EVERYDAY ELECTRONICS

858

FEBRUARY 1991

INCORPORATING ELECTRONICS MONTHLY

£1.50

MARC PHONE-IN Remote Control via the Telephone

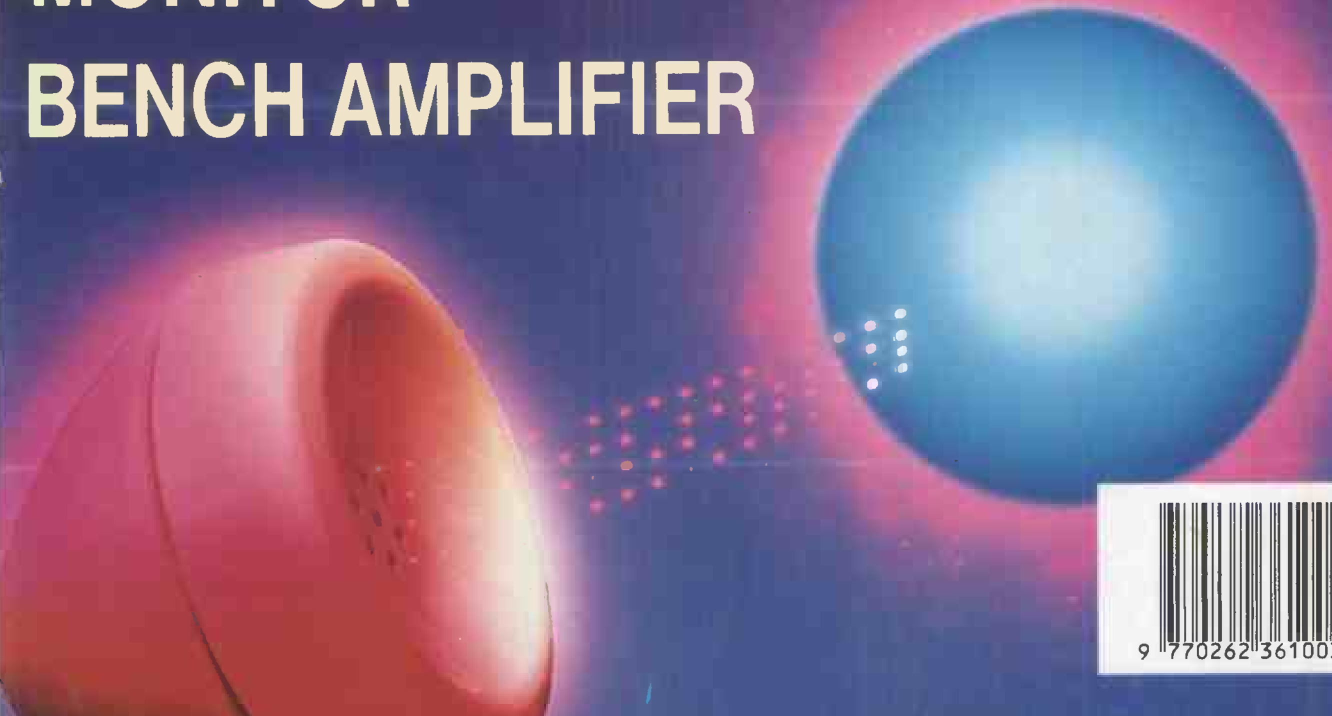
GINGERNUT Surface Mount 80m Amateur Band Receiver

DESIGN YOUR OWN CIRCUITS – 3 Amplifiers

PROJECT DEVELOPMENT FOR GCSE – 2 Starting your Project

VEHICLE VOLTAGE MONITOR

BENCH AMPLIFIER



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The No.1 Magazine for Electronics & Computer Projects

REAL POWER AMPLIFIER For your car, It has 150 watts output. Frequency response 20HZ to 20 KHZ and a signal to noise ratio better than 60db. Has builtin short circuit protection and adjustable input level to suit youe existing car stereo, so needs no pre-amp. Works into speakers ref 30P7 described below. A real bargain at only £57.00 Order ref 57P1.

REAL POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7.

PERSONAL STEREOS Customer returns but complete with a pair of stereo headphones very good value at £3.00 ref 3P83. We also have customer returned units with a builtin FM radio at £6.00 ref 6P34

2KV 500 WATT TRANSFORMERS. Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93

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. £6.00 ref 6P18

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42

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. £25.00 ref 25P24.

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43

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 15P39 Suitable mains adaptor £5.00 ref 5P191

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £18.00 ref 18P10

MINATURE RADIO TRANSCEIVERS. A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12

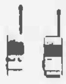
FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42

10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead £34.00 ref 34P1

WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179.

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. £25.00 ref 25P21.

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50



7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power ampl 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14.

NICAD BATTERYS. Brand new top quality. 4 x AA's £4.00 ref 4P44. 2 x C's £4.00 ref 4P73, 4 x D's £9.00 ref 9P12, 1 x PP3 £6.00 ref 6P35

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104. Bumper pack of 1,000 ties £14.00

BUILD AN IBM COMPATIBLE PC !

