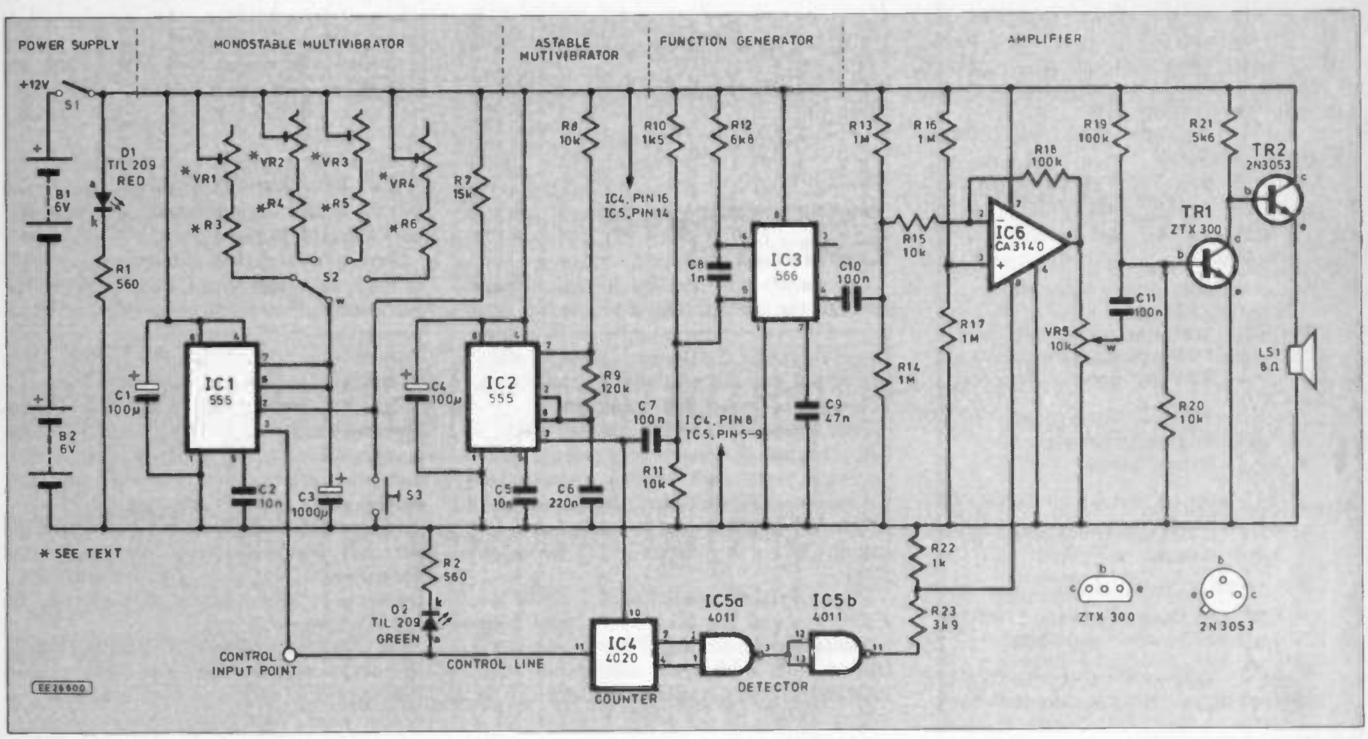
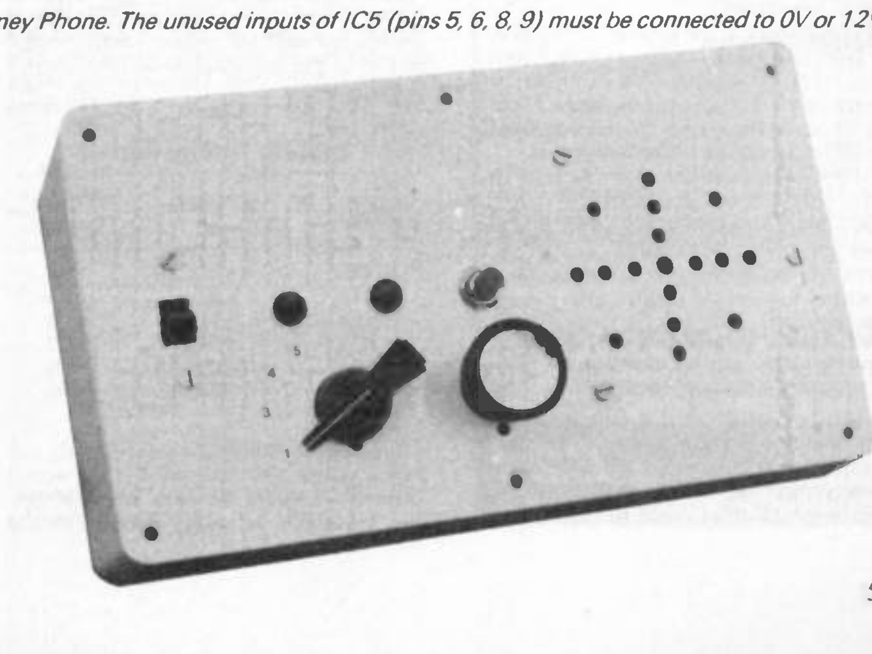


Fig. 4. Complete circuit diagram for the Phoney Phone. The unused inputs of IC5 (pins 5, 6, 8, 9) must be connected to 0V or 12V.

The Astable Multivibrator (IC2) uses the well-known 555 timer i.c. in astable mode. Frequency is determined by the values of resistors R8, R9 and capacitor C6. The values shown give a suitable warble and also give a sounding rate near to that of the standard telephone ringing sound. To vary frequency, it is best to alter the value of resistor R9, reducing it for a faster rate, increasing it for a slower rate.

Capacitor C4 decouples the i.c. from the supply so that the switching of the i.c. does not cause the counter i.c. to operate erratically. Capacitor C7 couples the astable output to the modulating input of the function generator.

The central frequency of the Function Generator (IC3) is determined by the values of resistors R10, R11, R12, and



AMPLIFIER

The Amplifier consists of IC6, TR1 and TR2. During the silent periods, the output of the first NAND gate of detector IC5 is high (see truth ta b le given earlier).

This output is inverted by the second NAND, to give a low output. This is fed to a potential-divider (R22/R23), with the result that the strobe input (pin 8) of IC6 is made low and the output (pin 6) is forced low. No signal passes to the next stage of amplification.

Transistor TR1 is biassed on by R20/R21, so that transistor TR2 is turned off during silent periods. This arrangement ensures that no current is passed by TR2 and loudspeaker LS1 during the long silent periods. This saves battery power and prevents TR2 from becoming over-heated.

When the output of the first detector NAND gate goes low, the output of the second gate goes high. This gives an input of about 2.5V to pin 8 of IC6, enabling its output. The signal voltage passes through potentiometer VR5, which being a variable potential divider acts as volume control.

The signal voltage tapped at its wiper passes through capacitor C11 and is amplified by transistor TR1. TR2 acts as an emitter follower, giving no further amplification but allowing a relatively large current to flow through LS1. This gives a high-volume sound output.

The circuit diagram Fig. 4 shows the outputs from the counter IC4 being used from stages four and six. As explained earlier, other outputs used singly or in combination, give different patterns of sounding.

A single NAND gate (IC5a) forms the detector stage and is used to give a low output when both its inputs are high. The low output turns off transistor TR3 and allows the sound signal to pass to TR2. The output is inverted by the second gate (IC5b), its input terminals being wired together so that it acts as a NOT gate. IC5 provides two spare gates for producing other types of sound patterns. The inputs of any gates that are not used *must* be connected either to the 0V rail or the supply rail.

TRIGGERING OPTIONS

The circuit is controlled by the voltage level on the control line. If this is low (less than 6V), the device sounds; if it is high (more than 6V), the device is silent. A number of options are available to control the voltage at the control input points.

The Monstable Multivibrator (IC1 – Fig. 1) holds the device silent for a given period of time, after which it sounds continuously until switched off. It is used in several applications including process-timing and for interrupting back-door gossipers!

