EVERYDAY WITH PRACTICAL ELECTRONICS

MARCH 1993

INCORPORATING ELECTRONICS MONTHLY
FULLY S.O.R. £1.80

DIGITAL AUDIO BROADCASTING

Future transmissions should match digital hifi quality

SIMPLIFLY

A joystick to mouse interface

CAR ELECTRIC WINDOW ENHANCER

MICROPHONE COMPRESSOR

THE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. **Now only £4.00 ref 4P151.** Good experimenters board.

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29R or £2 a metre.

12V SOLAR CELL. 200mA output Ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42R. Gives up to 15v.

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. **Now only £19.00 ref 19P29**

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43R

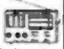
VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39R Suitable mains adaptor £5.00 ref 5P191R. Turn your camcorder into a cordless camera!

FM TRANSMITTER Housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2R. Good range device.

MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases and earpieces. £30.00 ref 30P12R

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AR.

12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. £19 ref 19P14R. Ideal for listening all over the world.



CAR STEREO AND FM RADIO. Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. **£19.00 ref 19P30**

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R. Ideal for garden use or as an educational toy.

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R, 4 x D's £9.00 ref 9P12R, 1 x PP3 £6.00 ref 6P35R Pack of 10 AAA,s £4.00 ref 4P92R.

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. New ed. £20.00 ref 20P32R.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1R

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158R. 35mm square.

FM BUG Built and tested superior 9v operation £14.00 ref 14P3R

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R. Limited stocks.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R. 800 rpm.

ELECTRONIC SPEED CONTROL KIT for C5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R. Potentiometer control.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3R. 2xC cell model £6.00.

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43R

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes **New low price £15.00 ref J15P4**

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10R. MAINS POWER SUPPLY KIT £20.00 REF 20P33R READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4R.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15 watt 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17R. Larger transformer £12.00 ref 12P41R.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. **New low bargain price only £2.00 ref B2P1**

25 WATT STEREO AMPLIFIER IC. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia included).

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R, PACK OF 100 £30.00 REF 30P16R

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.

12V 19A TRANSFORMER Ex equipment £20 but OK.

ULTRASONIC ALARM SYSTEM. Once again in stock these units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system **now only £19 !!!**

POWER SUPPLIES Made for the Spectrum plus 3 give +5 @ 2A, +12 @700mA & -12 @ 50mA. £8 ref Q8P3

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36R.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167R.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92R. Ideal for tea on the move!

LED PACK. 50 red, 50 green, 50 yellow all 5mm £8.00 ref 8P52

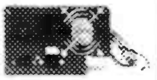
IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R. 3 metre version £6.00 ref 6P50.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62R or 2 sheets for £7.00 ref 7P22R.

STRIP BOARD CUTTING TOOL £2.00 ref 2P352R.

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries. Complete with hand charger & solar panel 14P200R. Set of 2 AA nicads £2 ref L2P9

PC STYLE POWER SUPPLY Made by AZTEC 110v or 240v input. +5 @ 15A, +12 @ 5A, -12 @ .5A, -5 @ .3A. Fully cased with fan, on/off switch, IEC inlet and standard PC fly-leads. £15.00 ref F15P4



TELEPHONE HANDSETS 10 brand new handsets with mic and speaker only £3.00 for 10 ref 3P146R

BENCH POWER SUPPLIES Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R

SPEAKER WIRE Brown twin core 100 feet for £2.00 REF 2P79R

MICROSCOPE 1200X MAGNIFICATION Brand new complete with shrimp hatchery, shrimps, prepared slides, light etc. £29.00 ref J29P4.

LIGHT ALARM SYSTEM Small cased alarms that monitor a narrow beam area for sudden changes in light level. Complete with siren that sounds for a preset time when unit is triggered. £7.00 ref J7P1

720K 3 1/2" DISC DRIVE FOR £9 Brand new units made by JVC complete with tech info just £9.00!! they have a metal tab instead of a button and you may want to fit an led. Combined power and data cable easily modified to IBM standard. ref L9P2.

MONO VGA MONITORS £59 Standard IBM compatible monitor made by Amstrad. New Our price just £59. Ref 59P4RB.

CAR BATTERY CHARGER Brand new units complete with panel meter and leads. 6 or 12v output £7.00 ref J7P2.

CUSTOMER RETURNED SPECTRUM +2 Complete but sold as seen so may need attention £25.00 ref J25P1 or 2 for £40.00 ref J40P4

CUSTOMER RETURNED SPECTRUM +3 Complete but sold as seen so may need attention £25.00 ref J25P2 or 2 for £40.00 ref J40P5

AMSTRAD 1640DD BASE UNITS
BRAND NEW AND CASED
TWO BUILT IN 5 1/4" DRIVES
MOTHER BOARD WITH 640K MEMORY
KEYBOARD, MOUSE & MANUAL
OUR PRICE JUST

£79!!!!

SCART TO D TYPE LEADS Standard Scart on one end, Hi density D type (standard VGA connector) on the other. Pack of ten leads only £7.00 ref 7P2R

OZONE FRIENDLY LATEX 250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R

VIEWDATA SYSTEMS Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R

COMMODORE 64 COMPENDIUM Pack consisting of a Commodore 64 computer, power supply, data recorder and software. All for £69 ref Q69P1.

PPC MODEM CARDS Made for the Amstrad PPC1640/1512 range these are plug in modules that operate at 2400 baud. No data. £15 ref Q15P5.

AMSTRAD LQ3500 PRINTER ASSEMBLIES Entire mechanical assemblies including print head, platen, cables, stepper motors etc etc. infact everything bar the electronics and case! Our price just £10 ref Q10P3.

AMSTRAD DMP4000 PRINTER ASSEMBLIES Entire printer assemblies including print head, platen, cables, stepper motors etc. Everything bar the electronics and case. Our price just £20 ref Q20P2.

TOROIDAL TRANSFORMER 146VA with tappings at 8v, 10v and 32v will give 50v at 3A or 32 at 4A etc. Centre tapped primary. £9 ref Q9P2. Fixing kit is £2 ref Q2P1.

AERIAL BRACKETS Wall plate 7.5" sq complete with rawl bolts, 10" stand off brackets with standard tube clamps. Will take up to 2" mast. Substantial bracket (would take body weight). £7 ref Q7P1.

TV SOUND RECEIVERS Popular units that with the addition of a speaker act as a tv sound receiver. Ideal as a stand alone unit or for connecting into HI FI!. £12 ref Q12P4

2,000 COMPONENTS FOR £3 Yes thats right! just send us £3 and you can have 1,000 resistors plus 1,000 capacitors! Our choice of value. Order ref Q3P1.

ETRI FANS Mains, 11 watt 80mm diameter. £6. Ref Q6P3.

LIGHTGUNS Originally made for the Spectrum+2 but may have other uses (good stripper). £2 Ref Q2P3

GX4000 GAMES CONSOLES Complete with motor racing game, psu and joystick. £15 ref Q15P3. Extra 4 games £12 ref Q12P2

VCR RABBIT SYSTEM Lets you control your VCR from a second set using the VCR remote control. Retail £99 ours £39!!!

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT TELEPHONE 0273 203500

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.

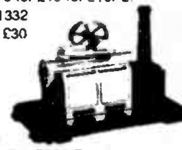
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY

FAX 0273 323077

VISA

CAMERAS Customer returned units. 3 for £10 ref L10P2.

STEAM ENGINE Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200



TALKING CLOCK LCD display, alarm, battery operated. Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cock crowing! £14.00 ref 14P200.R

HANDHELD TONE DIALLERS Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R

AMAZING TALKING COINBOX! Fully programmable talking, lockable coinbox BT approved, retail price is £79 ours is just £29! ref J29P2.

ANSWER PHONES £15 Customer returned units with 2 faults one we tell you how to fix the other you do your self! £18 ref J18P2 or 4 for £60 ref J60P3 BT approved (retail price £79.95!! each)

COMMODORE 64 MICRODRIVE SYSTEM Complete cased brand new drives with cartridge and software 10 times faster than tape machines works with any Commodore 64 setup. The orginal price for these was £49.00 but we can offer them to you at only £25.00! Ref 25P1R

90 WATT MAINS MOTORS Ex equipment but ok. Good general pupose unit £9.00 ref F9P1

HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt 4R speaker and a 2" 140R tweeter. If you want two of each plus 2 of our crossovers you can have the lot for £5.00 ref F5P2.

EMERGENCY LIGHTING SYSTEM Fully cased complete with 2 adjustable flood lights. All you need is a standard 6v lead acid battery. Our price is just £10 ref J10P29

AMSTRAD 464 COMPUTERS Customer returned units complete with a monitor for just £35! These units are sold as faulty and are not returnable.

WOLSEY DMAC DECODERS Made for installation in hotels etc as the main sat receiver no data but fully cased quality unit. £20 ref K20P1. Suitable psu £8 ref K8P3.

REMOTE CONTROLS Brand new Infra red CONTROLS originally made for controlling WOLSEY satellite receivers. £2 ea ref K2P1, or 20 for £19 ref K19P1.

TELEPHONES Modem 1 piece phones BT approved. Last no redial. £8 ref K8P1.

386 TOWER SYSTEMS Tower case 52cmx40cmx20cm. 2 fans, speaker, 275w psu, IEC I/L and O/L, 386 m/board with onboard disc controller, ethernet, display driver, parallel and serial ports. **There are several IC's missing from the m/board plus no data! £79 ref K79P1.**

DOS PACKS Complete set of PC discs with MS DOS 3.2, Locomotive basic, gemdesktop and gem paint. No manuals, 5 1/4" discs. £10 ref K10P2

CORDLESS TIE CLIP MICROPHONE transmits between 88-108MHZ FM 5.2cm x 2cm, uses LR44 watch battery. Complete with wire aerial & battery. £16 ref K16P1.

CHASSIS MOUNT TRANSFORMERS 240v primary, 12v secondary 20VA £2 ref K2P2. 240v primary, 16v secondary 10A (split winding). £10 ref L10P1

100 RED LED PACK (5MM) £5 REF K5P2

12V STEPPER MOTOR Ideal for models etc. 3" dia. £2 ref J2P14.

INFRA RED BEAM SWITCH 24v DC 5m range source & sensor housed in plastic case. £12 ref J12P1.

CAPACITOR BARGAIN PACK 100 CERAMICS £2 REF J2P2.

SPECTRUM JOYSTICKS TWO FOR £5 REF J5P2.

AMSTRAD PC CASE, POWER SUPPLY AND 720k FLOPPY DRIVE ALL THIS FOR £30 REFQ30P15

BUMPER PACK NO 1 10 of our popular £1 packs for just £5 our choice of contents.

BUMPER PACK NO 2 25 of our popular £1 packs for just £12. Our choice of contents.

LCD 1 X 32 DISPLAY Bargain price of just £3 complete with loads of data for a similar display. £3 ref L3P1.

USEFUL POWER SUPPLIES. 18v 900mA dc output (regulated) fully cased with mains cable and DC out cable. £6 ref K6P1.

UNCASED PC POWER SUPPLIES. Standard PC psu without case, fan etc. Good for spare or low cost PCI. £4 ref L4P6.

RADAR DETECTORS. Detects X and K bands (ie speed traps). Not legal in the UK so only available if you intend to 'export'it. £59 ref J59P1.

100 WATT MOSFET PAIR. Same spec as 2Sk343 and 2SJ413 (8A,140v, 100w) 1 N channel and 1 P channel. £3 a pair ref J3P9.

LOW COST CAPS. 1,000 capacitors £3 (33uf,25v) ref J3P10.

VELCRO. 1 metre length 20mm wide, blue. £2 ref J2P16.

JUG KETTLE ELEMENTS. Good general purpose heating element just £3 ea ref £3P8 or 5 for £10 ref J10P3.

VERY BIG MOTOR. 200v induction 1.1kw 1410 rpm 10"x7" GEC 1" keyed shaft. Brand new. £95 ref J95P1.

BIG MOTOR. 220-240v 1425rpm 2.8A 5/8th" keyed shaft GEC 6.5" x 8" complete with mounting plate. £38 ref J38P1.

SMALL MOTOR. Electrolux 160 watt 3,000 rpm, 220-240v 5/8" shaft precision built £18 ref J18P1.

EPROMS 27C64 PACK OF 10 £7 REF M7P1.
EPROMS 27C256 PACK OF 10 £9 REF M9P1.
EPROMS 27C512 PACK OF 10 £10 REF M10P1.

MODEMS FOR £1.25? These modems are suitable for stripping only hence they are only 4 for £5 ref J5P3.

SOLAR POWERED WOODEN MODELS. Complete with solar panel, motor and full instructions. £9 ref J9P2. 3 diff £20 ref J20P3.

SOUND OPERATED LIGHT. Clap your hands and light comes on. Turns after preset delay. (4 AA's req'd). £2 ref J2P3.

FERGUSON SRB1 REMOTE CONTROLS. Brand new units ideal for a spare or have two remotes! £4 each.

5 1/4" 360K DISC DRIVE Made for AMSTRAD 1640/1512 machines. White front. Our price just £9 ref Q9P1.

1993 CATALOGUE AVAILABLE WITH ALL ORDERS IF REQUESTED OTHERWISE A4 SAE FOR FREE COPY.

IN SUSSEX? CALL IN AND SEE US!

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 22 No. 3 MARCH 1993

EVERYDAY WITH PRACTICAL
ELECTRONICS

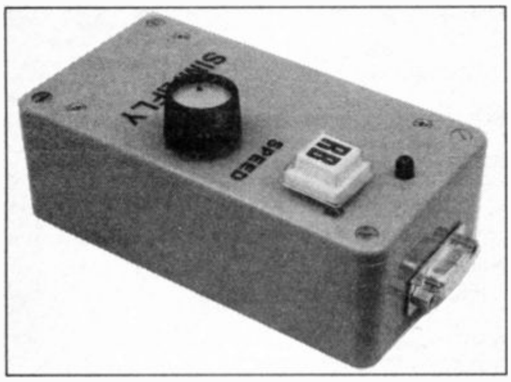
INCORPORATING ELECTRONICS MONTHLY

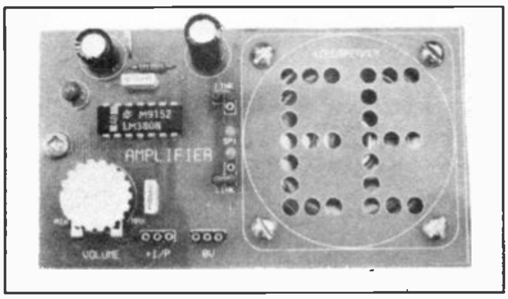
ABC CONSUMER PRESS

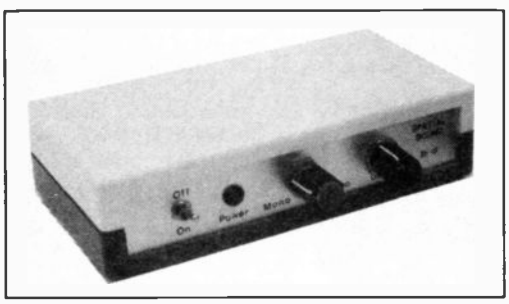
The No. 1 Independent Magazine for Electronics, Technology and Computer Projects

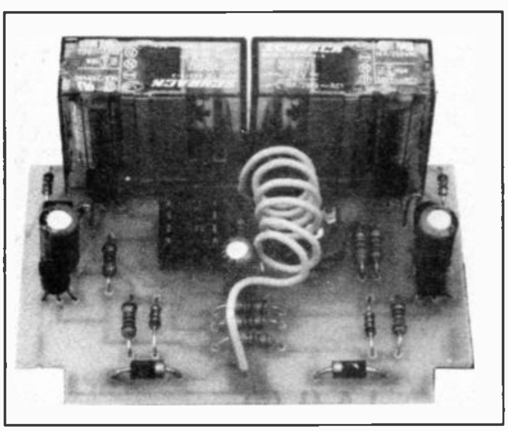
ISSN 0262 3617

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









Projects

Series

Features

FREE WITH THIS ISSUE MARCO TRADING CATALOGUE BANDED TO NEWSTAND COPIES

Our April '93 issue will be published on Friday, 5 March 1993. See page 163 for details.

NEXT MONTH

FREE!!

THE GREENWELD 1993

32 Pages of Amazing Offers!

Multimeters - Opto - PSU's - Radios - Books - Solar Leads & Cable - Connectors - Panels - Packs - Batteries - Graphics Supplies - Video Equipment Auto & Home Security - Radio Mics - Computer Hardware & Software - Metal Detectors + lots more!

MIND MACHINE MKII

Since the original "Mind Machine" entrainment project was published back in 1991, considerable effort has been made to find a simpler circuit capable of the same function. Whilst it worked well and proved popular with readers, it was complicated to construct, especially with it's programmable option. This may have deterred less experienced constructors who might otherwise enjoy experimenting in this exciting field.

This new version uses tape cassettes for program storage. A special generator, the subject of next month's porject, produces the "binaural" signals at a level suitable for cassette recorder "line" inputs. A tape is made of the desired sound program, which can then be used with just a player and headphones – a "Walkman" is ideal. This eliminates the programmer and audio amps at a stroke. A separate unit, to be described the following month, can be connected in parallel with the headphones to generate the lights. This is also simple to construct, and is pocket-sized for portability.

Learn to relax with this "programmable" entrainment unit.

FOG LIGHT ALERT

High-intensity rear fog lights are effective in warning a following car of your presence in conditions of poor visibility. The trouble is, they are easily left switched on by mistake. This means that when the headlights are next used, the fog lights will come on too. Leaving fog lights on in this way is bad practice – the Highway Code reminds us they should only be used when visibility is seriously affected. This project provides an audible warning in the form of a loud bleeping tone if the fog light switch has been left on.

UNIVERSAL DATA LOGGER

This Project utilising a single chip micro-controller (8031) and costing less than £20 to build, provides an easy way to measure a varying voltage and convert to a RS232 data stream. The input voltage to the board can be virtually any transducer or source that provides a d.c. voltage which is proportional to the process variable being measured. The serial output can then be fed to the serial port of any computer and data can be displayed graphically against a time axis. The author has written an example program that runs on a p.c. (monchrome only), although software may be written for any other computer type to achieve a graphical representation of the measured data.

EVERYDAY WITH PRACTICAL ELECTRONICS

APRIL ISSUE ON SALE FRIDAY MARCH 5th

SPARKOMATIC 4 x 150 watt CAR AMPLIFIER

The SA3200 is our top of the line 4 Channel Amplifier which is extremely well specified. It is very powerful and versatile and features separate bass and treble controls which gives the user the possibility of reducing bass response to the front speakers and adding treble for better stereo imaging. The bass response can then be increased to the rear speakers which are usually larger and capable of offering better reproduction. The SA3200 features a bridge operation switch which offers the possiblity of using the amplifier in 4, 3 or 2 channel mode. The 3 channel mode is ideal for installations where rear deck speakers are used in combination with a separate subwoofer.

● 4 x 150 Watts max ● 4 x 80 Watts into 4 Ohms at less than 0.5% THD ● 2 x 80 Watts plus 1 x 160 Watts at less than 0.5% THD ● 2 x 160 Watts into 4 Ohms at less than 0.5% THD ● Separate bass and treble controls for front and rear channels ● Separate sensitivity controls for front and rear channels ● 2, 3 or 4 channel operation ● Heavy duty power wires ● Glass blasted aluminium heatsink ● High current capacity

£251.65 plus £7 p&p

SPARKOMATIC 2 x 150 watt CAR AMPLIFIER

The SA1500 is a very highly specified 2 Channel Amplifier with built-in sub bass crossover. The SA 1500, which is ideal for powering medium sized subwoofers, will also operate in bridge mode as a 150 Watt mono amplifier.

● 2 x 150 Watts max. into 4 Ohms ● 2 x 70 Watts per channel at 0.5% THD ● Bridge mode operation ● Sensitivity adjustment ranging from 100mV to 1V ● Heavy duty power wires ● Built-in sub bass crossover ● Glass blasted aluminium heatsink ● High current capacity

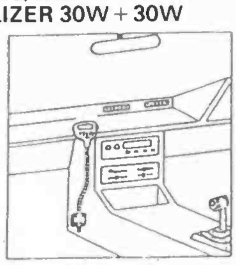
£117.65 plus £6.50 p&p

SPARKOMATIC 80 watt CAR POWER AMPLIFIER

The AMP 7000 produces high power at low distortion. The amplifier accommodates low level, high level and high power radio speaker inputs. The response is linear and extends beyond the capability of all music sources. This compact unit mounts easily and its quick connect terminals accept RCA or straight wire input terminals. Power rating 2 x 40 watt per channel. MMP 2 x 20 watt at 10%. THD response 20Hz-20kHz. Size 160mm x 130mm x 45mm.

£32.95 plus £3.50 p&p

EPSILON, HIGH POWER EQUALIZER 30W + 30W



5 band graphic equalizer, 10 l.e.d. level indicator, fader control, volume control, EQ-Defeat switch, CD input jack, power on/off switch, night slide l.e.d.

£56.65 postage £3.65

EMINENCE 4Ω PROFESSIONAL USA MADE IN CAR CHASSIS SPEAKERS

All units are fitted with big magents "Nomex" Voice coils NOT ALUMINIUM. "Nomex" is very light and can stand extremely high temperatures, this mixture makes for high efficiency and long lasting quality of sound.

V6 6½" 200W Max	Range 50Hz-3kHz £34.40
V6 8" 300W Max	Range 45Hz-3kHz £39.35
V10 10" 400W Max	Range 33Hz-4kHz £44.45
V12 12" 400W Max	Range 35Hz-3kHz £45.95
BOSS 15" 800W Max	Range 35Hz-4kHz £79.90
KING 18" 1200W Max	Range 20Hz-1kHz P.O.A.

Postage £3.85per speaker.

Build your own Bazooka sub woofer tube to suit Eminence car speakers. 10mm thick fibre supplied with grille and clamp terminals finished in black vinyl.

Eminence U10, Size 270mm x 700mm **£25.95** £3.50 p&p

Eminence U12 Size 320mm x 710mm **£29.95** £3.50 p&p

RTVC MAIL ORDER BARGAIN PACKS

No.	Qty. per pack		
MO21	1	60W Hifi tweeter made for *Jamo UK* size 90mm sq.	£1
MO22	2	30 watt 8 ohm Hifi chassis speakers. *Made for Hitachi UK* midi systems, size 125mm sq. with large 70mm magnet	£9.00 + £2.00 p&p
MO23	2	Pod Car Speakers. Moulded in black plastic with 15 watt 10cm *Goodmans* unit fitted	£3.95 pair + £2.50 p&p
MO23A	1 pr	40 watt Car Speakers made for Roadstar of Switzerland. Fitted with dual polypropylene cone and foam rubber surround. Big 70mm magent for good base response. Supplied with grills fixing screws and cable. Size 13cm, weight 1.5Kg	£11.70 pair + £3.65 p&p or TWO pairs for £25.00 UK post paid
MO24	2	Audax JBL 40-100watt dome tweeters. High performance 10mm Ferrofluid cooled horn loaded unit for load distortion and high output. Supplied with 1st order crossover, spec. 40 watts at 3kHz, 100 watt at 8kHz; size 51mm x 51mm x 16.5mm. Ideal for car use	£7.50 + £1 p&p
MO25	2	33000µF 10V d.c. can type computer grade quality electrolytic *UK made*	£1
MO25A	1	47µF 385V d.c. can type electrolytic. Size 350mm x 250mm. *UK made by Phillips*	£1.75
MO26	2	680µF 100V d.c. can type electrolytic size 45mm x 25mm	£1
MO27	3	2200µF 25V d.c. can type electrolytic size 45mm x 25mm	£1
MO28A	1	2200µF 40V d.c. can type electrolytic capacitor made by Seimans, size 48mm x 30mm	£1
MO29	1	33000µF 16V 27A can type electrolytic size 113mm x 50mm	£1
MO30	20	Assorted Variable trimmers	£1
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MO37	1	Large Tuning meter 125µA-0-125µA size 55mm x 47mm	£1.75
MO38	1	Dual VU meter 280µA f.s.d., size 80mm x 42mm x 15mm	£1.50
MO39	5	Coaxial Aerial Plugs, all metal type	£1
MO40	6	Fuseholders, chassis mounting for 20mm size fuses	£1
MO41	4	Fuseholders, in-line type for 20mm size fuses	£1
MO42	20	5 Pin Din 180° chassis mount sockets	£1
MO43	6	Double phono sockets	£1
MO44	5	6.35mm (¼") Stereo Jack sockets	£1
MO45	4	6.35 (¼") Mono Jack Plugs	£1
MO46	12	Coax Sockets chassis mount	£1
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MO48	30	Mixed control knobs	£1
MO49	1	Cassette tape transport mechanism, belt-drive, top loading, six piano key operation with knobs, stereo record/replay erase heads, heavy fly-wheel	£5.50 + £2.65 p&p
MO50	1	Hifi stereo pre-amp. module. Input for CD Tuner record player with diagram. *Made by Mullard*	£1
MO51	2	AM/FM tuner head modules'. *Made by Mullard*	£1
MO52	3	AM I.F. modules'. *Made by Mullard*	£1
MO53	1	FM stereo decoder module with diagram. *Made by Mullard*	£1
MO54	3	UHF Varicap tuned tuner heads unboxed, untested but complete. *Made by Mullard*	£1
MO55	1	25V d.c. 150mA Mains adaptor in neat plastic box, size 80mm x 55mm x 47mm	£1
MO55A	1	*ETRI* Brand new 80mm Cooling Fan. Five bladed A.C. impedance corrected motor on a cast aluminium chassis. Size 80mm x 40mm. Voltage 115V a.c. working, 130mA. *Japanese made.*	£5.95 + £1.40 p&p, TWO for £11.20 UK post paid
MO56	2	6V-0V-6V 4VA p.c.b. mount mains transformer 240V input, size 42mm x 33mm x 35mm. *UK Made*	£1
MO56A	1	28V 15 Amp Mains Transformer. Size 80mm x 55mm x 65mm. Weight 1Kg	£3.00 each + £2.50 p&p
MO56B	1	30-0-30 Volt 3 amp mains transformer. UK made for leading Hifi manufacturer. Size 96mm x 90mm x 80mm. Weight 2.8Kg	£7.00 each + £3.75 p&p
MO57	25	4 Volt miniature wire-ended bulbs	£1
MO57A	1	SRBP Copper Clad Printed Circuit Board. Size 410mm x 360mm x2mm	£3.65 + 75 p&p
MO58	2	Mono cassette tape heads. *Japan Made*	£1
MO59	2	Sonotone stereo cartridge with 78 and LP Styl. *Japan Made*	£1
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MO61	10	OC44 transistors. Remove paint from top and it becomes a photo electric cell (ORP12)	£1
MO63	6	14 watt output transistors. Three complimentary pairs in T066 case (replacement for AD161 + 162)	£1
MO64	5	5 watt Audio i.c. No. TBA800	£1
MO65	5	Motor Speed Control i.c.	£1
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MO72	1	WW II EX WD headphone, A BIT OF NOSTALGIA, low impedance	£3.50 + £1.20 p&p
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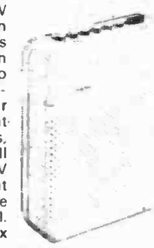

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EVERYDAY WITH PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

VOL. 22 No. 3 **MARCH '93**

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BLOOD SWEAT AND HAPPINESS!

As our *Teach-In '93* series starts to get to the really interesting bits the level of reader interest continues to grow. It is a tribute to our two dedicated authors who have "sweated blood" over the series that it is so popular. We are getting some interesting feedback from readers and we hope to publish a roundup of letters and replies to keep everyone informed and expand on one or two points readers are finding difficulty to grasp.

There are still plenty of new readers who are only now "coming on board" because they have just discovered the series. We can supply all the relevant back numbers and the *Mini Lab* p.c.b. (although we seem to be continually waiting for new stock because demand is so high). Information on back numbers is at the foot of this page and p.c.b.s are on pages 226 and 227.

Teach-In '93 will run for 12 parts and we expect to publish a few applications articles for the *Micro Lab* after the main series has finished. The *Micro Lab* add-on p.c.b. looks very exciting and opens up a whole range of further interests.

WHAT A BIND

We understand that no binders have been available for *Practical Electronics* (before the two magazines merged) for some time. We have also had a problem with supply of EPE binders recently. Once again, due to heavy demand, we ran out of stock. This has coincided with the introduction of a totally new binder based on a lever arch file.

These new binders will be very smart in dark blue with gold lettering on the spine. Once a retaining plastic "bar" has been placed over each magazine they can be easily entered and removed from the binder without any damage to the pages. We are sure regular readers who file each issue will find these a great improvement over our original orange binders – and, for the moment anyway, it's all done at the same price!

We are sorry if you have had to wait for a binder – they will be supplied very soon. If you are interested in ordering one please see below, or watch for full information next month.

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Certain back issues of EVERYDAY ELECTRONICS and PRACTICAL ELECTRONICS are available price £2.00 (£2.50 overseas surface mail) inclusive of postage and packing per copy – **£ sterling only please**. Visa and Access (MasterCard) accepted, minimum credit card order £5. Enquiries with remittance, made payable to Everyday with Practical Electronics, should be sent to Post Sales Department, Everyday with Practical Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH Tel: 0202 881749. 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 Jan, Feb, Mar, Apr, May, June, Oct, & Dec 88, Mar & May 89, Mar 90 & Sept 91. Everyday Electronics and can only supply back issues from Jan 92 to Oct 92 (excluding Mar 92) of Practical Electronics.**

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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.**

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot however guarantee it and we cannot accept legal responsibility for it.

COMPONENT SUPPLIES

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.

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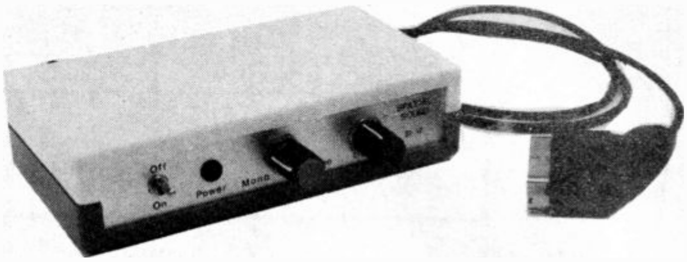
We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment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

SPATIAL SOUND



NICHOLAS WATKINS

Add psuedo stereo sound to your TV and Video or use this unit to enhance mono recordings or radio programmes.

WITH the advent of NICAM stereo television broadcasts, one would initially think a project of this nature would be redundant.

However, NICAM equipped TV sets are more expensive than their mono counterparts. Also to record in stereo, requires a stereo video recorder – which again is more expensive. Another point to consider, is that not all programs are broadcast in stereo.

This project creates a "spatial" stereo effect from a mono source. Its use is not limited to TV sound, as any mono source such as old movie soundtracks, low signal strength f.m. broadcasts, mono video soundtracks etc can be improved with this project.

HOW IT WORKS

If a stereophonic system has an identical signal coming from the left and right speaker, the sound will appear to come from midway between the two speakers – i.e. a central "image".

However if there are differences between the left and right channel, then the image will be spread out; hence creating a stereo effect.

This project works by introducing a frequency dependant phase shift in one channel – hence creating a difference between the left and the right channel. The phase shift varies between 0 and 180 degrees (Fig. 1). The frequency at which this occurs can be varied by the user.

The circuit is based on the all pass first order network (see Fig. 2). Basically the operation is as follows – the gain of this

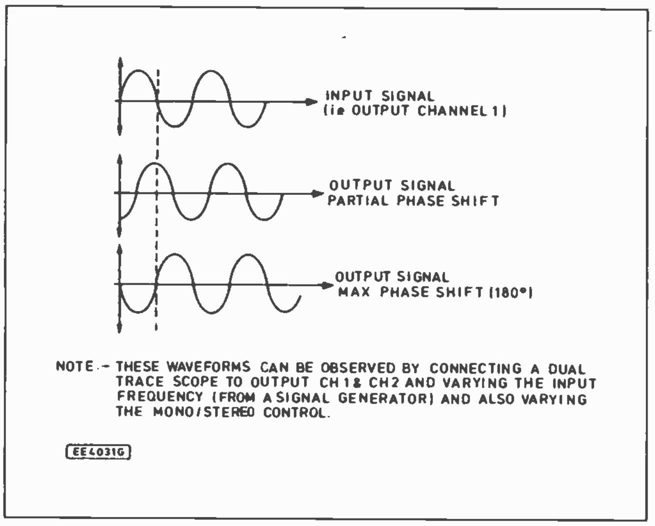


Fig. 1. Sine wave showing phase shift.

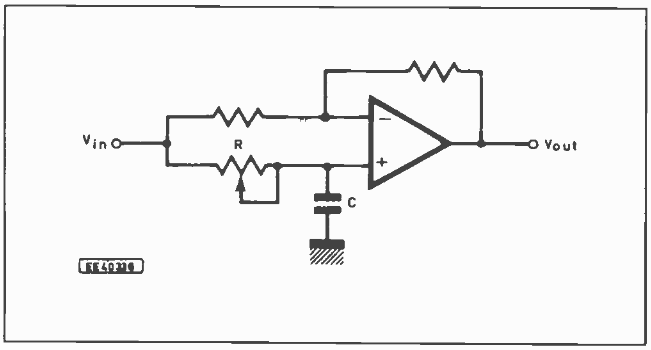


Fig. 2. Basic all pass network.

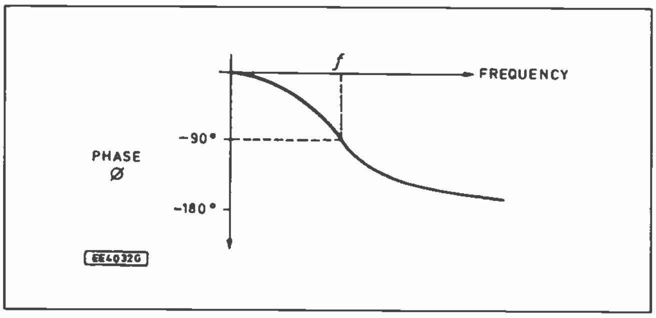
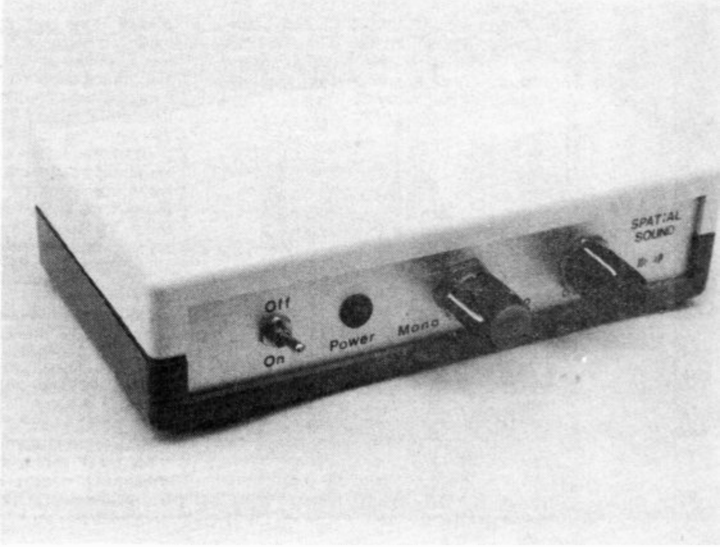


Fig. 3. Phase change with frequency.



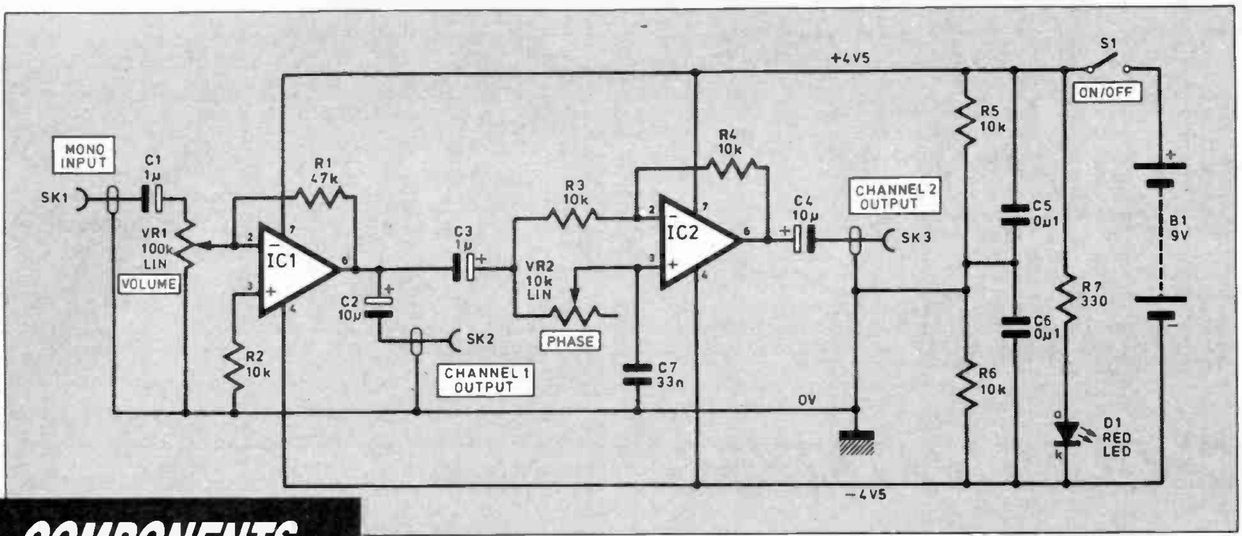


Fig. 4. Complete circuit diagram of the Spatial Sound unit.

COMPONENTS

See SHOP TALK Page

Resistors
R1 47k
R2 to R6 10k (5 off)
R7 330
All 0·6W ±1% metal film.

Potentiometers
VR1 100k rotary carbon lin.
VR2 10k rotary carbon lin.

Capacitors
C1, C3 1μ radial elect. 16V (2 off)
C2, C4 10μ radial elect. 16V (2 off)
C5, C6 0μ1 polyester (2 off)
C7 33n polyester

Semiconductors
D1 5mm l.e.d. (red) (1 off)
IC1, IC2 741 op-amp (2 off)

Miscellaneous
SK1, SK2, SK3 Phono socket (3 off)
S1 s.p.s.t. sub-min toggle switch
B1 9V (PP3 size)
Stripboard, 0·1 in. matrix, size 11 strips x 58 holes; 8 pin d.i.l. i.c. holder (2 off); case Verobox, 153x84x39·5mm; knobs (2 off); male SCART connector; audio screened lead; phono plugs; battery connector; wire; solder etc.

Approx cost guidance only **£9** *plus case*

network is 1 at all frequencies, however phase shifting occurs (see Fig. 3). As can be seen, the phase change increases from 0 to 180 degrees as the frequency increases. The point of maximum phase rate of change is f. This point is defined as $f = 1/(2\pi CR)$ with C and R being the component values in the all pass network, Fig 2.

CIRCUIT DESCRIPTION

The full circuit diagram appears in Fig 4. IC1 is a buffer amplifier, with gain being set by R1 and VR1. C1 is used to block d.c. R2 is included to minimise bias current error. C2, C3, C4 are all used as d.c. blocking capacitors.

The output from the buffer stage (IC1) is fed through C3 into the all pass network, the gain of this network is defined as R4/R3 = 10k/10k = 1.

Variable resistor VR2 and C7 are used to determine the frequency at which phase shifting starts. This gives control of f (see Fig. 3) from around 480Hz to above audio frequencies (i.e. no phase shift in the audio band – hence mono reproduction). The output from this stage can be up to 180° out of phase with the output from IC1.

Components C5 and C6 are supply decoupling capacitors. Resistors R5 and R6 form a potential divider giving the 0V rail.

CONSTRUCTION

Construction should be reasonably straightforward, the p.c.b. layout is shown in Fig 5. The stripboard is 0.1 inch pitch and measures 58 holes by 11 strips. This is not a standard size so the board must be cut from a larger piece using a hacksaw.

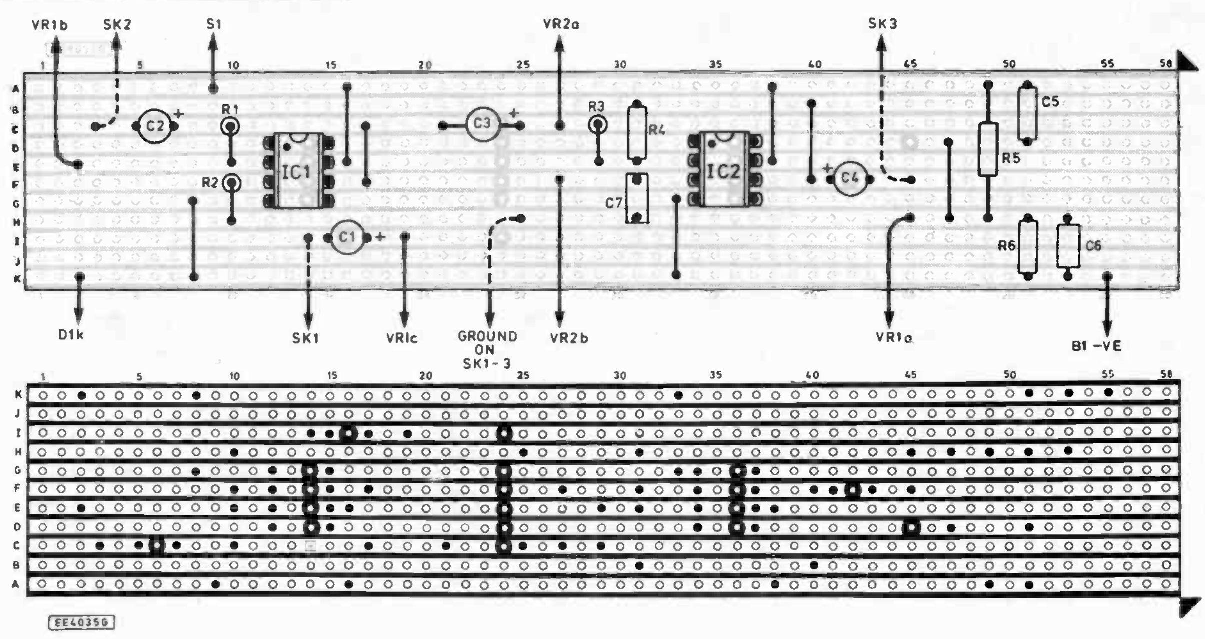
The two i.c.s should be mounted in holders. Make sure you do not miss any of the inter-strip link wires when assembling the board. Connections to VR1, VR2, S1 and D1 are made as in Fig. 6.