AT 12 meg turbo 286 mother board.	£115.00	pc1
1 meg memory for above board.	£55.00	pc2
4 meg memory for above board.	£214.00	pc3
AT keyboard	£49.00	pc4
AT power supply and pc case (complete)	£115.00	pc5
AT controller card with 2 x serial, 1 x parallel Floppy and hard controller + mono Display driver.	£74.00	pc6
1.2 meg 3 1/2" disc drive.	£74.00	pc7
1.44 meg 5 1/4" drive.	£66.00	pc8
Amber monitor 12".	£99.00	pc9
40 meg hard disc.	£270.00	pc10
100 meg hard disc.	£595.00	pc11

minimum system consisting of mother board, 1 meg of memory , case, power supply, 1.44 meg floppy, Interfaces, and monitor is

£525.00 inc VAT (single drive mono 286) pc12

£795.00 inc VAT (40 meg + floppy + mono 286) pc13

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158

TV SOUND DECODER. Nicely cased unit, mains powered 8 channel will drive a small speaker directly or could be fed into HI FI etc. Our price £12.00 ref 12P22

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39.

SINCLAIR C5 MOTORS. 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8.

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21.

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 17P3.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3.

MOSFETS FOR POWER AMPLIFIERS ETC. 100 watt mosfet pair 2SJ99 and 2SK343 £4.00 a pair with pin out info ref 4P51. Also avaliable is a 2SK413 and a 2SJ118 at £4.00 ref 4P42.

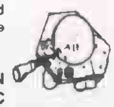
10 MEMORY PUSH BUTTON TELEPHONES. These are 'customer returns' so they may need slight attention. BT approved. £6.00 each ref 6P16 or 2 for £10.00 ref 10P77.

12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £8.00 each ref 8P26.

acorn data recorder ALF503. Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with complete assembly instructions £10.00 ref 10P81.



PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10. MAINS POWER SUPPLY KIT £20.00 REF 20P33 READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4.

SWITCHED MODE POWER SUPPLY (Boshert) +5 at 15A, +12 at 3A, -12 at 2A, +24 at 2A. 220 or 110v input. Brand new £20.00 ref 20P30.

SOLDER 22SWG resin cored solder on a 1/2kg reel. Top quality. £4.00 a reel ref 4P70.

600 WATT HEATERS. Ideal for air or liquid, will not corrode, lasts for years. coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.

TIME AND TEMPERATURE MODULE. A clock, digital thermometer (Celcius and Farenheit (0-160 deg F) programmable too hot and too cold alarms. Runs for at least a year on one AA battery. £9.00 ref 9P5.

Remote temperature probe for above unit £3.00 ref 3P60.

GEARBOX KITS. Ideal for models etc. Contains 18 gears (2 of each size) 4x50mm axles and a powerful 9-12v motor. All the gears etc are push fit. £3.00 for complete kit ref 3P93.

ELECTRONIC TICKET MACHINES. These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28.

JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174.

QUALITY PANEL METERS. 50uA movement with 3 different scales that can be brought into view with a lever! £3.00 each ref 3P81.

CAR IONIZER KIT. Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.

METAL DETECTOR. Fun light weight device for buried treasure! 33" long with tune and fine tune controls. £10.00 ref 10P101.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.

12 TO 220V INVERTER KIT. As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 100 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41.

VERO EASI WIRE PROTOTYPING SYSTEM. Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33.

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

STC SWITCHED MODE POWER SUPPLY. 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £12.00 ref 12P27.

CAMERA FLASH UNITS. Require a 3v DC supply to flash. £2.00 each ref 2P38 or 6 for £10.00 ref 10P101 (ideal multi-flash photography).

TELEPHONE AUTODIALLERS. These units, when triggered will automatically dial any telephone number. Originally made for alarm panels. BT approved. £12.00 ref 12P23 (please state telephone no req'd).

25 WATT STEREO AMPLIFIER ic. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69 (Circuit dia included).

MINATURE DOT MATRIX PRINTER assembly 24 column 5v (similar to RS type). £10.00 each ref 10P92.

LINEAR POWER SUPPLY. Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21.

MAINS FANS. Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166.

POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2.

MINI RADIO MODULE. Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716.

HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others £20.00 ref 20P26.

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

SURFACE MOUNT SOLDER. In easy to use tube. Ideal for above project £12.00 ref 12P18.

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.

FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88. Pack of 10 51/4" DSDD £5.00 ref 5P168.

SONIC CONTROLLED MOTOR. One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.

FRESNEL MAGNIFYING LENS. 83 x 52mm £1.00 ref BD827.

lcd display. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.

TRANSMITTER AND RECEIVER. These units were designed for nurse call systems and transmit any one of 16 different codes. The transmitter is cased and designed to hang round the neck. £12.00 a pair ref 12P26.

ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.

100M REEL OF WHITE BELL WIRE. figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107.

ULTRASONIC LIGHT. This battery operated unit is ideal for the shed etc as it detects movement and turns a light on for a preset time. (light included). Could be used as a sensor in an alarm system. £14.00 each ref 14P8.

CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. £4.00 each ref 4P82.

ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194.

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 6P36.

ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181.

HI-FI SPEAKER. Full range 131mm diameter 8 ohm 60 watt 63-20 khz excellent reprduction. £12.00 ref 12P33.

ASTEC SWITCHED MODE POWER SUPPLY. 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39.

VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190.

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 5P167.

CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292.

DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140.

PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135

POWERFUL SOLAR CELL 1AMP .45 VOLT! only £5.00 ref 5P192 (other sizes avaliable in catalogue).

SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92.