The monstable consists of IC1, R3 to R6, C1 to C3 and S2, S3. All of these components may be omitted if this option is not chosen. Fig. 4 shows a number of resistors and variable resistor switched in by a rotary switch S2 to allow selection of a range of times.

Given that the period of the timer is 1.1RC, where *R* is the resistance of one of the resistor/variable-resistor combinations, and *C* is the capacitance of C3, suitable resistances are:

Table 2: Timing Period

Length of period	Resistor	Variable resistor
30 sec	22k	10k
1 min	47k	10k
2 min	91k	22k
3 min	150k	22k
4 min	200k	47k
5 min	240k	100k

It is possible that resistors of slightly different values may be needed if the actual value of C3 differs markedly from 1000µF. The monstable is set by pressing switch S3; the device then remains silent until the period has elapsed.

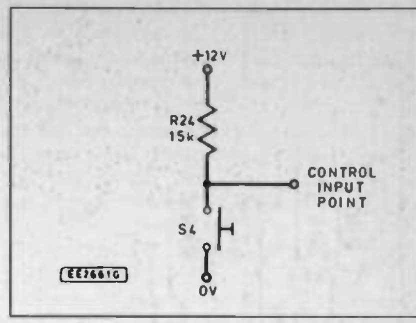


Fig. 5. Push-button triggering. The alarm sounds for as long as the button is pressed.

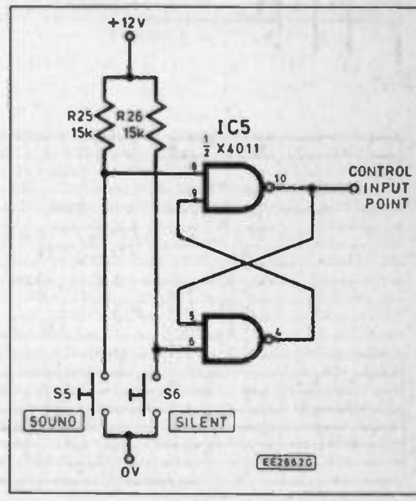


Fig. 6. Flip-flop triggering.

During this period the output of IC1 is high and the green l.e.d. (D2) is illuminated. If you require only a single timing period, S2 may be omitted and only one resistor and a variable resistor are connected between pin 7 and the 12V line.

For Push-Button triggering (Fig. 5) the alarm sounds for as long as the button is pressed. This is used in door-alerts, and other applications where an ordinary buzzer might normally be used.

The push-button switch is mounted on the case or externally. A normally-open security switch (e.g. magnetic switch on a door), a pressure-mat or a relay may be used instead

For Button-Controlled Flip-Flop (Fig. 6) the device sounds when the "set" button (S5) is pressed and continues sounding until the "reset" button (S6) is pressed.

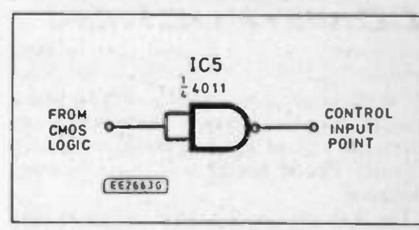
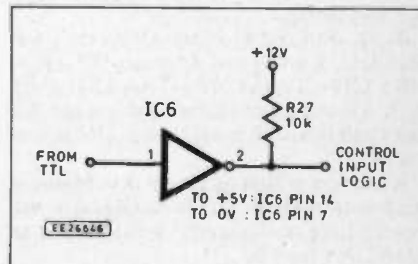


Fig. 7. Inverting a CMOS input.

Fig. 8. Interfacing to TTL output.



COMPONENTS

Resistors

R1, R2 560 (2 off)
R3-R6 see text
R7 15k
R8, R11, R15, R20 10k (4 off)
R9 120k
R10 1k5
R12 6k8
R13, R14, R16, R17 1M (4 off)
R18, R19 100k (2 off)
R21 5k6
R22 1k
R23 3k9
All 0.6W ±1% carbon film

See SHOP TALK Page

Potentiometers

VR1-VR4 Min. preset (see text for values), horiz. (4 off)
VR5 10k rotary, lin.

Capacitors

C1, C4 100µ elect 16V or 25V (2 off)
C2, C5 10n polyester (2 off)
C3 1000µ elec. 16V or 25V
C6 220n polyester
C7, C10, C11 100n polyester (3 off)
C8 1n polycarbonate
C9 47n polyester

Semiconductors

D1, D2 TIL209 or similar l.e.d.s, one red, one green
TR1 ZTX300 *npn* transistor
TR2 2N3053 *npn* transistor
IC1, IC2 555 timer (2 off)
IC3 566 function generator
IC4 4020 CMOS 14-stage synchronous counter
IC5 4011 CMOS quadruple 2-input NAND gate
IC6 CA3140 f.e.t. operational amplifier

Miscellaneous

S1 S.P.S.T. toggle or slide switch
S2 4-way rotary switch
S3 Push-to-make push-button
LS1 Loudspeaker 8 ohm
Plastic case (ABS), approx. 190mm × 110mm × 60mm; stripboard, 0.1in. matrix, size 19 strips × 73 holes; 8-pin d.i.l. sockets (4 off); 14-pin d.i.l. socket; 16-pin d.i.l. socket; 1mm terminal pins (18 off); knobs for S2 and VR5; battery-holders for 4 × AA cells (2 off); battery clips (2 off); nuts (6 off); bolts (3 off) and solder tags (3 off) for mounting loudspeaker; clip-on heatsink for TO5 can; connecting wire; solder etc.