Note the connections to SK1, SK2, SK3 and the sockets common ground connection are soldered to the rear of the stripboard to avoid making holes or filing this size of stripboard to allow the connections to be made from the front.

CASE

The prototype case is arranged as in the photographs. The on/off switch, power l.e.d. gain control and stereo width controls are mounted on the front panel. The input/output sockets are mounted on the rear plate of the case. Note, the rear panel is used as a common ground for the input/output sockets.

Fig. 5. Stripboard layout and wiring for the Spatial Sound unit.



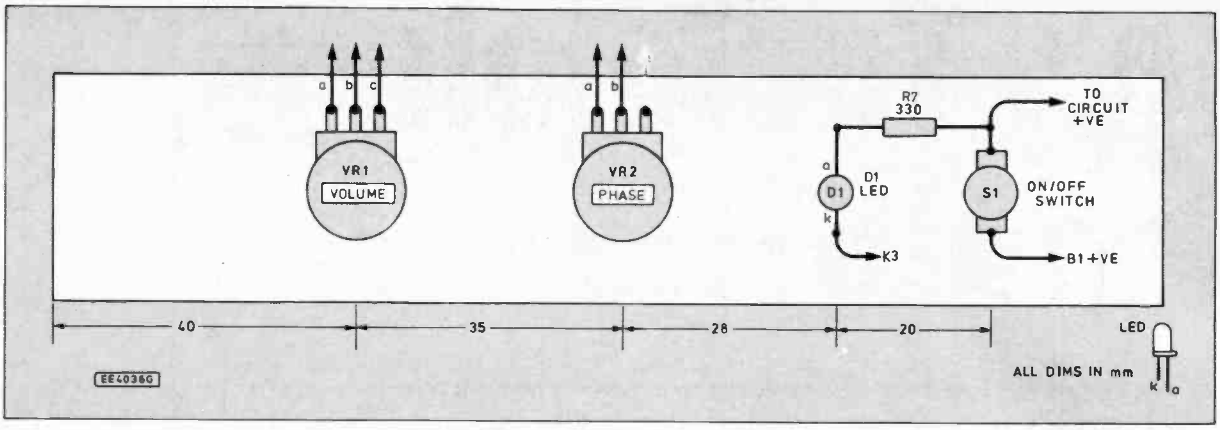
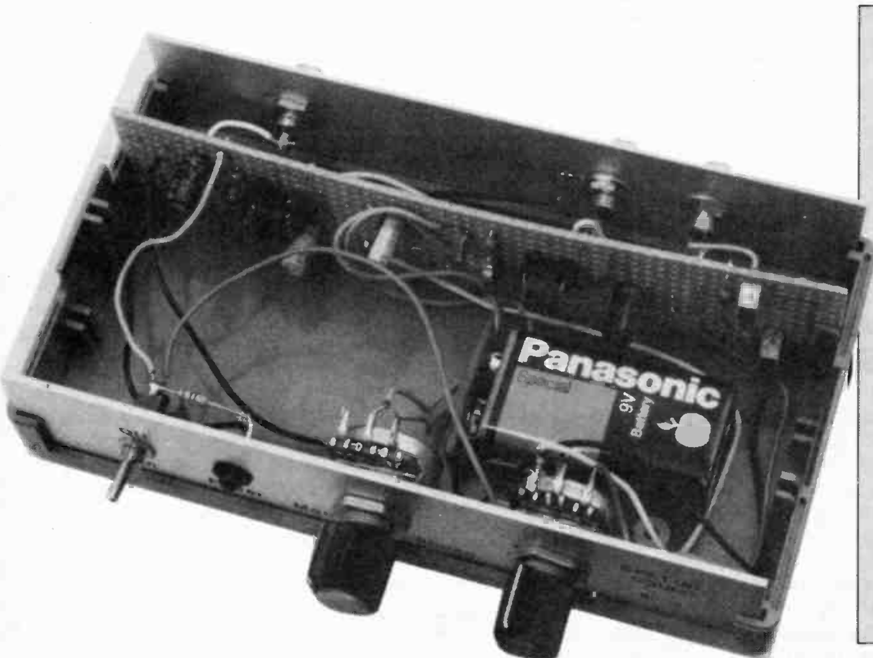


Fig. 6. Control and l.e.d. wiring diagram



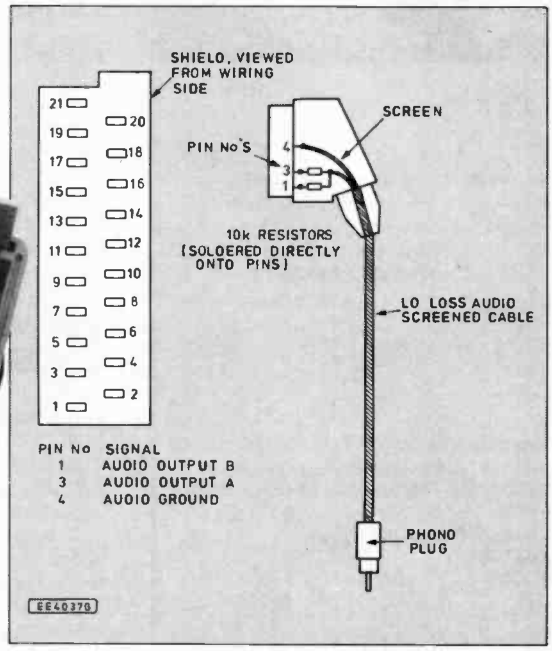


Fig. 7. Wiring of the SCART socket using two 10k resistors to combine the two signals.

Component layout is not critical, but the stripboard size was chosen, so it could be mounted in the slots provided by the Verobox.

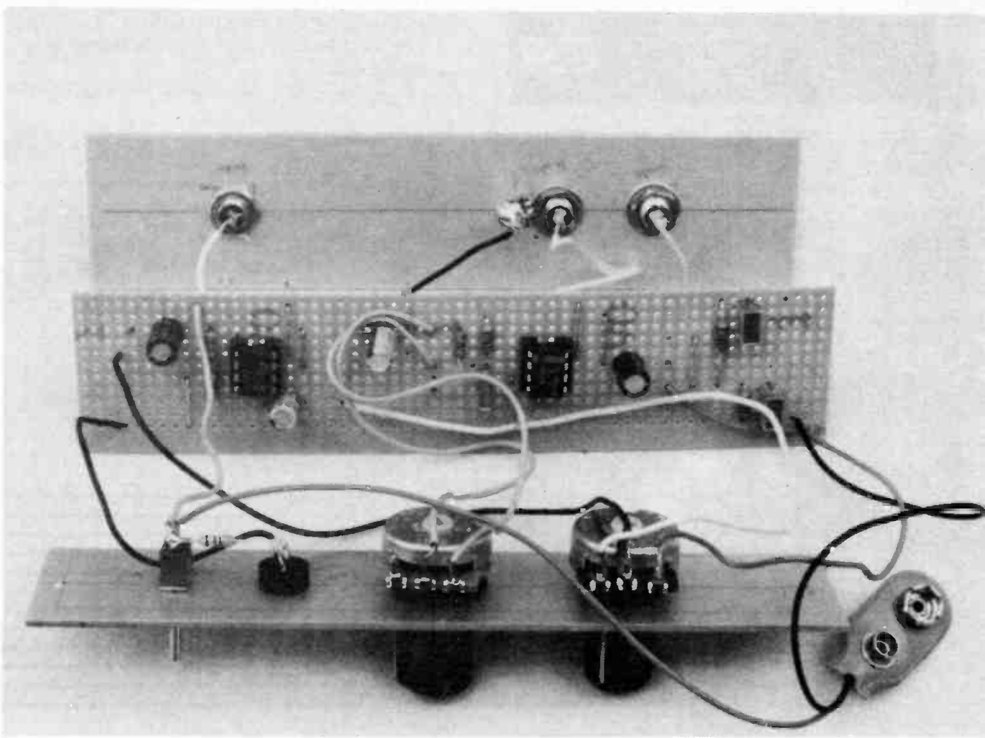
IN USE

In use, the output from this project is connected to the amplifier via the left and right channels of the AUX input (or Video In, CD or Tape 2) and the mono input signal is fed into the module, all via the phono sockets on the rear of the case.

The MONO/STEREO control sets the frequency at which phase shifting starts. So depending on the music content, this should be adjusted to give the best effect.

For a TVs source, the best way to obtain the audio signal is via the SCART/PERITEL socket which will be found on the rear of most modern televisions and videos. Even with mono videos/TV there will be an audio signal present at the left and right channel – so the addition of these two signals is obtained by connecting the output via two 10k resistors – see Fig. 7

Otherwise, the audio signal could be taken from the headphone/ext. spkr. socket via a 3·5mm jack plug. Simply plug in, switch on and adjust the Volume and Phase controls for best results. □



New Technology Update

Ian Poole reports on techniques for improving r.f. design and the increasing use of C.R.T.s.

A VERY large number of developments in electronics are driven by the computer section of the industry. Larger, faster memories, new 3·3V i.c.s, and better displays (as we will see later) are just a few examples. However, there are many other areas of electronics which are seeing some very exciting developments taking place. Sometimes they can even make use of ideas which started life in the computer technology.

R.F. Design

One such development which has benefitted is radio frequency design. Here there is a vast amount of scope for development because of the demand arising out of satellite communications, cellular phones, and the general telecommunications industry. In all of these areas there is a need for simple and cheap amplifiers capable of operating up to frequencies of around 2 GHz.

Using conventional components a typical amplifier would use several resistors, a number of capacitors, possibly a coil or two and of course the active device itself as shown in Fig. 1. All these components cost money and take up space on the board. To reduce both of these factors higher levels of circuit integration can be used. In fact by increasing the level of integration it is usually possible to improve the performance as well.

With these ideas in mind a new range of devices has recently been launched by Toshiba. They enable the component count of a circuit to be reduced quite considerably whilst still maintaining performance or improving the performance of the circuit.

The new i.c.s use bipolar technology and are fabricated using a process called SMART (Silicon Monolithic Architecture for R.F. Technology). They use as their basis a microwave transistor with a cut-off or transition frequency of 10GHz. This enables the performance of the whole i.c. to extend up to around 2GHz.

To manufacture these i.c.s it has been necessary to use sub micron dimensions, and this has required a great attention to be paid to the manufacturing processes. In addition to this, a technique called dry shallow junction processing is utilised. This has been borrowed from the manufacture of DRAM i.c.s found in computer circuits. However it is used to advantage here because it reduces spurious capacitance levels and allows circuits to operate at higher frequencies.

The cost of the new chips is expected to be fairly low. They are aimed particularly at the satellite tuner market. However they will no doubt find uses in many other radio frequency applications as well.

C.R.T. Developments

Much talk has been heard over the years about the fact that solid state displays are likely to replace cathode ray tubes (C.R.T.s) in the future. It must be at least ten years ago that people seriously started to suggest the replacement for the C.R.T. was just around the corner.

Now we seem to be as far away as ever. Rather than replacing the C.R.T., other types of display, including liquid crystal and electroluminescent varieties, seem to be used in areas where C.R.T.s would not be practicable. Contrary to what one might expect the use of C.R.T.s is on the increase, mainly because of the computer industry. The figures are quite convincing. Between 1991 and 1992 colour monitor production increased by almost 20 per cent and it is estimated that it will rise by another 10 per cent during 1993 despite the world wide recession we are currently experiencing.

These figures prove the dominance of the C.R.T. It is relatively cheap, reliable and currently it gives the best performance of any display. Its definition is good, it can change rapidly (unlike the L.C.D. which takes time to respond) and the colours are clear.

To retain this dominance of the market further developments are under way. With the improvements in computers this is placing greater demands on displays and in particular higher resolutions are required. This is demonstrated by the movement to VGA monitors and now onto Super VGA monitors. As technology progresses there will no doubt be further improvements in monitor standards in the future.

Another area where monitors have needed to improve is in their brightness. It is interesting to note that the increased use of the all too famliar "Windows" programme has meant that a much higher brightness is required across the whole of the screen. With previous generations of monitor which just displayed text on a dark background this was not a problem. Now with a whole screen brightly lit more stringent requirements are placed on the C.R.T.s.

If this was not enough, definition has to be maintained over the whole of the surface of the screen. Normally it is very good in the centre, but it falls off to the side and in particular in the corners where the electron beam has to be deflected to a greater degree.

Spot Shape

To meet the increasing requirements manufacturers have employed a number of new ideas. New types of electron gun have been developed. These guns actually alter the shape of the spot as it travels across the screen. If this were not done then a spot which was circular in the centre would appear as an oval further out.

To achieve the higher brightness the electron guns have again been the focus of attention. In the first instance their efficiency has been improved. In addition to this they have been modified to allow the use of higher voltages. By adopting both of these approaches a much more intense electron beam can be created, enabling a greater amount of light to be generated when it hits the phosphors on the screen.

A number of other developments are taking place. Screens are becoming flatter and this makes them easier to read. In addition to this, new silica based coatings are being applied to the screens. These reduce the amount of glare and also the static.

With these developments and many more taking place, the manufacturers see a very healthy market for C.R.T.s for some considerable time to come. Even though other displays are improving all the time one of the major advantages which C.R.T.s have is their price. Whilst this differential remains there is little chance of the trusty C.R.T. loosing its place in the market.

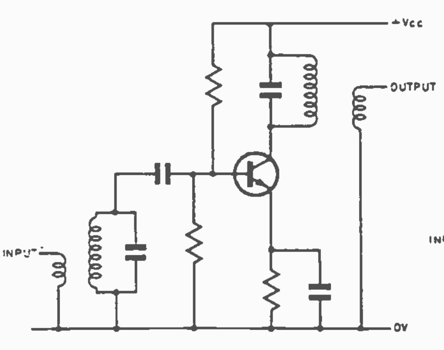


Fig. 1. A basic r.f. amplifier using a bipolar transistor.

By using i.c. technology the bias components can be removed and the tuning can often be simplified.

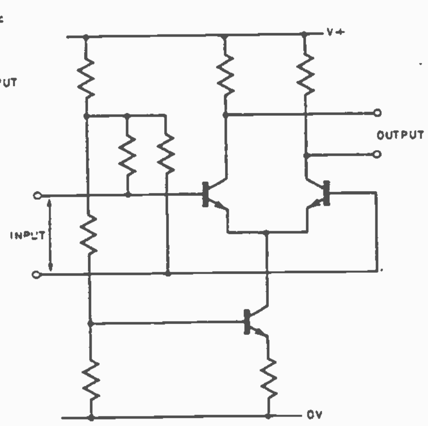


Fig. 2. Basic circuit of the i.c.

Innovations

A roundup of the latest Everyday News from the world of electronics

Power Logic Drive

A NEW family of integrated power i.c.s., ™Power + Logic, have just been announced by Texas Instruments. These new chips feature multiple, high performance DMOS power transistors with on-board CMOS control logic.

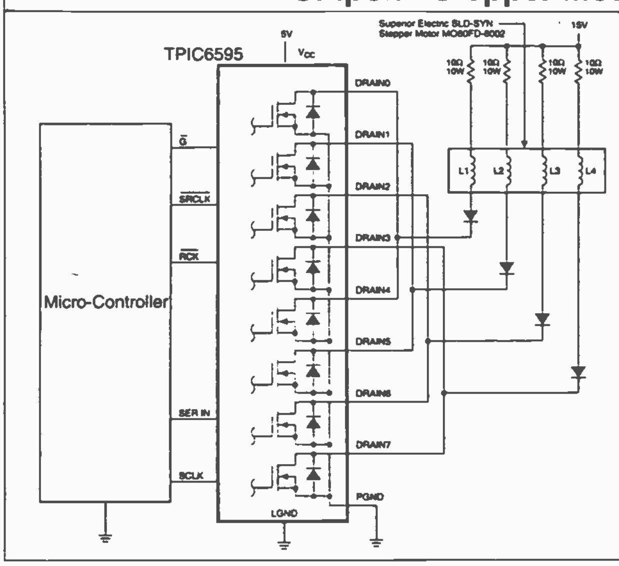
Developed using TI's new PRISM™ technology, the DMOS outputs have a 1Ω3 typical $R_{DS(ON)}$ for low power dissipation. The Double-diffused MOS (DMOS) output drivers are each capable of supplying, with all eight outputs active, 250mA continuous and up to 1·5A of pulsed current per channel. The outputs can be paralled to provide up to 6A of pulsed current for high current applications.

Each of the DMOS power outputs has a built-in 45V drain-to-gate Zener diode for enhanced unclamped inductive load switching. Each channel can absorb up to 75mJ of avalanche energy, making them well-suited for driving a wide variety of inductive and capacitive loads including fractional horsepower motors, solenoids, lamps and relays.

The 20-pin devices can handle logic switching speeds of up to 25MHz, allowing direct interface to a microprocessor.

Further information from: **Texas Instruments Ltd., Dept. EPE, Manton Lane, Bedford, MK41 7AP.**

Unipolar Stepper Motor Drive



Application Information

This circuit uses a TPIC6595 to provide a simple solution to the problem of translating logic-level timing into the current requirements of stepping motors. The system clock of the TPIC6595 is set for a frequency of 4kHz based on a time per motor step of 2.5ms and a total of ten TPIC6595 clock pulses per motor step. The motor is driven at its rated 1-A peak current by operating two output DMOS transistors in parallel.

The nature of a stepper-motor load causes both the positive and negative current to flow through the DMOS power transistor. The recirculating negative current may be blocked by placing a diode in series with each pole winding.

In this circuit, the drain of the DMOS is allowed to fly to its clamp voltage for short current decay times. The energy of the pole winding must be absorbed by the DMOS transistor. Consequently, this technique can be used only in applications that do not result in exceeding the device's thermal rating.

The first members of the Power + Logic family

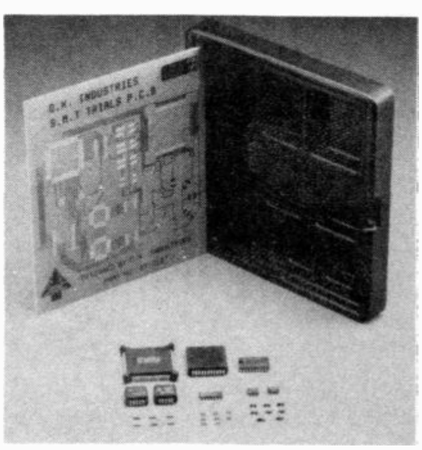
TPIC6259	Power + Logic 8-bit addressable latch.
TPIC6273	Power + Logic 8-bit D-type flip-flop latch.
TPIC6595	Power + Logic 8-bit shift register

SMART MOVE

Saving the expense of practising on the real thing, OK Industries' trials kit has been designed to enable the production engineer or "surface mount" student to carry out qualified evaluation of production and rework techniques on printed circuit boards.

Included in the boxed kit are Gull Wings, PLCC J lead, JEDEC, quad pack, Mini DIPs, SOTs, Mini MELF, chip resistors and capacitors and the trials board.

OK Industries UK Ltd., Dept. EPE Barton Farm Industrial Estate, Eastleigh, Hants. SO5 5RR. Tel: 0703 619841.



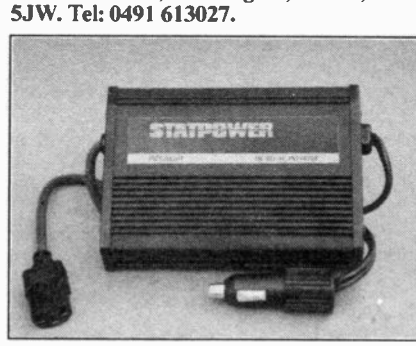
MOBILE POWER

Until now you have had to rely on noisy and expensive generators for 240-volt power to operate mobile radio communications or computer systems claims Merlin Equipment.

But help is at hand with the Merlin Pro Watt range of d.c. to a.c. inverters. These can be either plugged into the cigarette lighter in your car, or wired direct to the battery, the unit converts 12-volt d.c. power to 240-volt a.c. allowing you to benefit from mains power anywhere any time.

Ideal for amateur radio enthusiasts, microwave ovens, TV's, videos, computers, chargers, power tools etc. This family of inverters consists of four models, the pocket sized 125i and 200i claim 125W and 200W continuous output, with peak power of 400 watts. The 800i is rated at 800W continous and 2000W peak power. For really big power demands the 1500i model delivers 1500W continuous and 3500W peak.

For full details and prices contact: **Merlin Equipment, Dept. EPE, Scotts House, Cuxham Road, Watlington, Oxon, OX9 5JW. Tel: 0491 613027.**

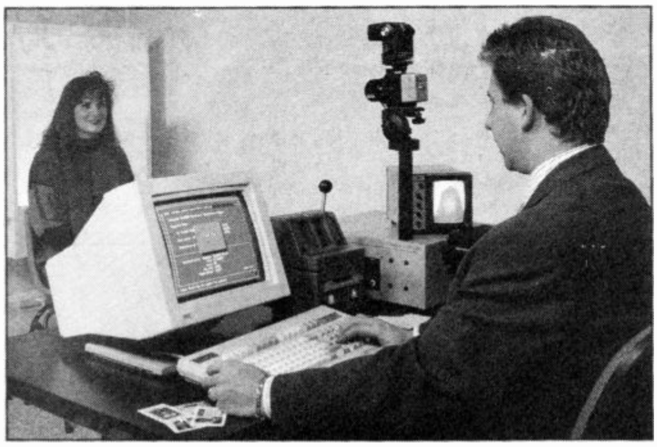


W. H. Smith opened its new branch this month at London Victoria station; this is claimed to be one of Europe's largest railway station shops.

IDENTIFICATION

IT IS claimed that one of the moves being considered by the Government, as a result of EC directives to scrap border controls, is the issuing of identity cards for all people over the age of 16. If this should happen then the demands for Polariod's video-based ID systems may be in increasing.

The ID-1000 is a video-based ID system that captures and digitises both colour portraits and signature images. By merging them with text data and pre-programmed ID card formats, which include any corporate logos or authorising signatures, the composite graphics are electronically recorded on Polaroid.



Producing an ID card from stored text data and a video portrait.

As the card is generated, the data is stored internally on the system's hard disc. The portrait and data can be retrieved for verification prior to ID card re-issue.

In use, the subject is seated in front of the ID-1000's high resolution, CCD colour video camera. This offers a freeze-frame feature on its monitor that allows the operator to preview the portrait before the ID card is produced.

The ID-3000 is the very latest of Polaroid's video-based ID systems. It features unlimited storage capacity, using advanced image compression techniques and supports magentic or optical disk storage options to accommodate future expansion.

This latest system is claimed to be the only electronic imaging system to offer a choice of media output, including inexpensive black and white thermal temporary or visitors passes through to either colour instant film or colour thermal prints for permanent, highly secure ID cards.

It also offers a range of optional software modules to expand the working capabilities of the system.

Further details from : **Polaroid (UK) Ltd., Dept. EPE, Ashley Road, St. Albans, Herts., AL1 5PR.**

FREE ENTRY

Computing is a very popular occupation amongst the disabled. Henceforth all disabled wheelchair users will be admitted to the *All Formats Computer Fairs* free of charge. See this month's *Circuit Surgery*.

THE THINGS PEOPLE PATENT!

PATENT ABSTRACTS. Anthony Edwards and Associates

The following abstracts are taken from recent UK patents in the general electrical/electronics area. British Patent Specifications can be ordered from Patents Office, Orpington, Kent BR5 3RD, England

Colour Cathode Ray Tube

In UK patent 2246012 Mitsubishi Denki Kabushiki Kaisha describe a colour cathode ray tube with an antistatic coating film formed over an outer surface of the face plate. The coating is composed of a polymer of silicon alkoxide, translucent conductive particles and several types of dyes or pigments so that it has a main absorption band in the range of 570nm-610nm, between the main green and red luminescence peaks of the c.r.t.

The coating also has a sub absorption band in either a first range between a wavelength of 380nm and a wavelength of 420nm or a second range between a wavelength of 470nm and a wavelength of 510nm. By incorporating at least two selected dyes or pigments in the antistatic coating the contrast performance of the cathode ray tube is improved.

Satellite Dish Cover

In UK patent 2246242 Michael Brassington and Philip Thomas Hatton describe a flexible material cover for a satellite dish. It has a circular front and an annular rear, the latter having an elasticated rim at the inner peripheral edge to hold the cover on the dish.

A front face of the cover is screen printed with a brick pattern to correspond to a building upon which the satellite dish is mounted, thereby camouflaging the dish. The cover may alternatively be sheet material or transfers which can be adhered to the surface of the dish and may be used for decorative, camouflage or advertising purposes.

Three-dimensional Electrical Circuit Substrate

In UK patent 2246316 Kitagawa Industries Co. Ltd. describe a method of manufacturing a three dimensional electrical circuit substrate. The conducting portion, comprising a circuit pattern, is formed on the surface of a film by silk screen printing.

The film is placed over a resin board in a mould in which the conducting portion of the film is opposed to the resin board. Subsequently, blow moulding and/or vacuum forming is applied to the mould.

The film and the resin board are thus closely overlapped, heat-bonded, and formed into a three-dimensional circuit substrate having a desired configuration. Prior to the blow moulding and/or vacuum forming, the film is provided with terminal connection holes and a printed resistive portion.

Snap Action Switch

In UK patent 2246664 Dewhurst plc describe an electrical snap action retractive switch. It includes snap springs arranged between an actuator and a carrier which carries a contact cooperable with the fixed contact on an external terminal.

The depth of the switch is reduced by positioning the contacts and the springs for returning the actuator to its unactuated state away from the line of action of the actuator. This reduction in depth has particular advantages for mounting the switch in substantially flat panels such as for control of electrically operated doors.

Electrical Cable Protection

In UK patent 2246673 Michael Ralph Forman and Florence Doreen Forman describe a cable (17) for connecting a hand-held electrical power tool (10), such as a hedge trimmer, to a power supply. It has a length of reinforced flexible plastics sleeve (20) or hose, e.g. PVC with braided nylon, fastened to that part of the cable which is most likely to contact the moving parts of the tool. The sleeve may be only 1m to 2·5m long, 10mm to 16mm thick and brightly coloured, and have an anti-friction surface.

The sleeve is fastened in position by releasable fastening means (21) at opposite ends of the sleeve so that it may be moved along the cable. Alternatively, helical or split ring fastening means may be used.

In a modification, instead of a reinforced plastics sleeve, the cable may be formed with a region of thicker insulation adjacent one end. This region may be moulded integrally with the insulation of the cable or formed by bonding an additonal layer of insulating meterial; the thicker region may be of the same or a different insulating material.

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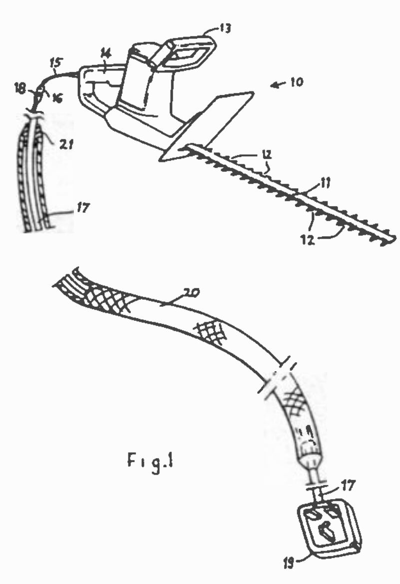
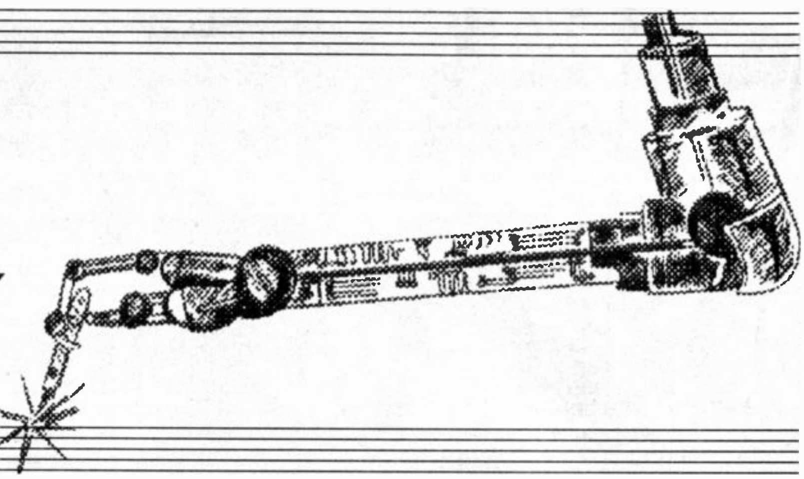


Fig.1

Regular Clinic

CIRCUIT SURGERY



MIKE TOOLEY B.A.

Once again, welcome to Circuit Surgery, our regular clinic which deals with readers' problems. In this month's Surgery we show how a standard 74LS00 quad 2-input NAND gate can be configured to produce all of the other logical functions. We also offer some advice concerning the selection and use of batteries and show how Robert Penfold's popular Car Ice Alarm can be modified to provide audible warning of hazardous road conditions. For good measure, we also take a peek (pun intended) at the increasingly popular All Formats Computer Fairs which never fail to provide a host of bargains for would-be experimenters!

All very logical

Martin Comfort writes from Kent with an interesting problem. Martin writes:

"Many logic circuits require a mixture of different logic gates (AND, OR, NAND and NOR). Often I find that I only use one gate out of the four available from a standard i.c. device such as the 74LS08. Can you explain how it is possible to make logic circuits using just one type of gate (e.g. 74LS00)."

Fortunately, Martin, this is a fairly simple problem and most digital electronics text books will provide you with a few clues. Sticking to one type of logic gate certainly does make sense, particularly if you need a mix of logic functions. Fig. 1 shows how all of the basic functions can be derived from a single 74LS00 (or similar) logic gate (pin connections as in Fig. 2).

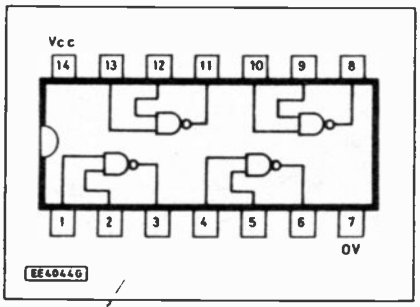


Fig. 2. Package outline and pin connection details for the 74LS00.

There is just one point worth making before we leave this subject. The time taken for a logic transition (i.e. a 0 to 1 or 1 to 0) to pass through a logic gate circuit can be important in some cases.

If the logic state transition has to pass through *several* logic gates (rather than just one) the "propagation delay" will be correspondingly increased. This delay is very small (usually between 10ns and 20ns) but can still be significant in high speed logic applications.

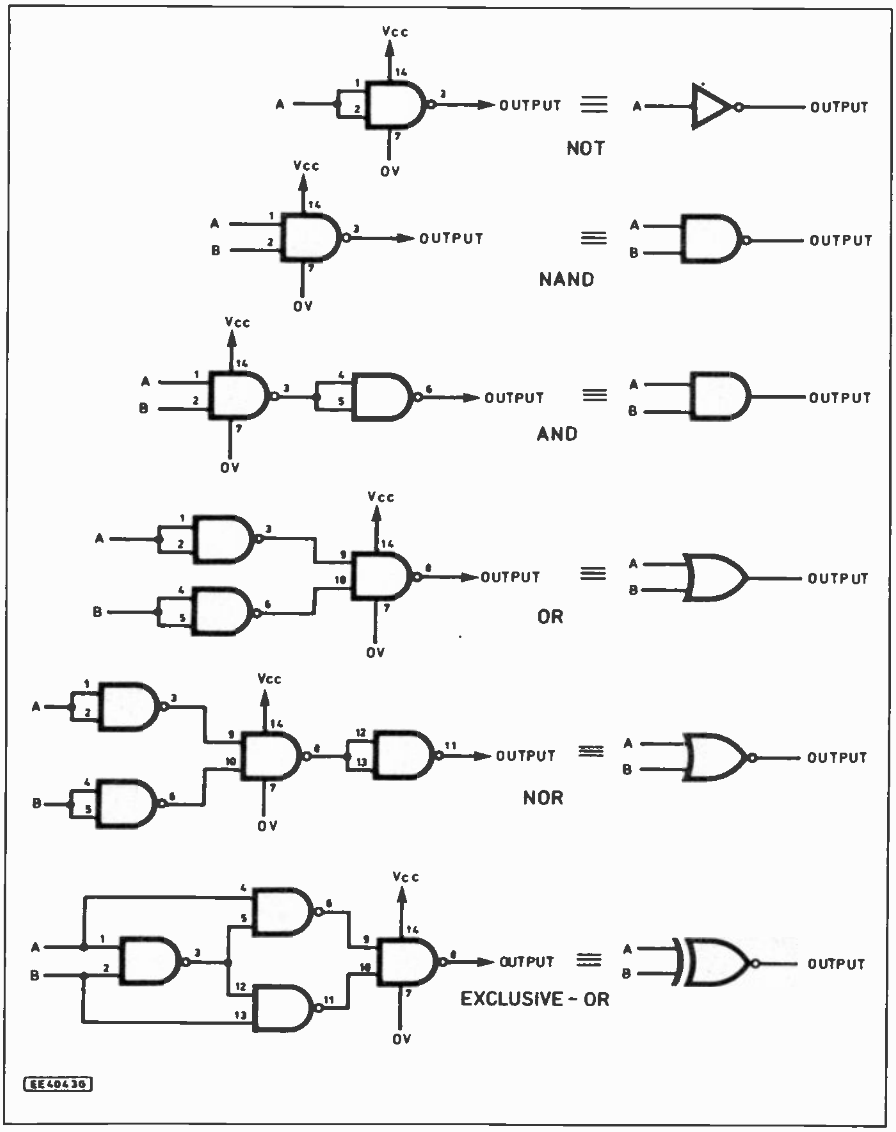


Fig. 1. Various logic functions produced by a single 74LS00 NAND gate

Car Ice Alarm

Mark Allen writes from St Albans with the following query:

"In January's Everyday with Practical Electronics *Robert Penfold described a* Car Ice Alarm. *This useful circuit provides a visible indication of the presence of ice. Most drivers, myself included, would probably prefer an audible warning. Can you show how the circuit could be modified to do this?"*

Fortunately, Mark, this is an easy one. All that you need is a piezoelectric sounder with integral drive circuitry (e.g. Maplin KU56L) connected in place of the l.e.d. D1 and resistor R5. Fig. 3 shows how.

New batteries for old

Mr S. Weller writes from Gloucester with a plea for help which will strike a familiar note with many readers. Mr Weller writes:

"I have several small items of electronic equipment powered by 9V PP3 batteries. Unfortunately, this is proving rather expensive as the batteries only seem to last a few hours.

The obvious answer (to increase the size of the battery) is not possible because of the small size of the plastic boxes. Please tell me what life I can reasonably expect from a PP3 battery and also what type/make of battery would give me the longest life?"

As Mr Weller has found, the choice of battery can be crucial. The popular PP3 battery is available in a variety of forms. As an example, Ever Ready make "Blue Seal", "Silver Seal" and "Gold Seal" types. The two former varieties are conventional zinc chloride types (the "Silver Seal" variety provides extra life when used on equipment which places a relatively heavy current demand or which is designed for continuous use). The "Gold Seal" range of batteries are new alkaline types and offer much improved performance over their predecessors.

The following table relates to several of the most popular variants of the PP3 battery supplied by two of the most well known manufacturers:

From the above, it is worth noting that the three alkaline types all provide very similar capacities (the Procell MN1604 is virtually identical to the standard Duracell but is designed for industrial rather than domestic use). In either case, the 550mAh rating should be more than sufficient for a wide range of applications in which the battery is required to supply a relatively high load current for some considerable time (note that the cheaper zinc chloride PP3 should generally not be used for loads which require a continuous current of more than about 50mA).

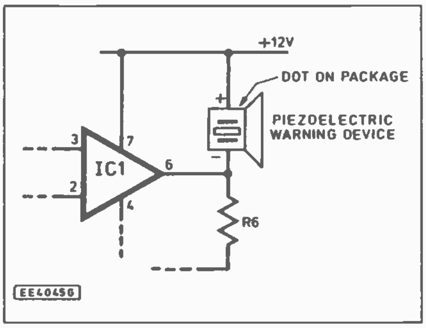


Fig. 3. Modification to the Car Ice Alarm *(Jan '93) circuit to provide audible output.*

In exceptional cases it might be worth considering the use of a zinc air battery such as the Duracell DA146. This provides almost three times the capacity of its MN1604 counterpart - but at a price!

Finally, it is worth noting that the PP3-sized nickel cadmium battery compares unfavourably with alkaline manganese and zinc air types. Nickel cadmium PP3 batteries should therefore only be used when a limited battery capacity is acceptable (I reserve this type of battery for use in various items of test equipment which are only used intermittently and which have fairly modest current requirements).

Table 1: Some comparisons of the popular PP3 battery.

Manufacturer	*Battery type*	*Active constituents*	*Voltage*	*Capacity*
Ever Ready	Gold Seal	Alkaline	9V	500mAh
Duracell	MN1604B1	Alkaline manganese	9V	550mAh
Duracell	Procell/MN1604	Alkaline manganese	9V	550mAh
Duracell	DA146	Zinc air	8.4V	1500mAh
Ever Ready	Rechargeable	Nickel cadmium	8.4V	110mAh

All Formats Computer Fairs

Like most readers I suspect that I have a particular weakness for a bargain. For this reason I have become a regular visitor to the *All Formats Computer Fairs*. For the benefit of the uninitiated, these popular events regularly tour the UK and provide an outlet for a large number of specialist traders and dealers. New and secondhand computer equipment is always available, with disk drives, displays and printers in abundance.

Don't be put off by the title; the fairs may cater for the computer enthusiast (particularly those who build or modify their own systems) but they are also a paradise for those with a more general interest in electronics. Printed circuit boards, keyboards, test leads, connectors, cables and a host of digital, processor and memory chips are always available at "rock bottom" prices. So, if you need to catch up with them, the programme for Spring 1993 is as follows:

Feb	20	North West	Haydock Park Racecourse J23 M6
	21	Scotland	City Hall, Candleriggs, Glasgow
	27	Hemel H/stead	Dacorum Pavilion, The Marlowes
	28	West	Brunel Centre, Templemeads, Bristol
Mar	6	Leicester	De Montfort Hall, Granville Road
	7	North	Univ. Sports Centre, Calverley St., Leeds
	20	London	Sandown Park, Esher, Surrey J9/10 M25
	21	West Midlands	National Motorcycle Museum J6 M42
	27	North West	Haydock Park Racecourse J23 M6
Apr	4	Scotland	City Hall, Candleriggs, Glasgow
	18	West Midlands	National Motorcycle Museum J6 M42
	24	London	Sandown Park, Esher, Surrey J9/10 M25

All fairs are normally open between 10 a.m. and 4 p.m. and stands are available at a very reasonable charge, contact Bruce Everiss on 0608-663820. See you there!

Next month: We shall be describing some simple methods of reducing mains hum, we also describe a simple audio amplifier for those with hearing difficulties. In the meantime, if you have any comments or suggestions for inclusion in *Circuit Surgery*, please drop me a line at: Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT.

Please note that I cannot undertake to reply to individual queries from readers however I will do my best to answer all questions from readers through the medium of this column.

Constructional Project

CAR ELECTRIC WINDOW ENHANCER

CHRIS WALKER

Upgrade your car electric windows to the luxury class. No mechanical modifications required.
One-shot option and safety stall feature.

ELECTRICALLY powered windows are a popular feature on cars these days. Some years ago they were reserved strictly for the top-market saloons or chauffeur-driven limos. Manufacturers now fit them to the upper-range models of all sorts of vehicles, large and small, in an attempt to add that extra touch of "luxury".

In reality, apart from the "status value", electric windows are a useful addition to a vehicle's equipment. For a start, they eliminate the arm-wrenching and finger-crippling action upon that awfully designed window handle; not too elegant or safe when driving in traffic.

In addition, how many times have you, as a lone driver, stopped to ask directions from a pedestrian only to have to sprawl headlong across the passenger seat whilst wrestling with a locking seat-belt just to wind down the glass? With electric operation the driver has fingertip control over several windows in the vehicle.

ONE-SHOT

An added feature on some cars is the "one-shot" facility, whereby the user can completely lower or raise the window with one press on the button without having to continuously hold it down. This is a useful facility as it frees the drivers hands for gear changing, steering or signalling without the need for repeated fumbling of switches.

Unfortunately, many smaller or cheaper cars equipped with electric windows do not have this one-shot facility, presumably omitted to reduce costs. The Electric Window Enhancer described here is an add-on unit which provides manual or one-shot operation using the existing window switch and motor.

No *mechanical* modifications to the window mechanism are required. In addition it incorporates a safety cut-out which switches off the motor if the window movement becomes obstructed. One Window Enhancer is required for each window to be modified.

The stall cut-out offers some degree of protection should an object become trapped by the closing glass. However, please remember that window automation poses hazards to inexperienced users; young children, for instance, should never be allowed to play unattended in any vehicle.

HOW IT ENHANCES

In a conventional electric window circuit the driver's control switch consists of two independently operated spring-biased changeover switches as shown in Fig. 1. These switches are actuated by a single rocker which, when not pressed, rests in the intermediate position between "UP" and "DOWN".