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

12 " HIGH RESOLUTION MONITOR. AMBER SCREEN BEAUTIFULLY CASED NEEDS 12V AT 1A TTL INPUT (SEP SYNCS). £22.00 REF 22P2.

RADIO CONTROLLED CAR. Sigle channel R/c buggy with forward reverse and turn controls, off road tyres and suspension. £12.00 ref 12P40.

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.

SUPER FAST NICAD CHARGER. Charges 4 AA nicad's in less than 2 hours! Plugs into standard 13A socket. Complete with 4 AA nicad batteries £16.00 ref 16P8.

ULTRASONIC WIRELESS ALARM SYSTEM. Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6.

TOP QUALITY MICROPHONE. Unidirectional electret condenser mic 600 ohm sensitivity 16-18khz built in chime complete with magnetic microphone stand and mic clip. £12.00 ref 12P42.

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18.

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186.

QUICK FIX MAINS CONNECTOR. Ideal for the fast connection of mains equipment. Neon indicator and colour coded connectors. £7.00 ref 7P18.

COPPER CLAD STRIP BOARD. 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62 or 2 sheets for £7.00 ref 7P22.

STRIP BOARD CUTTING TOOL. £2.00 ref 2P352.

3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2

TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109.

TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.

TOROIDAL TRANSFORMER. 24v 5A encapsulated 4" dia £5.00 ref 5P34.

BULL ELECTRICAL

250 PORTLAND ROAD HOVE
SUSSEX BN3 5QT DEPT EE
TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £2.50 POST
FAX 0273 23077

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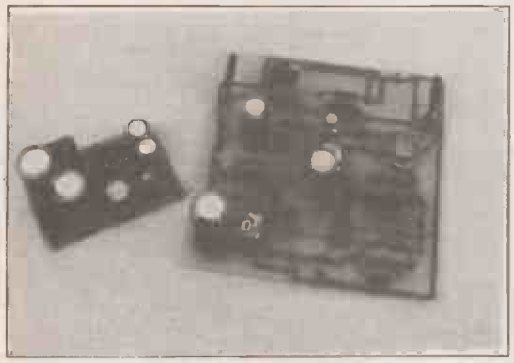
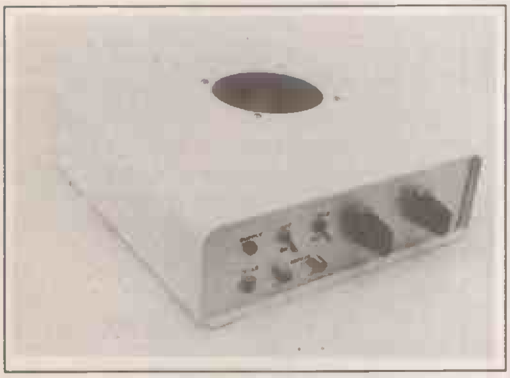
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .





Projects

Series

Features

Our March '91 Issue will be published on Friday, 1 February 1991. See page 75 for details.

NEW LOW PRICES ON MICRO PANELS!!

Z4209 Panel 360 × 210mm covered in high quality chips: 8085AHC, 8255, 8257, 8251A × 2, 8253-5, 8275, 8202A, 2732, 2716 all in sockets; 18 × 4116-2 + other mainly LS chips + min switches, LED's, oscillator, large tants, 3 × 50 way double sided edge connectors. Amazing value at only **£9.95**

Z4210 Panel 260 × 210 which could plug into the above board. Lots of memory on this one: 36 × 4116-20. Also 8085AC, 8202 & 2716 in sockets + 55 other mainly LS chips, DIL switch, large tants etc.
Price **£6.95**

Z4223 80186 Panel. 346 × 280mm 'Benchmark 186' panel packed with high class chips. Just look at what you get!! 80186 16 bit 8MHz microprocessor; 16 × 4164-12 RAMs; 2 × 6116-3; 2 × 2732 EPROMs; 2 × 8255AP-5; 8259AC-2; 6845SP; 146818P; 7201C all in sockets. Over 80 LS chips, 4 xtals, back up battery, 2 × 25 way 'D' sockets etc, etc!! Total chip value alone must exceed £150 and remember all the large chips are in sockets.
Price **£25.00**

Z4356 Microprocessor panel 310 × 85mm with 2 × 8035 8 bit CPU (64 bytes RAM) in sockets, 2 × 2716 EPROM 5 × P8243 1/0 expanders, also 18 other chips, 2 × 6MHz xtals etc.
Price **£3.00**

4 WAVEBAND RADIO

Z8891 Superb 4 waveband radio by Ross, model RR5. Covers FM 88-108MHz, MW 518-1610kHz, LW 150-275 kHz, SW 5.7-18.1 MHz (16.5-52.6m). Nicely styled case measuring 210 × 145 × 70mm with clear scale markings. Telescopic aerial, headphone socket. Volume, tone and tuning controls. ON/OFF switch and waveband selector switch and AFC switch. Mains/battery. (Takes 4 × C cells). Originally retailed at £19.95.
Our price **£14.95**

COMPONENT PACKS

LOTS MORE IN OUR CATALOGUE! **K531 Precision Resistor Pack** - High quality, close tolerance R's with an extremely varied selection of values mostly ¼W and ½W; tolerances from 0.1% to 2% - ideal for meters, test gear etc.
Price .... **250/£3.00**; 1,000/£10.00

K538 Diode Pack - untested small signal diodes like IN4148 etc, at a price never before seen!!
Price/1,000 .... **£2.50**