Approx cost guidance only **£21** *excl. Batt*

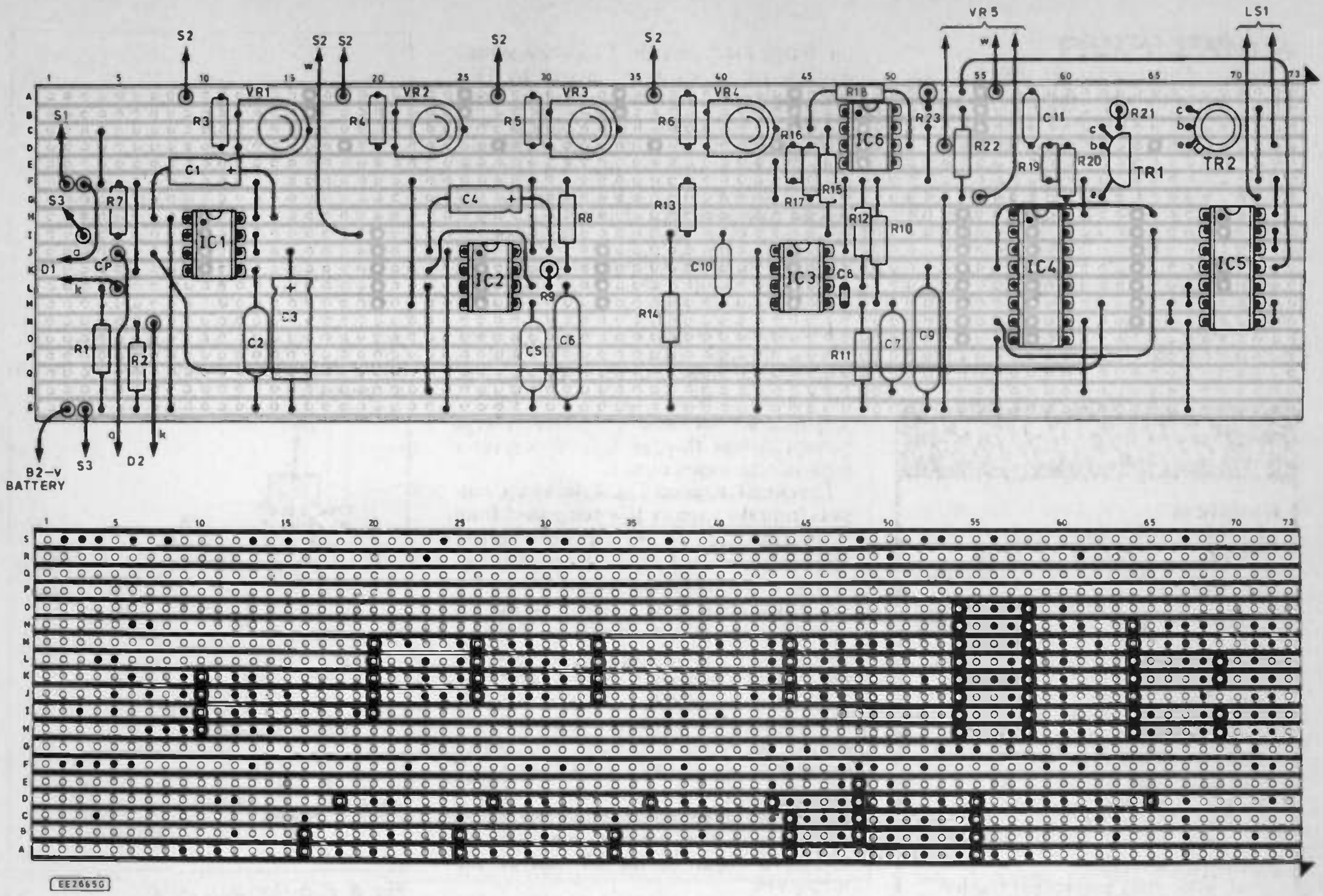


Fig. 9. Stripboard component layout and details of breaks required in the underside copper tracks. A small TO5 size heatsink is needed for transistor TR2.

Useful for an alarm for an elderly or infirm person, who may not have the strength to press a button for more than an instant. Two spare NAND gates from IC5 are used to construct the flip-flop.

For Logic Input the control input can be driven by an external device such as a sound-detector or security system which provides CMOS logic output, operating on a 9V or 12V supply. The 0V line of the external device must be connected to the 0V line of the Phoney Phone.

Use one of the spare gates of IC5 to invert the input (Fig. 7) if this operates in the wrong sense. Fig. 8 shows how to interface the control input point to a TTL output. To obtain a non-inverted input, use a 7407 or 7417; to obtain an inverted input, use a 7406 or 7416.

CONSTRUCTION

The constructor is warned that building and testing this device endangers the peace of mind of the whole family! Try to find a (preferably sound-proof) place well away from the rest of the household where the Phoney Phone sound will not cause annoyance.

Fig. 9 shows how all the sub-circuits may be set out on a piece of stripboard cut to slot into the recommended case. Details of the underside breaks in the copper tracks are also shown.

Begin with the function generator (IC3, R10-R12, C8-C9) and amplifier (R13-R21, VR5, C10-C11, IC6, TR1-TR3, LS1). Pin 8 of IC6 is left unconnected at this stage. Fit the small heatsink to transistor TR2 before testing.

When you switch on power, a continuous loud note of about 830Hz should be heard. If you hear nothing, check the setting of potentiometer VR5.

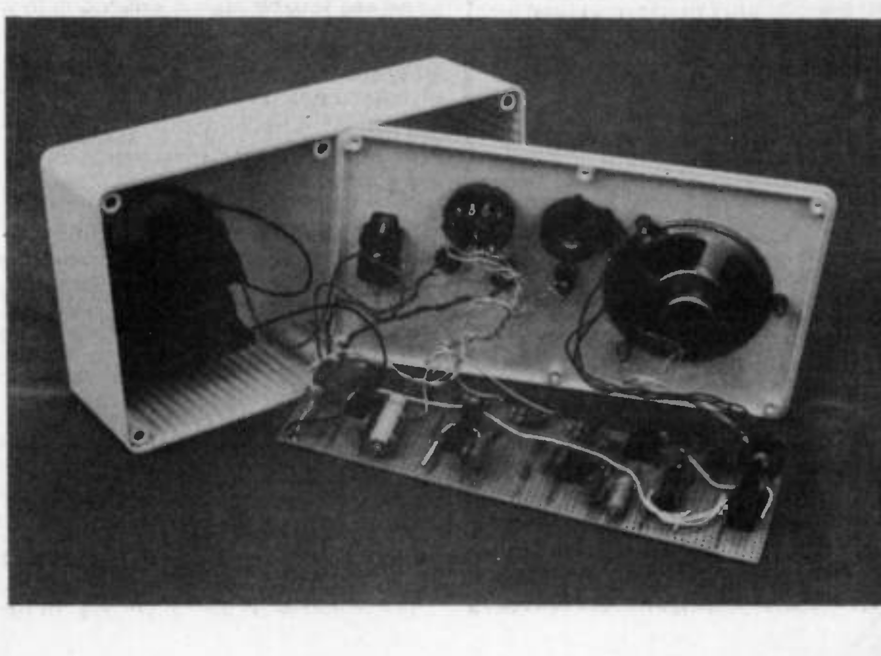
Next build the astable (IC2, R8-R9, C4-C7). The frequency of this can be measured with an oscilloscope and should be about 25Hz. However, you can easily check that the frequency is approximately right by listening to the sound. This should now be a continuous warbling note.

The counter and detector are the next stages to complete. Remember to observe the usual anti-static precautions when handling IC4 and IC5. Note that the unused inputs of IC5 *must* all be connected to 0V or 12V, even at the testing stage. Otherwise, IC5 may operate erratically.

For testing, temporarily connect pin 11 of IC4 to the 0V line to enable counting to occur. Before making the connection between the junction of R22/R23 and pin 8 of IC6, the outputs of IC4 may be monitored with a voltmeter.

Check that the output of pin 7 rises and falls slightly more often than once a second, while that of pin 4 rises and falls about once every 2.5 seconds (this is assuming that you are trying to simulate the normal Telecom sound). Otherwise, replace resistor R9 with other values until the frequency suits your need. When the junction R22/R23 is connected to IC6 pin 8 the familiar but phoney sound will be heard.

The completed unit showing components mounted on the rear of the lid.



MONSTABLE

The final stage of construction depends on which triggering option you have decided to incorporate. The monstable option is the only one that needs discussion.

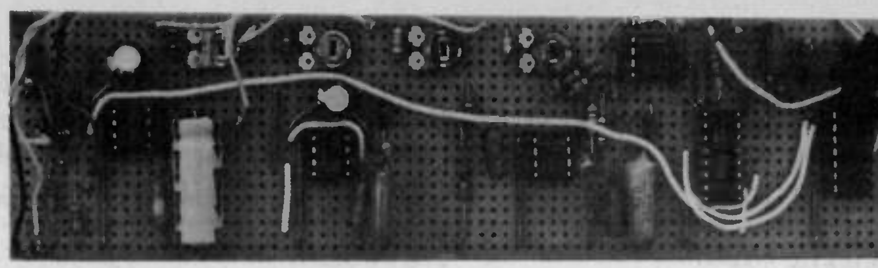
The values of resistors R3-R6 and presets VR1-VR4 are given in Table. 2. The output of IC1 (pin 3) is normally low when the circuit is first switched on. Pressing S3 for an instant triggers the i.c. and its output goes high. The length of time it stays high depends on the value of the timing resistors (R3-R6 and VR1-VR4) and capacitor C3.

If the circuit is to be used for process-timing, you will need to set each of VR1-VR4 to give the correct times. It is better if the output from pin 3 is *not* connected to IC4 yet and if pin 11 of IC4 is temporarily connected to the 12V rail. This allows the setting of the times to be done in silence. The output at pin 3 is measured by a voltmeter.

To set VR1 proceed as follows. Position the wiper so that it is near the centre of its track. Press switch S3 for an instant. Use a watch to measure how long the output stays high (12V). If this is longer than the required period, reduce the resistance of VR1 by turning the wiper slightly clockwise. If the period is shorter than required, turn VR1 the other way. Repeat this procedure until the timing is right.

If the value of C3 is markedly different from its nominal value, it may happen that the wiper reaches either end of the track and the timing is still not correct. In this event, either replace C3 or replace R3 with a resistor of higher or lower value and start again.

Repeat the above procedure for VR2 to VR4 in turn. Then connect pin 3 of IC1 to pin 11 of IC4. When power is switched on, the sound begins, but is silenced by pressing S3. The green l.e.d. comes on and the device remains silent for the selected time. Then the green l.e.d. goes out and the phoney sound begins. To operate the device without the initial sound, press S3 *before* switching on, then release it.