By operating the UP switch, a 12V p.d. appears across the motor. When the DOWN switch is selected the polarity across the motor is reversed and the motor runs in the opposite direction. When the control rocker is released, both terminals of the motor are shorted together (to 0V) and the motor is dynamically braked to a stop.

The exact wiring details of different vehicles may vary and it would be wise to acquire details of your own vehicle *before* attempting any modifications.

The Window Enhancer unit is inserted into the leads between switch and motor as shown in Fig. 2. A 12V power supply is also conveniently supplied from the window switch. When the switch is operated the motor responds as normal and stops when the switch is released.

However, if the switch is held pressed for more than about half-a-second the motor "latches on" and runs continuously until it is stalled, a condition which occurs when the window reaches the end of its travel or encounters an obstruction. Alternatively, the one-shot action is halted by clicking the control switch once more in the opposite direction.

Since all the wiring to the unit is made in the vicinity of the existing window switch, the Window Enhancer should conveniently fit in the door cavity or under the car's central console or wherever the control switch is located.

HOW IT WORKS

The full circuit diagram for the Car Electric Window Enhancer unit is shown in Fig. 3.

The operation of the "UP" section of the circuit, comprising transistors TR1 to TR3, will be described. The "DOWN" section (TR4 to TR6) is an almost exact copy of this.

When the UP window switch is depressed the anode (a) of diode D1 is connected to +12V and current will flow via D1 and through the coil of relay RLA. The contacts associated with this relay, RLA1, changeover and apply power to the window motor. If the UP switch is released the relay will relax and switch the motor off.

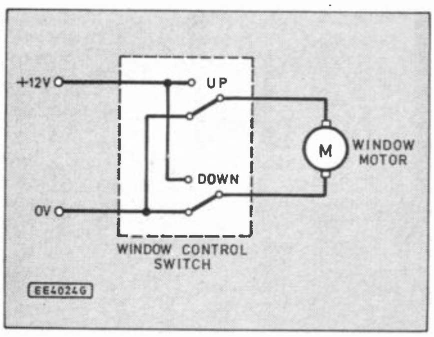
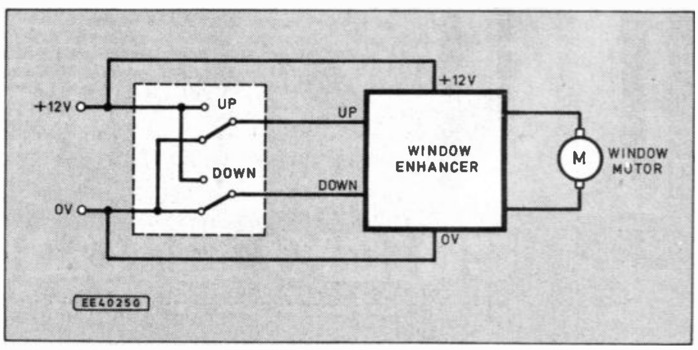


Fig. 1 (left). The conventional set-up for the driver's electric window control switch.

Fig. 2. (right). The Car Electric Window Enhancer is inserted into the leads, between the switch and motor.



Manual control of the window is thus retained.

Whilst the UP switch is held pressed, capacitor C1 charges via resistor R1 and when the p.d. across C1 reaches about 0·6V transistor TR2 switches on which, in turn, switches on transistor TR3. When this happens, current to the coil of relay RLA is supplied via TR3 so that, even if the UP button is released again, the relay stays switched on. In addition, the presence of +12V at the collector of TR3 ensures that C1 is kept charged via R1 so that transistors TR2 and TR3 remain fully latched on.

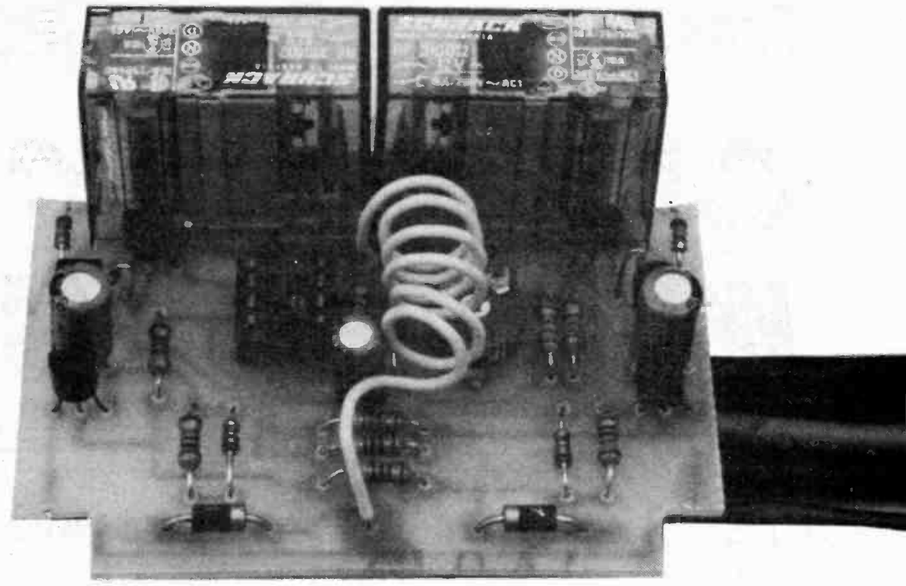
The values of R1 and C1 are chosen so that it takes about 500ms for capacitor C1 to charge sufficiently for transistor TR2 to switch on. Therefore, the relay only latches on if the UP button is held pressed for a period longer than this. If the UP switch is released before transistors TR2 and TR3 latch on, then capacitor C1 discharges almost instantly through diode D2 (and via the relay coil).

If, whilst relay RLA is latched on, the DOWN switch is operated, then current will flow through diode D4 and resistor R4 into the base of transistor TR1 which consequently switches on and rapidly discharges capacitor C1. This has the effect of resetting the "UP latch" and switching relay RLA off. Transistor TR1 will also switch on and discharge C1 when the output from op-amp IC1 goes high, a condition which indicates that the drive motor has stalled.

STALL SENSOR

The stall sensor has a two-fold action. It eliminates the need for microswitches to detect the end of travel of the window pane, and it also switches off the motor if, for example, fingers or other bodily parts become trapped by the closing glass. If you wish to test this cut-out action, use some ***inanimate*** object – we don't recommend you use your fingers, it may hurt!

The system detects the stalled motor condition by monitoring the current drawn by the motor. Under free-running conditions the motor consumes very little current, but this increases as the motor is loaded.



The completed printed circuit board component layout. Resistor R9 is made up from a pice of 0.6mm dia. insulated copper wire (approx 20cm), coiled up for neatness, and can be clearly seen above.

If the output shaft is completely prevented from rotating the motor supply current will rise significantly. The motor should NOT be subjected to this condition for any length of time, otherwise the heat generated as a consequence could burn out the armature or even start a fire. (All motors used for automotive window lifting should have been protected during design and manufacture, by equipping them with a thermal cut-out if necessary, to prevent such an extreme conclusion).

Return current from the motor has to pass through resistor R9 which is simply a short length of copper wire approximately 0·6mm in diameter (24 s.w.g. for the oldies!). A p.d. is developed across the wire which rises proportionally to the current passing through it; this is Ohm's law.

This voltage is monitored at the non-inverting input of IC1 (pin 3), an operational amplifier wired to act a a voltage comparator. Resistor R12 and capacitor C3 introduce a small delay (about 250ms) into the response of the voltage comparator so that the circuit does not detect brief current surges which may occur as the motor is switched on.

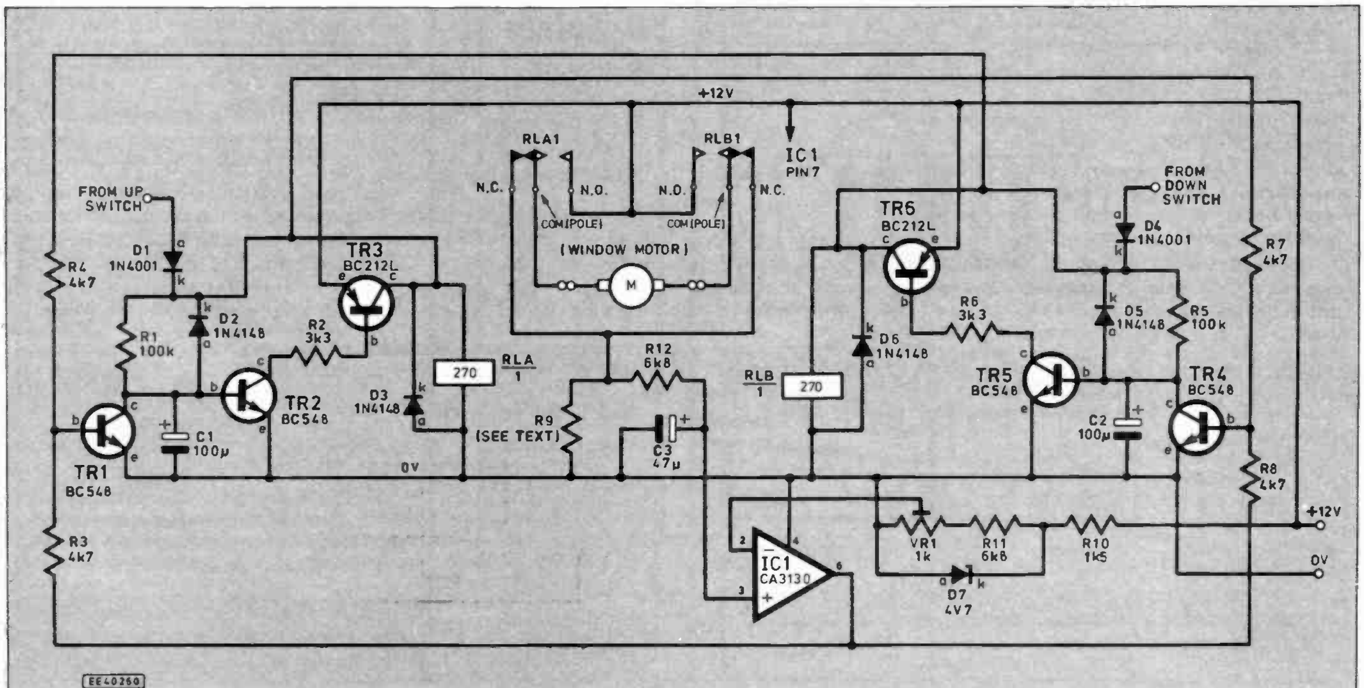
A reference voltage presented to the inverting input of IC1 (pin 2) is derived from Zener diode D7. By adjusting preset potentiometer VR1 the reference can be adjusted over the range 0V to 0·6V. When the voltage drop across resistor R9 exceeds the reference voltage, the output from IC1 (pin 6) swings up to about 12V and switches on transistor TR1 and TR4 as described earlier.

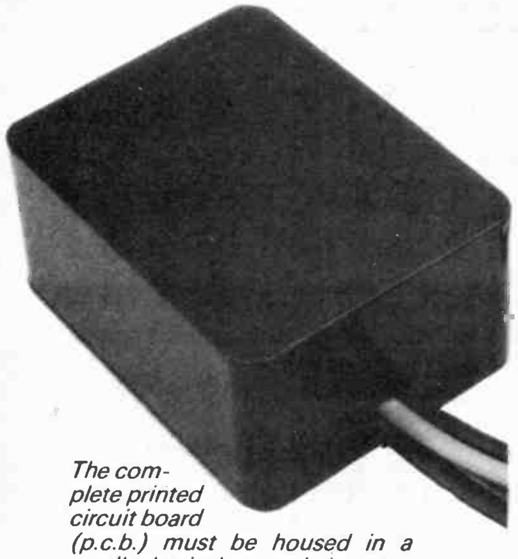
In practice, VR1 is adjusted so that the op. amp output is down at 0V under normal running conditions, but rises to 12V if the motor is stalled (or excessively loaded).

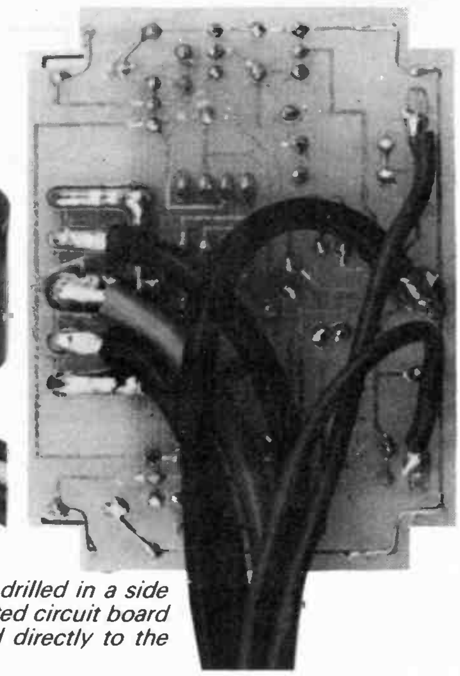
CONSTRUCTION

The entire circuit is constructed on a small single-sided printed circuit board, the

Fig. 3. The complete circuit diagram for the Car Electric Window Enhancer. The power supply to the circuit is taken from the window control switch, see Fig. 2.







The complete printed circuit board (p.c.b.) must be housed in a small plastic box and the connection leads taken out through a hole drilled in a side panel. An underside view of the completed circuit board showing the heavy-duty leads soldered directly to the copper pads is shown above right.

component layout and track pattern of which is shown in Fig. 4.

The completed board must be housed inside a small plastic case, suggested size 80mm x 62mm x 40mm (type MB1), and if this enclosure is used then the four corners of the p.c.b. should be removed as shown before any components are mounted.

Component assembly sequence on the p.c.b. can be in any order, but leave the relays until last as they are bulky and make the board difficult to handle easily. As usual, pay attention to the polarity of the three electrolytic capacitors and the orientation of the semiconductor devices.

Resistor R9 is manufactured from a length (about 20cm) of 0·6mm insulated copper wire. For neatness, this can be coiled up. It is recommended that IC1 is mounted in an 8-pin d.i.l. socket so that it can be removed if necessary to disable the stall sensor. This will be useful if the need should arise to fault-find on the circuit board at the end of construction.

IMPORTANT

The current drawn by the window lifting motor can be quite high and the following constructional points should be noted as a consequence:

The relays chosen have a contact rating of 16A d.c. If a different relay is employed, it is important to bear in mind that the contacts have to be able to break the high current drawn by the motor when it is stalled. Also, a different relay to the type specified may not locate onto the existing p.c.b. layout. The specified type is fairly popular and should be easily available.

Due to the problems encountered with passing high motor current along p.c.b. tracks, the flying leads connect to the circuit board by being soldered *directly* to the chunky pads *on the copper side* of the

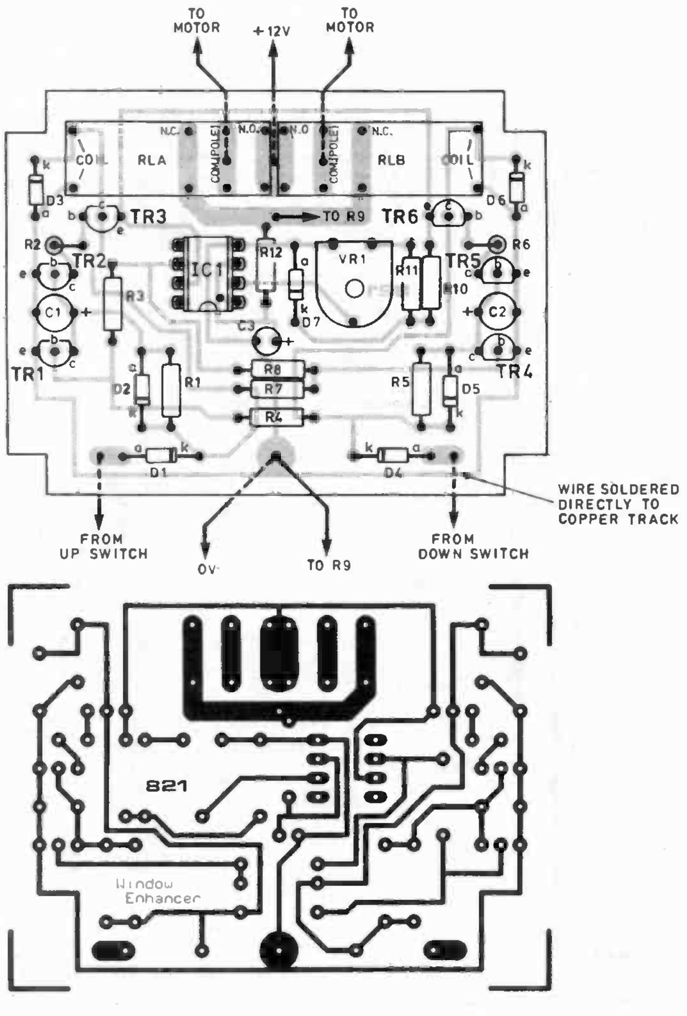


Fig. 4. Printed circuit board component layout and full size copper foil master pattern. Note the "dashed" lead-off wires are soldered directly to the underside copper pads (see text).

COMPONENTS

Resistors

R1, R5	100k (2 0ff)	
R2, R6	3k3 (2 off)	
R3, R4, R7, R8	4k7 (4 off)	
R9	See Text	
R10	1k5	
R11, R12	6k8 (2 off)	

All 0·6W metal film or carbon.

See SHOP TALK Page

Potentiometer

VR1	1k min. horizontal preset

Capacitors

C1, C2	100µ radial elect., 25V
C3	47µ radial elect., 25V

Semiconductors

D1, D4	1N4001 silicon diode (2 off)
D2, D3, D5, D6	1N4148 silicon diode (4 off)
D7	BZY88C4V7 4·7V Zener diode
TR1, TR2, TR4, TR5	BC548 *npn* silicon transistor (4 off)
TR3, TR6	BC212L *pnp* transistor (2 off)
IC1	CA3130 CMOS op. amp

Miscellaneous

RLA, RLB	12V relay, 270 ohm coil, 16A changeover contacts (2 off)

Printed circuit board available from EPE PCB Service, code 821; plastic case (type MB1), size 80mm x 62mm x 40mm; heavy duty connecting wire (50/0.25mm); 0·6mm insulated copper wire for R9; 6-way terminal block; 8-pin d.i.l. socket.

Approx cost guidance only **£16**

board. In addition, the short length of track which links the two sets of normally closed contacts (n.c.) on relays RLA and RLB and which also connects to resistors R9 and R12 should be reinforced by soldering a piece of stout copper wire along its length.

The flying leads themselves should be heavy duty 50/0·25mm insulated wire to reduce voltage drops and minimise the heating effect of a large current. It may be more convenient to use slightly thinner insulated wire to link between the UP/DOWN control switch in the vehicle and diodes D1 and D4 on the p.c.b. However, very thin wires may soon break due to vibration within the vehicle.

A small hole drilled in the plastic case to align with potentiometer VR1 will allow the preset to be adjusted with a small screwdriver when the lid is in place.

INSTALLATION

For safety, disconnect one terminal of the car battery before starting any work on the electrical system.

Connection between the car's wiring loom and the flying leads from the Window Enhancer can be made via a 6-way screw terminal block. Try to avoid "dodgy" connection methods such as "twisted and taped" joints. These cannot handle high currents and inevitably work loose over time.

Cut the two wires which run from the car's window control switch to the window motor. The Enhancer module fits into these wires as shown in Fig. 2. The two power supply leads for the module come from the +12V and 0V wires which feed the window control switch. *Use a heavy duty terminal block to splice into these wires.*

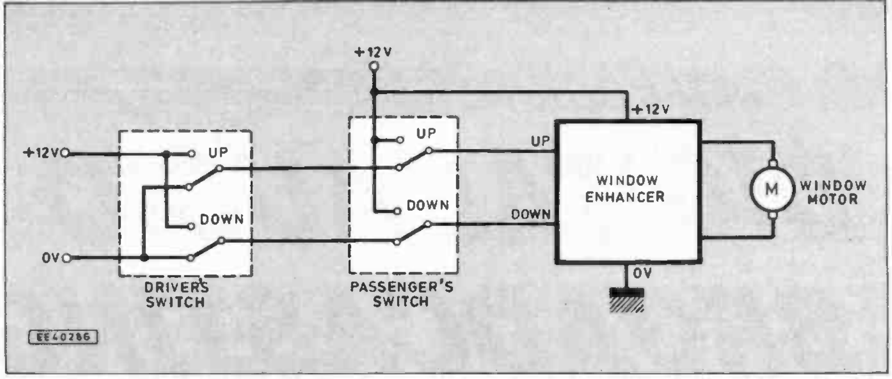


Fig. 5. Suggested possible wiring arrangement to achieve passenger/driver control of the passenger window.

At this stage it should be mentioned that *some* vehicles dynamically brake the motor by shorting *both* motor contacts to +12V instead of 0V as was described in Fig. 1. In order to permit the Window Enhancer to work with this type of system it will be necessary to interchange the +12V and 0V leads to the window control switch so that the motor is shorted to the 0V line. In any case, it is most important to check exact wiring details for your vehicle before attempting to fit the Enhancer.

Once installed, set preset potentiometer VR1 at about mid-position and re-connect the car battery. Switch on the electric window circuit in the car and check that the UP/DOWN switch still operates the window manually.

Holding the control switch closed for over half a second should cause the one-shot action to latch. Check that the relays cut out about half a second after the window reaches the end of its travel.

It may be necessary to adjust the sensitivity of the stall-sensing circuit. If the one-shot action fails to latch, turn VR1 anti-clockwise to de-sensitise the unit. If, on the other hand, the window motor refuses to cut out when the glass movement is restricted then turn VR1 clockwise. When setting up the stall-sensor, DO NOT allow the motor to remain in a stalled condition for more than a few seconds or damage to the motor could result.

DRIVER/PASSENGER ARRANGEMENT

Control of the passenger window is usually achieved with one of two switches located near driver and passenger. A possible wiring arrangement to achieve this is shown in Fig. 5.

The Car Electric Window Enhancer is placed between the passenger's switch and the motor as shown. It may be necessary to find a good 0V "earthing" point for the Enhancer power supply. □

Special Feature

DIGITAL AUDIO BROADCASTING

IAN POOLE

Future transmissions should match digital hifi quality.

AUDIO electronics has seen a great number of developments in recent years. The tape cassette which is so common now was introduced in the 1960s. In 1983 the compact disc was introduced. Now digital compact cassettes and mini-discs are set to battle it out for a new position in the hi-fi and audio market. In addition to this amplifiers, tuners, cassette and CD decks have made use of the latest electronic technology.

RADIO SYSTEMS

At the moment radio uses two systems for broadcast material. The first is amplitude modulation or a.m. which is used on the long, medium and short wave bands. It simply involves changing the amplitude or strength of the signal in line with the modulation as shown in Fig. 1.

With an a.m. signal it is found that two sidebands are produced spreading out either side of the main carrier as shown in Fig. 2. From this it can be seen that the signal takes up a finite bandwidth. In fact it takes up an amount equal to twice the highest frequency being transmitted. On the Long and Medium Wave bands the spacing and hence the bandwidth of each signal is 9kHz and hence the maximum frequency which can be transmitted is only 4·5kHz.

The other system which is in use is frequency modulation or f.m. Instead of changing the amplitude of the radio frequency signal its frequency is changed in line with the audio waveform as shown in Fig. 3. By making the frequency of the signal vary over a wide band (+/− 75kHz in the case of broadcast signals) it is found that the background noise can be reduced. In addition to this the signal is able to carry much higher modulating frequencies.

The audio itself is limited to 15kHz, but in addition to this other signals are carried above the audio range. Up until recently this consisted of the additional signals required for stereo, but now Radio Data System RDS signals are also carried.

Whilst the signal itself varies over +/− 75kHz a full 200kHz has to be allowed to accommodate the signal as shown in Fig. 4. Accordingly channels have to be spaced by this amount. This means that a national network like Radio 1 occupies a large amount of space because it has to use several channels so that adjacent regions do not interfere with one another.

THE NEED FOR CHANGE

With all the developments taking place with CDs, digital compact cassettes, mini-discs and the like, radio broadcasting seems to be the poor relation. The basic a.m. broadcasts have not changed to any real degree since they were first introduced in the 1920s. Even the high quality v.h.f. f.m. transmissions date back to the 1950s but with the introduction of stereo in the 1960s and finally RDS in 1988.

With the higher quality which v.h.f. f.m. supports, more people now listen to these broadcasts than those on the Long or Medium wave bands. However v.h.f. f.m. still has some distinct limitations. For the hi-fi enthusiast one of the greatest annoyance is the signal-to-noise ratio.

When compared to CD systems which typically achieve 100dB the ultimate figure of 70dB which can be achieved by a typical v.h.f. f.m. tuner today can be noticeably poorer. Even then this sort of figure can only be achieved when a good signal is present. To obtain this a large external aerial may well be needed.

One of the major problems with v.h.f. f.m occurs with car radios. The system was never intended for use in cars when it was first launched. However, over the years the

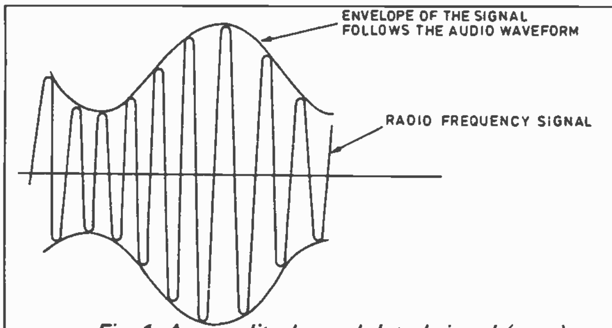


Fig. 1. An amplitude modulated signal (a.m.).

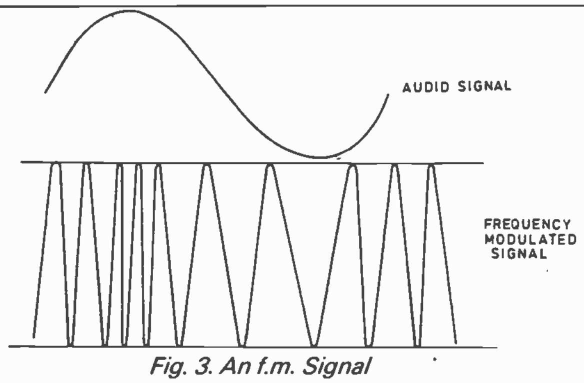


Fig. 3. An f.m. Signal

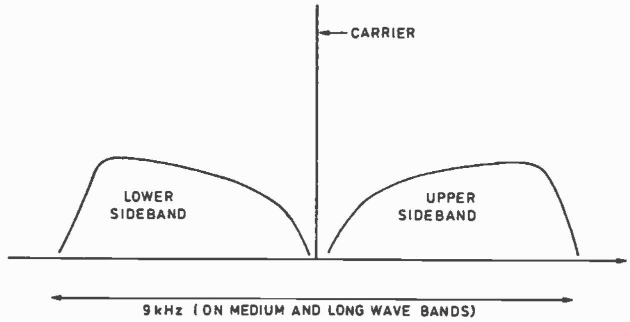


Fig. 2. Spectrum of an amplitude modulated signal (a.m.).

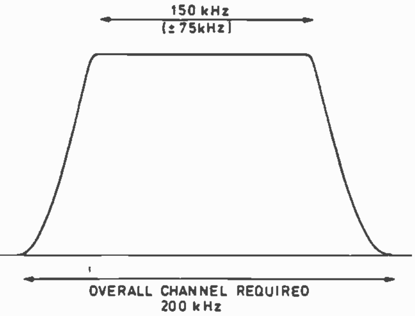


Fig. 4. Spectrum of an f.m. signal.

use of car radios has grown rapidly and the improved quality provided by f.m. has been put to good use.

Everyone will have experienced the annoying distortion which occurs from time to time, particularly when the signal is weak or when travelling in towns or near hills. This is caused by multipath distortion resulting from reflected signals arriving at the radio fractionally after the main signal.

NEW SYSTEM

When any new broadcasting system is developed the requirements must be laid down very carefully. This is very important because over the years vast sums of money will be spent by the broadcasters themselves and the listeners. This means that the system must not become outdated too quickly. Nor must it be so far advanced that equipment for it is outside the reach of the general public.

In addition to this there are a number of other requirements which are specified. In the case of DAB (Digital Audio Broadcasting) one requirement is to give audio quality equivalent to that of currently available CDs.

Another requirement is that it should be capable of giving good reception with a portable or car radio. There should be none of the problems with multipath distortion experienced with v.h.f. f.m..

Tuning should also be easy. With the large number of stations and transmitters on the f.m. band it is not always easy to locate the best signal of a national network, or a particular local radio station. The new RDS system helps overcome this to a major extent, but any new systems should not suffer from the same basic problem.

SYSTEM CHOICE

Experiments and development of a suitable system for transmitting digital radio have been taking place for some time. Initial tests employed the Nicam digital system used for transmitting stereo sound for television. This gave excellent results with a suitably mounted directional aerial. However the results were not at all encouraging with a poorly placed non-directional aerial like that used with a portable or car radio.

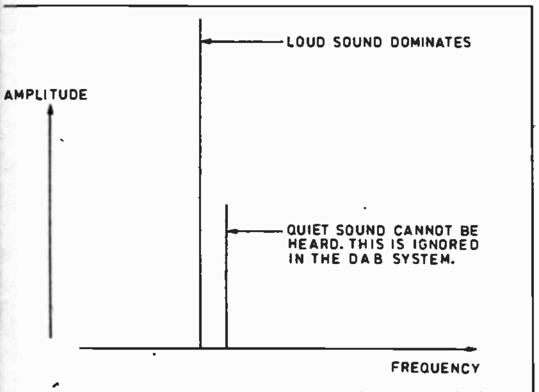


Fig. 5. Masking of quiet sounds by louder ones.

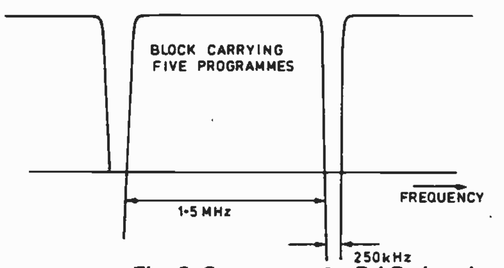


Fig. 6. Spectrum of a DAB signal.

The problem was caused by multipath distortion. The reflections caused data bits to overlap with the result that the signal could not be decoded. In general it has been found that interference from reflected signals becomes a problem once the delay between the main and reflected signal exceeds half a data bit period. If the reflected signal is very strong then even with this degree of time delay the signal can become indecipherable.

One way of overcoming this problem is to increase the time between the data bits. This reduces the problem of interference but also reduces the rate at which data can be sent. This is particularly important. A CD player operates at about 1·5 Megabits per second. Nicam digital sound requires just over 700 kilobits per second.

If sufficient spacing is placed between the data bits of a radio sound signal then the data rate is reduced to just 14 kilobits per second. A figure well below that required for the quality of sound which needs to be transmitted. To overcome this two main ideas are used.

MASKING

The first way in which the data rate is reduced is by taking account of the properties of the ear. It is found that a strong sound on one frequency will mask other sounds on frequencies near to it as shown in Fig. 5.

To make use of this fact the audio spectrum is split into a number of different bands. In each of these bands the strong signals are converted into digital data and the weak ones which the ear would not perceive are discarded. In this way the data rate for a 20kHz signal can be reduced to 128kbits/second. This is about one sixth the rate if masking had not been used.

MULTI-CHANNELS

The second method is to use a system which retains the slow data of each transmission whilst allowing more data to be transmitted. This is done by transmitting the signal on a large number of different carriers at the same time. If 50 carriers were used then the data rate would be increased from 14kbits/second to 700kbits/second – about that used for Nicam TV sound.

The system which is used is rather complicated and it is called Coded Orthogonal Frequency Division Multiplex, or COFDM for short. Using this five programmes or stations are transmitted together and they share a block of about 1500 carrier frequencies. This occupies 1·5MHz of bandwidth. In addition to this blocks would be separated by a further 250 kHz giving an overall bandwidth of 1·75MHz for each block (Fig. 6).

The DAB signal contains not only the basic audio signal. Other data carrying information like the station or service name is also added. In this way the radio can display the name of the station which is being heard as well as being able to act on other data which could be added at some future date.

NO RETUNING

Unlike f.m. which requires a national radio network to occupy several different frequencies DAB can operate with adjacent transmitters on the same block of frequencies. This can be accomplished because of the immunity of DAB to multipath distortion. This means that no retuning is required when travelling from one area of the country to another. There is no problem in locating the best frequency for a national station. It is simply a matter of tuning to the required block.

Local radio requires a slightly different approach. Four different blocks are required to split the country up into a areas without adjacent areas using the same block. This will mean that signals from distant transmitters are reduced. Any interference which is picked up will be treated as multipath distortion by the receiver and will be ignored.

FREQUENCIES

One of the major problems which DAB is encountering at the moment is that there is no spectrum available. In the UK 3·5MHz would be needed to carry two blocks for national services alone. A further 7MHz would be needed for local radio as well.

Investigations have shown that for land based systems frequencies in the v.h.f. portion of the spectrum are best suited for this purpose. At u.h.f., hills and obstacles cause greater problems with poor reception.

It is possible that one of the old 405 line TV bands could be used. However gaining international acceptance for an allocation is not easy in view of the heavy usage of this portion of the radio spectrum.

It is also intended that DAB signals should be broadcast from satellites. Frequencies around 1GHz (1000MHz) are about optimum. In a recent World Administrative Radio Conference a band of 40MHz stretching from 1452 to 1492MHz was allocated for this purpose. Unfortunately existing users need to be given time to move and it is unlikely that services will start to appear on these frequencies until after the year 2007.

RADIOS

The DAB system may appear quite complicated. Indeed when it is introduced it will rely heavily on computer type technology to unravel the signals which are picked up.

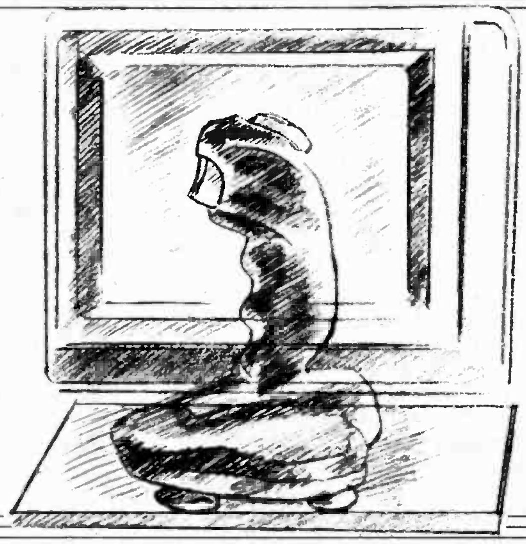
The radios will pick up the signals in the conventional manner. Once this has been done the signals will be converted into digital data. From this point specially designed microprocessors will be used to unravel the signals in a process called digital signal processing.

Initially it is expected that these radios will be quite expensive. However as the technology becomes more established their cost should fall rapidly in much the same way that personal computers did.

DAB radios will not be confined to the top end of the market. The system is intended for everything from the portable or clock radio to car radios and hi-fi systems. Push button tuning will be used to simplify operation and overcome the problems of locating the right station. Coupled with the much improved reception quality this will bring enormous benefits to listeners.

CONCLUSION

With the improvements which are constantly taking place in the recorded music section of the hi-fi industry radio broadcasting has to be able to produce a system which is comparable. Digital audio broadcasting appears to be the solution. The BBC have performed many tests and the system is giving very encouraging results. In the long term there is little doubt that it will be adopted. The only problem is that of finding some suitable frequencies. □



SIMPLIFLY ATARI STFM INTERFACE

GLENN BALLANTYNE

Joystick to mouse port interface. Should work with most PCs.

AS AN Atari STFM user, I was surprised to discover that several *Flight Simulator* programs I was running did not support joystick control. So, in an attempt to give a more realistic "feel" to this type of program, I have produced an interface that can be plugged into the Mouse Port and allow a standard switch-mode joystick to be used.

Although it will be used mainly with an Atari, I've also successfully linked it to an Apple Mac, so I feel quite sure that, with a suitable interface lead and connector, it should work with any machine and provide the normal vertical, horizontal and diagonal directions associated with a joystick.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Simplifly Interface is shown in Fig. 1.

With IC2 (a 4001) forming two bistables connected to four selected outputs of IC1 (a 4022 divide-by-eight counter) two square-wave pulse trains, one 90 degrees out of phase with the other, similar to those generated by a mouse when it is moved, are produced. The way these pulse trains are presented to the computer via two banks of four bilateral switches (IC4 and IC5) will determine the axis and direction selected.

As the clock rate from the oscillator, made from gates IC3a and IC3b, to IC1 pin 14 can be varied continuously over a wide range by Speed control VR1; effects like engine speed, rate of climb, etc. can be adjusted. An l.e.d. D1, buffered by gate IC3c connected to pin 12 (carry-out (CO)) of IC1, will give some visual indication of the clock frequency. Switch S1 will select any function assigned to the "Right" mouse button.

Because the bilateral switches, IC4 and IC5, require a "high" to turn them on, the joystick common connection, which would normally go to ground, is taken to the positive rail. Consequently, the "high" signal produced when the joystick FIRE button is operated has to be inverted to the expected "low" state and gate IC3d does this.

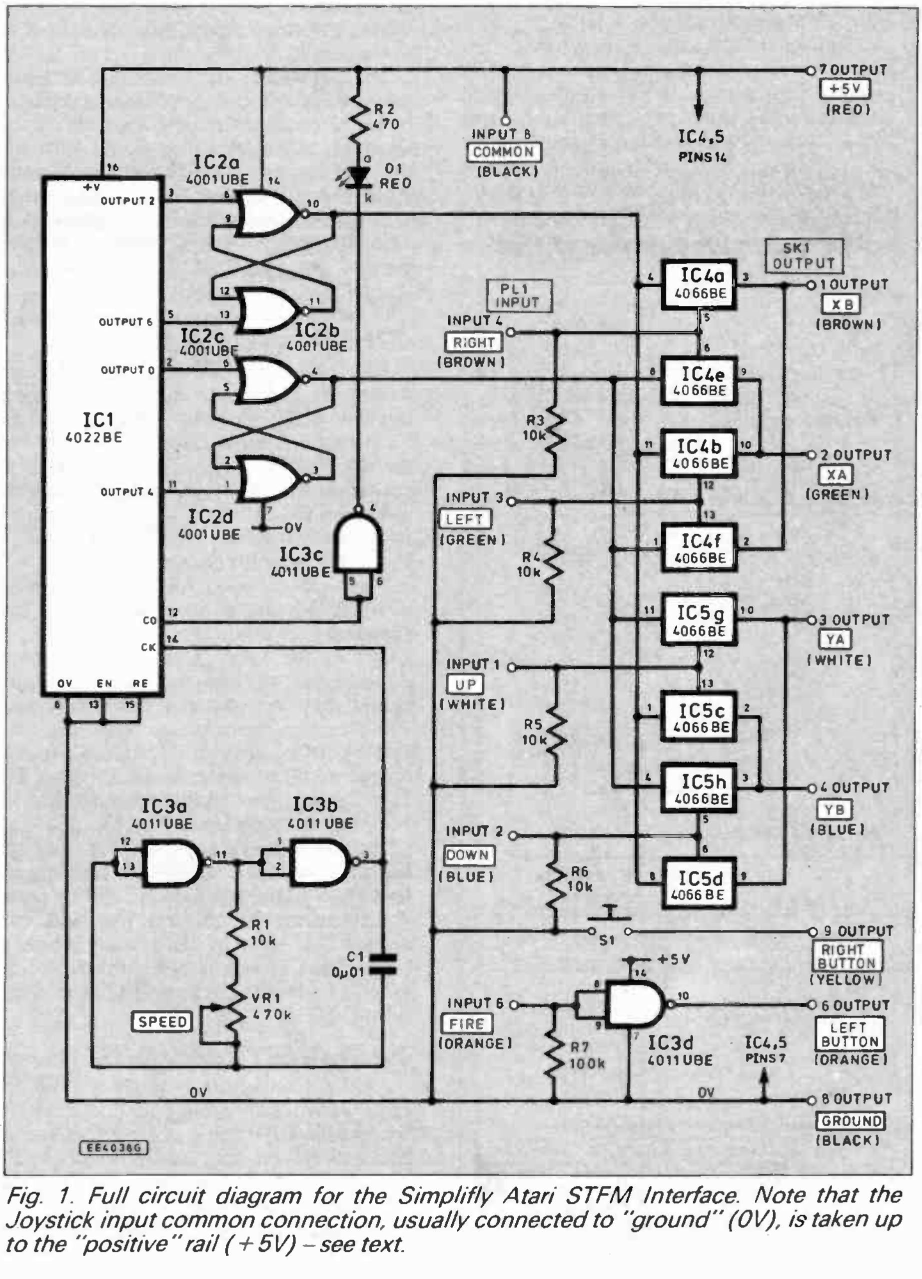


Fig. 1. Full circuit diagram for the Simplifly Atari STFM Interface. Note that the Joystick input common connection, usually connected to "ground" (0V), is taken up to the "positive" rail (+5V) – see text.

CONSTRUCTION

The Simplifly Interface is assembled on a single-sided glass-fibre printed circuit board (p.c.b.). This board is available from the *EPE PCB Service*, code 822.

The topside component layout and full size underside copper foil master pattern is shown in Fig. 2. The order of mounting the components on the board is not critical but should follow in order of size, from smallest to largest.

Before fitting the components, place the p.c.b., track side up, on the inside of the lid and mark the positions of the four mounting holes, VR1, switch S1 at hole "Z", the l.e.d., and the hole for the leads to PL1 and SK1. Leaving VR1 aside for the moment, solder the wire links, resistors, capacitor and i.c. sockets to the board. Before fitting S1, remove the corner of the switch nearest to the mounting hole otherwise it will foul the screw.