K537 IC Pack - a mix of linear and logic chips, from 6 to 40 pin. All are new and marked, but some may not be full spec.
Price/100 .... **£6.75**

K539 LED Pack. Not only round but many shaped LEDs in this pack in red, yellow, green, orange and clear. Fantastic mix of new full spec devices.
Price .... **100/£5.95; 250/£11.75**

K575 Plastic Power Pack. Mainly TO126 and TO220 transistors, SCRs, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP and BD types.
Price .... **50/£7.50**

K581 Copper clad board pack. We have now obtained further supplies of offcuts, all reasonable sizes. May include single and double sided, SRBP and glass fibre. Pack of approx 200 sq ins.
Price **£2.00**

K582 Polystyrene Caps. An amazing range of values from a few pF to 0.01. Tolerances 1-20%. Voltages to 500V. Pack of 200.
Price **£4.00**

K580 Metal Oxide resistors, TR4 0.25W by Electrosil. Wide range of values, mostly 5%, few closer tolerances. Super value pack of 200.
Price **£2.00**

K587 A selection of toggle switches, mainly from page 122 of our 1990 Catalogue. Includes single pole to 4 pole sub min, and min. Pack of 50, £30.00 at catalogue prices.
Price **£14.95**

MOTOR + GEAR PACK

K579. This pack contains 10 assorted battery powered motors (mostly 3V) + 90 gears etc; 16-60mm dia + worms and shafts. Amazing value.
Price .... **Only £7.95**

INDICATOR PACK

K700 Big variety of neons in this pack! Round, square and oblong, clip and screw fix. Red, Green, Amber and Clear. Tag & wire-ended. All are 110V, but suitable resistors for use on mains are included. Really great value for money!
Price .... **20/£2.50**

1991 CATALOGUE

YOU GET A GREAT DEAL MORE WHEN YOU DEAL WITH GREENWELD!!

The 1991 Greenweld Catalogue is out NOW!

- ★ Many substantial reductions
- ★ Quantity pricing for bulk buyers
- ★ 132 pages of value-packed goods
- ★ Next 6 updates plus lists included in price
- ★ Easy to use order form
- ★ 1st class reply paid envelope
- ★ Our famous Bargain List

Price to include Catalogue, current bargain list and next 6 lists. All supplied with reply paid envelope **£2.50** (UK & BFPO) **£5.00** Overseas.

SWITCH MODE POWER SUPPLIES

Over the years, we've had many different switch mode power supplies, but this latest unit is without doubt one of the finest we've ever seen! Made by Astec, it is a totally enclosed steel cased unit measuring 175 × 136 × 65mm, which has incorporated in it a switched and fused IEC mains inlet. Inside, the PCB is 160 × 80mm with output pins fitted on one end. A connector to these pins to extend the outputs to the exterior of the case is provided.

Specification:

Model Number:	**BM41012**	
Input:	115/230V, 50/60Hz	
Outputs:	+5V 3.75A +12V 1.5A −12V 0.4A	
Total Wattage:	65W	
Price	**£14.95;**	**100+ 11.21**

We've also discovered a small quantity of an Astec model offered previously. Regrettably we've had to increase the price, but they still represent outstanding value for money. Enclosed in a steel case 203 × 112 × 60mm is a PCB 197 × 106mm. Input and Outputs are via pins on the PCB.

Specification:

Model Number	**AC9231**	
Input	115/230V, 50/60Hz	
Outputs	+12V 2.5A +5V 6A 12V 0.5A (+ or −) 5V 0.5A (+ or −)	
Total Wattage	50W	
Price	**£17.95;**	**100+ 13.46**

We still have good supplies of yet another Astec model. This one is partially cased, the overall size being 160 × 104 × 45mm. The PCB measures 160 × 100mm. Input and Outputs are on flying leads, all colour coded. There is also an additional IEC socket to extend mains to another unit.

Specification:

Model Number	**AA12531**	
Input	115/230V, 50/60Hz	
Outputs	+5V 5A +12V 0.15A	
Total Wattage	50W	
Price	**£6.95;**	**100 + 5.21**

Also still available: An Astec 'bare board' model. The PCB is standard Eurocard size, 160 × 100mm. Input and Outputs are on right angle PCB pins. This is a very compact model offering excellent value for money.

Specification:

Model Number	**AC8151-01**	
Input	115/230V, 50/60Hz	
Outputs	+5V 2.5A +12V 2A −12V 0.1A	
Total Wattage	40W	
Price	**£12.95;**	**100 + 8.91**

Z8887 Made by STC, this 160 × 100mm PCB is attached to an aluminium chassis 165 × 102 × 65mm and has a single 5V 6A output. Supplied with connection details, we can offer these at fraction of their normal cost!
Prices ..... **£5.95; 10 + £4.95; 100 + £3.95**

VISTEL II VISUAL TELEPHONE

Total communication for deaf people - this brilliant piece of equipment has a full QWERTY keyboard and 40 character screen. Text editor. 9,500 character memory. Auto answer. Auto dial. Calculator. Printer interface. RS232 (V24/28) serial interface. Modem support V21/23/25. These are new and boxed but because the makers are bankrupt, there's no guarantee. Originally sold for over £500. A comprehensive 143 page instruction manual is provided. (Manual only - send £12, £10 refunded on return).