The layout of components on the completed circuit board.

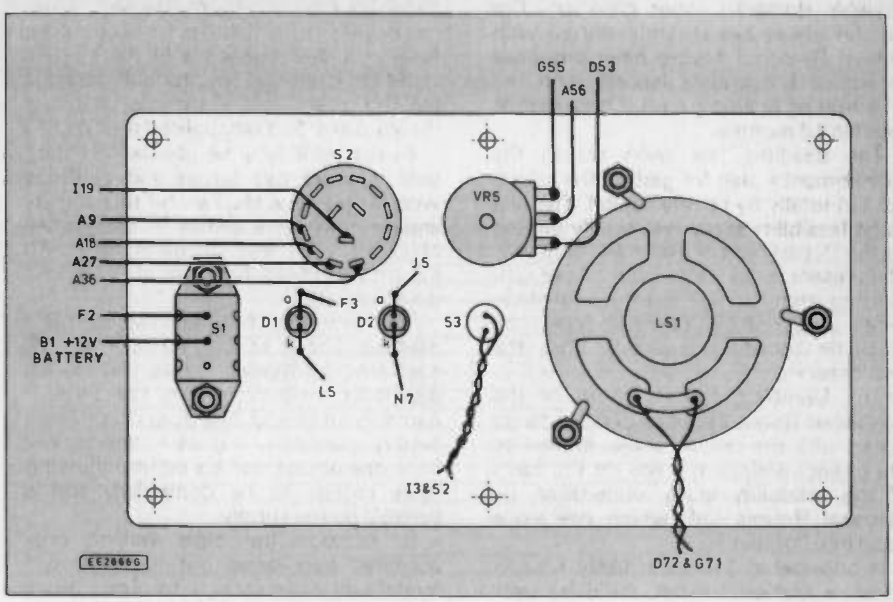


Fig. 10. All the off-board components are mounted on the lid of the case and wired to the circuit board at reference points indicated.

When the circuit board has been tested, prepare the case by drilling holes for the off-board components (Fig. 10). The loudspeaker may be held in place with three solder-tags, as shown.

The design uses two 4-cell battery holders, wired in series to give a 12V supply. The battery holders may be fixed in place using Blutack. Alternatively, fit a small ready-made mains PSU giving 12V d.c. at a minimum of 80mA. Mount all the components in the case and the Phoney Phone is ready for use, serious or otherwise. □

MARKET PLACE

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AVO 8 MODEL II, £50. Labgear colour bar gen. £50. Sony 7600D multi band £50. (0875) 811816.

COMMODORE spares i.c.s, 64K p.s.u., C16 p.s.u. modulators, few other spares. Swap for Spectrum 48K. Spares. Mr D. Wood, 17 Boydon Close, Ettingshall, Wolverhampton WV2 2NE.

EIRE. Late starter in electronics (33) seeks contact with others. Also info. on clubs and suppliers. Noel McGuinness, 29 McCabe's Villas, Booterstown, C. Dublin, Eire. Tel: (01) 831104.

WANTED for Samleco DX85 printer, parallel interface, or circuit diagram, or current address. G. Waye, 32 Lindale Avenue, Hornsea, North Humberside.

NEWBRAIN COMPUTER. Complete set of boards, keyboard, p.s.u. manuals, no case, hence £10 o.n.o. Brand new. N. Johnson. Tel: (0797) 252217 (weekends).

FOR SALE s.h. MEM motor switch. Amp rating 4.0 to 8.0, worth £50, £22. Cheque to S. J. Bennett, 17 Fresham Place, Henfield, W. Sussex BN5 9QJ.

WANTED any info. on Epson QX16 computer especially need users manual and also correct DOS version. Tel: (0825) 890771.

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MARKET PLACE AUGUST '90

Robot Roundup

NIGEL CLARK

DOMESTIC ROBOT

The Government-sponsored search for a viable domestic robot goes on. The second phase has recently started with Fulmar Research having been proposed to act as the project leaders with the intention of building a prototype mobile robot in 18 months.

The deadline has been set in the Government's plan for getting the search funded totally by private capital. The first stage feasibility study was totally funded by the Department of Trade and Industry. The present stage is receiving 50 per cent funding from the DTI but the final stage when a commercial robot is developed must be funded completely from the private sector.

The Domestic Robot Group of the Advanced Robot Initiative decided to go ahead with the second stage, known as the project definition stage on the basis of the feasibility study undertaken by Personal Robots Ltd, which has since gone into liquidation.

It considered the most likely area in which a domestic robot could be useful was in the commercial service industries where it could undertake tasks such as hotel and office cleaning, fast food preparation and high rise window cleaning. It recommended though that there be further investigation into four areas:

- Low cost single task devices for jobs such as lawn mowing, vacuum cleaning, cooking and home security.
- Multi-function domestic robot aimed at the luxury home market.
- Domestic service industry robot.
- Healthcare robots for the handicapped.

However, an important task was the building of a prototype to show how these jobs could be carried out and provide the basis for attracting the backing for the final development of the commercial device.

Under the leadership of Fulmar, which is understood to be working on the core technology for the prototype, as well as acting as the liaison with the Department of Trade and Industry, there are a number of organisations working on specific sections of the robot.

Fifty per cent of the funding not covered by the DTI is being met by the organisations doing the work, mostly university departments and research bodies, and other members of the Domestic Robot Group. The major test of whether the group's ideas are viable will come when the commercial backing has to be sought towards the end of next year.

EASY DOES IT

The kits and computer simulator company Ezi-Dunn, run by Stewart Dunn, has been making changes to its products. Based on the experience of the months since the launch of his products towards the end of last year, Dunn has improved the simulator and rationalised the kits.

At the same time he has been finding time to write two books and continue with his job as a teacher. All this activity should come to a climax in September, or possibly the end of this month with the new products and one of the books going on sale.

The simulator has received a major overhaul and is to be sold as a manual controller for models rather than as an alternative to a computer. The original had one input and five outputs and was battery powered, the new device will have one output and six inputs, allowing three motors to be controlled, and a variable power supply.

In addition the older version only accepted bare wires but the improved model will have sockets for 4mm plugs and screw terminals. With a new smarter box as well, the only design feature retained from the original are l.e.d.s on all the inputs and outputs and no memory. Dunn said that the changes were a move upmarket which made it look more like a conventional interface or controller, hence the change in its classification.

However, it is still intended to be an answer to the original problem which is lack of time available on the computer. The controller will still provide an inexpensive way of testing models and writing routines, with the help of the accompanying documentation, without having to join the queue for time on the school computers. When the model builders do get to use the computer they can immediately enter the routine and have the model working relatively quickly.

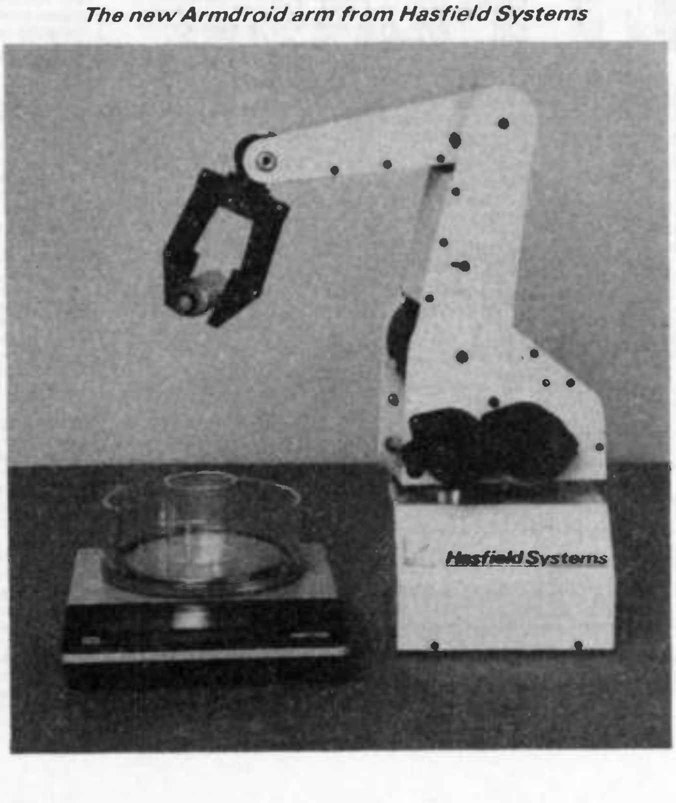
The number of kits has been cut down from four different sets of components to one central collection and two upgrades for particular user needs. Dunn said that the reason for the move was that people were unsure which kit suited their purposes so it was thought better to simplify the range.