Having stripped the outer sheath and screen from the 9-way cable, separate the individual wires. Cut lengths of about 300mm from all of the wires, except violet which is not used, one each from red and yellow and two from the other colours. Solder them to the p.c.b., matching them to the colours shown in Fig. 2.

Pass all these wires through hole "X", collecting and lacing them up with strong thread or some other means into two neat bundles, one for Input PL1 and the other, for Output SK1. Cut the wires to the same length and prepare the ends by stripping, tinning and trimming the soldered ends to about 3mm. Using the surplus wire, connect VR1 points A and B to points C and D respectively. Insert all the i.c.s into their holders.

CASE

Using a 3mm drill, bore and countersink the four holes for the mounting screws so that the screw heads are flush with the surface of the case lid. With the same drill, make guide holes for switch S1 and Speed control VR1. The hole for the l.e.d. is drilled mid-way between the two points marked for it.

Put the four support screws through their holes and with a nut on each, tighten them up. The p.c.b. can now be slipped on and off the screws so that the position of the hole in relation to switch S1 can be constantly checked. To ensure that S1 operates properly, it is essential that it is as close to the lid as possible, some care should be taken in making this hole.

I have found that a round file of about 8mm maximum diameter and a tapered reamer makes producing accurate or non standard size holes much easier. The file is

COMPONENTS

Resistors
R1, R3 to R6 — 10k (5 off)
R2 — 470
R7 — 100k
All 0·6W metal film

See SHOP TALK Page

Potentiometer
VR1 — 470k min. rotary carbon, lin.

Capacitors
C1 — 0µ01 ceramic disc

Semiconductors
D1 — 5mm red l.e.d.
IC1 — 4022BE divide-by-eight counter
IC2 — 4001UBE quad 2-input NOR gate
IC3 — 4011UBE quad 2-input NAND gate
IC4, IC5 — 4066BE quad bilateral switch (2 off)

Miscellaneous
S1 — Keyboard switch, with keytop 1 position
SK1 — D-type 9-way socket
PL1 — D-type 9-way plug

Plastic ABS case (type 2004), size 120mm x 65mm x 40mm; printed circuit board available from *EPE PCB Service*, code 822; 1m 9-way multicoloured screened cable; two pairs jack posts; "low height" control knob; M3 20mm pozi screws (4 off); M3 steel nuts (12 off); M3 spring washers (12 off); connecting wire for board links; solder etc.

Approx cost guidance only **£16**

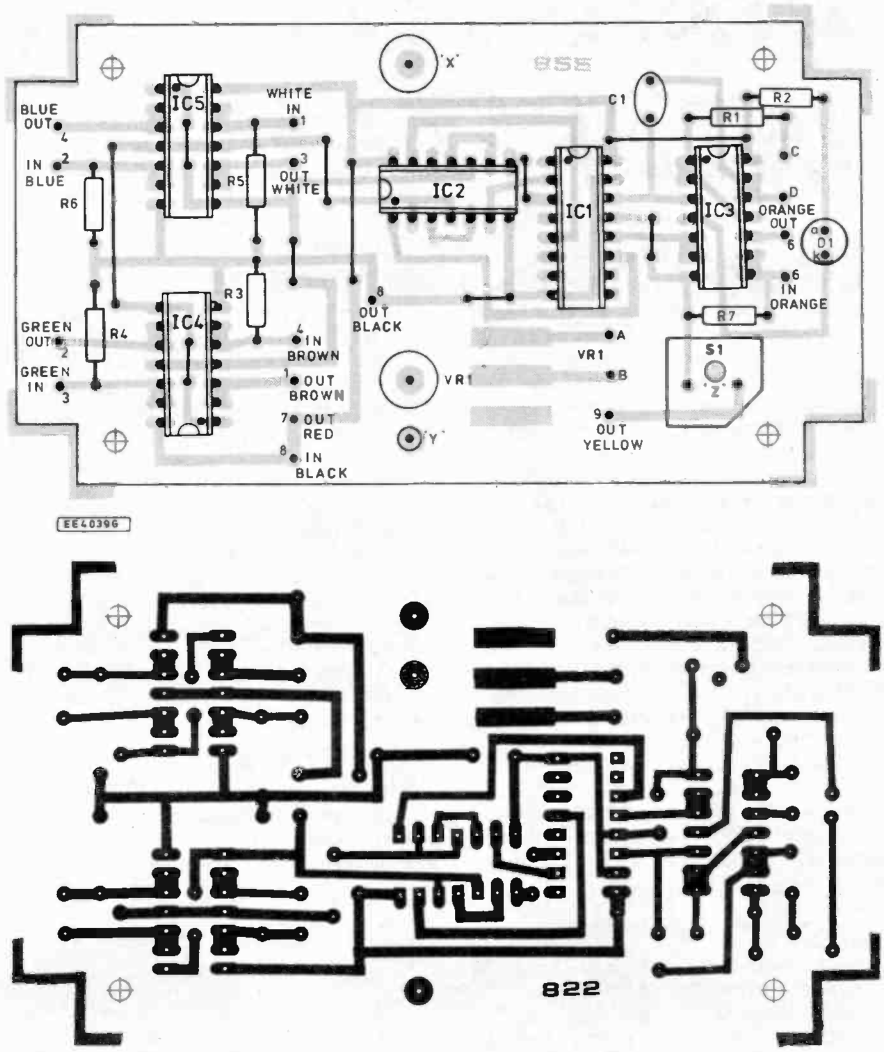
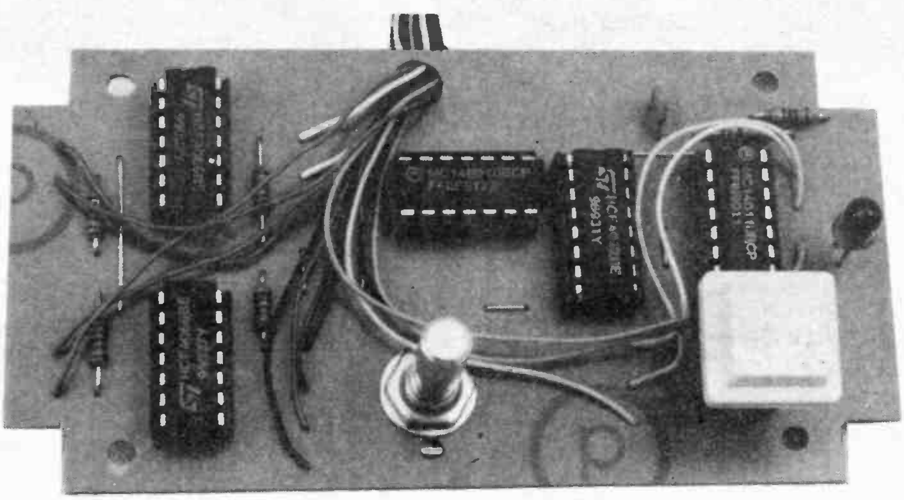


Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The completed prototype board is shown below. Make sure you insert the two line wires under IC4 and IC5 before mounting the i.c. sockets, see above.



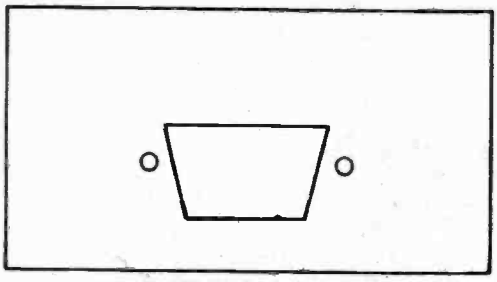


Fig. 4. Full size template for the male and female 9-way D-Connector cutouts.

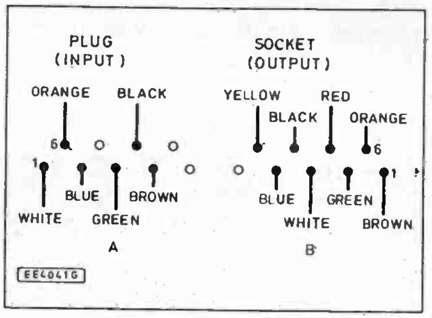


Fig. 5. Wiring connections to the 9-way male Input (PL1) and the female Output (SK1) D-Connectors.

PIN	FUNCTION	CABLE
OUT 1	= XB (RIGHT)	BROWN
OUT 2	= XA (LEFT)	GREEN
OUT 3	= YA (UP)	WHITE
OUT 4	= YB (DOWN)	BLUE
OUT 5	= NC	
OUT 6	= LEFT BUTTON	ORANGE
OUT 7	= +5v	RED
OUT 8	= GROUND	BLACK
OUT 9	= RIGHT BUTTON	YELLOW

Fig. 6. Connection and function details of the Output socket SK1.

used to adjust any tendency for the centre point of the hole to wander and the tapered reamer gradually opens up the hole to the size required.

Once you are satisfied that the flat top of S1 is touching the surface of the lid, rotary potentiometer VR1 can be fitted to the p.c.b., putting the lug in hole "Y", and bending the three terminals so that they will touch the board when the fixing nut is tightened. These terminals can then be soldered to their copper pads. The hole for the spindle of VR1 can now be enlarged.

With the p.c.b. removed, place another nut on each mounting screw and with the p.c.b. back on the screws again, gradually adjust the nuts so that when switch S1 is in contact with the lid, the nuts are just touching the component side of the board and that the board is parallel in all respects with the lid. A spot of glue can be applied to each nut to prevent them from moving.

Finally, with the hole prepared for the l.e.d., locate it on the p.c.b. with the short lead in the hole nearest S1 and, holding it to stop it from dropping out, put the board back on the screws and push the l.e.d. fully into its hole. It can then be soldered to the board.

If you want to apply any lettering to the lid, it should be done at this point. With the board back in place, place a spring washer and nut on each screw and tighten. Enclose a piece of card with the letters RB, for Right Button, in the keytop and place it on switch S1 and fit the knob to the Speed control VR1, this completes this phase of construction.

SOCKETS

Using the template in Fig. 4, mark the holes for the D-type sockets at both ends of the case. Cut these out using an Abrafile saw and tidy them up with a file till the sockets fit neatly. Mark and bore the holes for the jack posts. Pass one bundle of wires through each of these holes, and solder them to the sockets using Fig. 5 for guidance.

Experience has shown that the plastic holding the pins in the male socket can sometimes melt and that you really need three hands during soldering. If you plug the female into the male during this process, the pins will not be displaced and a small hobby vice or a lump of BLU-TACK will hold the socket to the work surface during soldering.

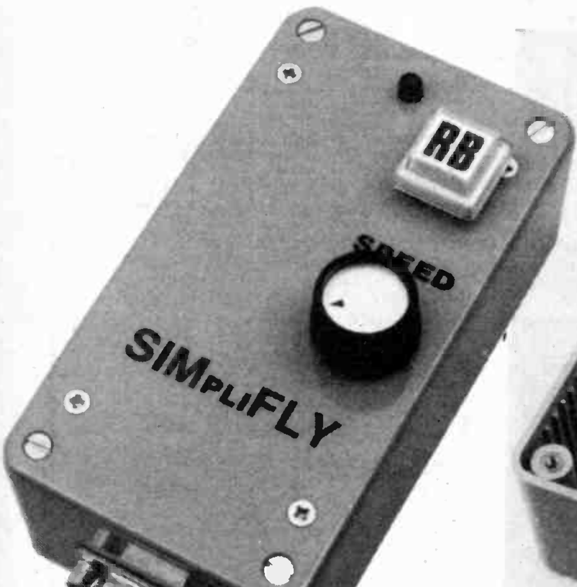
TESTING

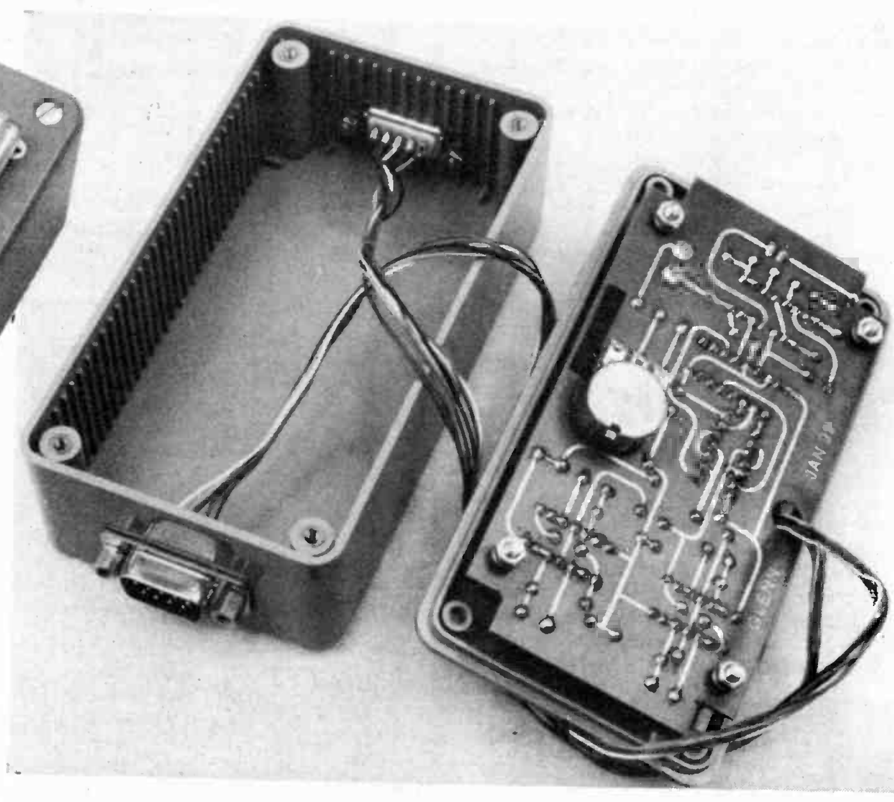
With the computer switched off, using a joystick extension cable for the Atari or if you are using another machine, a suitable lead made up from the details of the mouse port in your users manual and the information supplied in Fig. 6, connect the interface to the mouse port of your machine and plug a joystick into the "IN" socket. Turning the Speed control almost fully anticlockwise, switch the computer on an the l.e.d. should start to flash.

Once the desktop screen has loaded, operate the joystick and the pointer should slowly travel in the direction selected. Check all the directions including the diagonals, and observe the results while adjusting the Speed control. At maximum speed the flash rate will be so high that the l.e.d. will appear as a stead glow. Pressing the "FIRE" switch should simulate the operation of the left mouse button and using switch S1 should produce any function assigned to the right button.

Should any of the directions selected be reversed or not working at all or the l.e.d.. fail to light, check that IC4 is the correct way round, (upside down in relation to IC5), that you have not mixed up the "IN" and "OUT" wires or that your interface lead, if you have made your own, is correctly wired.

Finally, providing some care is taken in its construction, this Simplifly Interface should be problem free and increase your enjoyment when using *Flight Simulation* programs. □





The two D-connectors, each end of the case, and the p.c.b., mounted on the rear of the case lid, can be seen in the "opened out" photograph of the finished unit.

PERSONAL STEREO AMPLIFIER - ADD-ON

I. A. DUNCOMBE

A NUMBER of readers have enquired into the *Personal Stereo Amplifier* article, described in the November '92 issue, as to whether it could be used with personal stereos which operate from three volts. In its present design of course it cannot, as the minimum voltage available is just five volts. However by upgrading (or should that be down-grading), the original voltage regulator this can be achieved.

The new design is shown in Fig. 1. It uses an LM317T regulator capable of being adjusted down to a couple of volts. The preset, VR1 is used for this purpose in a similar manner as in the original design. A small p.c.b. is used and the design for this is shown in Fig. 2. It need not be built on a p.c.b. of course as plain perforated board will be equally suitable. The regulator is fitted with a small aluminium heatsink.

The author purchased his from Mailtech which came ready fitted with a heatsink, and at a very reasonable price.

CONSTRUCTION

When mounting the components be sure to leave the leads of the regulator and tantalum capacitor C2 long as indicated. A single-sided Veropin is soldered on the underside of the board on VR1's wiper terminal. Pins may also be used on the other two leads if need be.

To add the new unit to the existing board, remove the following components which are no longer required: IC2, C11, VR2, R5 and C12. The new board can then be placed into position (it will only fit one way round!) and soldered in position. Depending on the size of the large electrolytic, C10 it may be necessary to change this for a radial type to allow the new board to fit comfortably.

Adjust the preset to give the required voltage, 3V and the *Personal Stereo Amplifier* is ready for use once more. Bear in mind though, that due to the very low voltage, the main amplifier will not work if a 3V adapter is used to power this and the personal stereo. In all other respects however the unit performs as the original. □

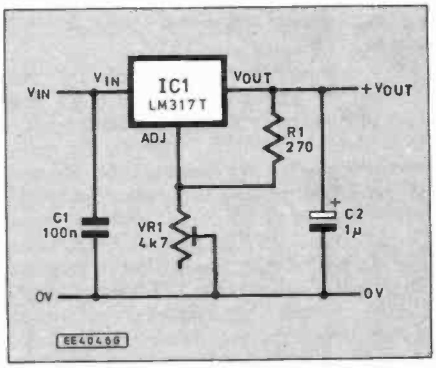


Fig. 1. Circuit diagram for the low-voltage Add-On Board for the Personal Stereo Amp. (Nov. '92).

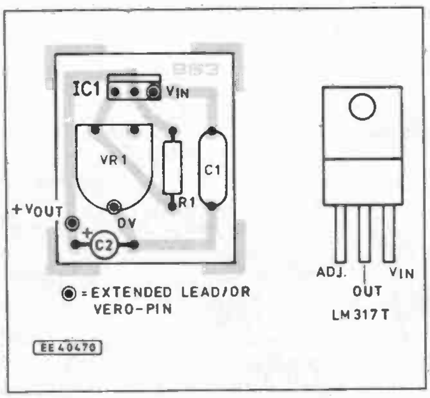


Fig. 2. (left) Circuit board component layout and regulator pinouts. (Above) The p.c.b. copper foil master pattern.

COMPONENTS

Resistor
R1 270 ¼ watt carbon

Potentiometer
VR1 4k7 horizontal p.c.b. mounting preset, lin.

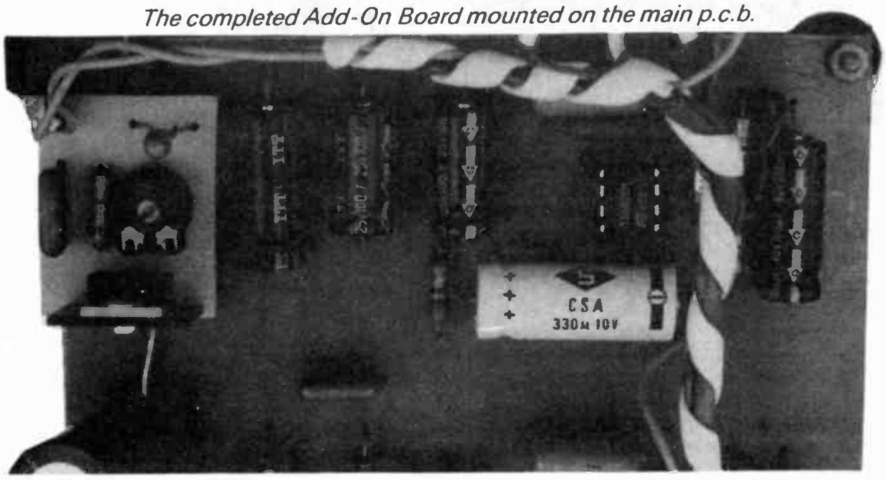
Capacitors
C1 100n polyester
C2 1µ solid tantalum 35V

Semiconductor
IC1 LM317T adjustable one amp regulator
Note: The regulator must be suffixed by 'T', other types supply less than one amp.

Miscellaneous
Printed circuit board available from the *EPE PCB Service*, code 823; three Veropins.

Approx cost guidance only **£5**

The completed Add-On Board mounted on the main p.c.b.



Teach-In '93

**with Alan Winstanley
and Keith Dye B.Eng(Tech)AMIEE**

Part 5

Teach-In '93 continues a tradition of offering an interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels.

LAST MONTH we introduced a work-horse of electronics – the transistor. These *npn* and *pnp* semiconductor devices enable us to assemble complete systems which are capable of performing a specified function, being able to interpret the information provided by a variety of input units, and also *processing* this information in order to operate an output device such as a relay or a light-emitting diode (l.e.d.).

Whilst the transistor is a versatile component, there is very little which it is capable of doing on its own, other than maybe acting as a simple solid-state switch or a crude amplifier. As we saw last month, you need several of them to form a complete and effective system, and the use of extra transistors means extra biasing components and coupling capacitors, more connections – and more calculations!

LONG-TAILED PAIR

A theoretical transistor arrangement called a difference or **differential** amplifier, also known as a "long-tailed pair", is shown in Fig. 5.1. It has two inputs and the output is taken from one of the transistor collectors as shown. The circuit is very useful because it amplifies the difference between input 1 and input 2. A signal change which is common to both inputs (a "common mode" change) is not amplified, but the circuit will respond to any signal differences *between* the inputs.

Try raiding the spares cupboard and building the circuit of Fig. 5.1 on the Mini Lab, using the 47k and 100k potentiometers to provide variable input voltages. We make no apologies for not showing a breadboard layout diagram: this in any case depends on which type of prototyping board you have fitted to your *Mini Lab*, and you ought to be able to design this modest layout yourself. Refer to Part Four for the ZTX300 pin-outs.

You could, if you wish, perhaps use an s.p.d.t. switch S1 as shown to very conveniently switch the L.E.D. Voltmeter between either input, and a second switch S2 to alternate readings between an input and the output: these save having to unhook wires all the time. After assembly, use the L.E.D. Voltmeter and trim the potentiometers to set about 2·5 volts on each transistor's base.

Then note the output voltage with the L.E.D. Voltmeter – we measured 8 volts in our own trials. Now increase input 1 (47k trimmer) by about 0·5 volts and see the output **rise** by about **2 volts**. Reset the circuit then increase input 2 (100k pot.) and the output **falls** by about 2 volts. Interesting! Input 1 is called the **non-inverting** input and Input 2 is the **inverting** input, because of the effect changes there have on the output.

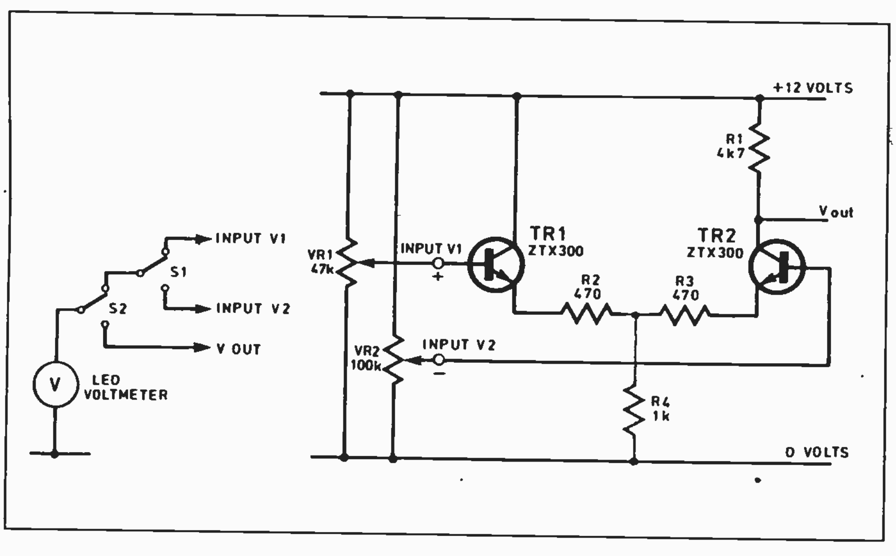


Fig. 5.1. A transistor differential amplifier.

If you decrease *both* inputs by 0·5V the output stays at around 8 volts. This is the circuit rejecting common mode signals. The operation of this particular circuit is of academic interest only, and it isn't necessary at GCSE Level to analyse the long tailed pair any further; the main thing to note is that if you increase the non-inverting input, then the output increases even more, whilst increasing the inverting input instead, causes the output to decrease (or invert). You will see shortly how we can neatly obtain the same effect without having to bother with a cumbersome transistor circuit such as this.

TYPICAL USE

A typical use of the long-tailed pair might be as a pre-amplifier to amplify the signals from low impedance microphones for instance. When the audio signal arrives at the microphone, it could be converted by a suitable circuit into two equal and opposite signals. These could be fed down two cables to the two inputs of the differential amplifier where they are amplified to produce a single output.

Now for the clever part. Often the microphone cables run past other electrical equipment such as disco lights which could cause interference which is picked up by *both* signal cables. The difference amplifier will reject this noise because it occurs on both signals – called "Common Mode Rejection" – and it only amplifies the transducer's audio signals instead.

CHIPS WITH EVERYTHING

The use of transistors is one means by which an electronic system may be realised. Fortunately though, it isn't always necessary to have to use numerous individual transistors because manufacturers have successfully miniaturised electronic components so much that semiconductor *integrated circuit* (i.c.) technology is now very widely used in all areas of consumer and commercial electronics. Integrated circuits consist of a tiny "chip" or die of silicon, on which a complete transistor circuit has been etched.

Fig. 5.2 illustrates the appearance of a **dual-in-line** integrated circuit, along with a scale outline of a transistor for comparison of size. We show the outline of the die within the d.i.l. package as well: you can see that it's much smaller than the plastic package.

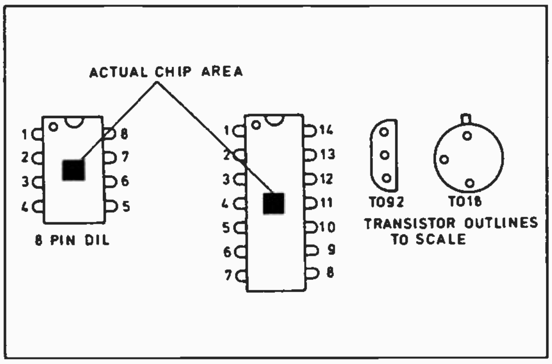
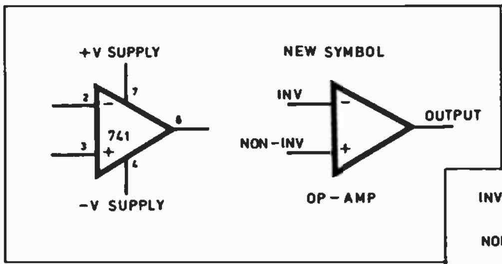
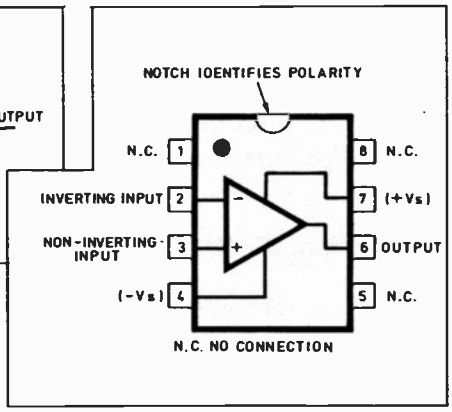


Fig. 5.2 (left). Typical dual-in-line integrated circuits. Note the small area of the silicon "chip".

Fig. 5.3a (below left). Symbol for an operational amplifier ("op-amp").

Fig. 5.3b (below). Pin-out connection for a typical 8-pin d.i.l. op-amp. Like most d.i.l. chips, a notch identifies orientation. Pins 1 and 5 are "offset null" pins for correcting inbalances. They are not used in GCSE electronics.





In basic form, an integrated circuit is a complete miniaturised semiconductor circuit containing transistors and resistors. Dual-in-line (d.i.l.) integrated circuits are often much more convenient to use than individual components (often called "discrete" components). Packages can be referred to by the total number of pins on their packages. The LM3911N used in the L.E.D. Voltmeter is an 18-pin d.i.l. device, for example.

Integrated circuits might only have say eight or fourteen pins, but represent a circuit containing dozens of transistors *plus* associated components like resistors and diodes. Whilst resistors can be formed from semiconducting material, unfortunately it's impossible to incorporate a *capacitor* of any significant value onto an i.c. chip, so if one is required you often have to add an external capacitor somewhere, depending on the circuit function. The same applies for inductors or coils.

LEVEL OF INTEGRATION

To give you an idea of the phenomenal advances in i.c. technology, it's possible to classify integrated circuits by the rough equivalent number of components they contain:

- **SSI** Small Scale Integration containing dozens of components;
- **MSI** Medium Scale, representing hundreds of components;
- **LSI** Large Scale, containing many *thousands* of components;
- **VLSI** Very Large Scale Integration devices having maybe up to 1,000,000 or more components on the chip;
- **SLSI** Super Large Scale Integration might contain say up to 2,000,000 devices!

I.C. technology has advanced from SSI in the early-mid 1960's to cutting edge SLSI chips thirty years later. A 386 computer chip is an example of VLSI but the developing 586 chips (recently named "Pentuim" by manufacturers Intel) are rumoured to contain getting on for two million components. You would need over 15,000 breadboards to assemble a 586 chip using discrete transistors! They would measure some 1·5 kilometres end to end.

As you know, your *Mini Lab* utilises i.c. technology too, and is already fitted with *six* integrated circuits, with a further nine to come: the ICL8038 and LM3911 chips are examples of d.i.l. packages but the three voltage regulators (for the +5V, +12V and Variable Power Supply) are i.c.s fabricated in so-called TO-220 packages which enable them to be bolted to heatsinks.

OPERATIONAL AMPLIFIERS

Whilst the area of **digital** electronics is concerned with signals which are either "high" or "low", **analogue systems** require the interpretation of signals which have varying states. An analogue signal could be the output from a heat or light-sensing unit we discovered last month, or the slowly rising voltage across a charging capacitor, or those generated by the potentiometers in our earlier experiment.

Integrated circuits are available which help us to build systems capable of handling either digital or analogue information, depending on the type of i.c. used. We will discuss digital electronics in depth in Part Six, meanwhile Fig. 5.3(a) is the schematic symbol for an **operational amplifier** or "op-amp", which is used extensively in analogue circuits. They're the sophisticated i.c. equivalent of the two-transistor circuit used at the start. Like transistors, op-amps have unique part numbers such as 741C, LF411C or TL081C, and they make use of varying technologies which give individual classes of op-amp particular operating characteristics.

We introduce the op-amp by utilising a cheap and readily-available 741 type for initial experiments. Fig. 5.3(b) shows the pin-out of a 741 op-amp in its standard 8-pin d.i.l. form. This represents a miniaturised circuit containing 24 transistors and associated resistors. Op-amps have two inputs: the *non-inverting* input with a positive symbol, and the *inverting input* depicted with a negative symbol. Take a look at Fig. 5.4(a) which shows an op-amp in a very simple demonstration circuit.

LIGHT-SENSITIVE COMPARATOR

You will recognise R1 and R2 as a light-detection unit or light-sensitive potential divider, which is connected to the inverting (–) input of a 741 op-amp designated as IC1. VR1 is used to set a voltage at the non-inverting (+) input of the op-amp. Note that this integrated circuit requires a power supply connection at pins 7 and 4 as shown (but see later when we mention the significance of dual supplies). Also see how each pin of IC1 is uniquely numbered on the circuit diagram to match the d.i.l. pin-outs.

The output of IC1 drives TR1, the *Mini Lab* power transistor which acts as a switch. Remember that TR1 is a Darlington transistor, which has a very high gain (h_{FE}). Here it has a filament bulb LP1 as a load. In this case, the bulb can only illuminate when TR1 base is about 1.4V more positive than its emitter (see last month).

Now go ahead and assemble this simple circuit on the *Mini Lab* breadboard as guided by Fig. 5.4(b). It's very important that the power supply is connected the right way round: the notch or indent in the d.i.l. pack identifies pin 1. Although the 741 is quite robust (and cheap!), failure to connect the power supply correctly may result in a "*dis*integrated circuit"!

The L.E.D. Voltmeter is set for 5V f.s.d. and by using one of the s.p.d.t. toggle switches as shown, you can read the voltage at either of the op-amp inputs. With assembly complete, set VR1 at mid-way, check the layout thoroughly then power up using the +5V section of the Power Supply. The bulb will probably be alight. Cover the l.d.r. with your fingertip – what happens? Adjust VR1 if necessary.

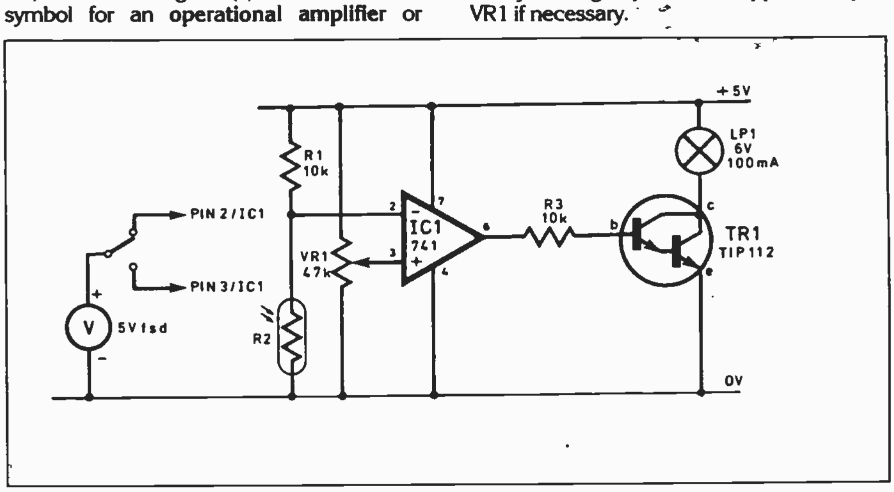


Fig. 5.4a. A light-sensitive comparator circuit.

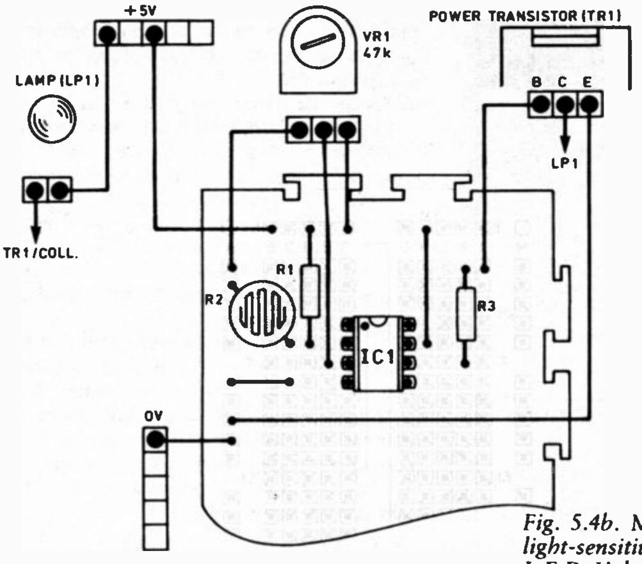


Fig. 5.4b. Mini Lab *layout of the light-sensitive comparator. Use the L.E.D. Voltmeter on pins 2 and 3 of IC1.*

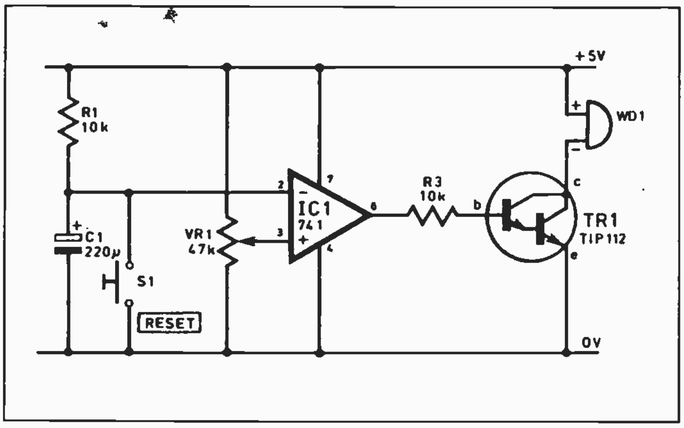


Fig. 5.5. Time delay circuit using an op-amp.

COMPARATOR

Use the voltmeter to measure the voltage at pin 3 (which you can alter with VR1), and note it here:

VOLTAGE AT NON-INVERTING INPUT (PIN 3):

Now check the voltage at the inverting input (pin 2). This depends on the light level falling on the l.d.r.; as you obscure R2 with your finger, the voltmeter reading will *rise* – you should be able to work out why (see last month). Measure the voltage on pin 2 *at the point when the lamp extinguishes*. It should be the same as the one you noted above. Try adjusting VR1 to a different setting and repeat the experiment.

In this circuit the 741 operational amplifier is acting as a comparator. It compares the voltages at the inverting and non-inverting inputs. When the voltage at pin 3 (+ input) is *higher* than that at pin 2 (– input) then the op-amp output switches *high*, almost to the supply voltage.

Thus if you set VR1 at midway, the voltage at pin 3 is about 2.5V. When R2 is brightly illuminated, the voltage at pin 2 will be quite low, typically well under 1V, so the output of IC1 (pin 6) goes high (we measured over 3·5V at the output).

This turns on TR1 which acts as a switch, completing the circuit to the bulb which illuminates. Conversely, if the non-inverting (+) input is *lower* than the inverting (–) input then, by comparator action, the output of the operational amplifier switches *low*, approaching 0V. This is sufficient to bias the transistor off, extinguishing LP1.

Now try transposing the positions of R1 and R2 – the circuit should now work in reverse, with the op-amp output going *high* and the bulb illuminating when the l.d.r. is darkened. Can you work out what is happening at the op-amp inputs? Use the L.E.D. Voltmeter to monitor the voltages at pins 2 and 3 as before.

This new arrangement could form the basis for an *automatic lamp system*, which will turn on when the ambient light has dropped to a level which you set with VR1. Substituting the l.d.r. for a thermistor (thermally-dependent resistor) would result in a simple thermostatic system, with the transistor switching on and off according to the temperature detected.

DIFFERENCE

In actual fact the op-amp is looking at the *difference between* the voltages at the two inputs. Operational amplifiers have a tremendously high gain, say 200,000 or more. The op-amp amplifies the *difference* in voltage between pins 2 and 3, so even when only a tiny difference of a few microvolts exists, the i.c. amplifies this by a large factor, resulting in the output switching dramatically high or low when connected as a comparator.

The 741 device is perhaps a bit of a dinosaur in electronics, and does not have a perfect output switching characteristic, so when it's operated on a single supply rail like our +5V supply, a "low" output might still be at 1V or more. Similarly its "high" voltage might fall short of swinging right up to the positive supply rail.

In the circuit of Fig. 5.4(a), if we used a normal silicon transistor like the ZTX300 for TR1, it might well remain switched on all the time because the 741 doesn't drop below the 0·7V needed to turn the transistor *off*. A Darlington switches off at less than about 1·4V base voltage – that's partly why we used it!

It's also worth knowing that the output of a 741 is short-circuit proof, the current being limited by internal resistors in the emitters of the 741 output transistors, so there's little fear of damage. Of course, this means that there's a limit to the current which the 741 can supply, so further current amplification using a transistor switch may be needed, depending on the load. There is sufficient current to light an l.e.d. though.

GCSE Electronics often makes use of other types of op-amp such as the popular 081, which is a FET-input type (see later) with an improved performance, so don't worry if you come across types other than the old 741. They all work in the same sort of way, and they are often pin-for-pin plug-in replacements for each other. For examination purposes, it is assumed that a "perfect" op-amp is used anyway.

TIME DELAY

The circuit shown in Fig. 5.5 features a 741 operational amplifier, this time with an RC network of R1 and C1 connected to the inverting input. The voltage at the non-inverting input is controlled by VR1 as before, and the output again drives a transistor switch, this time with the *Mini Lab* buzzer as a collector load.

We saw in Part Two of *Teach-In* how an electrolytic capacitor charges up exponentially through a series resistor. In this circuit, C1 will initially be in a discharged state, with no voltage across it: hence pin 2 starts at 0V. VR1 could set pin 3 at say half the supply rail, 2·5V. As soon as power is applied, the buzzer sounds because pin 3 is higher than pin 2 in voltage.

Then the capacitor starts charging up through R1, so the voltage at pin 2 starts to rise. Eventually, the rising potential at the inverting input overtakes the "reference" voltage at pin 3, when the comparator output will switch low, turning off the transistor and silencing the buzzer. Using the values shown, we measured a time delay of about 20 seconds. Pressing the switch S1 discharges C1 and restarts the circuit.

You should be able to build this simple circuit on your *Mini Lab* board. Utilise one of the convenient *Mini Lab* push switches as a reset switch. Be sure to connect the electrolytic capacitor the right way round. Then measure the time delay generated with your choice of RC network; you could select alternative values if you like. Experiment with the L.E.D. Voltmeter (5V f.s.d.) to monitor the slowly rising voltage at pin 2, comparing it against pin 3. Also replace the buzzer with say a light-emitting diode and resistor, if you like.

There are two ways in which you could alter the time delay: one is to adjust VR1 which adjusts the reference voltage, so that you change the op-amp switching point (or "threshold"). Another way would be to make R1 variable. Can you think of another way of creating a reference voltage at pin 3? (A Zener diode would work in such an application.)

We have so far described some basic applications using op-amps which form simple systems capable of interpreting analogue signals, such as those generated by light-sensors or RC networks. Remember that the circuits which you have just assembled contain in effect several dozen transistors and resistors, thanks to integrated circuit technology. We now delve a little deeper into op-amp theory, showing how it's possible to improve performance with some careful additions to the external circuit surrounding the operational amplifier.