Our special price **£150.00**

BBC SOFTWARE

Special Price to schools for Classroom Pack !

For BBC 'B' Computer; full colour leaflets on request.

Z4326 Music Master recorder tutoring system. Was £52.78
Our price **£14.95**

Z4328 Mupados Recorder Tutor with stereo cassette containing 52 tunes and handbook. Originally £30.94
Our price **£7.95**

Micro Maestro turns computer screen into a music stand! Supplied with audio cassette. Original price £17.25

Z4332 Keyboard **£4.95**
Z4333 Concert pitch **£4.95**
Z4334 B^b **£4.95**

BREADBOARDS

FREE, if requested, with every breadboard sold this month! K574 wire link pack with about 250 links for use with breadboard or PCB's!

G708 Protobloc 1 - 400 tiepoints, Size 80 × 60mm. Takes up to 3 16 pin chips.
Price **£2.50**

G711 Protobloc 2 has a total 840 tie points. Will accommodate up to 7 16 pin devices. Size 172 × 64mm **£3.95**

G712 As above, but mounted onto a rigid base plate complete with 3 4mm terminals for power connections. A mounting bracket which clips into the base is also provided to accept a variety of components including switches and pontentiometers, etc **£6.95**

G724 2 of type G711 mounted onto a rigid baseplate with 3 coloured terminals , for power connections. Overall size 225 × 150mm **£13.95**

G736 3 of type G711 and an additional strip of 100 tie points mounted onto a rigid base plate with 4 coloured terminals. Overall size 242 × 195mm.
Price **£19.95**

GREENWELD

ELECTRONIC COMPONENTS

All prices include VAT (except bulk components); **P&P £2.00** per order. Min Credit Card £5. No CWO min. Official orders from Education welcome; min invoice charge £10.00.
Payment is accepted by cheque, postal order, cash, including foreign currency bank notes, book tokens, Access, Visa, Connect.
Our stores have enormous stocks of components and our trade counter is open from 9-5.30 from Mon-Sat. Come and see us!

Tel: (0703) 236363
Fax: (0703) 236307

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GLUE GUNS

87-0400 Hot melt glue gun. Electronically controlled heating element which melts the long stick of glue when inserted. Trigger feed. Mains operated. 'Normally sells for £8.60.

Our price £4.95

Glue sticks - pack of 10 .... £1.00

NI-CAD BATTERIES

Regular stocks: AAA £1.20; AA 99p; C £2.20; D £2.30; PP3 £3.95

Z4150 Ex mobile radio battery. 58 × 63 × 33mm case (sometimes damaged) contains 8 × AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rated 1.2V 600mA.
Price **£3.00**

Z4149 As above but 84 × 66 × 33mm. There are again 8 cells but they are longer than AA size, being 73mm long. Each cell rated 1.2V 900mA.
Price **£4.50**

Half AA Nicads available in 3 styles. Each cell rate 1.2 V 0.25Ah. Normal charge 25mA for 16hr.

Z1809 Cell with wires attached at both ends.
Price **£1.00**

Z1810 Cell enclosed in black heatshrink with wires attached at both ends.
Price **£1.00**

Z1811 Pack of 4 cells, enclosed in black heatshrink with wires attached at both ends.
Price **£3.95**

Z1830 Saft 40 RF310 back up Nicad battery PC mounting on 70 × 22.5mm centres. Rated 3.6V. 10mAH (20mA). Overall size 76 × 28 × 8mm.
Price **£2.00**

Z1829 Nicad 25mm dia × 34mm long rated 9.6V 500mA. PC mounting tags.
Price **£2.00**

Z1719 Back-up battery 4.8V 110mA PCB mounting. 23.5mm dia × 16.5mm made by Emmerich. Normally £3.76.
Price **£1.50**

Z1720 Lithium Manganese coin cell. Extremely thin, just 1.6mm × 20mm dia model 2016. Normally £1.67.
Price **70p**

Z1409 PC mounting deac 6V 100mA. Rating made by Memec 30 × 15 × 27mm. List £4.65.
Price **£1.50**

TAPE DECKS

Z8885 Telephone answering machine believed to have been used as an alarm system. Steel chassis 245 × 220 × 35mm contains PCB 228 × 145mm and an 8-track cassette unit. The output from the tape head is fed into an MC3301 quad op-amp. The PCB also has 10 CMOS gates, 3 relays, isolator transformer, several transistors, R's, C's, etc. 12-way connector for BT line, 12V supply etc also plug and socket arrangement for Auto/Manual and Bell delay.
Price **£10.00**

Z4307 8-track cassette mechanism. Sturdy steel chassis 132 × 126 × 50mm. Contains 12V motor, solenoid, tape head and mechanical bits to change track.
Price **£2.50**

Z4274 Micro cassette mechanism 100 × 74 × 35mm as used in dictaphones/answerphones etc. Complete with head, optical sensing and hall effect switch, solenoid and motor.
Price **£2.00**

BULK COMPONENTS (All + VAT IN THIS SECTION)

Our 16 page Bulk Buyers List is out now - send for your copy.