The core kit contains electronic components and mechanisms and the Ezi-Dunn board which allows components to be connected on the board without the need for solder. Dunn said the kit would be suitable for middle and elementary schools. The upgrades were to provide equipment for devices to GCSE standard and for the study of digital logic.

Each kit contains some ideas for devices which can be built. But Dunn added that the components were sufficient to build other devices.

Dunn's first book, entitled *Electronic Projects Made Simple*, is, as the name implies, a collection of projects. There are more than 100, starting with simple electronic circuits and moving on to more complex models. He is still working on the second, *Computers in Technology*, which is centred on control technology and should be published before the end of the year.

The new Armdroid arm from Hasfield Systems



UP-GRADE BOARD

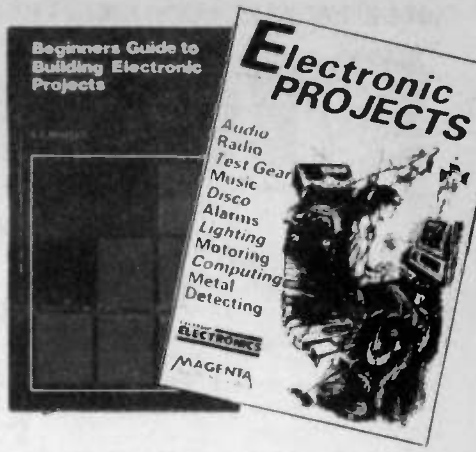
As part of its upgrading of the Armdroid arm, Hasfield Systems has completed the work on the operating software to run the ArmCon 2 bipolar stepper motor drive board. The board will be able to control up to eight bipolar motors either as a general controller or as part of the Armdroid drive system. When fitted to the Armdroid it can control up to seven motors, six for the arm and the other for an external device such as a carousel.

A set of software routines, called ArmPrim, has been created for the new board which allows a number of the robot's actions to be pre-set so that, for example, the user can decide on the maximum and minimum velocities and the levels of current for various actions.

As with the existing Armdroid controller the new board provides for all the relevant axes to move at the same time for the arm to reach a certain position and for the movements to be ramped, that is accelerated and decelerated, rather than starting and stopping at the machines maximum speed.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full details are given on the last book page.
For another selection of books see next month's issue.



MORE BOOKS NEXT MONTH — MORE BOOKS NEXT MONTH

PROJECT CONSTRUCTION

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
96 pages **Order code BP110** **£2.50**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£2.50**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.
112 pages **Order code No. 227** **£1.95**

ELECTRONIC SCIENCE PROJECTS
O. Bishop
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.
144 pages **Order code BP104** **£2.95**

ELECTRONIC PROJECTS — BOOK 1
Published by *Everyday Electronics* in association with Magenta Electronics.
Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16k Sideways Ram, Simple Short Wave Radio, Insulation Tester, Visual Guitar/Instrument Tuner, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider—(Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages(A4 size) **Order Code EP1** **£2.45**

CIRCUITS & DESIGN

PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 1
PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 2
R. A. Penfold
These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.

BOOK 1 contains: Oscillators—sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers—simple monostable circuits using i.c.s, the 555 and 7555 devices, etc. Miscellaneous—noise generators, rectifiers, comparators and triggers, etc.

BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.

BOOK 1 *128 pages* **Order code BP117** **£1.95**
BOOK 2 *112 pages* **Order code BP118** **£1.95**

ELECTRONIC ALARM CIRCUITS MANUAL
R. M. Marston
One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.
Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.
124 pages **Order code NE11** **£10.95**

DESIGNING DC POWER SUPPLIES
G. C. Loveday C.Eng MIERE
Covers all aspects of the design of regulated power units, using discretes, i.c. regulators and switched units. It also covers protection circuits and reference supplies. Many design examples and exercises all with fully worked solutions are given.
131 pages **Order code BM2** **£6.95**

ELECTRONIC POWER SUPPLY HANDBOOK **NEW**
Ian R. Sinclair
This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems, IC switch-mode regulators, DC-DC converters and inverters.
The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.
136 pages **Order code PC108** **£7.95**

MODERN OPTO DEVICE PROJECTS
R.A. Penfold
In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these devices have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.
While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.
104 pages **Order code BP194** **£2.95**

DIGITAL LOGIC GATES AND FLIP-FLOPS
Ian R. Sinclair
This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning. This is not a constructor's book in the sense of presenting circuits to build and use, it is for the user who wants to design and troubleshoot digital circuitry with considerably more understanding of principles.
Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.
No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.
200 pages **Order code PC106** **£8.95**

HOW TO USE OP-AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible
160 pages **Order code BP88** **£2.95**

MICRO INTERFACING CIRCUITS–BOOK 1
MICRO INTERFACING CIRCUITS–BOOK 2
R. A. Penfold
Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.
Book 1 is mainly concerned with getting signals in and out of the computer;. Book 2 deals primarily with circuits for practical applications.
Book 1 *112 pages* **Order code BP130** **£2.25**
Book 2 *112 pages* **Order code BP131** **£2.75**

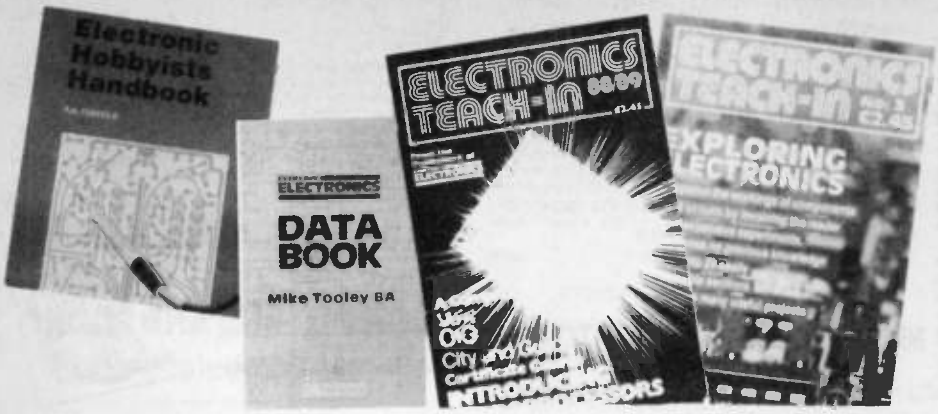
SENSORS AND TRANSDUCERS
Keith Brindley
There are a considerable number of transducers. Look through any electronic components catalogue and you'll find a wide variety of types, and each type has many versions. It's not easy to choose a transducer correctly for a particular function. In many specifications, terms and procedures are referred to which might deter you from using one that is, in fact, the best for the job. Yet, opting to use a transducer merely because it is easier to interface into the measuring system is not the answer. A greater knowledge of all types of transducers capable of doing the task is the ideal, and only then can a totally satisfactory decision be made to use one in particular.
176 pages **Order code NE17** **£12.95**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.
The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.
92 pages **Order code BP179** **£2.95**

50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components—the light-emitting diode (LED). Also includes circuits for the 707 common anode display
64 pages **Order Code BP42** **£1.95**
BOOK 2 50 more l.e.d. circuits **Order code BP87** **£1.95**

ELECTRONICS SIMPLIFIED —CRYSTAL SET CONSTRUCTION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.
80 pages **Order Code BP92** **£1.75**

TEACH-IN, THEORY, AND REFERENCE



ELECTRONICS TEACH-IN 88/89— INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