SCHMITT TRIGGER

Look back at Fig. 5.4(a), the circuit diagram for a simple light-operated switch using a 741 as a comparator. We explained that the 741, like all op-amps, has a very high gain, and amplifies the *difference* between the two inputs by a factor of say 200,000 or so. This gain is termed the *open loop gain* (the gain of the op-amp when no feedback is used – see later), and will vary

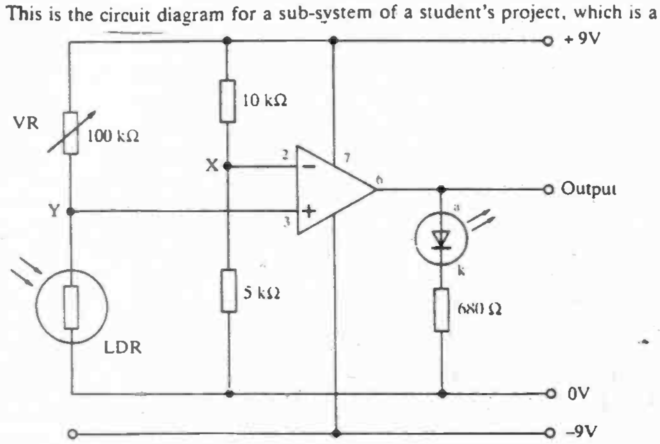
TEACH-IN GCSE QUESTIONS

The following question is reproduced with the permission of the Northern Examining Association, and is taken from their GCSE Electronics Paper 2 Summer 1991 Examination (2052). We acknowledge their assistance with thanks. The answer is the work of the Authors and may not constitute the only possible solution.

Operational amplifiers are one of the fundamental devices which we use for processing analogue information. This question combines nicely the theory of the comparator with the practical aspects of utilising them. Note the use of a split supply. After following *Teach-In*, you would have no problems at all – but the last question makes you stop and think!

Question © The Northern Examining Association.

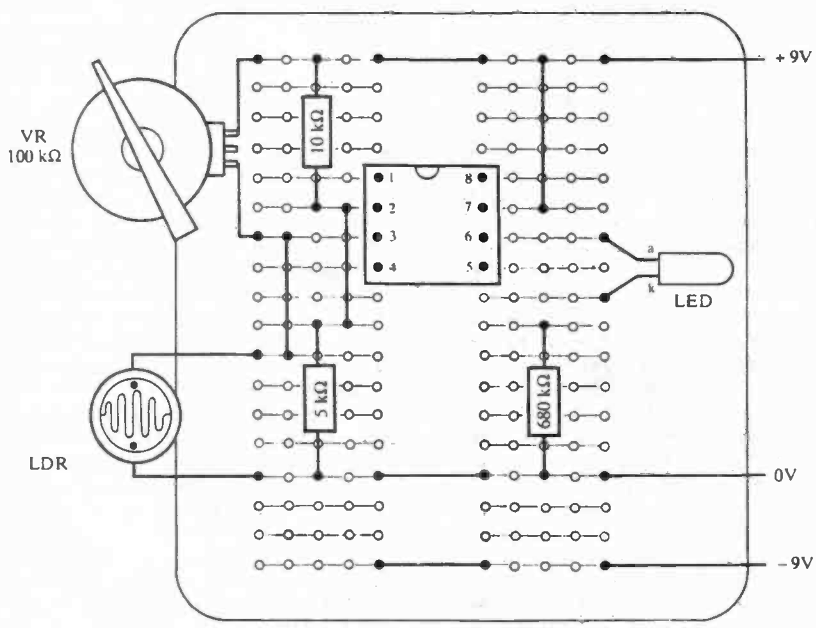
A3 This is the circuit diagram for a sub-system of a student's project, which is a smoke detector.



The op-amp is powered by a ± 9V supply.
The LDR has a resistance of 20 kΩ when an internal light shines on it.
The resistance increases when smoke passes between the LDR and the light.

(a) (i) Calculate the voltage at point X in the circuit.
(ii) How should the voltage at point Y compare with that at X if the LED is to light up?
(iii) If VR is set at 50 kΩ, will the LED be on or off when no smoke is present? Explain your answer.

(b) In order to test the circuit a breadboard was used. This has rows of small sockets into which components or single core wire can be inserted. The sockets are joined together inside the breadboard in groups of five. In the drawing the thin lines indicate these groups.
The student set up the breadboard as shown.



(i) Add a line for the missing power connection to the op-amp.
(ii) The student has made three other mistakes in setting up the circuit. Label these on the above diagram.

(c) The three mistakes have been corrected. To improve the system the student suggested that the variable resistor should be replaced by another LDR identical with the first.
This should be illuminated by the same light source but should not allow smoke to pass across it.
Would this be an improvement?
Give reasons for your answer.

between individual examples of the same chip. A few microvolts difference between the inputs is thus amplified into large output transitions.

One problem with this light-operated circuit is that it's so sensitive that minor input movements either side of the switching point could cause the output to swing high and low repeatedly before settling down. It doesn't always switch over cleanly and sharply, though you won't notice if you use say just a bulb as a load. More advanced circuits could be affected by this nervous behaviour, however.

It's rather like a high-speed car trying to travel round a sharp bend, and hitting both kerbs a few times before negotiating the bend safely! If you slow the car down, it might steer a more predictable route. Speed of operation and high gain aren't everything: you have to control an op-amp in order to make it really useable.

Feedback is a principle used in electronics in order to "tame" a high gain circuit so that we may obtain more predictable results. Fig. 5.6(a) shows a 741 in its comparator mode again. A potential divider R1 and R2 sets up a reference voltage on the non-inverting input, and VR1 can be set to adjust the inverting input voltage. This time we used an l.e.d. D1 with series resistor on the output: the l.e.d. glows brightly when the output is high. It might still glow very dimly when the output is low.

Omitting R3 completely for now, build this circuit on the breadboard, observing that the 12V rail is used this time. We haven't shown a layout diagram as you should now be capable of finding your way around and assembling this circuit for yourself ("A" Level candidates would certainly be expected to). The l.e.d. can fit straight onto the breadboard, observing the correct polarity of the lead-outs.

Use the L.E.D. Voltmeter (10V f.s.d.) to monitor the threshold voltage at which the l.e.d. changes state. This point is measured at pin 2 of IC1. With pin 3 fixed at half the supply rail by R1 and R2, varying the voltage at the inverting input will obviously cause the comparator output to change state when the inverting input traverses 6V.

FEEDBACK

Now add the resistor R3 between IC1 output and the non-inverting input, as shown in the circuit diagram, then rotate VR1. Now there are *two* noticeable switching points. When we ran the experiment, we noted that the l.e.d. lit when the inverting input was anything up to 7·5V or so, then it extinguished. However, the input voltage had to fall back to about 4·5V or lower before it illuminated again. There was thus a difference of 3V between the switching levels.

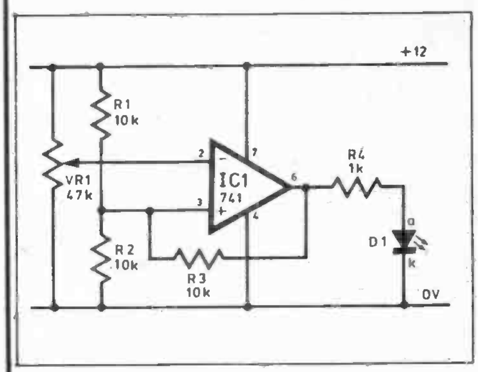


Fig. 5.6a. An op-amp Schmitt trigger.

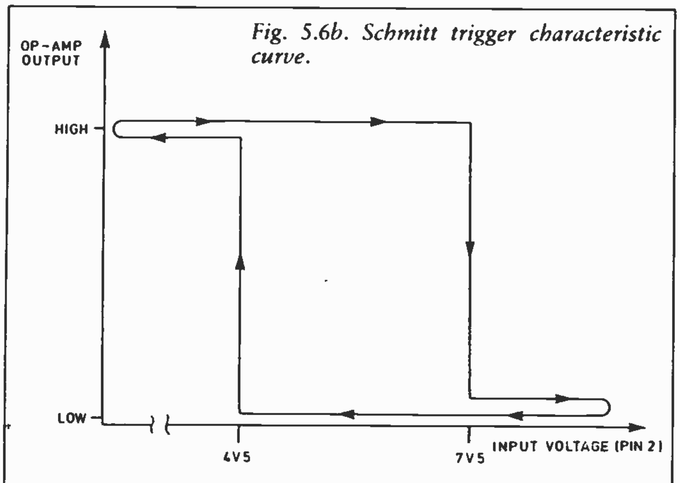


Fig. 5.6b. Schmitt trigger characteristic curve.

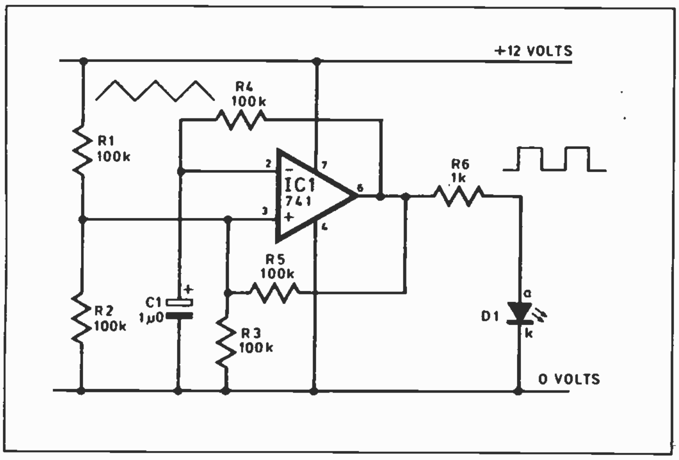


Fig. 5.7a. L.E.D. flasher/oscillator.

GCSE QUESTION (see previous page)
ANSWERS

(a) (i) Voltage Divider theory: X is 5k/15k × 9 = +3V.

(ii) Fundamental comparator action: the voltage at Y should be higher than that at X for the l.e.d. to light.

(iii) The l.e.d. is off: the l.d.r. resistance is 20k in the absence of smoke. With VR set at 50k, then using voltage divider theory, the non-inverting input (Y) will be 20k/70k × 9 = +2·6V. The inverting input (X) is +3V, so by comparator action, the output is low and the l.e.d. is off.

(b) (i) Connect pin 4 to the –9V strip.

(ii) The middle (wiper) terminal of VR should be used instead of either one of the outer pins; the l.e.d. series resistor has changed mysteriously to 680k – and it's disconnected from the l.e.d.!

(c) Yes. The second l.d.r. would compensate for any failures in the bulb system or power supply. It clamps Y at mid rail, 4·5V, so it would be best to make X the same by changing the 5k resistor to 10k for maximum sensitivity. A reduced power rail or dirt on the bulb would dim the bulb so both l.d.r.'s darken by the same amount – hence the mid-way point at Y is maintained and the smoke alarm still functions normally.

Only very few candidates managed to analyse the circuit fully.

Adding the *feedback resistor* R3 has an important effect, turning our simple comparator into a circuit called a **Schmitt Trigger**. When the op-amp output is high, R3 is paralleled with R1. This modifies the potential divider formed by R1 and R2, which previously set pin 3 at halfway between the supply rails. Now the output voltage of this divider is about 8V: check by calculating the value of R1 and R3 in parallel (5k), then apply the Potential Divider formula with this new value for the top half of the divider.

Likewise when the op-amp output is low, R3 is placed in parallel with R2, which now alters the bottom half of the potential divider to 5k and means that the voltage at pin 3 becomes 4V. So what's happening is that when the op-amp switches high or low, it causes the voltage at its non-inverting input to change. This means that there are now *two* threshold voltages, 4·5V and 7·5V as measured. (The reason these measured values differ slightly from the calculation is because the 741 output doesn't truly swing between +12V and 0V).

HYSTERESIS

The difference of 3V between the two values is called **hysteresis**, and is the fundamental characteristic of the Schmitt Trigger. A **Schmitt Trigger Characteristic Curve** is shown in Fig. 5.6(b), based on the measurements we took. Notice the arrows on the curve, indicating the direction which the trend must follow before a switching event takes place. Try predicting the effect of changing the value of R3 using the potential divider formula, then try and prove it on the *Mini Lab*.

This circuit has some extremely important applications: its main use is to convert a slowly-moving input voltage into a rapid "snap-action" transition. For instance, it could be driven by the signal produced by the light-sensing unit. A normal comparator without the feedback is reasonably effective, but the Schmitt Trigger removes the "jitter" at the threshold level, because once the Schmitt has triggered, the hysteresis ensures that the signal has to rise or fall to a different value before the circuit changes state again.

The feedback resistor also improves the speed of response of the circuit, because once the 741 output starts to go high towards the positive rail, this makes the non-inverting (+) input more positive, which makes the output even more positive, and so on. Thus *positive feedback* is used to accelerate the triggering characteristic – valuable when you are trying to deal with very slow-moving voltages (e.g. monitoring dusk or dawn with an ORP12 l.d.r., or maybe room temperature using a thermistor).

OSCILLATOR

Fig. 5.7(a) is a form of Schmitt Trigger using a 741 op-amp. This time an RC network R4 and C1 is connected across the Schmitt Trigger as shown. Assemble this circuit using components of roughly the value indicated: the l.e.d. will blink on and off! This circuit is one type of **relaxation oscillator**, which here gives a good quality square wave signal at the output, and a triangle at pin 2.

Assuming that on power-up the output swings high, the l.e.d. illuminates and C1 charges up through R4. Pin 6 is high so R5 is parallel with R1; pin 3 is then clamped at 6V. C1 continues charging until pin 2 exceeds the non-inverting input, when the l.e.d. extinguishes and then R5 is paralleled with both R3 and R2. This reduces the threshold at pin 3 from 6V to roughly 3V. Then C1 will discharge through R4 to 0V via pin 6, until the inverting input drops below the non-inverting input again, when the output swings high. The circuit **oscillates** like this continuously. What is the hysteresis of this Schmitt-based oscillator? (3V roughly.)

The frequency of operation in Hertz is determined by the values of R4 and C1. You could experiment by changing C1 for a lower value, perhaps 0µ1 so that the circuit oscillates at higher audio frequencies. You could go on to assemble a suggested loudspeaker amplifier stage as shown in Fig.

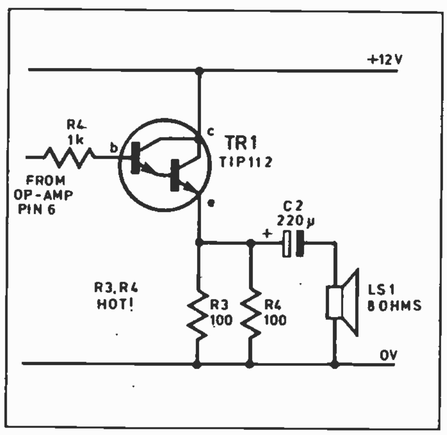


Fig. 5.7b. Loudspeaker driver circuit suitable for the oscillator of Fig. 5.7a.

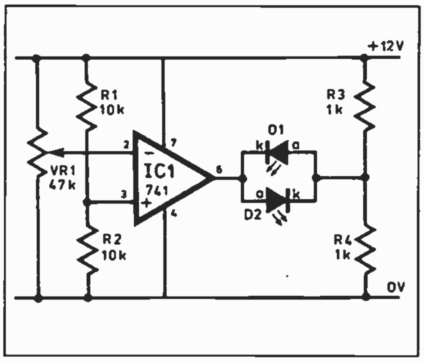


Fig. 5.8a. Sink and source capability of an op-amp.

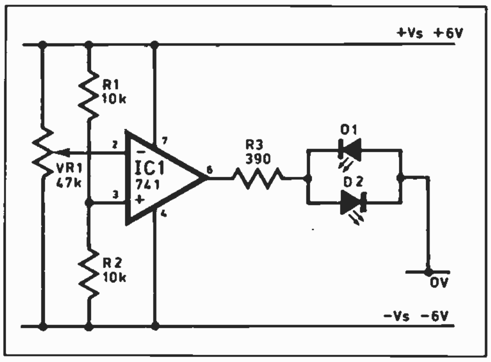


Fig. 5.8b. Use of an op-amp with dual supply rails.

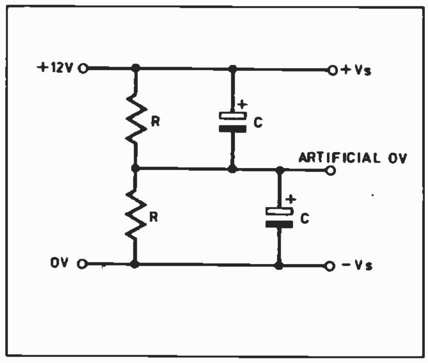


Fig. 5.9. One way of creating "artificial" split rails from a single supply.

5.7(b). You will hear the audio frequency clearly on the *Mini Lab* loudspeaker.

The circuit of Fig. 5.8(a) shows a variation on the theme of comparators. We use the +12V rail again, the comparator section being familiar but now we have added two light-emitting diodes D1 and D2 to the output. Build this on the *Mini Lab* using different-coloured l.e.d.'s if available, or even a bi-colour type. Both l.e.d.'s can plug straight into the breadboard. Rotate VR1 and see what happens. The light-emitting diodes change over!

When the op-amp output is high, source current flows through D2, which illuminates, and then flows to 0V through R4. Conversely, when the output is low, current **sinks** into the output through R3, causing D1 to light. Op-amps have a "complementary" output similar to the output stage which uses an *npn* and *pnp* transistor, shown last month. This means that current can actually flow *both ways* at pin 6 of the op-amp.

DUAL SUPPLIES

It should be noted though that just because the output pin of any particular device (such as an op-amp or a digital i.c. like those we describe next month) is at 0V, this does *not* necessarily mean that current can sink into it: it depends on the internal circuitry and the type of technology used in that device. The humble 741 will both sink or source current as shown above, but some other types of integrated circuit definitely won't. Conversely, some devices such as certain logic gates are much happier actually sinking current than sourcing it.

It is very common to utilise operational amplifiers with *split supplies*. Instead of the straightforward +5V or +12V rails we used to introduce the op-amp, these devices were usually intended to operate from split rails such as ±15V (that is, 30V with a 0V centre tap). However the most recent op-amps are indeed designed to run from a single rail. The *Mini Lab* does not offer a split supply rail but in Part Two we showed how it is possible to *simulate* a split supply by using two batteries (Fig. 2.4) connected to form a ±6V supply.

Fig. 5.8(b) depicts how, instead of using a simple +12V supply rail, *split supplies* could be used to power the circuit we've just seen. The +6V and –6V rails are connected as shown. 0V itself is not directly wired to the op-amp, which means that there is still a potential difference of 12V across the device between pins 7 and 4.

The output of the comparator is a different story. Because it can sink or source current, the output can now swing anywhere between +6V and –6V with respect to the 0V rail. To drive our pair of light-emitting diodes, the l.e.d. configuration has been modified as shown. They are now commoned to 0V and they are also both connected to the op-amp output through a 390 ohm series resistor.

When the op-amp output is high (+6V), source current flows out of the op-amp, through the series resistor and D2 to 0V. Conversely when the output is low (–6V this time, not 0V), current sinks from the 0V rail, through D1 and the resistor and into the op-amp output.

Therefore the op-amp output now swings around the 0V rail instead of between 0V and the positive supply. Sometimes we can actually use ordinary operational amplifiers designed for dual rails, on a single supply. We could do this by creating an artificial 0V to bias the op-amp as shown in Fig. 5.9 where two equal resistors divide the supply in two, and the capacitors help to smooth and filter noise from the rails.

AWESOME AMPLIFIER

The next section requires the Mini Lab *Audio Amplifier – refer to the constructional section of this month's issue for details of this easy-to-build and economical module.*

A circuit for a **microphone pre-amplifier** is given in Fig. 5.10. The circuit has been adapted to work from a single rail by using R1 and R2 to provide a mid-rail reference point, which holds the non-inverting input of IC1 at 6V. It's like Fig. 5.9. but without the smoothing capacitors. The microphone is coupled via C1 and R3 to the non-inverting input. Thus when audio signals enter the microphone, they are converted to a.c. signals which are seen by pin 3.

IC1 is actually connected as a **non-inverting amplifier** (see later), so positive-going inputs are seen as positive-going amplified signals at the output. C2 prevents d.c. current flowing in the feedback path but allows a.c. to flow. The gain of this amplifier is the ratio of VR1/R4, i.e. 220 maximum.

The op-amp used this time for the pre-amplifier is a CA3140 which is a FET-input type (the FET transistor is described separately). Unlike the bipolar 741, these have an extremely high input impedance and draw no noticeable current and so they don't load the signal from the microphone. You could use another FET-input type like the TL081C with equal success. The old 741 is also worth a try.

You can now go ahead and assemble the pre-amplifier on the *Mini Lab*. It's not difficult, and it's best to spread the circuit out on the breadboard. A cheap moving coil microphone (e.g. a cassette recorder mic. as used last month) is required, and is hooked up to 0V and the pre-amplifier using croc-clip leads or similar. Then connect the pre-amplifier output (pin 6 of the CA3140) directly to the +I/P terminal of the *Mini Lab* Audio Amplifier. You may have noted that a coupling capacitor is present on the input of the Audio Amplifier. What does it do? It lets the a.c. signal shift from one d.c. bias voltage to the next.

We have to say that the performance of this system can only be described as awesome! Gain and sensitivity are far in excess of the transistor amplifier described last month. Be prepared for plenty of ear-piercing howlround! We suggest using the microphone against the earpiece of a personal stereo: you will be impressed with the results! Adjust the volume control of the LM380 amplifier or the gain of the pre-amplifier using the 2M2 potentiometer. The system which you have just constructed with two integrated circuits (the op-amp and the LM380) represent probably 40 or 50 transistors.

TONE CONTROL

A very simple form of tone control is shown in Fig. 5.11. It's usual to interpose tone controls between the pre-amplifier and

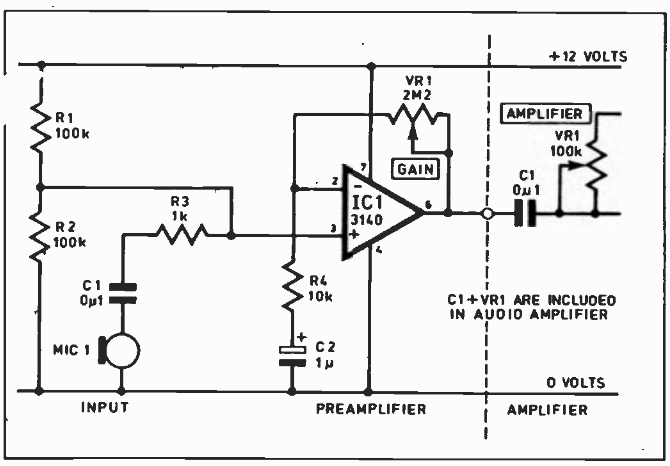


Fig. 5.10. A complete microphone amplifier system using the Mini Lab Audio Amplifier.

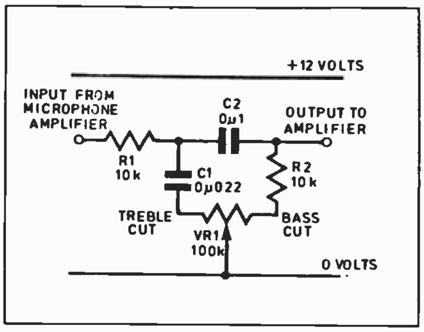


Fig. 5.11. A simple treble and bass-cut tone control circuit.

the main power amplifier, where they are the most effective. Essentially, R1 and C1 form a low pass filter which will cut higher (treble frequencies) whilst C2 and R2 make a high pass filter which will cut lower (bass) frequencies. VR1 shifts the balance between the two filters. This simple arrangement can't actually *boost* frequencies, but it might be worth assembling it on the *Mini Lab* to check out the results. Use it in conjunction with a personal stereo and the microphone pre-amp. It's not quite a hi-fi graphic equaliser but you should notice a little difference.

ANALOGUE SUB-SYSTEMS

We have described some useful applications using op-amps as comparators and amplifiers which are easily demonstrated on the *Mini Lab* board. They have further applications in analogue systems, which enable us to conveniently construct a variety of sub-systems or building blocks capable of processing analogue information in various ways. Fig. 5.12 illustrates the important ones.

When used with a feedback network, op-amps try to maintain their equilibrium or "stabilise" themselves by zeroing the difference between their inputs, hence their output movements are controlled by events at the inputs; the output moves to compensate as needed for any input changes, the move passing back through the feedback network to the input, until the input difference is zero as far as possible.

An **inverting amplifier** is shown in Fig. 5.12(a). Since the non-inverting input is at 0V, the op-amp output feeds back through R2 which provides **negative feedback** to try to make the inverting input 0V too. It can be shown that gain is equivalent to –R2/R1 (the minus indicates inversion). Imagine R1 as 10k and R2 at 100k. Gain is therefore –10. If a +1V input voltage is applied, what happens to the output? It inverts this to –10V, which through R1/R2 voltage divider action results in 0V at the inverting input. Hence +1V appears across R1 and –10V across R2.

Point "X" is called a **Virtual Earth** even though it's not directly wired to ground. It's created by the "intelligence" of the op-amp and cannot be treated like an ordinary 0V rail. The op-amp maintains this point at 0V in its attempt to zero the input difference. The Virtual Earth is not physically joined to 0V as *no current actually flows to Earth*. The circuit's input impedance is that of R1, which at 10k is quite poor.

An adder or **summing amplifier** is shown in Fig. 5.12(b) which is an inverting amplifier where we can combine several input signals, all referred to the 0V Virtual Earth. It provides an output voltage equal to the sum of the input voltages. Thus $V_{out} = V1 + V2 + V3$. By choosing the resistor ratios carefully, we can use a summer to convert combinations of digital signals to a single analogue output voltage: a **digital-to-analogue** converter.

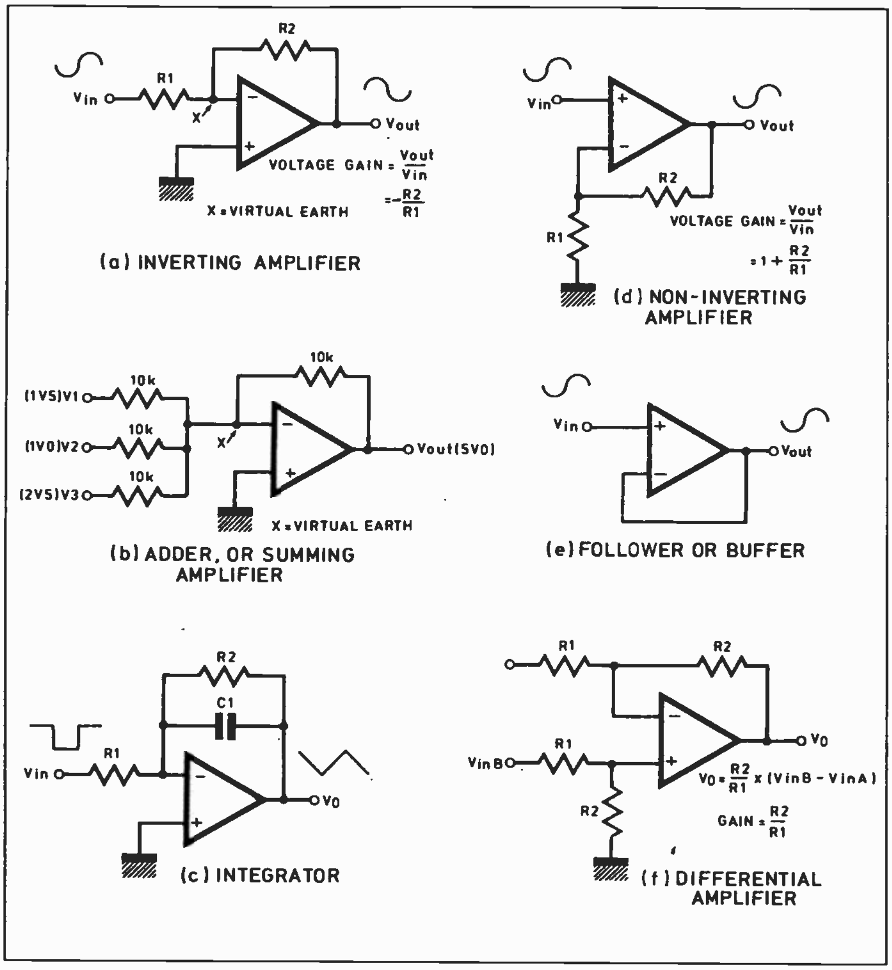


Fig. 5.12. Analogue signal processing systems.

INTEGRATOR

An **integrator** is another inverting amplifier, with a capacitor across the feedback resistor, see Fig. 5.12(c). This converts an input pulse into a voltage which is averaged over time. The op-amp output decreases when a positive-going input voltage is applied until the feedback resistor balances the input voltages. The output would be a triangle waveform in the case of a square wave input.

Fig. 5.12(d) is a **non-inverting amplifier** which simply amplifies an analogue waveform. A positive-going input signal results in a positive-going output with a gain determined by the ratio of R2/R1. However, the input impedance is the same as that of the op-amp input: extremely high in the case of a FET-input type like the 3140 or 081.

A **follower** like Fig. 5.12(e) is based on the non-inverting amplifier but without the resistor network. It has unity gain (i.e. 1), so it doesn't amplify the signal, but it does *buffer* it or *follow* it. See the "Emitter Follower" last month. Again it has a high input impedance so it won't load the signal.

Finally, Fig. 5.12(f) is a **differential amplifier** which as we have seen amplifies the voltage difference between the inputs. Gain can be set with external resistors to make the circuit consistently controllable. V_o equals the input difference multiplied by R2/R1.

Fig. 5.13 shows the performance of a typical op-amp, plotting gain against frequency. The high open-loop gain (no feedback) is only available at low frequencies. A circuit with a gain of 1,000,000 would only work for frequencies up to a miserable 100Hz. Adding a feedback network reduces gain to say 100, but signals up to 100kHz can now be amplified, and furthermore we are now given repeatable and consistent results.

You now know all the fundamental rules about the use of operational amplifiers. Clearly the use of integrated circuits like these saves a tremendous amount of inconvenience which would result if using separate discrete transistors. Op-amps form easily-

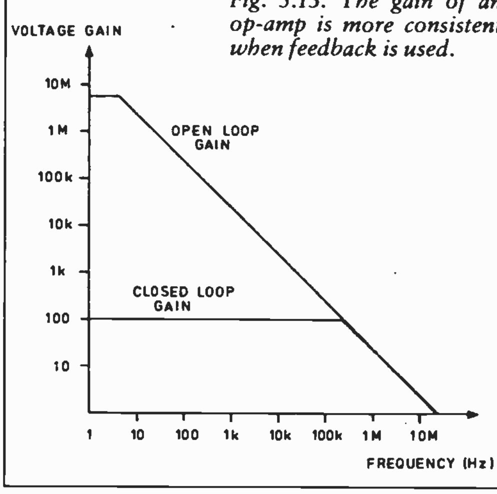


Fig. 5.13. The gain of an op-amp is more consistent when feedback is used.

assembled sub-systems and can be used almost as freely as simple resistors, to make very effective electronic systems to process analogue signals.

We will be spending the next two parts of *Teach In* by examining the world of *digital systems*. Unlike the analogue systems we have looked at which process varying signals, digital systems talk strictly in terms of "on" or "off" or "high" and "low". So we will be checking out digital integrated circuits with many interesting demonstrations, and a further three modules of your *Mini Lab* will be constructed.

ALL RIGHT SO FAR?

Teach-In is devised specially for beginners in electronics. If you have any problems relating to any particular topic discussed in *Teach-In*, remember that the Authors will try to help, so please write in with your queries – we welcome feedback (positive or negative!), comments and suggestions from everyone. *The Editor regrets that lengthy technical queries cannot be handled over the telephone.*

Don't forget that your *Mini Lab* now has a variety of modules which will help you to develop your own ideas or demonstrate circuit principles. In between reading through *Teach-In*, you can also use the *Mini Lab* to build a choice of the circuits which regularly appear as constructional projects in *Everyday with Practical Electronics*, experimenting with them as you wish perhaps before committing the circuit to a final fully-built version. Finally, check out the *EPE Direct Book Service* which has a wide range of specially-selected text books covering many topics in electronics, computing, construction and more.

FETS

The Field Effect Transistor (FET) functions in a completely different way to the *npn* and *pnp* bipolar ("two polarities") transistors we have used up to now.

FET's have several flavours, depending on their internal construction. Standard semiconductor JFET's (Junction FETs) are available in *n*-channel and *p*-channel types, roughly equivalent to *npn* and *pnp* transistors. Another form is the MOSFET (Metal Oxide Silicon FET) which uses a completely different fabrication technique. Uniquely these latter types have an extremely high input impedance which draw no current.

Fig. 5.14(a) is the schematic symbol for a popular FET. They have three terminals - **drain, source** and **gate**. The main difference is that instead of drawing base current like a bipolar transistor, the FET operates simply by attracting or repelling electric charge internally, and no appreciable current flows into the gate. Again unlike an ordinary transistor, FET's thus have a high input impedance.

Fig. 5.14(b) shows an *n*-channel MOSFET connected as a simple switch. No gate resistor is required. Connecting it to +12V turns the FET on and drain current will then flow. Easy! The modern MOSFET makes an excellent power switch, and can handle analogue signals very effectively. Their "on" resistance is very low, almost like a perfect solid-state switch.

FET's are used as input transistors on many modern op-amps, the inputs of which draw no current, unlike the bipolar 741 types which are constructed from semiconductor *npn* transistors. Thus, FET-input op-amps make excellent buffers because they don't load the signal.

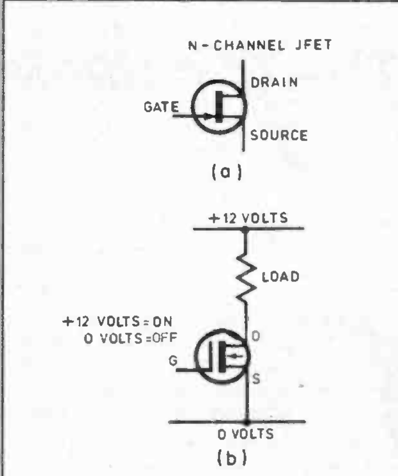
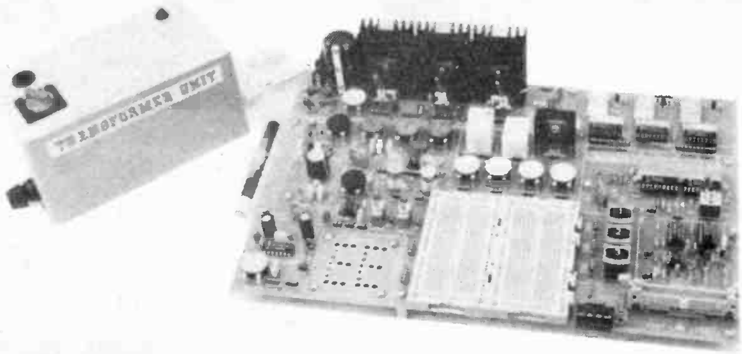


Fig. 5.14. The field-effect transistor. (a) A Junction FET. (b) A MOSFET in a simple switching circuit.

Teach-In Project

MINI LAB



Alan Winstanley & Keith Dye B.Eng(Tech)AMIEE

The Everyday with Practical Electronics Mini Lab has been created to accompany Teach-In '93, and enables the reader to assemble demonstration circuits by following the clear instructions and diagrams contained in the main text, with every chance of it working first time.

THIS month your *Mini Lab* p.c.b. takes a further step towards completion with the assembly of a very simple but highly effective Audio Amplifier. This is constructed adjacent to the loudspeaker which was installed last month.

The circuit diagram is shown in Fig. 1. and is seen to centre around IC1, an LM380N integrated circuit audio amplifier which is contained within a 14-pin d.i.l. package. The device has a fixed gain of 50 and is protected against short-circuits and thermal overload. The power output is specified at up to 2 Watts or so.

The input signal is coupled by C1 to remove any d.c. voltage content, so that the a.c. signal is presented to the amplifier. A potentiometer VR1 acts as a volume control by controlling the difference between the inputs, which determines overall gain. The surrounding capacitors C2 and C3 help to remove any spikes on the supply and provide local smoothing of the power rails by acting as a reservoir capacitor. C5 removes the d.c. content of the output, so that only a.c. flows into the loudspeaker SP1 which the LM380 can drive directly without the need for extra buffering.

Because the temperature of the LM380 will rise when its power dissipation increases, it is possible to obtain a reasonable power output level before the internal thermal limit circuit takes control, by heatsinking the chip on the *Mini Lab* board. This is effected by soldering the chip *directly* to the p.c.b. where areas of copper foil help to sink the heat away from the integrated circuit. Finally, it is necessary to link the loudspeaker to the Audio Amplifier circuit by using s.i.l. sockets to hook up to C5 and 0V. Thus by removing these links, the loudspeaker can be made to operate independently – useful if you need a sound output transducer for any reason.

Once again we see how convenient an integrated circuit can be – imagine the number of transistors you would need to provide the same performance and protection as a single LM380 audio amplifier. In our case, it also vastly simplifies assembly, with a very high chance of the circuit working first time.

CONSTRUCTION

Assembly is very straightforward and the silk-screen printing on the p.c.b. assists with

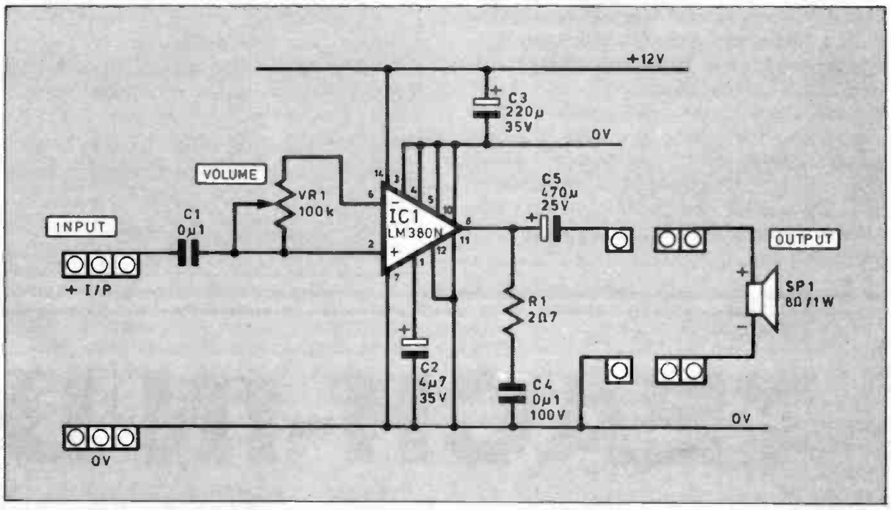
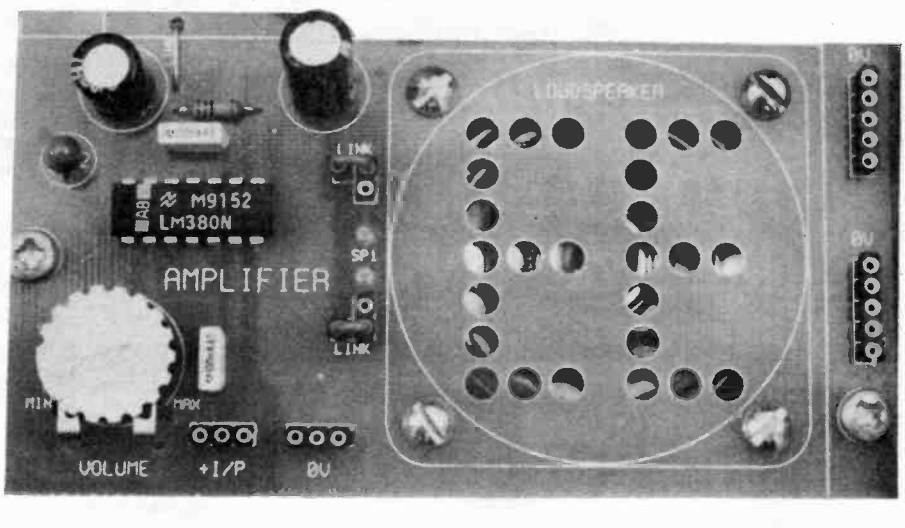


Fig. 1. Circuit diagram of the Mini Lab Audio Amplifier. The loudspeaker SP1 was fitted to the Mini Lab p.c.b. last month.

component positioning, see Fig. 2. Link wires are required adjacent to C3, and also to the right of the Triangle Output of the 8038 Signal Generator (check with last month's issue), to ensure that the +12V power supply continuity is maintained. Insert these links first, followed by the s.i.l. sockets.

Continue with the smaller components and trimmer resistor (for which a thumbwheel type is preferred), then the i.c. which *must* be correctly orientated: the notch at one end should match the similar markings on the board. As stated earlier, the i.c. is best soldered directly to the board



MINI LAB COMPONENTS

Resistors
R1 2Ω7 5% ¼W Carbon film

See SHOP TALK Page

Potentiometer
VR1 100k 0.25W preset potentiometer and thumbwheel

Capacitors
C1 0µ1 (100n) polyester
C2 4µ7 tantalum bead 35V
C3 220µ radial elect. 25V
C4 0µ1 (100n) polyester
C5 470µ radial elect. 25V

Semiconductors
IC1 LM380N audio amplifier i.c.

Miscellaneous
s.I.I. turned pin sockets (6 off) [N.B. The loudspeaker was fitted in Part Four.]

Price £4 Approx

without using a d.i.l. socket: make sure you have inserted it correctly, and solder each pin quickly and neatly, avoiding excessive heat or shorting out adjacent pins with surplus solder. Finally solder in the radial-lead electrolytic capacitors which *must* be connected the right way round.