Z4353 6 way DIN lead to open end	100 + 0.104
	1k + 0.07
Z80 CPU's by Zilog	100 + 0.35
2.2μF 25V Tants	100 + 0.04
	1k + 0.025
5V 5A TO3 Regulator	100 + 2.00
12V 5A TO3 Regulator	100 + 2.00
HM6116LP-4 RAM	100 + 0.60
200V 25A Bridge Rectifier	100 + 0.75
TIPP31	100 + 0.07
	1k + 0.04
TIPP32	100 + 0.07
	1k + 0.04
10,000μF 40V cans	100 + 1.50
4,700μF 63V cans	100 + 1.30
BDW93 Darlington	100 + 0.20
BDW94 Darlington	100 + 0.20

NEXT MONTH

FREE! 32-PAGE MARCO SPRING CATALOGUE SUPPLEMENT

Yes believe it or not its spring again! Well it soon will be and of course EE is the first to bring you the spring catalogue supplement from Marco Trading. 32-pages full of offers and bargains

EXTRA!

SIMPLE ALARMS FEATURE

- **BASIC ALARM SYSTEM** •
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- **TELEPHONE NUISANCE ALARM** •

Various inexpensive, easy to build alarms for a wide range of applications; to deter the mugger, burglar, thief and nuisance 'phone caller.

BATTERY TO MAINS INVERTER

Winter storms have already left many homes without power for lengthy periods, with the use of our battery to mains inverter at least you could keep the gas central heating running – or a decent light – or the TV – or a fridge (if you really need it?)

Since it is nearly spring (see above) you could of course build the inverter to use when camping or caravanning – take the electric drill or food mixer on holiday!

EVERYDAY ELECTRONICS

MARCH ISSUE ON SALE FRIDAY 1ST FEBRUARY 1991

ELV

Technik für Kenner - Made in Germany

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

ULTRASONIC CAR ALARM

This system is specially designed to protect your car and its contents against potential thiefs. Low current consumption and high noise immunity are just two of its distinguishing features.

Complete kit including case
44.367BKL .... £ 30.40

In addition the system has a voltage sensing device i.e. the alarm is also triggered if appliances are switched on by an unauthorised person (e.g. the interior lighting when the door is opened).

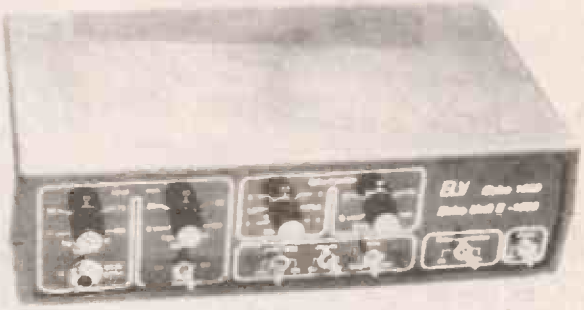
DIGITAL PROFESSIONAL ECHO 1000

(Elektor Electronics June 89)

This low cost echo unit is certain to impress music lovers - amateur and professional - everywhere. Excellent specification and top performance make the EU 1000 a winner and despite meeting professional requirements the unit will not make too big a hole in your pocket.
Working on the delta modulation principle on a digital base, delay times up to one second are possible at full bandwidth and large signal to noise ratio.

Complete kit
44.255BKL .... £ 99.50

Ready assembled module
44.255F .... £ 134.50



Specification

Input sensitivity:
Input 1 : 2 mV
Input 2 : 200 mV
Dealy Time:
variable from 60 ms to 1 s
Bandwidth :
100 Hz to 12 kHz

Additional features:
- inputs mixable
- single and multiple echo
- adjustable delay level
- switchable vibrator
- switch-controlled noise suppression

PC Radio (Elektor Electronics Febuary 1990)

This FM radio consists of an insertion card for IBM PC-XTs, ATs and compatibles and is available as a kit or a ready-built and aligned unit. The radio has an on-board AF power amplifier for driving a loudspeaker or a headphone set, and is powered by the computer. A menu-driven program is supplied to control the radio settings.

Complete kit
44.544BKL .... £ 82.75

Ready assembled module
44.544F .... £ 137.30

VM 1000 Video-Modulator

(Elektor Electronics March 90)

Many inexpensive or older TV sets lack a SCART or other composite video input, and can only be connected to a video recorder or other equipment via an RF modulator. The modulator operates at a UHF TV channel between 30 and 40. Use is made of a single-chip RF modulator that couples low cost to excellent sound and picture quality.

Complete kit
44.546BKL .... £ 36.90

Ordering and payment:

- all prices excluding V.A.T. (french customers add 18.6%T.V.A.)
- send Euro-cheque, Bank Draft or Visa card number with order. Please add £ 3.00 for p & p (up to 2 kg total weight)
- postage charged at cost at higher weight Air/Surface -
- we deliver worldwide except USA and Canada
- dealer inquiries welcome

RFK 7000
RGB-CVBS Converter

(Elektor Electronics October 89)

Nearly all computers supply as an output signal for colour monitors RGB signals. With the help of the RFK 7000 it is possible to record this signals with a videorecorder or to give them onto a colour TV (This is only possible, if the computer delivers a vertical sync. of 50 Hz and a horizontal sync. of 15.625 Hz).
The voltage supply is gained from a 12V/300mA-DC voltage mains adaptor.