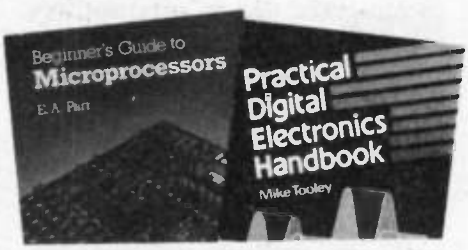
FROM ATOMS TO AMPERES
F. A. Wilson
Explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever.
Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?
Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.
244 pages **Order code BP254** **£3.50**

BEGINNERS GUIDE TO MICROPROCESSORS
E.A. Parr
An excellent grounding in microprocessors, this book is broadly relevent to the whole of our Introducing Microprocessors course. It is easy to read and well illustrated.
224 pages **Temporarily out of print**

ELECTRONICS—A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

ELECTRONICS TEACH-IN No. 3 — EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.
Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.
88 pages (A4 size) **Order code TI3** **£2.45**

NEWNES ELECTRONICS POCKET BOOK
E. A. Parr
Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op.amp. applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.
315 pages (hard cover) **Order Code NE02** **£9.95**



EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.
It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.
A must for everyone involved in electronics!
256 pages **Order code DATA** **£8.95**

ELECTRONIC HOBBYISTS HANDBOOK
R.A. Penfold
Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.
88 pages **Order code BP233** **£4.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.
The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics.
128 pages **Order Code 228** **£2.50**

PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
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COMPUTING

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Michael Tooley
An invaluable compendium of facts, figures, circuits and data, indispensable to the designer, student, service engineer and all those interested in computer and microcomputer systems. It will appeal equally to the hardware or software specialist and to the new band of "software engineers". This first edition covers a vast range of subjects at a practical level, with the necessary explanatory text. The data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit.
205 pages (hard cover) **Order code NE01** **£9.95**

AN INTRODUCTION TO Z80 MACHINE CODE
R. A. & J. W. Penfold
Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The Z80 is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128.
144 pages **Order code BP152** **£2.75**

A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., C.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.
192 pages **Order Code BP112** **£3.50**

COMPUTERS AND MUSIC — AN INTRODUCTION
R.A. Penfold
Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone.
Computer-based music systems in the past have tended to be either horrendously expensive, very crude, or both! These days, prices are much more modest and the potential of the equipment is much greater. Consequently a lot of musicians are being tempted into the unfamiliar territory of computer music systems.
If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.
This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.
174 pages **Order code PC107** **£7.95**

GETTING THE MOST FROM YOUR PRINTER
J. W. Penfold
Details how to use all the features provided on most dot-matrix printers from programs and popular word processor packages like Wordwise, Visawrite and Quill, etc. Shows exactly what must be typed in to achieve a given effect.
96 pages **Order Code BP181** **£2.95**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
This guide is writen with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.
64 pages **Order code BP232** **£2.95**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold
Obtain a vast increase in running speed by writing programs for 68000 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.
112 pages **Order code BP184** **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.
It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.
144 pages **Order code BP119** **£2.50**

AUDIO & MUSIC

BEGINNER'S GUIDE TO HI-FI
Ian Sinclair
The *Beginner's Guide to Hi-Fi* will appeal to the audio enthusiast, whether newly won over by advances in technology or well established and wondering whether to update equipment. The book deals with the sound from its sources in the studio to its ultimate end in your ears, and shows what sound is, how it is recorded and how it is reproduced.
Every aspect of Hi-Fi, from pickup cartridges to loudspeakers, has been covered, and the emphasis has been on explaining design aims. Cassette systems have been given considerable prominence, including the more modern Dolby C and dbx noise reduction systems. The CD record has been covered in detail so that you can find out just why this system of sound reproduction is so superior.
194 pages **Temporarily out of print.**

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel
This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.
148 pages **Order Code BP256** **£2.95**

MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold
The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.
A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.
90 pages **Order code BP246** **£5.95**

PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
128 pages **Order code PC101** **£5.95**

COMPUTERS AND MUSIC
— see computer section

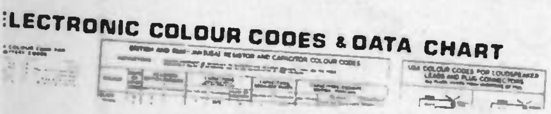
DATA & COMPONENT IDENTIFICATION

HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr
Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.
Chart **Order code BP101** **£0.95**

INTERNATIONAL DIODE EQUIVALENTS GUIDE
A. Michaels
Designed to help the user in finding possible substitutes for a large selection of the many different types of diodes that are available. Besides simple rectifier diodes, also included are Zener diodes, l.e.d.s, diacs, triacs, thyristors, OCIs, photo and display diodes.
144 pages **Temporarily out of print**

LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese linear i.c.s. Also includes details of functions, manufacturer and country of origin.
320 pages **Temporarily out of print**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.
Chart **Order code BP7** **£0.95**



TESTING & TEST GEAR

TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller
Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief description of these faults, *vis*—sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.
Chart **Order code BP70** **£0.95**

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
R. A. Penfold
This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits. Plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.
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Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models is available. But which is the right 'scope for a particular application? What techniques will get the best out of the instrument?
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RADIO, TV, SATELLITE

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P. Shore
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Listening to Short Wave Radio; ITU Country Codes; Worldwide Short Wave Radio Stations; European, Middle East and North African Long Wave Radio Stations; European, Near East and North African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time differences from GMT; Abbreviations; Wavelength/Frequency Conversion.
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R. A. Penfold
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Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.
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F.A. Wilson
As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc.
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COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
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See next month's issue for another three page selection of books.

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Please check price and availability (see latest issue of Everyday Electronics) before ordering from old lists.

Note—our postage charge is the same for one book or one hundred books!

MORE BOOKS NEXT MONTH

HIGH GRADE COMPONENT PARCELS

EVERYTHING MUST GO!

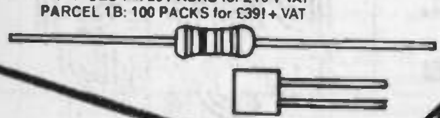
Unless otherwise stated, all the clearance parcels we offer contain brand new, top grade components. If some of the offers look too good to be true, all I can say is that the optimists will get some stunning bargains, the cynics will never know what they've missed, so everybody will be happy! All offers apply only while current stocks last – watch out for next month's parcels or, better still, be the first to hear about any new offers by putting your name on our mailing list. (Please write in, or 'phone Pete Leah on 0272 522703 after 6.30 pm).

UNIVERSAL EVERYTHING PARCEL

This one contains some of just about any component you care to name! There are passives (resistors, capacitors, tants, presets), opto devices (couplers, LEDs of all shapes and sizes, infra-red components, 7-segment displays), semiconductors (transistors, diodes, ICs, rectifiers), and all kinds of other odds and ends (relays, VDRs, neons, battery connectors, mixed components packs). A stunning range of components – enough to get a workshop or lab. started – at a ridiculously low price.

The components are of excellent quality, in packs originally intended to sell at £1 each. To make sure you get a good variety, the 20-pack parcel will have no more than two of any one pack, the 100 pack parcel will have at most five of any one pack. Packs supplied as they come – our choice.

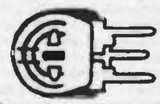
PARCEL 1A: 20 PACKS for £10 + VAT
PARCEL 1B: 100 PACKS for £39! + VAT



MASSIVE CLEARANCE SALE

Once again, a general purpose parcel containing a huge variety of components: resistors, capacitors, ICs, transistors, electrolytics, tants, triacs, LEDs, diodes, thermistors, trimmers, VDRs, all sorts. All new, top quality components. This is mostly remainders from our own stock – stuff we forgot to advertise, or have in too small a quantity to sell individually. Guaranteed to be worth at least eight times the price if valued from any standard component catalogue! What more can I say?

PARCEL 2A: 1000+ top grade components for £12! + VAT (Value £100+)
PARCEL 2B: 5000+ top grade components for £49! + VAT (Value £500+)



INTEGRATED CIRCUITS

This parcel contains nothing but ICs. The mixture offers TTL and CMOS logic, interface ICs, linear, data converters, op-amps, special functions, and so on. Some of the ICs are pre-packed with data sheets, some (TTL, CMOS, op-amps) we expect you to identify for yourself, others will be covered by the free *data pack* provided, and the rest you'll have to identify under your own steam. If you know your ICs you'll be in for a few nice surprises.