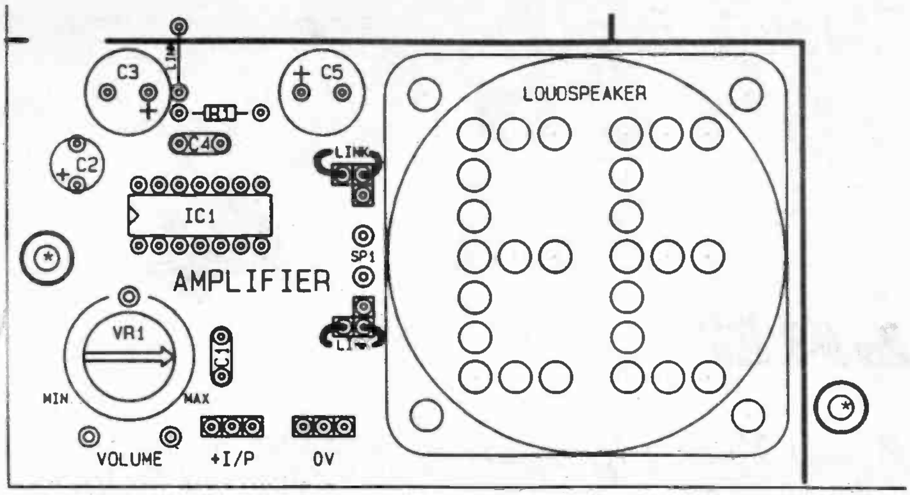


Fig. 2. Mini Lab layout for the Audio Amplifier. Two solder pins are needed at the location marked "SP1" pointing downwards, these are then connected, using insulated wire, to the loudspeaker terminals.

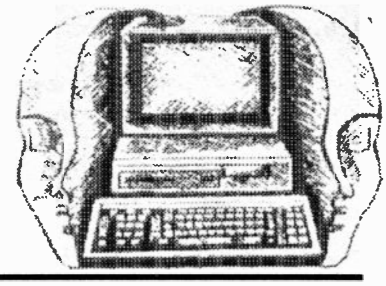
TESTING

Using two short link wires, connect the loudspeaker as shown in Fig. 2 and check out all wiring before switching on the +12V supply. Hopefully a switch-on "thump" should be heard from the loudspeaker, in which case switch off and then connect the input of the Audio Amplifier to the sine-wave output of the 8038 Signal Generator. No 0V signal input link wires is actually needed as this is commoned by the p.c.b. to all the other 0V terminals around the board. Select the 500Hz range then switch on the +12V supply for the Generator and Amplifier.

An audio tone should be heard from the speaker – adjust the Volume and Frequency controls as needed. **Please take care** when using the Audio Amplifier on other frequency ranges: the LM380 circuit is extremely effective and certain pitches will prove ear-piercing, so please consider others. If this test is successful then the Audio Amplifier is complete and ready for use. In Part Eight, we deal with Communications and the Audio Amplifier is used in conjunction with the Mini Lab Radio Tuner to form an amazingly effective AM radio – music while you work!

Next month: 555 Timer and Logic Probe.

INTERFACE



Robert Penfold

THERE are plenty of old jokes based on the theory that you always have to wait at least half an hour for a bus, and then three buses come along together. Electronics and computing seems to be governed by the bus theory, and there are long periods with few new developments, separated by shorter periods when there are numerous launches of new components.

The bus theory also seems to govern the demise of existing products. Mike Kenward, the Editor of *Everyday with Practical Electronics*, commented in a recent Editorial about the number of electronic components that had disappeared from the market recently.

Hall Lights

Some of these components are integrated circuits that were introduced not all that long ago, while others are old favourites that have been available for many years. Many of these components (such as spring-lines and certain dual gate MOSFETs) are of little relevance to the computer add-on enthusiast. Fortunately, the popular computer chips are now so well established that they should be available for many years to come.

Probably the only recent component casualties which are used in home computing applications the TL170C and TL172C Hall effect switches. There might still be some of these devices available in the shops, but they are no longer manufactured and will cease to be available once existing stocks have been sold.

The TL170C and TL172C are semiconductor switching devices which are activated by a magnetic field. These components have numerous uses, and I remember using them in an electronic lock project many years ago. A more popular application is for position sensing applications, particularly in computer controlled model railways.

For example, they are often used in automatic signal lights to sense a passing train. A typical arrangement is to have one sensor by the signal, and another a little further along the track. The signal is turned to "red" as the train passes it by, and then back to "green" again as the train passes the second sensor. This is basically the way real train signals function, but is obviously a rather simplified version of the real thing.

Hall effect sensors can be used in other model train sensing applications, such as automatic train control systems where the train must be made to stop at a particular position on the track.

Along The Lines

Linear Hall effect sensors are still available, and it would presumably be possible to produce a magnetic switch based on one of these devices. However, this is not really a very practical method as the cost of linear Hall effect sensors is relatively high. The only practical alternatives are opto-sensors, or old fashioned sensors such as microswitches and reed switches.

Reed switches are the most popular old technology method of train position sensing, and are the method still favoured by many model railway enthusiasts. Unlike microswitches, they do not require any physical contact with the passing train. Like Hall effect switches, they require the train to be fitted with a small bar magnet, and they are activated by the passing magnetic field.

The switch is closed when the magnetic field is present, and open when it is absent. Most component retailers sell matching bar magnets for their reed switches.

The obvious way to activate the reed switch is to place the end of the bar magnet close to it. This does not give the desired result though, and it is highly unlikely that this will result in the switch closing even if the magnet is actually touched against the switch.

The bar-like reed switch and the magnet must be parallel to one another and reasonably well aligned in order to activate the switch. Note that magnets other than bar types are not likely to give satisfactory results with reed switches.

The operating range is not very great, and is typically between about 5 and 40 millimetres. For operation in model train applications small magnets and switches are obviously preferable, and they should have an operating range of about 20 millimetres or more. In practice, very small magnets often fail to give adequate operating range.

Magnets

In my experience it is best to use a slightly larger magnet (such as the Maplin "large" type), and to fit it lengthwise and centrally along the base of a piece of rolling-stock. The reed switch is fitted along the centre of the track, and will probably have to be embedded in the sleepers or mounted beneath them in order to prevent it from derailing the train.

It is perhaps worth mentioning that this system will work properly in reverse. In other words, it is quite acceptable to have the bar magnet mounted in the track, and the reed switch fitted inside a piece of rolling stock. This inverted setup is rather less useful, but it is occasionally used for something like automatic train lighting, where the lights come on as the train approaches a tunnel, and switch off again when the train emerges from the tunnel.

Logic Interfacing

The contact ratings of reed switches are often quite low. This is of no great consequence in model train applications where the switches will not be used to directly control motors etc., but will be used to drive computer ports or other logic inputs.

In some cases the reed switch can be interfaced to a logic input using a circuit as basic as the one shown in Fig. 1. Normally R1 holds the logic input low, but the input is pulled high when the switch closes. Simply swap S1 and R1 if the input must normally be high, and pulsed low when the switch is activated.

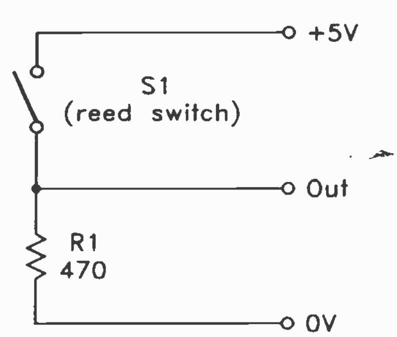


Fig. 1. Interfacing a reed switch to a logic input.

There is a potential problem with this system in that the switch may only be operated very briefly as the train passes. This obviously depends on factors such as the speed of the train, and whether or not the system is operating well within its maximum operating range. As with any form of mechanical switch, there is potentially a problem with contact bounce producing multiple output pulses.

In a computer based system the brevity of the pulses might be of no consequence. It may be possible to use an edge triggered input, or to simply monitor the switches at a high enough rate to ensure that no pulses are missed.

It may well be possible to sort out any contact bounce problems using a software solution. However, it is often easier to add some simple hardware to provide debouncing and a consistent output pulse duration.

Debounce

A 555 monostable (Fig. 2) probably provides the most simple and inexpensive method of debouncing and pulse stretching. S1 is the reed switch, but the circuit can also be used to debounce a microswitch or any other type of mechanical switch. Resistor R1 normally holds the trigger input of IC1 high, but when the switch closes, pin 2 of IC1 is taken below the trigger threshold and a positive output pulse is produced at pin 3.

Resistor R2 and capacitor C2 set the output pulse duration, and the specified values give a pulse length of just over a second. The pulse duration is proportional to the values of these two components, and can easily be altered to suit individual requirements. The nominal pulse time is 1.1 C.R seconds (with the value of C2 in microfarads and that of R2 in megohms).

Reed switches may represent a less interesting means of train position sensing than using Hall effect devices, but they are a very practical choice. They generally give slightly better maximum operating range, and are quite cheap. Although they are a form of mechanical switch they are fast in operation, with the smaller types having operating times of only about one millisecond. They are also very long lasting, with typical operating lives of around 100 million operations!

Light Railway

If a higher-tech method of detection with no moving parts is required, then an opto-switch of some kind is probably the best choice. The circuit of Fig. 3 is for an opto-sensor which is based on a reflective infra-red sensor (the Maplin "Sensor OPB706B" is suitable).

This is basically just an infra-red l.e.d. and a photo-transistor in a common casing, and with both components "looking" in the same direction. It is the same device that was used in the barcode "pen" that was featured in a previous *Interface* article.

Any light from the l.e.d. that is reflected back to the photo-transistor produces a reduction in the collector to emitter resistance of the transistor. If enough light is reflected back to the sensor, the collector voltage of the transistor becomes low enough to trigger IC1, and produce a positive output pulse of just over one second in duration.

The sensitivity control VR1, should be set for the lowest sensitivity (i.e. the lowest resistance) that gives satisfactory results. This minimises the risk of spurious triggering by ambient infra-red light.

Target

In use the sensor is mounted in or on the track, "looking" upwards. Obviously the sensor must be mounted low enough to ensure that it will not come into contact with passing trains. The sensor incorporates an infra-red filter, but you should still avoid having the sensor aimed directly towards an electric light or any bright light source.

As the train is likely to be very dark on the underside, a target for the sensor must be fitted to the underside of one piece of rolling stock. The target is simply a small piece of white paper or aluminium foil which is glued in place. Alternatively, a small area on the underside of a piece of rolling stock can be painted white.

The sensor can detect targets as small as a few millimetres square, but in the interest of good reliability it is best to make the target as large as circumstances permit. Of course, if there should happen to be a metal plate or other reflective surface on the underside of the train, there is no need to add a reflective patch.

The maximum range of the system should be more than adequate at about 10 to 20 millimetres. The circuit operates very rapidly, and there is no risk of fast moving trains slipping past, undetected.

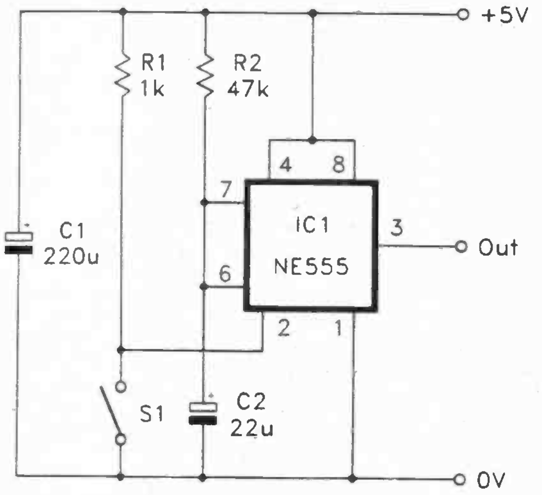


Fig. 2. Using a 555 monostable to provide pulse stretching and debouncing.

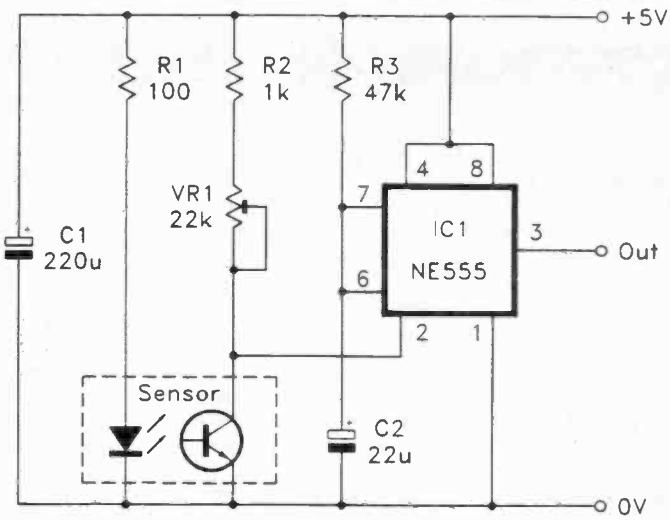


Fig. 3. A simple position sensor based on a reflective opto-sensor.

Home Base

Jottings of an electronics hobbyist – Terry Pinnell

Auto motive?

I used to be in a very lucky position of getting a new company car every three years, which was about 60,000 miles. The only downside was that it had become increasingly difficult to justify installing my gadgets in them, as their own in-built accessories had become so comprehensive.

Hardly a grave crisis I'll agree. More like the problem you occasionally hear of, the pools winner who is apparently worried about how to spend the winnings. But my car had always been a major target for my electronics creations.

Come to think of it, one of the first gadgets I ever made was when I was 16 for my number one motor car. This was an old Hillman – one lady driver, hardly driven, etc. I paid £35 for it, which was not very much even then, and I suppose a dispassionate observer would have described it as a heap.

It was nevertheless my pride and joy and had to be protected against theft. This took the form of a secret switch hidden behind an old rag in the glove compartment, disconnecting the ignition. Returning to the car one evening with my pal Kev, and forgetting the switch's recent installation, I still recall with shame his futile gasping efforts to push-start it on the slight uphill gradient – eventually rewarded when the penny dropped and I surreptitiously closed the switch.

But returning to my theme: it wasn't just loosing an obvious target for new projects but also the wasted effort on previous ones. With the imminent delivery of a new car I would painstakingly remove then all, ready for re-installation. In fact this became a factor in my choice of car. On one occasion the clincher in choosing an identical model was that it would maximise my investment; those hours spent studying the manufacturer's wiring diagrams and groping around looking for connection points would not be in vain.

At its peak my car was probably enhanced with around a dozen gadgets of varying usefulness. Not all of them succumbed to the redundancy trend though.

Cold facts

Even after the acquisition of a car boasting a digital thermometer I kept my home-brewed ice alarm. With more than our fair share of treacherous country lanes I had come to rely on its flashing light, triggered at about one degree centigrade air temperature.

On at least one occasion it probably prevented a serious accident. Alerted on leaving for work one morning, I inched round a nearby blind bend, to find a Volvo upside down a few yards ahead. Its owner scrambled out with everything except his good mood intact and told me that the car had hit black ice and the roadside bank had then neatly flipped him over. I recall being impressed to see him wriggle back into the car to make a 'phone call!

My new car's thermometer did not have an integral ice alert so the two devices complemented each other anyway.

There is plenty of scope for personalisation when making these things. For example, the variant I've fixed in my wife's car has an audible as well as a visual warning (a mixed blessing) and my own latest version sports an amber l.e.d. to indicate temperatures between 2°C and 4°C in addition to the red one triggered under 1°C.

Lighting on a solution

One of my most useful projects in the earlier days of this hobby was also one of the simplest. It was a Lights-left-on Alarm based on a two transistor circuit from R. M. Marston's book *20 Solid State Projects for the Car and Garage*, published by Butterworths. I must have made half a dozen of these for myself, family or friends over the years.

If the lights are on when the ignition switch is turned off, then a tone sounds to warn you. If you deliberately want to leave the lights on, such as for parking, then the tone gradually decreases in frequency and finally disappears altogether after about ten seconds, thereafter drawing only microamps.

But my last company car gave an audible warning if the ignition switch was removed while any circuit remained switched on, including the sidelights. So my ancient unit became yet another victim of modernisation.

Fluid situation

Sitting on one occasion in a new car poring through the handbook, it seemed that another circuit was about to become redundant. I was now the proud owner of a "computer checkout" and the manual told me that this monitored all sorts of things, registering their status with an illuminated symbol. For example, a wheel was quickly overlayed with "OK" when the brakes were first successfully applied, and so on.

One of the symbols was a bottle which was supposed to be displayed when the washer fluid level dropped below some minimum level. But in fact it did no such thing – not surprisingly, as there was no sensor of any kind in the container. Galactic HQ in Milton Keynes duly advised me that imported vehicles did not have this particular luxury, so I promptly re-installed my own unit.

Washer Circuit

The basic circuit for my Simple Washer Fluid level Alarm is shown in Fig. 1. When power is first applied via the ignition switch, a brief positive pulse sets the bistable IC1; pin 4 goes low and therefore the transistor and l.e.d. are kept off. If the fluid then falls below the minimum level set by the position of the upper probe, the resistance between the probes rises to a very high value and the voltage at pin 1 goes high, resetting the bistable and thus activating the l.e.d.

The 1µ5 capacitor smooths out sudden changes, such as caused by the fluid sloshing around when cornering. Once the l.e.d. is latched on it stays so until the ignition is switched on again. So if the bottle is refilled while the engine is running, the warning will misleadingly remain on. If you make one of these and use the same sort of probes as I did (just stripped insulation from copper wire) you'll find they will need cleaning every few months to ensure reliable triggering.

My recent move out of the company-car scene into buy-your-own-car mode has changed the situation drastically and I'm now scrabbling around for all those old circuits again – with decidedly mixed feelings.

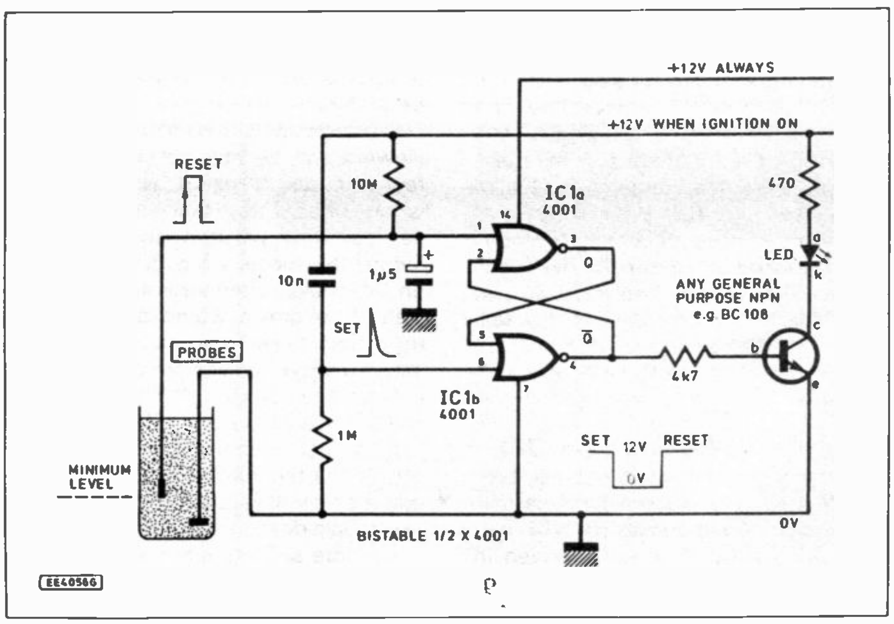


Fig. 1. Simple Washer Fluid Alarm circuit.

FOX REPORT

by Barry Fox

FUTURE OF TV

At a seminar staged recently by the BKSTS (British Kinematograph Sound and Television Society) at the Science Museum, several speakers made the same point. We are moving into an era when there will be more and more TV channels, but we are also moving into an era when there will be less and less money for the TV stations to spend on programming.

Roger Bolton, one of the most respected documentary producers (he headed Thames TV's *This Week* team at the time of "Death on the Rock"), told how it is now an "immensely depressing time to be in television – a lot of producers and production companies will not survive". Bolton now runs an independent company and admits that he has to impose working practices on his staff, which he cannot condone. There is no job security and no holiday or sick pay, simply because he cannot afford it on the budgets available.

More and more independents are competing for less work. The grapevine tells that Channel Four got over 600 applications for the score of Equinox programmes, forty of them on the DCC/MD battle. And Channel 4 will soon have to cut back because from 1st January it is no longer supported by the advertising revenue of the ITV network. Why else do you think that Channel 4 now puts out the *Big Breakfast*, a kids TV programme on speed for adults?

Oracle and TV-AM gave one hint of the future as they played out the last months of their franchises. We saw endless competitions with questions so easy that large numbers of people will phone in with answers at 36p/48p a minute, of which 28p goes to the advertiser. Hopefully the Independent Television Commission will not allow this to continue into the new franchises. Perhaps one of the ITC's brass will get a phone bill run up by his children.

DIGITAL COMPRESSION

Digital compression can put at least four PAL-quality TV programmes into the space currently occupied by one terestrial channel and half a dozen in a satellite channel. With digital signals, at low stength, there is less risk of interference between close channels. So terrestrial TV can use the "taboo" channels in the cracks between main channels, and satellites can use frequencies shared by different craft closely spaced in orbit. Cable capacity can go up tenfold.

The technology is not a pipe dream. Full Motion Video for CD-I proves it works. Greenland now gets its TV news pictures by compressed video from satellite, because much of the country is too far North for analogue TV reception.

The professional decoders used at Greenland's TV stations are made by Compression Labs Inc, look like a domestic receiver, and cost only $3000. Tele-Communications Inc in the US is ordering a million set-top domestic decoders for its cable subscribers to start using in January 1994.

PAY-PER-VIEW

No wonder people wonder who will pay for programmes to fill the hundreds of extra channels that will be opened up. But they are missing the point.

It is already quite clear (e.g. from recent patents) that station programmers do not intend even trying to put different material on each channel. They will move into the technology of staggered simulcasting, with pay-per-view reception.

It will work like this. When a TV company transmits a 100 minute movie, it will use a cluster of five digital channels. The same movie will be transmitted, five times over, but starting progressively twenty minutes later on each channel.

The signals will be scrambled, but viewers will be able to tune in for a few minutes to get a sight of what is on offer. They will then make a pay-per-view payment to watch and record the movie from the beginning, on whichever channel is first with the start of the movie. So no-one will have more than twenty minutes to wait for a pay-per-view impulse movie purchase.

The time is coming right for this change. UK viewers pay leas than 25p per day per household in licence fees for all that the BBC offers. The cost of cable or satellite subscriptions is well over 50p a day.

As more satellite channels scramble, putting the subscription rates up even further, more and more people realise that they are continually paying for a service which they often do not use, either because they are busy, away on business or away on holiday. This realisation is sowing the seed for pay-per-view TV.

All the modern analogue encryption systems make provision for pay-per-view working. The industry is just waiting for public dissatisfaction with subscription viewing to make the time right to offer PPV. By the time digital services come on stream, in the second half of the decade, PPV will be a familar concept.

The main losers in this movie-based scenario will be viewers who get the chance to see very few documentaries, the independents who get no money to make them and the shops, trying to rent or sell movies on video tape to people who can get them delivered electronically into the home.

KIT BUILDING

It is a long time since I built a circuit from a kit. I solder leads, make up the occasional junction box and do the odd simple running repair. But time is too tight to build circuits from scratch unless something I need is only available in kit form. So I am pretty rusty at stuffing components into a p.c.b.

Obviously a lot of people do build kits, though, because magazines like EPE publish construction articles and are heavy with adverts for kits. For some people building circuits is like doing a jigsaw, making a matchstick house or constructing a model aeroplane. It is therapy after a hard grind at different work. And it is a wonderful way to get a feel for how things work, and why.

Recently a friend wanted to control the speed of a 12 volt motor. We burned out several heavy duty resistors. Then I noticed J and N Bull's advert for a Pulse Width control kit. I bought one and hope it will do the trick. But already one thing is clear. Although I do not doubt that the price for component content is fair, just a little more thought would surely make kits like this far more useful and accessible to a wider public.

The single instruction sheet gives a circuit diagram but no explanation of how the circuit works. If you do not already know how PW control operates, you will not learn anything from just soldering components to the board where marked.

MICROPHONE COMPRESSOR

ROBERT PENFOLD

Avoid the disasters of severe distortion with this low cost, easy-to-build signal compressor.

MANY pieces of audio equipment require the signal level to be set and maintained quite accurately if they are to function correctly. An inadequate signal level simply gives a poor signal to noise ratio.

The consequences of an excessive signal level are usually more drastic, with severe distortion being the best that can be hoped for. In an extreme case it is possible that the loudspeaker system could be damaged.

The two types of audio equipment where problems with inappropriate signal levels are most likely to cause problems are public address (PA) systems and tape recorders. Experienced users know how to use the equipment to best effect, but inexperienced users often make a complete hash of things. PA equipment in particular, often seems to have an extremely tough time in the hands of illogical people who think that you need to shout into the microphone in order to be heard!

ON THE LEVEL

Some equipment is fitted with an automatic level control circuit which maintains a reasonably stable signal level despite wide variations in the input level. This is actually quite a common feature in tape recording equipment, but it seems to be relatively rare in PA systems. However, there is usually no difficulty in using an external automatic level control circuit between the microphone and the tape recorder, PA amplifier, or whatever.

Units of this type are known as "compressors", as they take a wide range of input levels and compress them into a relatively limited range of output levels. The compressor featured here includes a built-in microphone preamplifier, and it is designed to feed into a high level input on the amplifier or tape recorder. If necessary though, it is easily modified to provide a low level output that can feed into a microphone input.

SYSTEM OPERATION

The block diagram of Fig. 1 helps to explain the way in which the compressor functions. The first stage is a high gain preamplifier which boosts the weak microphone signal. Next the signal is fed to a voltage controlled attenuator (v.c.a.), a buffer stage, and then to a further high gain amplifier.

Two voltage amplifiers are needed in order to provide the massive amount of gain required to bring the very weak input signal up to a level that can drive the signal processing stages which introduce the automatic gain control. The v.c.a. is placed between the two voltage amplifiers as this gives a good compromise between two conflicting requirements.

In order to obtain a low level of distortion the v.c.a. should be fed with a very low signal level. On the other hand, feeding it with too low a level can give rise to problems with noise and excessive breakthrough from the control input.

A v.c.a. is rather like a volume control that is governed by a d.c. control voltage. In this case the v.c.a. normally provides little attenuation, and small input voltages do not have any effect on the degree of attenuation. Increasing the control voltage above a certain threshold voltage causes the losses through the v.c.a. to increase dramatically.

The control voltage is produced by first amplifying the output signal slightly, and then rectifying and smoothing the amplified signal to produce a positive d.c. signal. This d.c. voltage is roughly proportional to the strength of the input signal.

With low input levels the voltage produced is too low to have any effect on the v.c.a. However, if the input signal is taken above a certain threshold level, the control voltage fed to the v.c.a. becomes large enough to start introducing significant losses. The higher the input level is taken above the threshold level, the greater the losses become.

This gives a form of negative feedback, with higher input levels being largely balanced by reductions in gain. This tends to hold the output signal at an almost constant amplitude, even if the input signal is taken well beyond the compression threshold level. In fact an increase of 26dB from the threshold level gives a change in the output of only about 6dB (i.e. a twenty-fold increase in the input signal is compressed to a doubling of the output level).

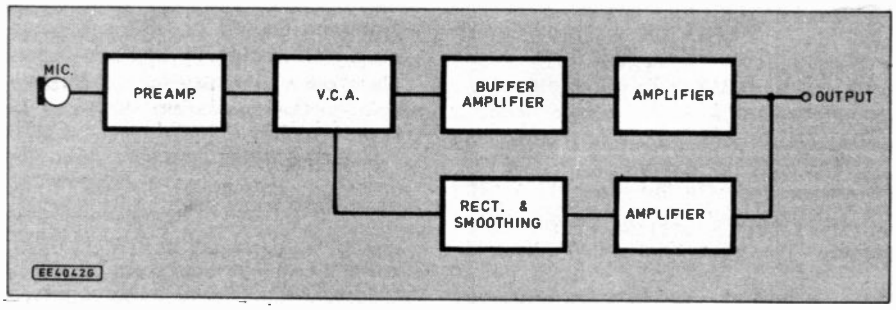


Fig. 1. Block diagram for the Microphone Compressor.

CIRCUIT OPERATION

The full circuit diagram for the microphone compressor is shown in Fig. 2. IC1 is used as the basis of the preamplifier, and this is an operational amplifier used in the non-inverting mode. It has a voltage gain of 40dB (100 times) and an input impedance of about 600 ohms. This will give good results with virtually any *low* impedance microphone.

For operation with *high* impedance microphones a lower level of gain and a higher input impedance are needed. This can be achieved by making resistor R1 100 kilohms in value and reducing R5 to 10 kilohms.

The LF351N specified for IC1 is suitable for non-critical applications, such as most PA work. For applications where a really good signal-to-noise ratio is needed it would be advisable to use an NE5534A for IC1. This is significantly more expensive than the LF351N, but it will give a roughly tenfold improvement in the signal-to-noise ratio.

A CMOS 4007UBE complementary pair plus inverter is used to form the voltage controlled attenuator (v.c.a.) network. In this case it is only the *n*-channel MOSFET which is used, and no connections are made to the other sections of the device. The drain-to-source resistance of the MOS-

COMPONENTS

Resistors

R1	680
R2	2k7
R3, R17	47k (2 off)
R4	68k
R5, R15	100k (2 off)
R6	1k
R7	56k
R8	150k
R9	22k
R10, R11	1M (2 off)
R12	2k2
R13, R14	33k (2 off)
R16, R19	10k (2 off)
R18	2M2

All 0·25W 5% carbon film

See SHOP TALK Page

The completed compressor showing front panel layout. Keep the input and output sockets well separated to avoid any feedback pick-up from the output wires to the input wires.

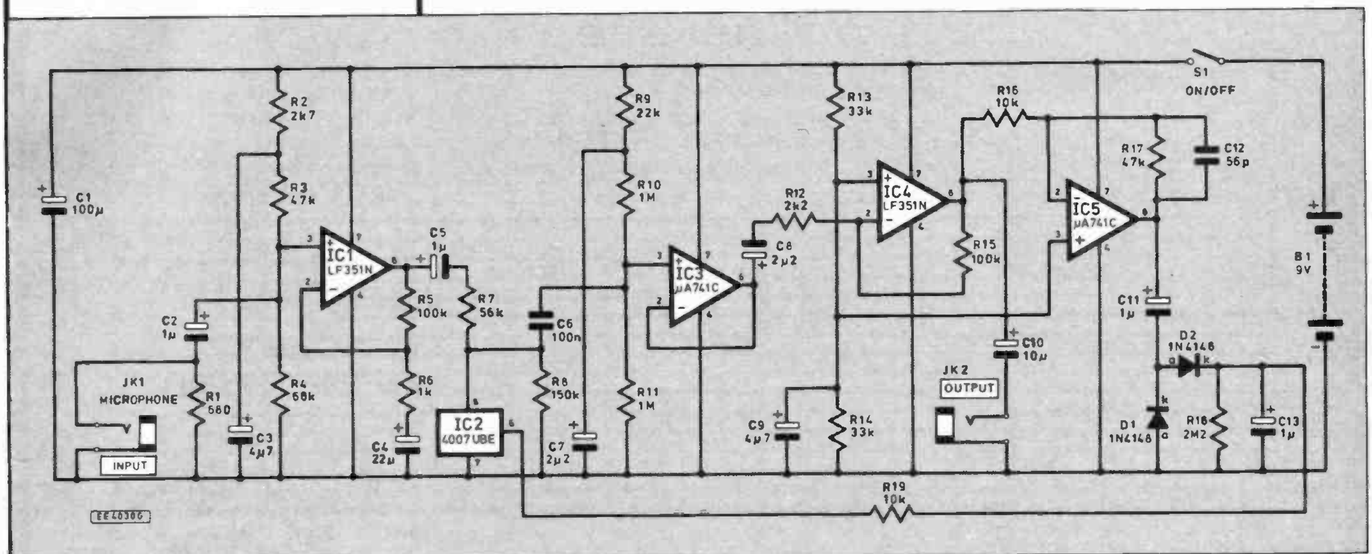


Fig. 2. Full circuit diagram for the Microphone Compressor. Only one n-channel f.e.t. of IC2 is needed, all other pins are unconnected.

Capacitors

C1	100µ axial elect.
C2, C5, C11, C13	1µ radial elect., 63V (4 off)
C3, C9	4µ7 radial elect., 63V (2 off)
C4	22µ radial elect., 25V
C6	100n polyester
C7, C8	2µ2 radial elect., 63V (2 off)
C10	10µ radial elect., 25V
C12	56p ceramic plate

Semiconductors

D1, D2	1N4148 silicon signal diode (2 off)
IC1, IC4	LF351N bifet op.amp (2 off)
IC2	4007UBE CMOS comp. pair plus inverter
IC3, IC5	µA741C op.amp (2 off)

Miscellaneous

JK1	3·5mm jack socket
JK2	Standard 6·35mm (¼in.) jack socket
S1	Rotary on/off switch
B1	9 volt battery (PP3 size)

Stripboard 0·1in. matrix, size 60 holes by 19 strips; 8-pin d.i.l. i.c. holder (4 off); 14-pin d.i.l. i.c. holder; battery connector; control knob; metal instrument case, approx. 230mm x 135mm x 50mm; connecting wire; 6BA fixings; solder; etc.

Approx cost guidance only £16

FET acts as a voltage controlled resistor. This forms an attenuator in conjunction with resistor R7.

The *n*-channel MOSFET is an enhancement mode device, which means that it has a high resistance with little or no input voltage to the gate terminal. Strong positive gate voltages bias the device into conduction, giving low drain-to-source resistances. This gives the desired v.c.a. effect with low losses through R7 at low control voltages, and large losses with high control potentials.

The buffer amplifier is formed by IC3. This has an input impedance of 500 kilohms, which ensures that there are minimal losses through the v.c.a. with low control voltages. IC4 operates as an inverting mode amplifier with a voltage gain of around 52dB (40 times). This gives an overall voltage gain of about 72dB (4000 times), which might seem excessive.

Remember though, that low impedance microphones have output levels that are often well under one millivolt r.m.s. Also, bear in mind that in normal use the unit will go beyond the compression threshold, and that the voltage gain of IC1 and IC4 will be tempered to some extent by losses through the v.c.a.

Another inverting mode amplifier, IC5 provides a low voltage gain of only about five to six times. Thus maximum output level is effectively controlled by the gain of IC5.

With the specified values an output level of around one volt peak-to-peak should be obtained. This is suitable for the high level inputs ("aux", "tuner", etc.) on most amplifiers, tape recorders, etc. However, if necessary a slightly lower output level can be obtained by making resistor R17 higher in value (around 100 kilohms), or a higher output level can be produced by reducing its value to around 22 kilohms.

The rectifier and smoothing circuit is a conventional half-wave passive type based on diodes D1 and D2. This has a fast attack time so that the unit rapidly responds to any input signal which exceeds the compression threshold level. It has a slower decay time in order to ensure that there is minimal distortion. The decay time is still reasonably short though, so that the unit will respond as quickly as possible to reductions in the input level.

The output of the smoothing circuit is fed to the input of the v.c.a. via protection resistor R19. Note that no buffering is needed at the input of the v.c.a. as a MOSFET transistor has an extremely high input resistance.

A small (PP3 size) 9V battery is adequate as the power source since the circuit has a current consumption of only about six milliamps.

CONSTRUCTION

The complete circuit for the Microphone Compressor can be built on a single piece of 0·1in. matrix stripboard. The topside component layout, details of breaks in the underside copper tracks and interwiring are provided in Fig. 3.

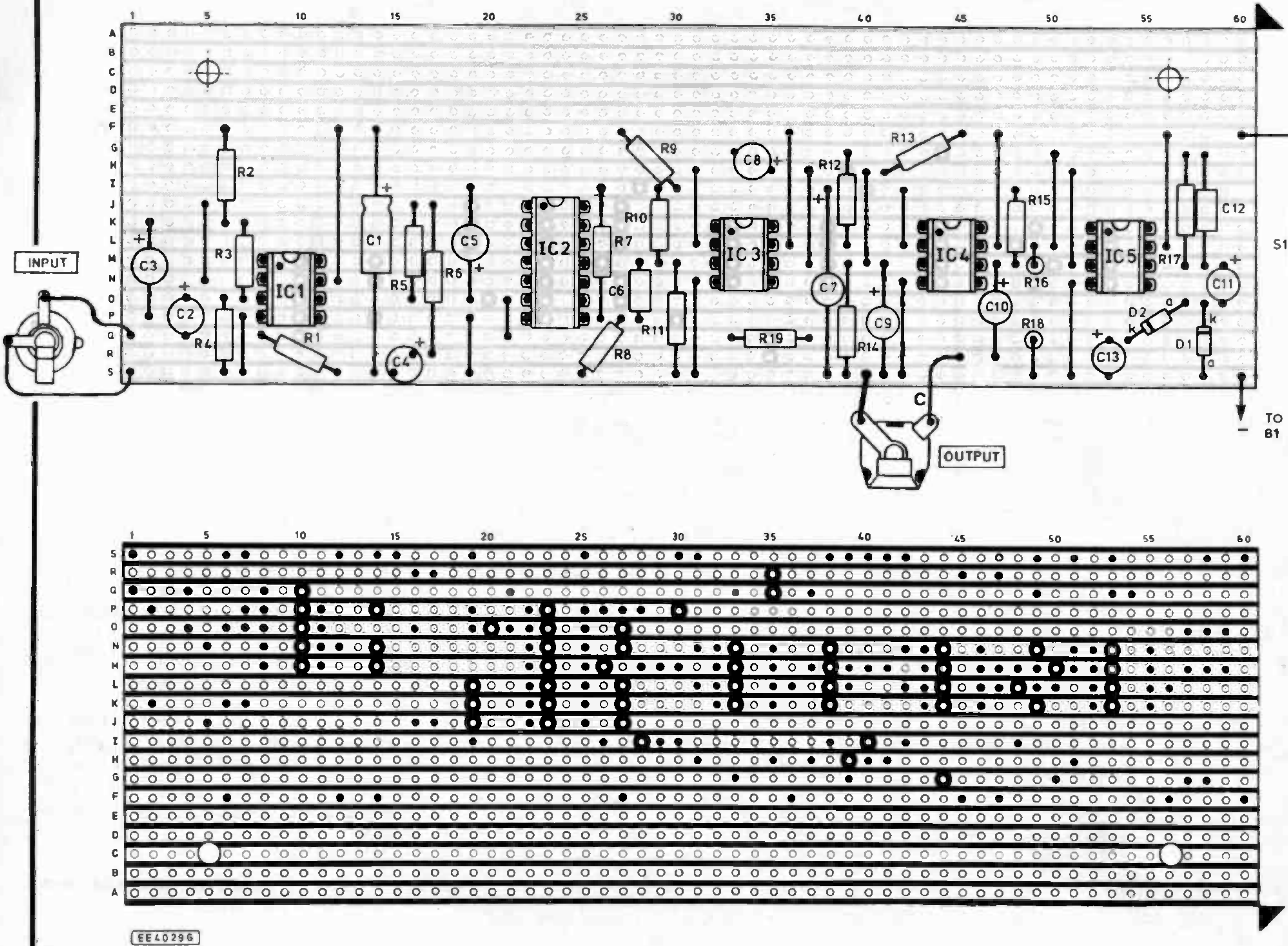


Fig. 3. Stripboard component layout, wires to front panel components and details of breaks required in the underside copper tracks. If the output must be attenuated (see text), insert a one megohm resisotr in place of lead "C".

The board has 60 holes by 19 copper strips. A board of this size must be cut from a larger piece using a hacksaw. Cut along rows of holes rather than trying to cut between rows (which is virtually impossible with 0·1in. matrix board).

Be very careful when working with stripboard as these boards are quite brittle and break easily. Any rough edges are easily smoothed using a small flat file.

The two mounting holes are 3·3 millimetres in diameter and will take 6BA or metric M3 mounting bolts. I would not recommend plastic stand-offs for use with stripboard, as they rarely seem to provide secure results with stripboard.

Fitting the components and link-wires is quite straightforward, but there are a fair number of components and wires to add. Work methodically across the board from one side to the other, making sure that you do not rush things.

Note that IC2 ***must be a*** 4007UBE (unbuffered) device, and not a 4007BE. The 4007UBE seems to be the only version offered by most component retailers.

This component is a CMOS device, and it requires the standard anti-static handling precautions. Use a holder for this device, and do not fit it in place until the unit is in all other respects finished. Handle IC2 as little as possible once it has been removed from its anti-static packaging. The other four integrated circuits are not MOS types, but I would still recommend the use of holders for them.

Fit single-sided solder pins to the board at the points where connections to the off-board components will be made. Tin the tops of the pins with a generous amount of solder.