Complete kit
44.525BKL .... £ 66.50

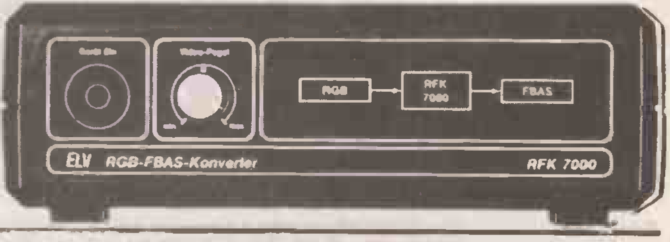
Ready assembled module
44.525F .... £ 119.50

FRK 7000
CVBS-RGB Converter

With the help of the FRK 7000 e.g. it is possible to use a cheap clour monitor with RGB input on a video recorder.
The voltage supply is gained from a 12V/300mA-DC voltage mains adaptor.

Complete kit
44.509BKL .... £ 66.50

Ready assembled module
44.509F .... £ 119.50



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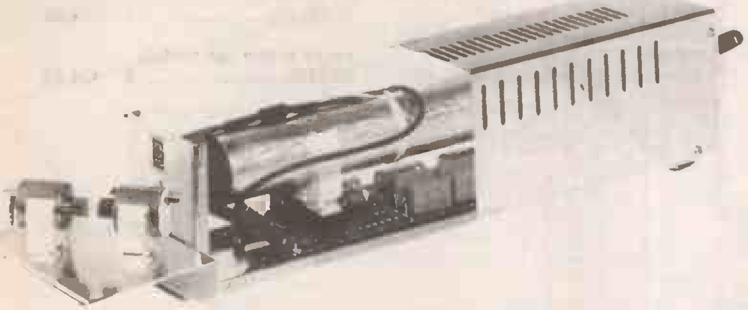
LPS 8000 / LC 7000 Low Cost Show Laser

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



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

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

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

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

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

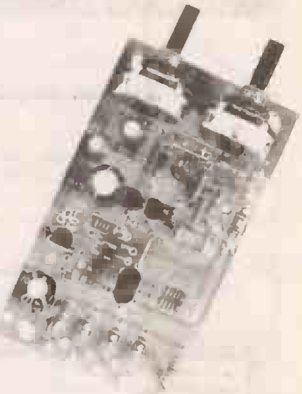
LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F.................... £ 104.30

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

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

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

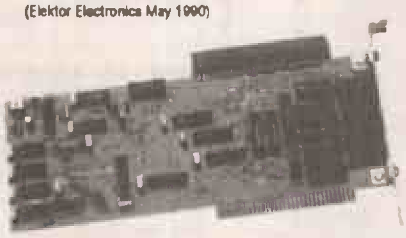


Complete Kit
(including Box, PCB and all parts
44.324BKL .... £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

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



Complete kit
44.517BKL .... £ 77.95

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

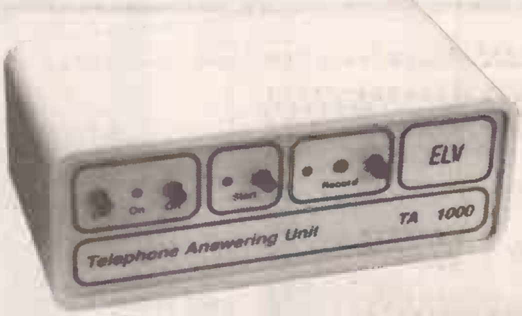
TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

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

Complete kit
44.433BKL .... £ 45.65

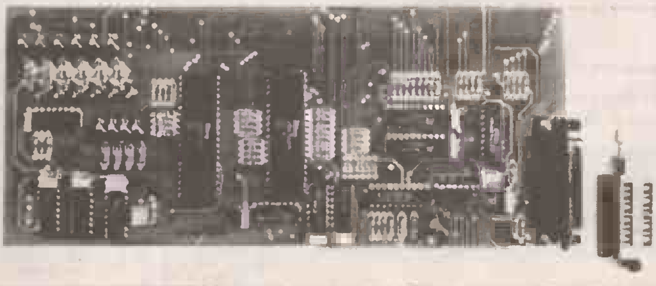
Ready assembled module
44.433F.................... £ 87.25



IC TESTER for IBM-PC-XT/AT

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

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



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

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

Software, single
44.474SW .... £ 17.85

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

HIGH GRADE COMPONENT PARCELS

EVERYTHING MUST GO!

Unless otherwise stated, all the clearance parcels we offer contain brand new, top grade components. If some of the offers look too good to be true, all I can say is that the optimists will get some stunning bargains, the cynics will never know what they've missed, so everybody will be happy! All offers apply only while current stocks last – watch out for next month's parcels or, better still, be the first to hear about any new offers by putting your name on our mailing list. (Please write in, or 'phone Pete Leah on 0272 522703 after 6.30 pm).

UNIVERSAL EVERYTHING PARCEL

This one contains some of just about any component you care to name! There are passives (resistors, capacitors, tants, presets), opto devices (couplers, LEDs of all shapes and sizes, infra-red components, 7-segment displays), semiconductors (transistors, diodes, ICs, rectifiers), and all kinds of other odds and ends (relays, VDRs, neons, battery connectors, mixed components packs). A stunning range of components – enough to get a workshop or lab. started – at a ridiculously low price.

The components are of excellent quality, in packs originally intended to sell at £1 each. To make sure you get a good variety, the 20-pack parcel will have no more than two of any one pack, the 100 pack parcel will have at most five of any one pack. Packs supplied as they come – our choice.