PARCEL 3A: 100 ICs for £12! + VAT
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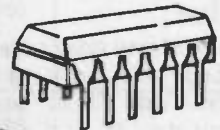
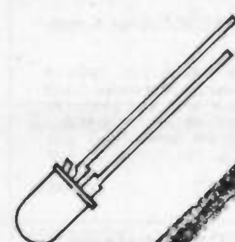


LEDs

All shapes, sizes and colours of LEDs. Round ones in various sizes, rectangular ones, red, green, amber and yellow ones, clear and tinted lenses, all sorts.

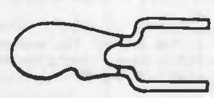
PARCEL 7A: 100 LEDs for £5.90 + VAT
PARCEL 7B: 500 LEDs for £24.90 + VAT



TANTALUM CAPACITORS

A nice range of tants in values up to 47µF. Lots of useful caps, and we're not mean with the most expensive ones. A fine selection.

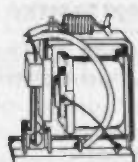
PARCEL 4A: 100 TANTS for £6.80 + VAT
PARCEL 4B: 500 TANTS for £29! + VAT



RELAYS

All kinds of relays: plug-in, PCB mounting, low voltage (down to 3V coils), miniature, reeds, heavy duty contacts, signal contacts, you name it. A fantastic selection. You'll be back for more!

PARCEL 16A: 50 RELAYS for £12 + VAT
PARCEL 16B: 200 RELAYS for £38 + VAT



CAPACITORS

An exciting selection of capacitors. There are ceramics for decoupling and general use, Polystyrenes for high performance circuits, dipped and moulded polyesters in values from a few nF up to 2.2µF (very expensive!), tants and aluminium electrolytics – just about any capacitor you'll ever need. Don't miss this one!

PARCEL 8A: 1000 CAPACITORS for £6.50 + VAT
PARCEL 8B: 2500 CAPACITORS for £14.90 + VAT

TRANSISTORS

A mix of general purpose silicon transistors, mostly bipolar NPN and PNP, with a few FETs and unijunctions thrown in (when available) to spice the mixture. The contents vary from month to month – at the moment there are BC212s, BC213s, BC548s, BC238Bs, MTJ210s, and so on. Next month – who knows? All top quality components.

PARCEL 6A: 200 TRANSISTORS for £7.80! + VAT

UK Orders: Please add £2.50 towards postage and packing and 15% VAT to the total
Europe and Eire: Please add £6.00 carriage and insurance. No VAT
Outside Europe: Please add £12.00 carriage and insurance. No VAT

HIGHGRADE COMPONENTS LTD
Unit 111, 8 Woburn Road, Eastville, Bristol BS5 6TT

PCB SERVICE

Printed circuit boards for certain constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to **The PCB Service, *Everyday Electronics*, 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everyday Electronics* **(Payment in £ sterling only).**

Boards for some older projects – not listed here – can often be obtained from Magenta Electronics, 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST. Tel: 0283 65435 or Lake Electronics, 7 Middleton Close, Nuthall, Nottingham NG16 1BX. Tel: 0602 382509.

NOTE: While 90% 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 before ordering. We can only supply boards listed in the latest issue. Boards can only be supplied on a payment with order basis.

PROJECT TITLE		Order Code	Cost
Spectrum I/O	FEB'87	557	£5.35
EE Buccaneer Metal Detector	JUL'87	570	£4.10
Monomix		571	£4.75
Noise Gate	SEP'87	577	£4.41
Transtest	OCT'87	580	£3.32
BBC Sideways RAM/ROM	NOV'87	585	£4.10
Twinkling Star	DEC'87	588	£3.00
Transistor Curve Tracer	JAN'88	592	£3.00
Game Timer	FEB'88	583	£3.55
Semiconductor Tester	MAR'88	594	£3.19
SOS Alert		595	£3.00
Stereo Noise Gate	APR'88	597	£6.65
Pipe & Cable Locator		598	£3.00
Inductive Proximity Detector		574	£3.00
Multi-Channel Remote Light Dim	MAY'88		
Transmitter		599	£3.00
Receiver		600	£3.07
Door Sentinel		605	£3.00
Function Generator – Main Board		606	£5.91
Power Supply		607	£4.19
Multi-Chan Remote Light Dim	JUN'88		
Relay/Decoder		601	£4.86
Dimmer Board		602	£3.07
Power Supply		603	£3.00
Headlight Reminder		611	£3.00
Video Wiper	JUL'88	612	£6.75
Isolink		613	£4.21
Tea Tune	AUG'88	609	£3.00
Time Switch		614	£4.84
Suntan Timer		610	£3.07
Car Alarm		615	£3.12
Breaking Glass Alarm	SEP'88	617	£4.27
Amstrad PIO		618	£6.77
EPROM Eraser	OCT'88	620	£4.07
Doorbell Delay	NOV'88	616	£3.56
Micro Alarm		621	£3.12
Infra-Red Object Counter Trans	} £9.28	622	£4.61
Receiver	as a	623	£3.23
Display	set	624	£3.05
Seashell Sea Synthesiser		625	£4.84
Reaction Timer Main Board	DEC'88	626	£3.46
Display Board		627	£3.00
Downbeat Metronome		629	£4.84
EPROM Programmer *(On Spec)*	DEC'88	630	£8.29
Phasor		631	£5.64
Monkey/Hunter Game	JAN'89	634	£3.36
Continuity Tester	FEB'89	619	£2.67
4-Channel Light Dimmer		635	£7.67
Mini PSU		636	£3.23
Sound-to-Light Interface	MAR'89	637	£6.24
Midi Pedal		639	£7.00
Midi Merge		640	£3.00
Audio Lead Tester		641	£5.77
Light Sentinel	APR'89		
Main Control Board		632	£9.20
Remote Interface (4 boards)		633	£4.59
Electron User Port		638	£6.64
4-Channel Auto-Fade Interface		642	£6.80

PROJECT TITLE		Order Code	Cost
Pet Scarer	MAY'89	644	£3.00
Electron A/D Interface		645	£4.84
Spectrum EPROM Programmer	JUN'89	628	£7.87
Bat Detector		647	£4.95
Programmable Pocket Timer	JUL'89	648	£3.82
Electronic Spirit Level	AUG'89	649	£3.85
Distance Recorder		651	£5.23
Treasure Hunter		652	£3.73
Xenon Beacon	SEP'89	650	£4.13
Probe Pocket Treasure Finder		653	£4.12
Power Supplies – Fixed Voltage		654	£4.08
Variable Voltage		655	£4.48
Music on Hold	OCT'89	646	£3.85
Power Supplies – 25V 700mA		656	£4.35
30V 1A		657	£4.55
EE Seismograph – Control		658	£4.08
Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49
Wash Pro	NOV'89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
Processor		662	£4.56
Power Supplies – 1.5V-25V 2A		663	£4.78
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC'89	665	£3.98
Biofeedback Signal Generator	JAN'90	666	£4.08
Four-Channel Light Chaser		667	£6.70
Quick Cap Tester	FEB'90	668	£3.92
Weather Station			
Anemometer – 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
EE Weather Station	MAR'90		
Display Driver		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
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen and Sunlight Sen		686/687	£4.16
Amstrad Speech Synthesiser		689	£4.68
Quizmaster		690	£4.74
80 Metre Direct Conversion Radio	JUN'90	691	£4.95
Mains Appliance Remote Control			
Infra-Red Transmitter		692/693	£4.75
Mains Appliance Remote Control	JUL'90		
Encoder Board A		694	£6.61
Encoder Board B		695	£4.78
The Tester		696	£4.15
Mains Appliance Remote Control	AUG'90		
Mains ON/OFF Decoder		697	£4.55
(5 or more 697's ordered *together* £3.25 each)			
Simple Metronome		698	£3.94

Please note it is important to give project title as well as order code.