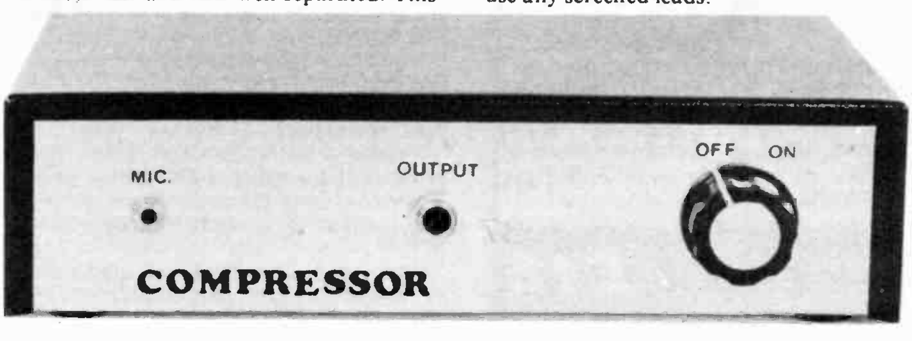
CASE

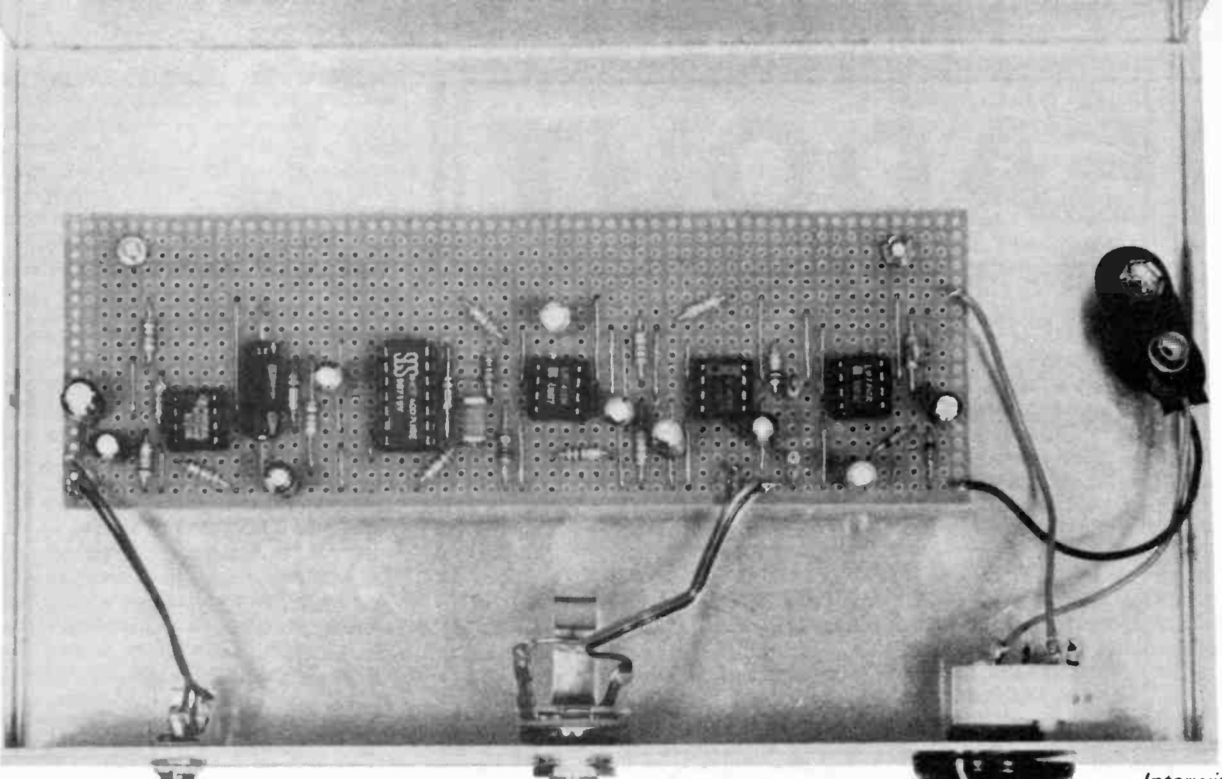
The prototype is housed in a metal instrument case about 200 millimetres wide, but this is somewhat larger than is really necessary. I would strongly recommend using an "all-metal" case rather than one of plastic or plastic and metal construction. An all metal case provides good screening against mains "hum" and other electrical noise.

The front panel layout should have jack sockets JK1 and JK2 well separated. This helps to avoid problems with instability due to stray feedback from the output wiring to the input wiring. Although 3·5mm and 6·35mm jack sockets are specified for JK1 and JK2 respectively, you can obviously use any audio connectors that fit in well with the other equipment in the system.

The component board is mounted on the base panel of the case, just to the rear of the two sockets. Use spacers about 6 to 12 millimetres long over the mounting bolts to keep the connections on the underside of the board well clear of the metal case.

The small amount of hard wiring can now be added. This is also included in Fig. 3. Provided the wiring to JK1 and JK2 is kept short and direct, and if an all-metal case is used, there is no need to use any screened leads.





Interwiring from board to front panel components.

IN USE

Ideally the unit should drive a high level input, as this will give the optimum signal-to-noise ratio. If there is no option but to feed the output of the unit into a microphone input, it is imperative that the output signal is attenuated. Otherwise there will almost certainly be severe clipping and distortion in the input stages of the recorder or amplifier. In order to attenuate the output it is merely necessary to use a resistor of about 1M (megohm) in value to carry the connection from the circuit board to JK2 (lead "C" in Fig. 3).

The unit is wired into the system using an ordinary screened audio lead to connect JK2 to the input of the main amplifier, tape deck, or whatever. The level/volume control on the ancillary equipment is set so that overloading does not occur even with a loud input to the microphone. Relatively weak sounds should provide a fairly high signal level in the ancillary equipment, making the presence of the compression fairly obvious if the unit is functioning correctly. □

READOUT

DOING IT

Dear Ed.,

I read with interest the article on doing the metalwork of your projects in *Actually Doing It!* (EPE Dec '92), and would like to offer my advice to fellow readers.

I have found that two very useful additions to my tool kit are "Abra" files and Cone cutters.

The first items are available from any good tool merchant and they are long, thin, hardened toothed cutting wires, which fit a Coping saw frame or a standard Hacksaw frame (with adaptors). They have the advantage of being moveable in any direction, so you can cut almost any shaped hole in aluminium, plastic or steel panels.

The second, the Cone cutters are quite expensive (the largest size for holes up to 30mm in diameter costs over £30) but enable you to cut neat holes in thin aluminium, plastic and steel just using an electric drill and making a small pilot hole first. Compared with buying individual chassis punches, (and the Allen keys to turn them with), they work very well, and soon pay for themselves.

Also, for making holes in plastic boxes I found that an ordinary flat woodworking bit works very well.

Changing the subject, I recently bought an oscilloscope, and my first job was to look at the waveform of my two Ni-Cad battery chargers to see if they could be used to recharge ordinary batteries as per an article called *"Better Use of Dry Cells"*, written by Alen Tong in EE Aug 1991. I found that the waveform of both chargers was in the form of PCR as mentioned in the article.

In both chargers this was produced by shunting an l.e.d. and not an ordinary silicon diode, with a resistor. The l.e.d. acts as a charge indicator. In fact on the bottom of one charger it gives instructions on how to charge ordinary batteries as well as Ni-Cads.

I now try and recharge all my batteries, but have had mixed success. It is best to catch the alkaline ones before they get too flat, otherwise they won't recharge. Also, ones that have been kept a long time don't accept the charge, but you can only try!

Just one more thing! Is it possible to publish the p.c.b. layouts in EPE on acetate film?, so that readers can use them directly for making their own p.c.b.s?

I ask this because I find that photocopying the page onto acetate does not work too well, and it picks up the background paper as fine grey spots which really spoils the contrast.

Failing them being printed on acetate film, could they possibly be printed on better quality paper? I am sure that most readers would not object to paying a few more pennies for EPE for the improved quality.

I hope that you find my letter interesting, and I look forward to reading EPE in the year to come. I have always found it the best electronics magazine.

David Cheeseman
Chobham

One word of warning – don't try to charge dry cells unless your charger is of the PCR type, they can explode if fed with a direct current. Any other views on our p.c.b.s and/or paper quality? – Ed.

CAT'S WHISKER

Dear Ed.,

I am one of the Cat's Whisker brigade mentioned by Mr. P. W. Warwick of Cheltenham (*Readout* Jan. 1993) and am sitting quite content with a pair of earphones listening to an Oriental Lady from the other side of the world.

The radio is from EE August 1987, the heart of which is a transistor array CA3086. This i.c. just happens to be on offer by one of your advertisers at £1 for four. This appealed to my thrifty outlook.

But I must take to task many of your advertisers who I am convinced make their profit out of the carriage/carton/packing/postage/minimum order charge. After all you can send 200g second class for 41p. There were some interesting items in your latest catalogue insertion, but minimum order £10, delivery £2 to £8 plus VAT, and heaven help you north of Aberdeen.

I sometimes wonder whether many of the advertisers are the same company, trading under a different name, spread about the country. And you will all have noticed the cost of the catalogues from the "Big Boys". *Of course* they contain much information, but by the time you get to the bottom line on the order form, you have wasted much time and effort, and you can't afford it anyway.

I'm going back to my Oriental Lady – I don't understand her and I don't understand sales techniques, but maybe 70 year old O.A.P's are not the target for Oriental Ladies or advertisers.

Another of the Analogue Lot.
P. McBeath
Northumberland

P.S. Regarding mnemonics for resistors, I don't need one because I have circuit symbols and component data presented free with *Everyday Electronics* October 1977, so there!

OFFENSIVE – NOT NOW

Our offensive mnemonic competition resulted in a large response. We have selected a few interesting and varied letters (we do not necessarily endorse the views of readers) and a range of old and new mnemonics for your enjoyment!

Our thanks to everyone who responded – there are a few versions that seem to be widely used. Unfortunately we do not have the space to include all those sent in.

Dear Ed.,

I write in connection with several complaints which the Commission has received from educationalists who have taken umbrage at the mnemonic used in *Teach-In '93* in the November issue of *Everyday with Practical Electronics.* Overall, the complainants feel that the mnemonic in question serves to belittle girls' interest in, and contribution to, the study of electronics in a grossly unsavoury way.

We, too, are appalled by the discriminatory and derogatory message which the mnemonic conveys, a message which runs contrary to the efforts made by this Commission and others to combat sexism in male-dominated subjects like science.

I would have ordinarily urged you to reconsider the magazine's position, but I understand from one of your colleagues that you have already decided to rectify the matter by publishing an apology to, and announcing a new mnemonic competition for, readers in the next issue of the magazine. This news is most welcome.

Christopher Frenie
Education and Training Unit
Equal Opportunities Commission

Dear Ed.,

I was pleased to read Councillor Des Loughey's letter in the latest issue of the magazine. As a member of the teaching profession who teaches Electronics to GCSE and A Level standard I too was surprised to see the mnemonic you published for the resistor colour codes, although I must admit that it was at least slightly toned down from the original version passed on to me by a former member of the navy.

In a day and age when we are trying to encourage girls to study Electronics and Physics which have traditionally had a male bias, rhymes of this nature are unhelpful in promoting a welcoming image to females. Even if that were not the case it is inappropriate to use a mnemonic which is so blatantly sexist.

I would like to submit the following mnemonic which I teach my students and has proved useful to them as a more positive alternative.

British **B**ulldogs **R**un **O**ver **Y**our **G**arden **B**arking **V**iciously **G**rowling **W**ildly.

On a more positive note may I congratulate your magazine on it's commitment to education and on another excellent *Teach-In.* I am advising all my students to take out a subscription for at least the duration of the course and doubtless many will continue to take it after they leave college.

David Grant
Gosport

Dear Ed.,

May I say how pleased I am that despite your take over of *Practical Electronics* you are maintaining your policy of presenting projects that are not only relatively inexpensive and easy to build but are useful too.

My main areas of interest are test instruments and computing projects. I think its fair to say that *Everyday with Practical Electronics* caters for most of my needs very well.

I am following the excellent *Teach-In '93* series which has appealed to me in a number of ways. a) Brushing up on electronics knowledge. b) The circuit board will be a very useful test bed as well as a good teaching aid. My two children, son 11yrs and daughter 9yrs, have had some fun with it already.

Although the mnemonic for resistor colour codes has been around for a long time, I must admit to having been a little uneasy about its use too. Whilst I have no wish to join the so called "Politically Correct" camp I do feel, on reflection, that the present mnemonic is inappropriate.

In response to your request for an alternative mnemonic I would like to suggest the following:-

Brass Bells Ring Out Yule-tide Greetings But Vinyl Gongs Won't

Keep up the good work.

David Price
Ashford

Dear Ed.,

With reference to your letter from Counsellor D. L. on page 795, Dec '92. Tut-tut, you really are not very politically aware are you? If you lived and worked in education in a county like Derbyshire you would realise that, given the proper political bias, there are very few phrases, or words come to that, which do not offend someone if they try hard enough.

My list of possible mnemonics contain all sorts of unacceptable ideas, depending on your bias. It will probably upset some of the following, the temperance movement, gay rights (guys marrying women), animal rights, vegetarians, and probably many more I have not even though about. However mnemonics are an aid to memory, if the blinkered minority are so upset let them work out their own version, assuming their minds can get away from the tracks into which they have become so rutted!

These I prefer,

Best Bitter Runs Over Your Gullet, But Vodka Gives Warmth.

Buy Brown Rags Or You Get Back Very Grimy Wipes.

Buy Bargain Rally Offers, You Get Very Good Whatsits.

Then of course you could start at the other end and write it in reverse order.

Why Get Vexed, Better Get Your Options Reversed Before Beginning.

S. Dodds
Derby

Dear Ed.,

I also disliked the colour code mnemonic in the November issue. I am glad that my name is not Violet. It is memorable only because of it's offensiveness.

However, I wish to offer the following mnemonic that I was taught at the Mars Electronics factory where I work:-

Bye Bye Rosie Off You Go (to) Birmingham Via Great Western.

Virginia Kennedy
Reading

This one is very popular as you can see below – for younger readers Great Western refers to the old "Great Western Railway." – Ed.

Dear Ed.,

I must admit to a knowing smile when I read about the offensive mnemonic for resistor colour code. I was taught it thirty years ago while undergoing technical training in the army and I still use it today, as do countless others. We must have had a very forward looking instructor because we were taught an alternative version to be used in front of offendable councillors:-

Bye Bye Rosie Off You Go Back Via Great Western.

I hope this gets you off the hook but as the GWR no longer exists I'm sticking with the other version.

J. Cole
Catterick Garrison

Dear Ed.,

I am a male electronics instructor at a Women's Technology Centre. The centre's trainees consist mainly of married women and single parents and we aim to train them to go into employment after their training.

The traditional mnemonic for the resistor colour code was taught to me but I have had to use alternative ones to avoid it being seen as offensive, embarrassing and sexist.

My less offensive suggestions are enclosed. I hope that it will get you out of trouble with the councillor.

Betty Brown Runs Over Your Garden But Violet Grey Won't

OR

Bad Beer Rots Our Young Guts But Vodka Goes Well

Peter Shields
Mirfield

From *Raymond Whitaker* – Halifax.

A **Black** Hole – Zero
One **Brown** penny
Two **Red** lips
Three **Orange** balls, as in Pawnbroker
This gets worse as we go along!
Four **Yellow** door panels
Five **Green** fingers
Six legged **Blue** bottle
Seven (Violent) **Violet** Men, refering to the film "The Magnificent Seven"
Eight(y), old and **Grey**
The **White** cat has nine lives.

Amazingly it works very well, possibly because the "picture" images sometimes spring to mind before the actual colours.

Dear Ed.,

I hate to think what would have happened to your more sensitive readers if you had published the version current when I was in the army, and later, in industry too!

To spare your, their and my own blushes (sheltered life!), I won't repeat it here, but submit my own harmless and in glorious colour.

Bad Boys Run Over Your Garden But Vegetables Grow Well.

What do you think?

J. E. Maudsley
Verwood

From *W. E. Woodnoth,* Arnold

Billy Bunter Ran Of Yelling Ganagway Burning Vinda-loo Geewhiz Whoops

Dear Ed.,

My mnemonic not only states a very important fundamental electronic principle, it also incorporates the name of the very component whose colour code we are interested in:

Buy Better Resistors Or You'll Get Battery Voltage Going Wonky!

If you want to be patriotic you could say British instead of Better, and for those who don't like the word Wonky, they could substitute West.

Eric Moore
Ballyclare

From *D. Heathfield,* Bournemouth

Black Beauty Ran One Year Giving Bookies Very Good Wins

From *C. W. Heddle,* Crown Woods School, Eltham.

Black Berries Ripen On Your Green Bushes. Very Good With Golden Syrup.

Unlike many mnemonics for the purpose, this has definite links with reality to distinguish the Black from Brown, Green from Gold and Grey.

From *C. I. Wells,* Bedale

Black Bears Run Over Yellowstones Grounds But Visting Grizzlys Walk

From *Peter Elson,* Gillingham

Bold Braves Rush Out Yelling Grievances Before Very Great Warrior

THE WINNER

Finally the "original" one we liked best – a years subscription plus a binder goes to Mr. M. Humphrey *from Winsford:*

Big Bears Roar, Orang-utan's Yell, Gorilla's Bellow, Vixens Growl Well

Just to remind everyone the sequence from 0 to 9 is **Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Grey, White.**

HAM FISTED!

Our contributor Tony Smith *recently invited readers comments on taking up amateur radio. What follows is part of a readers letter – more of this letter and this subject next month.*

Dear Tony,

So you would be interested to hear from any readers who have considered taking up amateur radio but for some reason decided against it. Well here's my view.

Several years ago I became interested in Short Wave Radio as a listener so I decided to find out how to get on the airwaves myself. To cut a long story short, I found out that if I wanted to talk to people all over the world on short wave I had to pass a Morse exam. As someone who can barely type with two fingers the thought of having to memorise some meaningless (to me) code and send a message in it was too much.

I didn't see the point of doing the class B with its normally fairly limited range. The cost in both time and money for classes and then equipment did not justify the benefit.

So that's what put me off. To me, and I'm sure to a lot of other people, it seems a crazy situation that to speak to people worldwide you first have to learn to communicate in Morse.

Imagine if the telephone was like this. The class B license would let you talk to people in local areas and the class A would let you talk to people all over the world. However, to get a class A you would have to pass a Morse exam just in case conditions were bad. Most people with common sense would try to phone another time.

Lui Giacomello
Edinburgh

If other readers would like to comment on this subject we would be pleased to hear from them. – Ed.

BIOMET PULSE MONITOR

JOHN BECKER

Part Two

Probe the rhythm of life with this mini heart monitor.

THE Biomet is a heart and pulse rate monitor which can be used on its own or in conjunction with a computer. The computer screen displays heart rhythm waveforms and pulse rates. Pulse rates are also shown on the Biomet's liquid crystal display screen.

Last month we described the probe amplifier, beats-per-minute converter, pulse rate display and the PC-compatible ADC interface circuits. The constructional details for the Sensor and Display printed circuit boards were also included together with the full components list. We conclude this month with constructional details for the ADC Interface board, setting-up procedures and software listing.

ADC INTERFACE BOARD

Component layout and full size copper foil master details of the ADC Interface board are shown in Fig. 12. This double-sided board is available from the *EPE PCB Service*, code 819.

As shown, the board is a double-sided p.c.b. designed for insertion into a standard PC-compatible expansion slot. For the test model, the author etched the p.c.b. as two single-sided boards, plugging them into two expansion slots. As explained later, with only minor changes, the ADC board can also be used as an ADC interface for non-PC-compatible computers.

All components on the ADC board may be mounted conventionally. The capacitors do not need to be mounted flat, and i.c. sockets may be used. As with the other boards, carefully check the soldering and correct component orientation. Ordinary unscreened 3-core cable of about two or three metres in length may be used to connect the Biomet to the ADC board.

Although the Biomet uses an opto-isolator to isolate its circuits from the ADC, *care MUST be taken to ensure that the interconnecting cable cannot come adrift and touch the mains connections within the computer.*

SETTING-UP

All voltage measurements quoted in the following setting up procedure can be taken using either a digital or an analogue multimeter. Except for opto-isolator measurements, the meter's common probe is connected to the 0V line of the power supply (battery negative, or wiring pin number 8 on the Display board).

The positive probe is connected to the point which is referred to as being "monitored" or "checked". Unless otherwise stated, all quoted voltages are d.c. Note that quoted a.c. voltages may differ between meter types due to the meter's waveform interpretation technique.

If parts of the circuit fail to work as described, it is likely that an assembly or soldering error has been made in the associated areas. Component failures, although possible, are usually unlikely.

Check out the Sensor board first. It may be connected to the Display board, but not yet to the ADC board. Switch on the 9V supply and check that the voltage on TP1 (test point) is approximately 4·5V (half the battery voltage level).

Monitor TP2 and observe that the voltage here is changing between about 1V and 8V (the exact swing range may vary depending on the meter's response time; the important point being checked is that the circuit is slowly oscillating). Adjust VR5 until the circuit oscillates at about one cycle per second. Turn the wiper of VR6 fully clockwise (maximum output).

Set the wiper of preset VR2 midway.

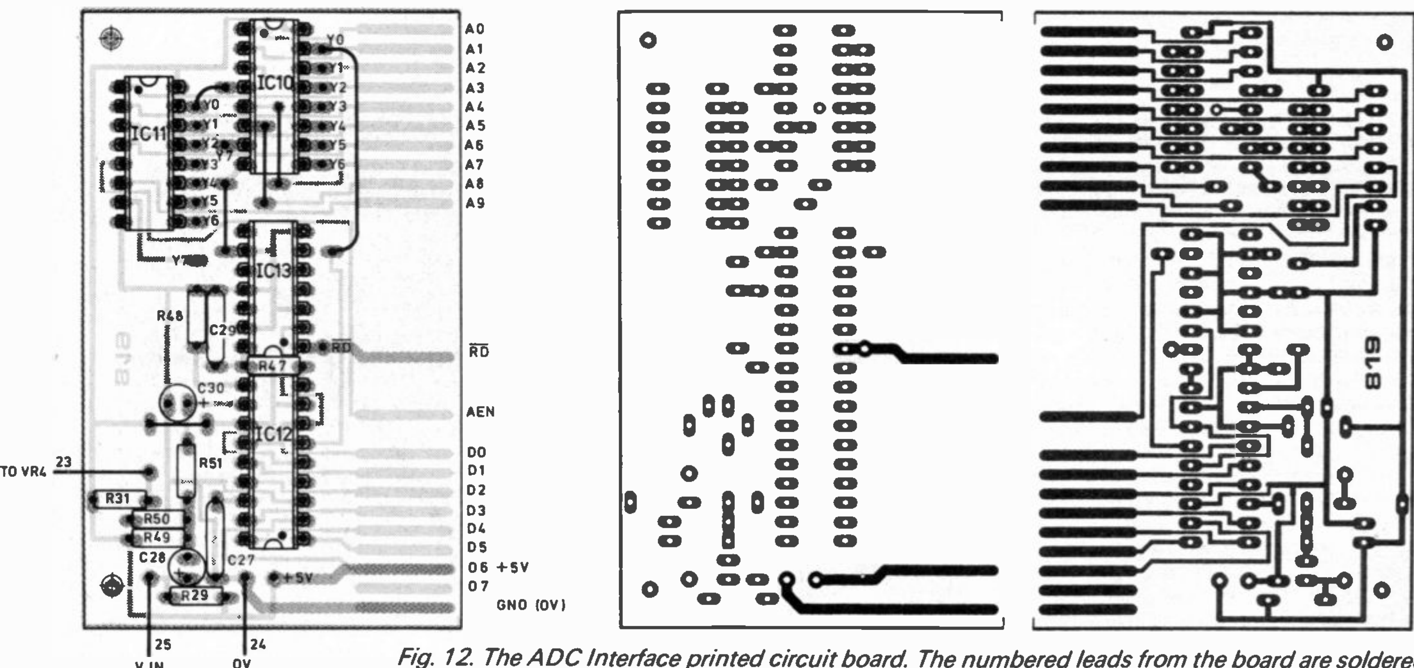


Fig. 12. The ADC Interface printed circuit board. The numbered leads from the board are soldered in the stereo jack plug JK2, see Fig. 8 and Fig. 11 (last month).

Check that an a.c. voltage is present on TP3, probably reading about 4V a.c. This checks that the 5kHz oscillator is running, although not necessarily at exactly 5kHz.

Turn the wiper of VR3 fully clockwise (maximum gain), and set the wiper of VR1 midway. With all jack sockets empty of plugs, monitor TP4 and check that the voltage here is changing up and down at the same rate as that on TP1, although probably at a lower amplitude.

If l.e.d. D4 has been included, it should now be flashing. Due to the nature of the amplified test oscillator waveform, the l.e.d. may flash at twice the rate of the oscillator, responding to both phases of the test waveform pulses. If the l.e.d. has been omitted, monitor IC3 pin 14 and observe that the voltage on this pin is strongly "toggling" up and down, so proving that the comparator is working.

Reducing the setting of VR3 (turning its wiper anti-clockwise) will reduce the amplitude of the output at TP4, eventually to the point at which the comparator ceases to be triggered. Reducing VR6 should have a similar effect.

DISPLAY BOARD CHECKING

Re-adjust presets VR3 and VR6 until the comparator is again being triggered. Monitor TP5 and check that it is toggling at the same rate as the test oscillator output at TP2.

Check that a voltage of +5V is present at TP6. Monitor TP7 and check that an a.c. voltage is present (probably about 2·5V a.c.), so proving that the oscillator of IC7 is functioning. Check that IC8 pin 3, IC8 pin 11, and l.c.d. pin 1 or pin 40 all produce similar a.c. readings. Now check that a negative voltage of about −3·8V is present at TP8.

With these tests carried out, it should be apparent that the l.c.d. screen is active. The + (plus) symbol should be flashing in time with the output at TP5, and at least three digits should be visible, displaying any number from 000 upwards.

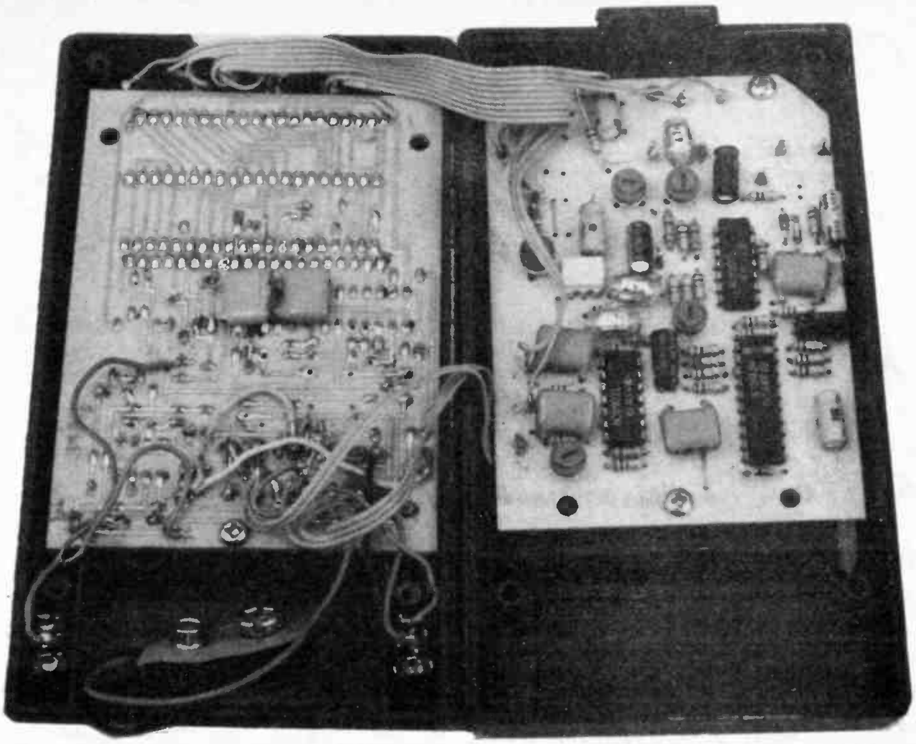
Monitor TP9 and adjust VR8 until the multimeter shows a reading of one volt, or as close as possible. This sets the reference level against which the DPM chip IC7 assesses the values of input data voltages.

Switch on S2, so setting the Biomet into battery check mode. Check the precise voltage across the 9V battery and adjust VR9 so that l.c.d. shows a reading 10 times the numerical value on the meter. That is, if the meter reads 9·2V, set VR9 so that l.c.d. shows a reading of 092. Remember when setting VR9 that the l.c.d. updates its numerical display at a rate of about one sample every two or three seconds.

Alignment of the pulse rate converter stage around IC8 can now be carried out. Switch S2 back from battery test to pulse rate monitor mode. Observe the l.c.d. and make sure that the + (plus) symbol is flashing evenly, adjusting any associated presets if necessary.

Monitor TP5 and adjust VR5 so that about 60 pulses can be counted during a period of exactly 60 seconds. Adjust the wiper of VR7 until the l.c.d. shows the same number, i.e., if the pulse count over 60 seconds is 61, set the l.c.d. readout for 061.

There is a slight chance that the span range of VR7 may be just under that actually required. If so, fractionally reduce the reference voltage at TP9 by readjusting the wiper of preset VR8 until the display shows the correct number. This action will then necessitate the resetting of the battery check preset VR9.



The completed Biomet opened out to show the Display and Sensor boards mounted in the hand-held case. The sensor board is the one on the right.

50Hz SUPPRESSION

If an accurate frequency counter is available, the 50Hz filter can be aligned by adjusting VR2 until the frequency output at TP3 is exactly 5kHz.

Alternatively, the correct clock frequency can be set using a multimeter. However, this technique requires that the Biomet is being set up within a few metres of mains powered equipment which radiates at least a small amount of 50Hz "hum".

Plug the chest probe cable into SK1. Temporarily join together the far ends of the cable pair so that electrical contact is made. This ensures that the probe lead will pick-up 50Hz "hum" equally along both its paths, feeding it equally to preamps IC1a and IC1b.

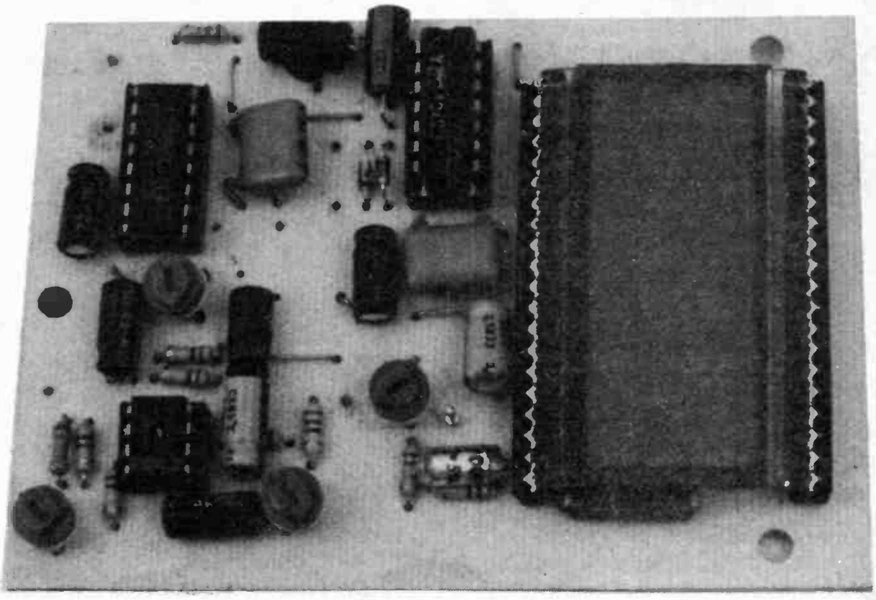
Monitor TP4 on a millivolt a.c. range. Touch a finger to the bare wire at the far end of the chest probe lead. The 50Hz hum picked up through your body will be amplified by the circuit. If necessary, adjust the setting of VR3 to increase the gain. Carefully adjust VR2 until the meter reading is at its lowest millivolt a.c. level.

For the alignment of the differential circuit's balance, keep the probe and meter connections as above. Now adjust VR1 until the lowest millivolt a.c. reading is obtained. If adjusting VR1 makes no difference, leave its wiper at about midway.

ADC INTERFACE INSERTION

The software Listing 1 does not need to be loaded for the initial checking of the opto-isolator and the ADC.

Switch off the Biomet and the computer. Referring to the computer manual and the



The completed Display board. Note the radial electrolytics are laid flat to save space and the display driver i.c. is mounted under the LCD.

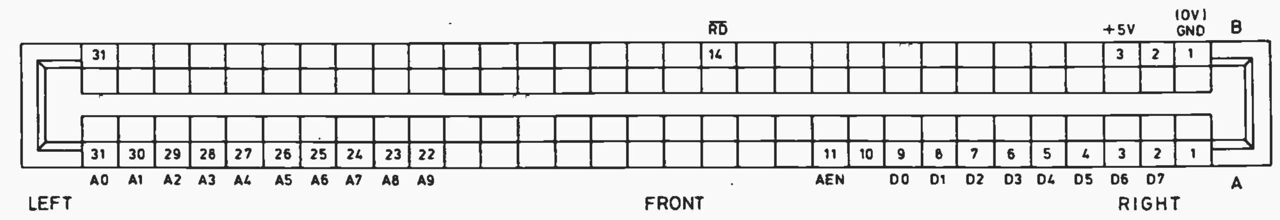


Fig. 13. PC-compatible expansion socket. (Orientation as found in the Amstrad 1640.)

PC-compatible expansion slot shown in Fig.13, check the correct orientation for the ADC board. Insert the board carefully into the expansion slot, ensuring that the edge connector tracks line up with the slot terminals. It may be necessary to slightly file down the sides of the p.c.b. in order to achieve satisfactory alignment.

Switch on the computer. If it does not respond correctly as usual, immediately switch off and recheck the interface assembly and insertion.

Assuming that all is well, plug the interface connecting lead into SK2 of the Biomet. This can be done with the computer switched on since resistors R29 and R31 in series with the lead prevent any brief shorting between the connector pins from placing an adverse load on the computer power supply.

Insert an unconnected jack plug into Biomet socket SK3 to switch the test oscillator out of circuit. Connect the multimeter's common lead to the computer 0V connection at TP11. Monitor the collector of the opto-isolator's output transistor at TP10 and adjust the wiper of VR4 until the meter reading is about 2·5V.

Remove the jack plug from SK3 to bring the test oscillator back into circuit. Check that the voltage at TP10 now changes in time with the test oscillator rate.

The Biomet is now ready to have the signal on TP10 processed by the computer.

SOFTWARE

The software, Listing 1, is written in QUICKBASIC, but is compatible with GW-BASIC. These are two of the most popular Basic dialects for PC-compatibles. Users of QUICKBASIC may delete the line numbers except where they are associated with GOSUB and GOTO routines.

The program begins by setting the screen colour and graphics modes, and specifying display and printout factors.

The routine commencing at line 280 reads data from the ADC board via the computer bus address decimal 768 (lines 310 and 340) and plots it as a waveform on the screen. The 'Z$=INKEY$' statement in line 290 reads the keyboard and if a key has been pressed any relevant action stated within the subroutine between lines 440 and 520 is performed. The actions include changing trigger level and waveform positioning factors, and also calling the printer subroutine between lines 530 and 650.

The printer commands conform to standard Epson protocols and should be recognised by the majority of 9-pin or 24-pin dot-matrix Epson printers.

SOFTWARE RUNNING

Type the Biomet software program into the computer, save it and then run it with the Biomet connected as above.

The computer should go straight into graphics mode, showing a blue background with yellow lines creating three boxed sections each containing a red horizontal line. The screen should also show the start of a moving green trace within the first box, representing the waveform being monitored via the ADC Interface.

After filling all three boxes, the green trace will resume from the top of the screen, each box being cleared of the previous trace before the new one begins.

Vertical positioning of the trace on screen is software controlled but the alignment of its waveform shape is determined by the bias on the opto-isolator transistor, as set by VR4. Carefully adjust VR4 until the upper and lower points of the screen trace appear to be fully displayed. If necessary, modify the signal amplitude by adjusting VR3 and/or VR6.

When the screen trace reaches the end of each boxed section, the heart pulse rate is calculated and displayed. The rate is established from the number of times that the waveform amplitude has crossed a trigger value during its pass across the screen. Represented on screen by a red line, the trigger value can be moved up or down by pressing the "+" or "−" (plus or minus) keys on the keyboard.

Listing 1: BIOMET PC-Compatible Software Program

```
100 REM HEART MONITOR HE103 06 OCT 92
110 REM SOFTWARE COMPATIBLE WITH QUICKBASIC AND GWBASIC
120 SCREEN 0: COLOR 15, 4: SCREEN 1: COLOR 1, 2
130 DEFINT A-B, P, T: Q = 10: W = 25: TM = 96.2
140 DIM P(300), G(1300), A(319, 2), B(319, 8)
150 DATA 255,127,63,31,15,7,3,1,128,192,224,240,248,252,254,255
160 FOR A = 0 TO 7: READ T(A): NEXT: FOR A = 0 TO 7: READ V(A)
170 NEXT: FOR A = 0 TO 8: B(0, A) = 255: B(319, A) = 255: NEXT
180 J(0) = 1: J(1) = 255: J(2) = 255: J(3) = 255: X$ = CHR$(27)
190 B$ = X$ + "*" + CHR$(1) + CHR$(64) + CHR$(1)
200 G$ = B$ + CHR$(255): FOR A = 1 TO 318: L$ = L$ + CHR$(1)
210 NEXT: P$(0) = " ": P$(1) = CHR$(3)
220 LOCATE 1, 3: PRINT "PULSE         TRIG [+/-]  GRAPH [u/d]"
230 FOR D = 8 TO 199 STEP 63: FOR A = TM TO 319 STEP TM
240 LINE (A, D + 63)-(A, D + 60), 3: NEXT
250 LINE (0, D)-(319, D), 3: LINE (1, D + W)-(318, D + W), 2
260 NEXT: LINE (0, 8)-(0, 196), 3
270 LINE (319, 9)-(319, 196), 3: GET (1, 9)-(318, 72), G
280 F = 0: FOR D = 8 TO 194 STEP 63
290 Z$ = INKEY$: IF Z$ <> "" THEN X = W + D: GOSUB 440
300 PUT (1, D + 1), G, PSET
310 P = 0: Y = 0: C = Q + 64 - (INP(768) AND 63)
320 IF C > 63 THEN C = 63 ELSE IF C < 1 THEN C = 1
330 PSET (1, D + C): IF C < W THEN Y = 1
340 FOR A = 1 TO 318: B = Q + 64 - (INP(768) AND 63): X = 0
350 IF B > 63 THEN B = 63 ELSE IF B < 1 THEN B = 1
360 IF B < W THEN X = 1: IF X <> Y THEN P = P + 1: P(P) = A
370 IF X <> Y THEN LOCATE 1, 1: PRINT P$(X)
380 LINE -(A, D + B), 1: A(A, F) = B: FOR Z = 1 TO 3: NEXT
390 Y = X: NEXT: IF P < 2 THEN T = 0: S = 0: GOTO 410
400 S = INT((P(P) - P(1)) / (P - 1) * 10) / 10: T = TM / S * 60
410 LOCATE 1, 8: PRINT T; "  ": F = F + 1: NEXT
420 GOTO 280
430 REM At input of 1.0Hz, S is the correct value for TM
440 IF Z$ = "p" THEN GOTO 530
450 IF Z$ = "+" THEN W = W - 1: IF W = 0 THEN W = 1
460 IF Z$ = "-" THEN W = W + 1: IF W > 63 THEN W = 63
470 IF Z$ = "u" THEN Q = Q - 1: IF Q = -11 THEN Q = -10
480 IF Z$ = "d" THEN Q = Q + 1: IF Q = 21 THEN Q = 20
490 Z$ = INKEY$: IF Z$ <> "" THEN GOTO 440
500 PUT (1, D + 1), G, PSET: LINE (1, X)-(318, X), 0
510 LINE (1, W + D)-(318, W + D), 2
520 GET (1, D + 1)-(318, D + 63), G: RETURN
530 WIDTH LPRINT 255: LPRINT : LPRINT X$; "@"; CHR$(1); CHR$(15)
540 LPRINT TIME$; "  "; DATE$; "  PULSE RATE"; STR$(T); X$; "0"
550 FOR K = 0 TO 2: L = W + (K * 63) + 8: PSET (1, L)
560 FOR A = 1 TO 318: LINE -(A, L), 3
570 C = A(A, K): E = A(A + 1, K): IF C > E THEN SWAP C, E
580 M = INT(C / 8): N = INT(E / 8): B(A, M) = T(C MOD 8)
590 FOR H = M + 1 TO N: B(A, H) = 255: NEXT
600 B(A, N) = B(A, N) AND V(E MOD 8): NEXT
610 LPRINT B$; CHR$(J(K)); L$; CHR$(J(K))
620 FOR M = 0 TO 7: LPRINT G$;
630 FOR A = 1 TO 318: LPRINT CHR$(B(A, M)); : B(A, M) = 0: NEXT
640 LPRINT CHR$(255): NEXT: NEXT
650 LPRINT B$; CHR$(J(K)); L$; CHR$(J(K)): K = 0: RETURN
```

The waveform's position on the screen can be moved up or down by pressing lower-case (unshifted) keys "u" or "d". Vertically moving the trace will also change its relationship to the trigger value. New trigger and positioning values are actioned only in the interval between the trace moving from one box to another.

PRINTOUT

A printout of a screened waveform can be called by pressing lower-case (unshifted) "p". The printout instruction will be actioned when the screen trace reaches the end of its current screen box.

The boxes are scanned by software one at a time, the printout being made after each box has been scanned. The scanning process is indicated by a yellow line being drawn in place of the red trigger line. Following completion of the full screen printout, normal monitoring and screen display resumes as before.

PULSE RATE CALCULATION

The rate at which the monitored waveform crosses the screen will depend on the speed at which the computer processes the software commands. This factor must be taken into account during the pulse rate calculations and is held by the numerical value of variable 'TM' in line 130. The value of 'TM=96.2' as shown was that required when the listing was compiled by QUICKBASIC for running on an Amstrad 1640.

The value of TM for other computer/software configurations is easily established from the 'S= . . .' routine in line 400 when related to a pulse input rate of exactly 1Hz. Set the Biomet test oscillator for a rate of as close to 60 pulses per minute as you can realistically achieve. Alternatively, via SK3, feed in a pulse rate of 1·0Hz from a signal generator.

Run the program with TM at the value shown in the listing. Shift the trigger level up or down until the waveform evenly crosses the red line. Then, after one or more boxes of waveform data have been displayed on screen, stop the program by pressing keyboard keys CTRL and BREAK. Now tell the computer to print the value of 'S' (PRINT S <RETURN>).