EE PRINTED CIRCUIT BOARD SERVICE

Please send me the following p.c.b.s.

Order Code	Project	Quantity	Price

I enclose cheque/PO for £..........

Name..........

Address..........

Please allow 28 days for delivery (see note above)

BLOCK CAPITALS PLEASE

TRANSISTORS

AAY32	9p
AC107	40p
AC125	25p
AC126	25p
AC127	21p
AC128	21p
AC128K	28p
AC141K	30p
AC142K	30p
AC176	22p
AC176K	28p
AC187	21p
AC187K	28p
AC188	21p
ACY18	48p
ACY19	48p
AD149	60p
AF124	50p
AF125	50p
AF126	50p
AF127	50p
AF139	30p
AF239	30p
AF379	45p
BA145	10p
BA148	10p
BA154	6p
BA157	12p
BB105B	18p
BB205B	24p
BC107	8p
BC108	8p
BC109	8p
BC109C	10p
BC116	10p
BC118	11p
BC140	20p
BC141	20p
BC142	20p
BC143	20p
BC147	8p
BC148	8p
BC149	8p
BC157	8p
BC159	8p
BC160	30p
BC171	10p
BC172	10p
BC177	14p
BC178	14p
BC179	14p
BC182	7p
BC182L	7p
BC183	7p
BC183L	7p
BC184	7p
BC184L	7p
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BC213	7p
BC213L	7p
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BC214L	7p
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BD901	50p
BD977	50p
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BDX33	60p
BDX53	60p
BDX65	80p
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BDW24	55p
BDW93	50p
BDW94	50p
BDY20	100p
BDY92	100p
BF137	35p
BF154	25p
BF167	30p
BF173	40p
BF178	30p
BF180	16p
BF181	18p
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BF198	10p
BF199	8p
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BF258	18p
BF259	18p
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BF469	30p
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BF472	28p
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BF495	16p
BF506	25p
BF595	16p
BF596	16p
BF616	30p
BF617	30p
BF757	40p
BF758	41p
BF759	40p
BF760	40p
BF763	40p
BF869	22p
BF870	22p
BF871	22p
BF872	23p
BF960	38p
BF961	35p
BF963	40p
BF964	38p
BF966	40p
BFR40	25p
BFR79	25p
BFR90	52p
BFR91	99p
BFT37	130p
BFT42	30p
BFT43	30p
BFT84	30p
BFW92	35p
BFX29	20p
BFX84	20p
BFX85	20p
BFX87	15p
BFX88	15p
BFX89	60p
BFY17	30p
BFY18	40p
BFY50	14p
BFY51	14p
BFY52	14p
BFY56	25p
BFY64	25p
BFY90	45p
BLY48	85p
BR100	14p
BR101	43p
BR103	37p
BR303	85p
BRY39	55p
BRY49	38p
BRY56	33p
BS574	33p
BSX20	15p
BSX26	18p
BSX29	19p
BT100A	70p
BT106	180p
BT109	90p
BT116	80p
BT119	100p
BT138	60p
BT146	99p
BT151	58p
BTY79	140p
BU100A	110p
BU104	100p
BU105	80p
BU108	100p
BU109	100p
BU110	110p
BU111	140p
BU124	60p
BU126	70p
BU180	150p
BU184	100p
BU204	75p
BU205	70p
BU206	100p
BU208	70p
BU208D	80p
BU209	140p
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AMATEUR BAND	RECEIVER TUNING RANGE	TUNING PACK
160m 1.810–2.000MHz	1.800–2.010MHz	1
80m 3.500–3.800MHz	3.490–3.810MHz	1
40m 7.000–7.100MHz	6.690–7.150MHz	2
10.100–10.150MHz	10.000–10.500MHz	2
20m 14.000–14.350MHz	13.990–14.400MHz	3
18.068–18.168MHz	18.000–18.500MHz	3
15m 21.000–21.450MHz	20.990–21.500MHz	3
24.890–24.990MHz	24.540–25.000MHz	4
10m 28.000–29.700MHz	A, 27.975–28.525MHz	4
	B, 28.475–29.025MHz	4
	C, 28.975–29.525MHz	4
	D, 29.475–30.025MHz	4

A kit excluding the optional items, Box and Chassis, Pot Mounting Bracket, Front and Rear Panels and Tuning Kits is available. For full list of optional extras see Maplin Catalogue.

LM60Q (Dir Conv Rx Kit) £64.95
LM61R (Tuning kit 1) **£3.45**
LM62S (Tuning kit 2) **£3.45**
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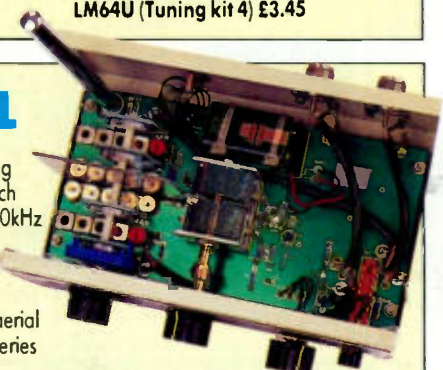
ACTIVE AERIAL

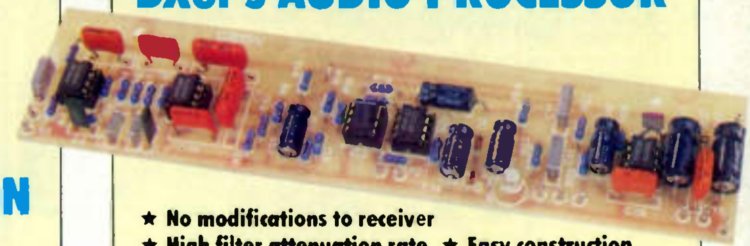


An active aerial pre-amplifier having five selectable tuned RF ranges which cover a total frequency range of 150kHz to 30MHz. The unit includes a gain control operating on the MOSFET amplifier, and a low battery LED warning indicator. Connections to aerial and receiver are made using UHF series connectors, with a direct, straight through or 'by-pass' mode operative when the unit is switched off.
A telescopic aerial is included for use where a proper outdoor aerial is not practical or possible. A printed stick-on front panel for the active aerial project is available as an optional extra.

LM05F (Active Aerial Kit) £52.95
Optional items:
FA99H (Active Aerial f/panel) **£3.95**
XY45Y (Case 222) **£6.45**

Photo shows Kit with some optional extras, see Maplin Catalogue for further details.

DXer's AUDIO PROCESSOR



- ★ **No modifications to receiver**
- ★ **High filter attenuation rate** ★ **Easy construction**

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LK05F (DXer's Processor Kit) £11.95
Optional items: **HB26D** (Knob (3 off required)) **68p each**
XY45Y (Case 222) **£6.45** **FM03D** (9V PP6 Battery) **£1.98**

SW/MW AERIAL TUNING KIT

Given that the aerial impedance of most communications receivers is 50, unless the impedance of the aerial matches this exactly all of the RF energy will not be efficiently transferred from the aerial to the receiver. The greater the mismatch, then the weaker the signal will appear, and under adverse conditions it could vanish completely into background noise. This aerial tuning unit comprises two variable tuning capacitors and a tapped inductor in a passive 'T' configuration. This arrangement covers approximately 600kHz to 30MHz, and matches the aerial load impedance to the input impedance of the receiver. The ATU can also be used for transmitter aerial matching in the same frequency range, including the 27MHz citizen band, up to a power rating of 10 Watts. A printed stick-on front panel is available as an optional extra for the aerial tuner unit.

LM06G (Aerial Tuner Kit) £36.95
Optional items: **FD11M** (Aerial Tuner f/panel) **£3.95**
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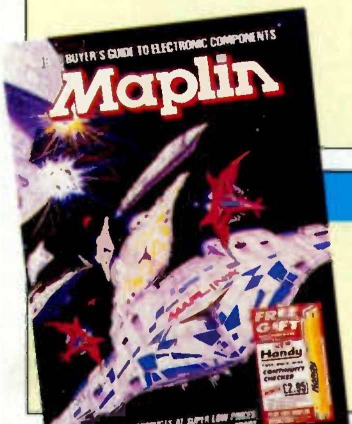

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