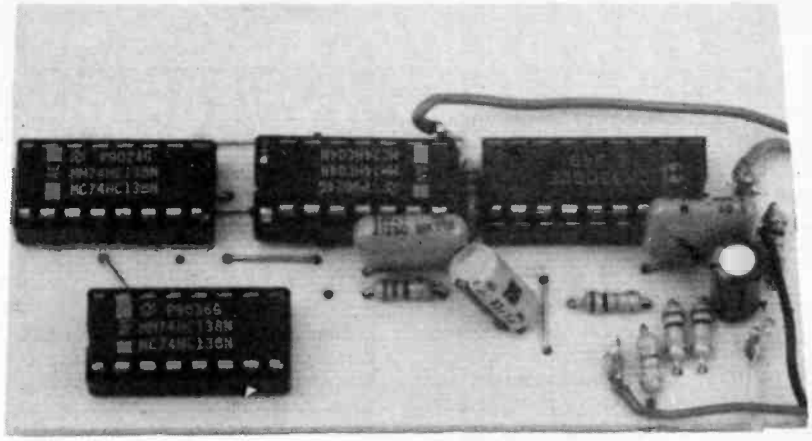
Substitute the answer for the existing value of TM, then resave the program. Note that with repeated samplings of the 1Hz input waveform, the value of S may change slightly depending on the inevitable hysteresis of the ADC sampling and display procedure. If so, choose an average value of S.

PC-INCOMPATIBLES

It is regretted that neither the author nor *EPE* can advise on converting the software listing for other Basic dialects, or for use with computers which are not PC-compatible.

However, if you wish to interface the Biomet to a non-PC-compatible computer, you may find that you can make use of the ADC part on its own, omitting the address decoding lines, and putting the p.c.b. in a separate box. For example, your computer may have a User Port dedicated to external input/output interfacing. If so, the ADC can be entirely controlled by the eight data lines of the User Port. The computer manual will advise on the location of the +5V/GND power supply points.

Omit IC10, IC11 and IC13. Connect D0-D6 of the p.c.b. to D0-D6 of the User Port.



Early prototype topside component layout for the ADC Interface board. The final board is a double-sided p.c.b., see Fig. 12.

Connect D7 of the User Port to the $\overline{RD}$ connection of the p.c.b.. Solder a link wire between pins one and two of the IC13 position. Connect IC12 pin 6 to IC12 pin 3 (so grounding pin 6). IC12 is then under control from User Port line D7 allowing D0-D6 to be read on command, as follows:

First load the User Port data direction register with decimal 128, so setting bits D0 to D6 as inputs and D7 as an output. IC12 can then be controlled by setting D7 high, reading the data on D0 to D6, and then setting D7 low.

For example, a routine which would cause a Commodore 3032 to sample the ADC and print its output value on the computer screen is:

```
10 POKE 59459,128: REM SET DATA
   DIRECTION REGISTER
20 POKE 59471,128: REM SET D7
   HIGH
30 A=PEEK (59457) AND 127: REM
   READ D0 TO D6
40 POKE 59471,0: REM SET D7 LOW
50 PRINT A;: REM PRINT DECIMAL
   VALUE OF D0 TO D6
60 GOTO 20: REM REPEAT
   SAMPLING INDEFINITELY
```

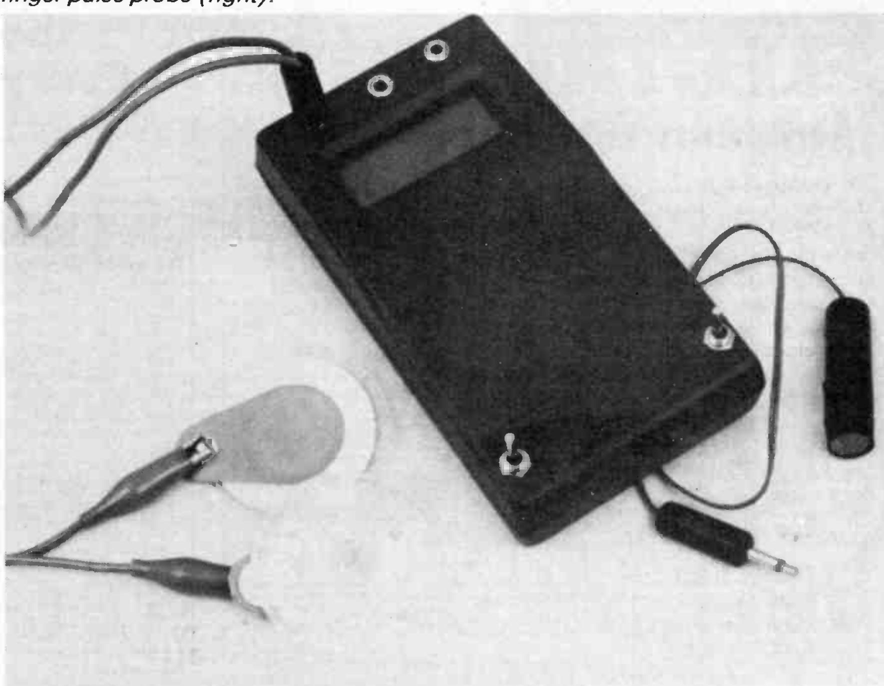
CHEST MONITORING

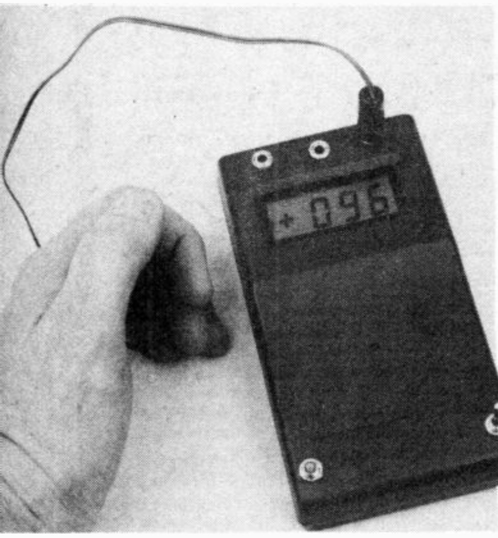
Standard medical chest-monitoring electrode pads were used with the Biomet test model. Measuring about 47mm in diameter, they are self-adhesive and have a press-stud to which the connecting leads can be attached using small crocodile clips. The author's pads came from a medical supply company, although some chemists may also be able to supply them.

Electrical contact with the skin is optimised by the lubricant with which the pads are impregnated during manufacture. The pads can be re-used several times if the electrical contact area is smeared with K-Y lubricating jelly (available from chemists) prior to each re-use. When the adhesive eventually weakens, the pads may be secured to the chest using strips of first-aid plaster.

It is not essential to use commercial monitoring pads. The author has satisfactorily used two copper discs the size of 2p coins. Connecting leads were soldered to the discs, which were then smeared with K-Y jelly. The use of larger discs will increase the signal strength.

The completed Biomet showing the chest-monitoring electrodes (left) and the finger pulse probe (right).





Using the finger probe.

There are many places on the body at which heart and blood flow pulses can be sensed and you may find it interesting to experiment with the monitoring pads connected to different body zones. However, the strongest heart signals are likely to be found with one pad attached to the upper right chest, and the other attached to the lower left of the rib cage. Connect the pads to these positions and plug their cable into SK1. Adjust VR3 until the l.c.d. + (plus) symbol flashes or the signal waveform shown on the computer screen is at a reasonable amplitude.

It may be necessary to move the probe pads around a bit until the optimum signal strength is obtained. The subject should remain as still as possible during monitoring since muscle movements can generate strong electrical impulses.

FINGER PULSE MONITORING

With the chest probe unplugged from SK1, plug the finger pulse probe into SK3.

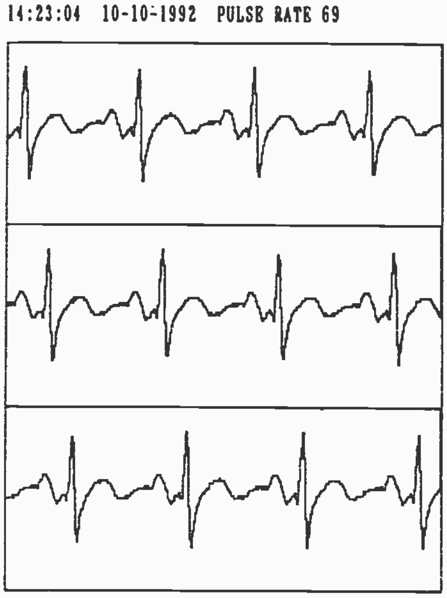


Fig. 14. Typical readout of monitored heart rhythm using chest probes.

Enclose the probe body between the fingers and palm of one hand, then place the thumb lightly over the face of the light sensor.

Turn the hand so that the thumb faces any reasonably bright light source, daylight or artificial. Adjust the settings of VR3 and/or VR6 until the l.c.d. "+" (plus) symbol flashes evenly in response to changes in the blood flow. Keep the hand as still as possible to avoid erratic triggering.

EXAMPLE WAVEFORMS

As an example, the waveform generated by a normally healthy subject and monitored using the Biomet is shown in Fig. 14. The waveform displays typical strong peaks at regular intervals with two

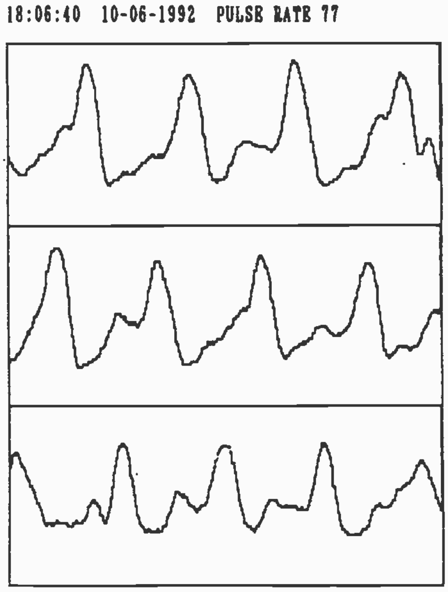


Fig. 15. Typical readout of monitored pulse using finger probe.

lesser peaks between each main peak. There are several variations of this type of waveform which are of no significant medical concern.

A printout of another healthy subject's pulse as detected by the finger probe is shown in Fig. 15.

Typically, the heart rate of a moderately relaxed subject will be between about 60 and 90 pulses per minute. Following exertion, heart rates may rise much higher.

Medical texts should be consulted for information about pulses rates and the interpretation of heart waveforms. Heed a note of caution, though. Before hastening to the nearest hospital armed with a printout showing an unusual waveform, make sure that your monitoring equipment or technique is not faulty! □

Techniques

ACTUALLY DOING IT!

by Robert Penfold

IT IS quite a time since I last received a letter which included a question such as *"how many ohms are there in a microfarad?"*. As ohms are the units used in resistance values, and farads are the units used for capacitance, the question is basically nonsensical. However, for a beginner electronics can sometimes be a bit confusing, with a plethora of new terms, names, etc. to contend with.

BASIC UNITS

The basic units of measurement used in general electronics are given in Table 1, and should help to clarify matters. Note that although "R" is the generally accepted abbreviation for ohms, previously the Greek letter omega (Ω) was used. Omega is still used to some extent, and it is something you are likely to see quite often in component catalogues and other publications.

At *Everyday with Pratical Electronics"* we have stopped using the letter R for resistor *values* where it applies to ohms, i.e. 100R (100 ohms) would be shown as just 100 on the circuit diagram. We have also dropped the use of the letter F for capacitor values, except of course "whole units" – see later.

Learning the right units for each type of component, etc. should not be too difficult, and it is something that you should pick up as you go along. In electronics there is no substitute for "hands on" experience, and by building simple projects and actually using components you will gain a great deal of knowledge, even though you may not realise it at the time. I know that this is a point I have made many times before, but it is one that it is definitely worth making again.

TRUE VALUES

One problem with some of the basic units of measurement used in electronics is that they are extremely large. Capacitance values are measured in farads, but you are unlikely to encounter capacitors of so many farads in value.

There are capacitors of about one farad in value listed in some component catalogues, but these are "specials" which are intended as an alternative to NiCad batteries in memory back-up circuits. In normal electronics most capacitors have values of a few thousandths of a farad or less. In radio circuits there are often capacitors having values of a few millionths of a millionth of a farad.

As well as inconvenient units of measurement, there is also a slight problem in that the difference between the highest and lowest values in general use can be truly vast. An audio power amplifier could well have resistors of a few million ohms in value in its preamplifier stage, while in its output stage there could be resistors of just a fraction of an ohm in value.

In order to avoid having most electrical quantities expressed using huge multi-digit numbers, often having a decimal point followed by half a dozen zeros before the important digits are reached, very large or small numbers have a prefix letter. This prefix letter indicates that the units in use are some fraction or multiple of the basic unit of measurement.

For example, most electrolytic capacitors have their values marked as so many µF. The "µ" is an abbreviation for "micro", which simply means *"one millionth of"*. A 2·2µF capacitor therefore has a value of 2·2 microfarads, or 0·0000022 farads in other words.

It is now the accepted practice for the letter indicating the units of measurement to be used to indicate the position of the decimal point as well. Consequently, a value of 2·2µF would normally be written in the form "2µ2". A value of 47µF would be written as simply "47µ", and one of 0·47µF would normally appear on circuit diagrams, etc. in the form "0µ47".

The "F" for farads, "R" for ohms, etc. are usually omitted when this system is used. The exception is when the units in use are the basic unit of measurement (e.g. 4R7 is 4.7 ohms). If the "R" (or whatever) is not needed to indicate the position of the decimal point, then it is often omitted. For example, a value of 680R would normally be appear as just "680" on a circuit diagram or in a components list.

The main point of this system is that it keeps the number of digits used to a minimum, which is helpful when values have to be marked on small components. It is also useful in that it minimises the size of labels on circuit diagrams, which helps to keep the diagrams as uncluttered as possible.

Table 2

Letter	*Prefix*	*Multiplier Value*
p	Pico	0·000000000001
n	Nano	0·000000001
µ	Micro	0·000001
m	Milli	0·001
k	Kilo	1000
M	Mega	1000000
G	Giga	1000000000
T	Terra	1000000000000

COMMON UNITS

The standard prefix letters, what each one stands for, and the multiplication factor it represents are shown in Table 2. Some letters are shown as upper case, while others are given in lower case. To be strictly accurate you should always use whichever case is shown in Table 2.

It is particularly important to use the right case for the letter "m", since in lower case it represents milli (one thousandth), and in upper case it stands for mega (one million). Although the letter "u" is now generally accepted as the abbreviation for micro, previously the Greek letter mu was used. In fact it is still used a great deal, and it is the abbreviation for micro that is normally used in *Everyday With Practical Electronics.*

The prefixes from pico to mega are in common use, and you need to become familiar with them. Giga and terra are little used in practice, and are mainly of academic importance.

There is a potential source of confusion in that you may find the same value written in two or three different forms. For example, a components list might specify a capacitor having a value of 10n, but in a components catalogue you might find polystyrene capacitors listed as having values from 10p to 22000p, and polyester capacitors having values from 0·01µ to 1µ. Reference to Table 2 will reveal that 10n is the same as 10000p (1n = 1000p), and that it is also the same as 0·01µ (1µ = 1000n).

When dealing with capacitance values it is more than a little helpful to bear in mind that 1µ equals 1000n and 1000000p, and that 1n equals 1000p. Similarly, with resistors it is useful to remember that 1M equals 1000k and 1000000R, and that 1k equals 1000R.

CRYPTIC CAPACITORS

Some components have the value marked in a straightforward form that is

Table 1: Basic Units

Component/Measurement Type	*Letter*	*Units*	*Value Range*
Resistors	R	Ohms	0R1 to 10M
Resistance (In General)	R	Ohms	1mR to 1TR (tera)
Capacitors (non-elect.)	F	Farad	1pF to 2µ2
Capacitors (elect. & tant.)	F	Farad	220n to 10000µ
Capacitors (variable/trimmer)	F	Farad	5pF to 500pF
Inductors	H	Henries	0·1µH to 4H
Loudspeakers (impedance)	R	Ohms	2R to 80R
Headphones (impedance)	R	Ohms	8R to 4k
Impedance (general)	R	Ohms	1mR to 1TR
Voltage	V	Volts	1µV to 20kV
Current	A	Amperes	1nA to 10A
Power	W	Watts	1µW to 1kW

easy to interpret. For example, capacitors are often marked with something like "10n" or "560p". Some components have their values marked in rather more cryptic forms.

Most resistors, plus some capacitors and inductors, have their values marked using coloured bands and a simple method of coding. This is a topic which merits an article of its own, and it is not something that we will pursue further here.

Many capacitors, and disc ceramic types in particular, have the value marked using a three digit number. This method can be a bit confusing at first sight, but it is really quite simple to follow.

As a simple example, suppose that a capacitor is marked "104". The first two digits are simply the first two digits of the value. The third digit is the number of zeros that must be added to the first two digits in order to give the full value in picofarads.

In our "104" example the first two digits are obviously "10", and the third number indicates that four zeros must be added to these in order to give the full value. The component therefore has a value of 100000p, which is the same as 100n and 0µ1.

This method of marking seems to be used for capacitors from about 1n to 470n in value. Table 3 provides some further examples which should help to clarify the way in which this system operates.

On these capacitors, and many other types of component, you will often find all sorts of extra letters and (or) figures. These seem to worry some newcomers to project construction, but you soon get used to picking out the important digits and ignoring the rest.

The extra letters and numbers are usually of no relevance at all. In most cases they are simply manufacturers batch numbers, or other markings which are only of significance to those at the factory where the components were produced. However, a few of these additional markings do tell you something useful about the components.

Table 3

Marking	Value (p)	Value (n)	Value (µ)
102	1000	1	0·001
222	2200	2·2	0·0022
472	4700	4·7	0·0047
103	10000	10	0·01
333	33000	33	0·033
683	68000	68	0·068
224	220000	220	0·22

For capacitors the most common additional marking is the maximum operating voltage. This will simply be marked in the form "50V" or whatever. The tolerance of the value may also be marked on a capacitor in a straightforward fashion (e.g. "20%"). The tolerance is often marked using a standard code letter, as detailed in Table 4.

Table 4

Code Letter	Tolerance
F	1%
G	2%
H	2·5%
J	5%
K	10%
M	20%

A capacitor helpfully marked "473K 63V" would therefore have a value of 47n, a tolerance of 10 per cent (i.e. the value is within 10 per cent of 47n), and a maximum voltage rating of 63 volts. A capacitor rather unhelpfully marked "M47 682 3859" would presumably have a value of 6n8, possibly with the "M47" indicating a tolerance of 20% and a maximum operating voltage of 47 volts. The "3859" would be purely extraneous data.

SHOP TALK

with David Barrington

Car Electric Window Enhancer

All components needed to construct the *Car Electric Window Enchancer* are standard items and should not cause any sourcing headaches. However, care must be taken when selecting the relays, they must be able to handle (break) the high motor current if a stall condition is encountered. Also, they must have an identical contact layout if they are to sit directly on the p.c.b. The 12V 16A relay used on the model was bought from **Maplin**, code YX99H.

It is important that heavy-duty insulated wires (50/0·25mm) be used for off-board wiring. Due to the large currents, the leads must be soldered *directly* to the underside copper pads as indicated. In addition, the underside copper pads as indicated. In addition, the copper tracks which take the relay contacts, and the track associated with R9/R12, should be reinforced by soldering heavy-duty wires along their tracks.

The printed circuit board is available from the *EPE PCB Service*, code 821 (see page 227). It is most essential that *before* commencing construction, the vehicle manual is consulted to make sure that the window controller can be fitted to the car. If in any doubt at all seek the advice of your local garage workshop.

Biomet Pulse Monitor

Most of the "special" components required to build the *Biomet Pulse Monitor* were covered last month. But to reiterate, the CA3306CE 6-bit flash ADC chip required for this month's *ADC Interface* board is available from **Maplin**, code CR23A.

The location and purchase of the self-adhesive chest-monitoring electrode pads could be a problem. It is a case of searching the local directory for a "medical equipment" supplier listing or approaching the local chemist to see if they can help. However, as pointed out, it is not essential to use commercial monitoring pads and it might mean adopting a similar method to that described by the author.

The double-sided interface printed circuit board is available from the *EPE PCB Service*, code 819 (see page 227). It is regretted that we cannot advise on converting the software listing for other Basic dialects, or for use with computers which are not PC-compatible.

Personal Stereo Amp. – Add-On

The small add-on circuit for the *Personal Stereo Amplifier*, published in the November '92 issue, is the result of requests from readers for a version which will operate with three volt personal stereos. The components are all readily available and should not cause any purchasing problems.

However, when ordering the voltage regulator you must ask for the LM317T type, with the emphasis on the suffix **T**. Other types seem to be rated at less than one amp.

The small printed circuit board for the *Add-On Circuit* is available from the *EPE PCB Service*, code 823, and is designed to mount directly on the main board (Nov '92), once the original regulator (IC2) and associated components have been removed. (C10 may have to be mounted vertically or replaced with a radial type).

Spatial Sound

Once again, the components listed for the *Spatial Sound* project are "off-the-shelf" items and should all be stoked by most of our components advertisers. The stripboard is not a standard size and will have to be cut from a larger piece.

The two-piece plastic case, with aluminium front and rear panels, or one very similar should be available from most advertisers. This is one area where suppliers carry very good stocks and sometimes have "special offers" running.

Scart connectors should now be widely available. They are certainly carried by **Cricklewood**, **Maplin**, **Cirkit**, **Greenweld** and **Marco Trading** to name a few.

Simplifly Atari STFM Interface

There is not a lot to report in the way of hard to find parts for the *Simplifly Atari Interface*.

The keyboard switch and cap were purchased from **Maplin**, codes FF61R and FF62S (keytop 1) respectively. The chassis mounting D-connectors are available from most sources, but may be offered in separate parts i.e. shell, cover and possibly the jack posts.

The printed circuit board is available from the *EPE PCB Service*, code 822.

We do not expect any component buying problems to be encountered by readers who wish to tackle the *Microphone Compressor* or the *Mini Lab Teach-In* projects.

Kit News

After many years of experience in the audio visual field **Canal Bridge Audio** of London, have recently launched a full range of kits and professionally finished products for electronics enthusiasts, including surveillance, counter-surveillance, test kits and many other types.

Customers will have the choice between kit, module and professionally finished product. There are top quality kits at a very reasonable price for those wishing to build, modules for incorporation into projects, and the finished product for those who prefer the work to be done for them.

Among the many interesting items is a recording briefcase which, with a built-in highly sensitive microphone, is ideal for making high quality recordings of business meetings, conferences, etc.

An advice service is also provided by experienced staff to help with all manner of queries and give a full technical back-up. The design team is already working on updating models and expanding the innovative ranges, so it is worth keeping in touch for furture developments.

For a full catalogue write to: **Canal Bridge Audio, Dept EPE, 172, Caledonian Road, London N1 0SG.** ☎ *071 837 3744.*

VIDEOS
ON ELECTRONICS

Everyday with Practical Electronics is pleased to announce the availability of a range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They should prove particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

The first four videos available are:

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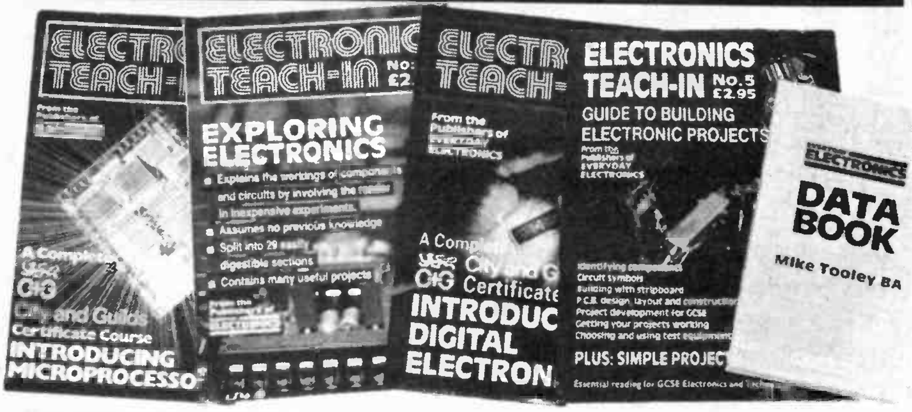

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Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book.
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The book contains the complete *Project Development for GCSE* series.

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(published by EE in association with PC Publishing)
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TESTING, THEORY AND REFERENCE

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Jack Darr and Delton T. Horn
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190 pages Order code T2925 **£9.05**

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages Order code BP239 **£2.95**

MORE ADVANCED USES OF THE MULTIMETER
R. A. Penfold
This book is primarily intended as a follow-up to BP239, (see above), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in chapter 2 extended the capabilities of a multimeter to make it even more useful. The add-ons described include an active r.f. probe, a high resistance probe, an a.c. sensitivity booster, and a current tracer unit.
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THE ILLUSTRATED DICTIONARY OF ELECTRONICS – 5th EDITION
Rufus P. Turner and Stan Gibilisco
With more than 27,000 terms used in electronics today, this collection is THE most comprehensive dictionary available. Including all practical electronics and computer terms, it is as up-to-date as the latest advances in the field itself! Tables and data on subjects most often consulted for projects and experiments are included. Other conversion tables include English/metric and metric/English conversions for units of energy, power and volume, and Fahrenheit/Celsius temperature conversion charts.

Setting this edition apart from other electronic dictionaries is its emphasis on illustration. Featuring more than complete definitions, this fourth edition includes over 450 detailed drawings and diagrams.

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720 pages Order code T2900 **£23.95**

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.
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F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias – tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages Order code BP53 **£3.95**

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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The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components – resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
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The subjects covered include: PC overview; Memory upgrades; Adding a hard disk drive; Adding a floppy disk drive; Display adaptors and monitors; Fitting a maths co-processor; Keyboards; Ports; Mice and digitisers; Maintenance (including preventative maintenance) and Repairs, and the increasingly popular subject of d.i.y. PCs.

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R. A. & J. W. Penfold

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The book explains: what hardware requirements you need in order to run Windows 3.1 successfully, and how to install, customise and fine-tune the program, and how to optimise your system resources. How to manipulate Windows screens and how to run Windows and DOS applications under the Windows Graphical User Interface (GUI) environment. How to use the Windows triple Management system; Program Manager, File Manager and Print Manager to advantage. How to use the word processor accessory Write to type, edit, format, print and save documents.

How to use Paintbursh and its tools to draw and edit drawings, and how to set up, sort and search a Cardfile database and exploit its autodial feature. How to use the Windows Calendar to enter appointments, add special times and alarms. How to use the Terminal accessory to connect to remote systems, specify terminal emulation preferences, communications setting, telephone number and prepare files for transfer. How to use the Notepad, Macro Recorder, PIF Editor and Calculator.

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A summary of all DOS commands, illustrated with examples, is given in the penultimate chapter, which turns it into a useful reference guide.

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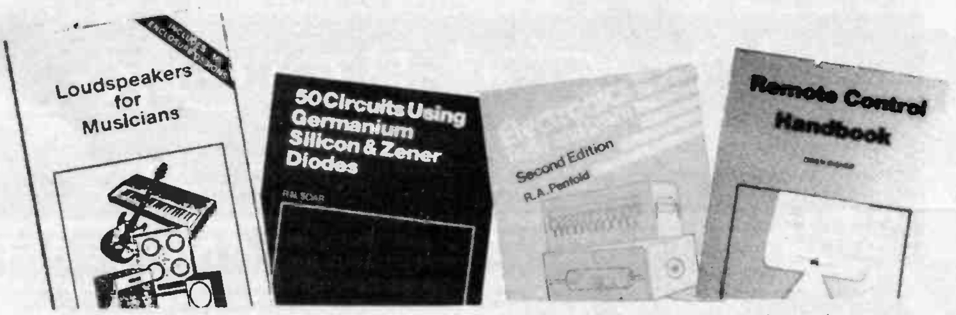

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R. A. Penfold
Modern synthesizers are extremely complex, but they mostly work on principles that are not too difficult to understand. If you want to go beyond using the factory presets or the random poking of buttons, this is the book for you.

It covers the principles of modern synthesis – linear arithmetic as used by Roland, phase distortion (Casio), Yamaha's frequency modulation, and sampling – and then describes how the instruments are adjusted to produce various types of sound – strings, brass, percussion, etc. The theoretical side of synthesis is treated in an easy to understand way – the technical information being restricted to what you need to know to use your instrument effectively.
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AUDIO
F. A. Wilson, C. G. I. A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems – amplifiers, oscillators, disc and magnetic recording and electronic music.
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DATA

PRACTICAL ELECTRONIC DESIGN DATA
Owen Bishop
This book is a comprehensive ready-reference manual for electronics enthusiasts of all levels, be they hobbyists, students or professionals. A helpful major section covers the main kinds of component, including surface-mounted devices. Foe each sort, it lists the most useful and readily available types, complete with details of their electronic characteristics, pin-outs and other essential information. A special feature of this section are the easily followed charts and tables which advise the reader on how to select the best type of component for any particular puspose.

Basic electronic units are defined, backed up by a compendium of the most often required formulae, fully explained. There are five more extensive sections devoted to circuit design, covering analogue, digital, radio, display, and power supply circuits. Over 150 practical circit diagrams cover a broad range of functions. The reader is shown how to adapt these basic designs to a variety of applications. Many of the circuit descriptions include step-by-step instructions for using most of the standard types of integrated circuit such as operational amplifiers, comparators, filters, voltage converters and switched-mode power supply devices, as well as the principal logic circuits.
328 pages Order code BP316 £4.95

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RADIO/TV

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I. D. Poole
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REPORTING AMATEUR RADIO

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Amateur radio two-way voice communication normally involves two stations on a single frequency, one transmitting and the other receiving, each switching from transmit to receive or vice-versa when an "over" is completed. Unlike using the telephone, which permits normal conversation without interruption, such "simplex" communication allows only one party to speak at a time and it is necessary to use a recognised procedure to indicate the end of an over.

If telephone type conversation is required it is necessary to set up a "duplex" arrangement which uses two separate frequencies, with one station transmitting continuously on one frequency and the second station likewise on the other.

This results in a more natural conversation, but as it usually requires at least an extra receiver at each end (if transceivers are in use) it is not always practicable, apart from the fact that double the usual amount of spectrum is required for the contact.

Now, according to a recent report in the *Japan Amateur Radio League News*, newly developed technology will result in "single-frequency 2-way simultaneous communication radio equipment". This is apparently achieved by dividing the operator's voice signals into 0·2 second segments, compressing them into half the time before transmission, thus leaving the other half for receiving.

I don't know when we are likely to see such equipment available on the amateur market or how expensive it will be. It will, of course, need to be compatible with older-style equipment otherwise there won't be many contacts possible, especially in the early days!

If and when it does comes into use it will not entirely result in the end of old-style amateur communication and "lingo". The licence regulations will still require each station to announce its callsign at the beginning and end of each transmission (which will then be the entire length of the contact and not the length of each over) and at 15 minute intervals during the transmission if it goes over that time.

I have a feeling, however, that something will be lost if amateur communication simply becomes the equivalent of just picking up a telephone!

AUSTRALIAN EXPERIMENT

A joint proposal has been made by the Queensland Department of Education and the Wireless Institute of Australia for a trial use of licensed amateur radio stations to transmit televised lessons between schools. A similar arrangement already works successfully in Canada which has similar problems to Australia in terms of distance and the availability of scarce resources.

The idea is to maximise the number of classroom hours available to specialist teachers in small communities. A teacher would remain at one location and communicate with students at a number of schools over a large area by means of amateur TV.

The Education Department has undertaken to train its staff in amateur radio. It will supply transmitting equipment including repeater stations, as necessary for the trial and the equipment may be used for normal amateur operation after school hours.

The WIA, which is Australia's national radio society, sees advantages in the increased use of amateur frequencies for the benefit of the community at a time when most amateurs themselves are unable to use them. It also visualises an increased interest in amateur radio as a result of its greater exposure outside the hobby.

At the time of writing, the Australian licensing authority was considering this proposal, having previously put it out to consultation in the amateur community at large. It is hard to visualise, however, that there could be any objections to this imaginative idea.

RSGB ANNUAL REPORT

How does one describe the scope of the work of the Radio Society of Great Britain, our national Amateur Radio Society? In his introduction to the Society's Annual Report, 1991-92, General Manager Peter Kirby describes it as "adviser, negotiator, publisher, librarian, coordinator, representative, tester, policeman, organiser, bestower of awards, promoter, educator, researcher, card sorter and book seller, quite apart from the administrative functions necessary to run a £1.5M company".

The Report expands on many of these activities in detail. The space available here is insufficient to do justice to even one,but a few examples picked at random will give some idea of what is involved.

The Society represents UK amateurs both nationally (to the licensing authority and others) and internationally as a member of the International Amateur Radio Union. In the year under review, representatives attended conferences or meetings in Indonesia, Singapore, Malaysia, Austria and Spain (the latter being the ITU World Administrative Radio Conference).

Expert volunteers provide advice to members on Electromagnetic Compatibility (interference) problems or difficulties in obtaining planning permission for antenna installations. A particular problem during the year was the number of cases related to the false triggering of security alarms by breakthrough from radio signals. Alarm manufacturers were contacted by the Society and responded positively to the problem.

The RSGB ran nearly 100 contests over the year and awarded many trophies for service to the Society and to amateur radio in general. It also made sixteen awards to record achievements on the HF, VHF/UHF and microwave bands.

It organised three major events, the National Mobile Rally at Woburn; the VHF Convention at Sandown Park; and the National Amateur Radio Convention and Exhibition at the NEC, Birmingham.

1480 Morse tests were carried out by 296 volunteer examiners. The Amateur Radio Observation Service kept an eye on amateur radio itself, to ensure the regulations were observed; and the Monitoring Service logged intruders in the amateur bands, reporting these as necessary to the Radiocommunications Agency.

The new Novice examination was in its first year. The RSGB's training arrangements for this were carefully monitored and the first examination results showed a pass rate of over 80 per cent. Meetings were held with the Air Training Corps to establish ways of aligning the ATC's Communications and Radar course with the Novice Licence Training Scheme. According to the RSGB, this has the potential for recruiting an extra 40,000 newcomers to amateur radio.

USEFUL BROADCAST GUIDE

The International Short Wave League has again produced its invaluable *Guide to English Language Broadcasts to Europe* (Winter Schedules 1992/3). Stations will send their new schedules to listeners if they write for them but there is really no need for that when this inexpensive publication covering literally hundreds of transmissions is so readily available.

All the necessary information is presented in time (UTC) order in one-hour blocks around the clock, showing country and station names, alternative frequencies in kilohertz (kHz), and the types of programme to be heard. Particularly useful for those interested in programmes about shortwave radio itself is a section on *The Dx Week*.

This provides details, on a daily basis, of programmes giving the latest news from the shortwave world, e.g., information about new stations, changes in schedules, technical developments, advice on improving reception, and so on. A good number have some content relating to amateur radio, and a few are entirely devoted to it.

There is a great deal of work involved in preparing such a comprehensive listing (27 pages × A4). It is compiled on a voluntary basis by four League members, each well-known in the world of shortwave listening, and is available to non-members as well as ISWL members.

To obtain a copy, send £1.00, or two IRCs, or £1 postage stamp to ISWL HQ, 10 Clyde Crescent, Wharton, Winsford, Cheshire CW7 3LA, and mention that you read about the Guide in EPE. Used with my world band receiver I find it quite invaluable and recommend it unreservedly.

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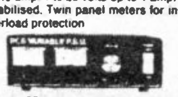

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Published on approximately the first Friday of each month by Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Printed in England by Benham & Co. Ltd, Colchester, Essex. Distributed by Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Sole Agents for Australia and New Zealand–Gordon & Gotch (Asia) Ltd., South Africa–Central News Agency Ltd. Subscriptions INLAND £20 and OVERSEAS £26 (£43.50 airmail) payable to "Everyday with Practical Electronics" Subs Dept, 6 Church Street, Wimborne, Dorset BH21 1JH. EVERYDAY with PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

OMP POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE (A4) S.A.E. 50p STAMPED FOR CATALOGUE ★

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS

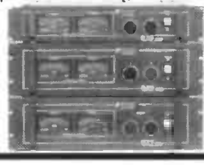
THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

FEATURES: ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

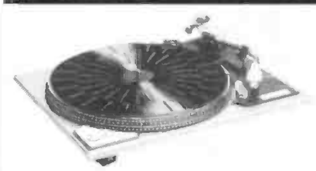


SIZES:- MXF200 W19"xH3½" (2U)xD11"
MXF400 W19"xH5¼" (3U)xD12"
MXF600 W19"xH5¼" (3U)xD13"
MXF900 W19"xH5¼" (3U)xD14¾"

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH

OMP VARISPEED TURNTABLE CHASSIS



★ Manual arm ★ Steel chassis ★ Electronic speed control 33 & 45 R.P.M. ★ Vari pitch control ★ High torque servo driven DC motor ★ Transit screws ★ 12" die cast platter ★ Neon strobe ★ Calibrated balance weight ★ Removable head shell ★ ½" cartridge fixings ★ Cue lever★ 220/240V 50/60Hz ★ 390x305mm ★ Supplied with mounting cut-out template.

PRICE £61.30 + £3.70 P&P

OPTIONAL MAGNETIC CARTRIDGES STANTON AL500MkII PRICE £16.95 + 50P P&P GOLDRING G950 PRICE £7.15 + 50P P&P

STEREO DISCO MIXER DJ6500

★ WITH ECHO ★

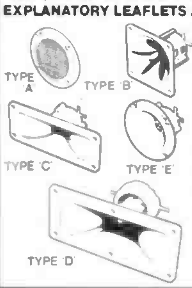
STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. MANY OUTSTANDING FEATURES:- including Echo with repeat & speed control, DJ Mic with tone control & talk-over switch, 7 Channels with individual faders plus cross fade, Cue Headphone Monitor. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.

Price £134.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if two are put in series. FREE EXPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.



TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi apeakers. Price £4.90 + 50p P&P.
TYPE 'B' (KSN1005A) 3½" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.
TYPE 'C' (KSN1016A) 2"x5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.
TYPE 'D' (KSN1025A) 2"x6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.
LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.

OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

Made especially to suit today's need for compactness with high output sound levels, finished in hard wearing black vynide with protective corners, grille and carrying handle. Each unit incorporates a 12" driver plus high frequency horn for a full frequency range of 45Hz-20KHz. Both models are 8 Ohm impedance. Size: H20" x W15" x D12".

CHOICE OF TWO MODELS

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100WATTS (100dB) PRICE £163.50 PER PAIR
OMP 12-200WATTS (200dB) PRICE £214.55 PER PAIR

SPECIALIST CARRIER DEL. £12.50 PER PAIR

IN-CAR STEREO BOOSTER AMPS

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono
ALL POWERS INTO 4 OHMS

Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

OMP MOS-FET POWER AMPLIFIER MODULES

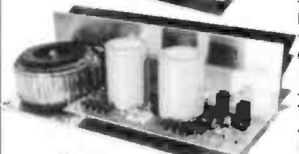
SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D.s (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control for very fast rise and decay times. Tough moulded plastic case, with acrylic tinted front. Size 84 x 27 x 45mm.
PRICE £8.70 + 50p P&P

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (50p STAMPED) FOR COMPLETE LIST.

P - From McKenzie Professional Series
S - From McKenzie Studio Series

McKENZIE:- INSTRUMENTS, P.A., DISCO, ETC

ALL McKENZIE UNITS 8 OHMS IMPEDANCE

8" 100 WATT P C8-100GP GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 80Hz, FREQ. RESP. TO 7KHz, SENS 96dB. PRICE £31.45 + £2.00 P&P
10" 100WATT S C10-100GP GUITAR, VOICE, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 72Hz, FREQ. RESP. TO 6KHz, SENS97dB. PRICE £38.89 + £2.50 P&P
10" 200WATT S C10-200GP GUITAR, KEYB'D, DISCO, EXCELLENT HIGH POWER MID.
RES. FREQ. 69Hz, FREQ. RESP. TO 5KHz, SENS 97dB. PRICE £53.21 + £2.50 P&P
12" 100WATT P C12-100GP HIGH POWER GEN. PURPOSE, LEAD GUITAR, DISCO.
RES.FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 98dB. PRICE £40.35 + £3.50 P&P
12" 100WATT P C12-100TC (TWIN CONE) HIGH POWER, WIDE RESPONSE, P.A., VOICE, DISCO.
RES. FREQ 45Hz, FREQ. RESP. TO 12KHz, SENS 97dB. PRICE £41.39 + £3.50 P&P
12" 200WATT S C12-200B HIGH POWER BASS, KEYBOARDS, DISCO, P.A.
RES. FREQ. 45Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £71.91 + £3.50 P&P
12" 300WATT S C12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARDS, DISCO ETC.
RES. FREQ. 49Hz, FREQ. RESP. TO 7KHz, SENS 100dB. PRICE £95.66 + £3.50 P&P
15" 100WATT P C15-100BS BASS GUITAR, LOW FREQUENCY, P.A., DISCO.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS 98dB. PRICE £ 59.05 + £4.00 P&P
15" 200WATT P C15-200BS VERY HIGH POWER BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 3KHz, SENS 98dB. PRICE £80.57 + £4.00 P&P
15" 250WATT S C15-250BS VERY HIGH POWER BASS.
RES. FREQ. 39Hz, FREQ. RESP. TO 4KHz, SENS 99dB. PRICE £90.23 + £4.50 P&P
15" 400WATT S C15-400BS VERY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 40Hz, FREQ. RESP. TO 4 KHz, SENS 100dB. PRICE £105.46 + £4.50 P&P
18" 500WATT S C18-500BS EXTREMELY HIGH POWER, LOW FREQUENCY BASS.
RES. FREQ. 27Hz, FREQ. RESP. TO 2KHz, SENS. 98dB. PRICE £174.97 + £5.00 P&P

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND
8" 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P
10" 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P
10" 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P
12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND
5¼" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P
6½" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P
8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. PRICE £12.99 + £1.50 P&P
10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

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PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
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FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

PHOTO: 3W FM TRANSMITTER

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