PARCEL 1A: 20 PACKS for £10 + VAT
PARCEL 1B: 100 PACKS for £39! + VAT

MASSIVE CLEARANCE SALE

Once again, a general purpose parcel containing a huge variety of components: resistors, capacitors, ICs, transistors, electrolytics, tants, triacs, LEDs, diodes, thermistors, trimmers, VDRs, all sorts. All new, top quality components. This is mostly remainders from our own stock – stuff we forgot to advertise, or have in too small a quantity to sell individually. Guaranteed to be worth at least eight times the price if valued from any standard component catalogue! What more can I say?

PARCEL 2A: 1000+ top grade components for £12! + VAT
(Value £100+)
PARCEL 2B: 5000+ top grade components for £49! + VAT
(Value £500+)

INTEGRATED CIRCUITS

This parcel contains nothing but ICs. The mixture offers TTL and CMOS logic, interface ICs, linear, data converters, op-amps, special functions, and so on. Some of the ICs are pre-packed with data sheets, some (TTL, CMOS, op-amps) we expect you to identify for yourself, others will be covered by the free *data pack* provided, and the rest you'll have to identify under your own steam. If you know your ICs you'll be in for a few nice surprises.

PARCEL 3A: 100 ICs for £12! + VAT
PARCEL 3B: 500 ICs for £49! + VAT

TANTALUM CAPACITORS

A nice range of tants in values up to 47μF. Lots of useful caps, and we're not mean with the most expensive ones. A fine selection.

PARCEL 4A: 100 TANTS for £6.80 + VAT
PARCEL 4B: 500 TANTS for £29! + VAT

LEDs

All shapes, sizes and colours of LEDs. Round ones in various sizes, rectangular ones, red, green, amber and yellow ones, clear and tinted lenses, all sorts.

PARCEL 7A: 100 LEDs for £5.90 + VAT
PARCEL 7B: 500 LEDs for £24.90 + VAT

RELAYS

All kinds of relays: plug-in, PCB mounting, low voltage (down to 3V coils), miniature, reeds, heavy duty contacts, signal contacts, you name it. A fantastic selection. You'll be back for more!

PARCEL 16A: 50 RELAYS for £12 + VAT
PARCEL 16B: 200 RELAYS for £38 + VAT

TRANSISTORS

A mix of general purpose silicon transistors, mostly bipolar NPN and PNP, with a few FETs and unijunctions thrown in (when available) to spice the mixture. The contents vary from month to month – at the moment there are BC212s, BC213s, BC548s, BC238Bs, MTJ210s, and so on. Next month – who knows? All top quality components.

PARCEL 6A: 200 TRANSISTORS for £7.80! + VAT

CAPACITORS

An exciting selection of capacitors. There are ceramics for decoupling and general use, Polystyrenes for high performance circuits, dipped and moulded polyesters in values from a few nF up to 2.2μF (very expensive!), tants and aluminium electrolytics – just about any capacitor you'll ever need. Don't miss this one!

PARCEL 8A: 1000 CAPACITORS for £6.50 + VAT
PARCEL 8B: 2500 CAPACITORS for £14.90 + VAT

UK Orders: Please add £2.50 towards postage and packing and 15% VAT to the total
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Outside Europe: Please add £12.00 carriage and insurance. No VAT

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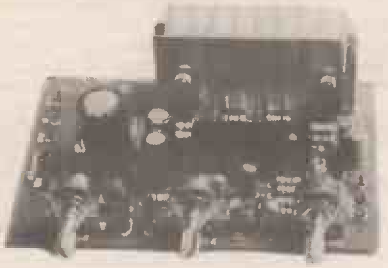
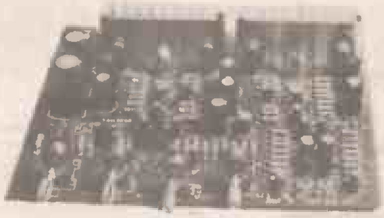
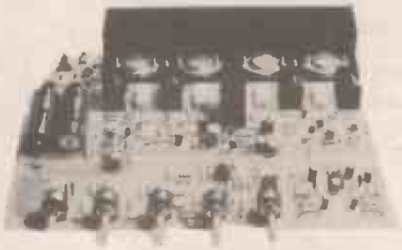


Note: All of the kits shown include all the parts and heatsinks/hardware to make a good quality amplifier. These amplifiers are only available in kit form for assembly by home constructors and hence each kit has a different ease of assembly. Any further details on any of the kits shown will be sent out free to customers who enquire at the address or phone number (24 Hr Answerphone) shown below

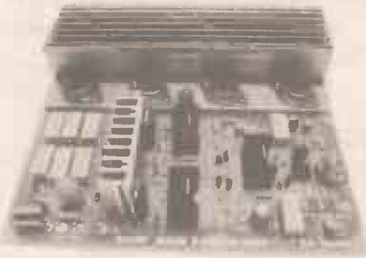


TA 300 mono pre/power amplifier. Output power 30 Watts R.M.S. into 8 Ohms. Frequency Response 20Hz-20KHz (−3dB). Two band tone controls. Dual input sensitivity 50mV and 150mV. Harmonic distortion 0.1%. Size approx 125 x 85 x 40mm. **Price £12.00 + £1.50 P&P**

TA 323A Stereo pre/power amplifier incorporating phono equalisation and two band tone controls. Output Power 30 Watts x 2 into 8 Ohms. Frequency Response 20Hz-20KHz (−3dB). Harmonic distortion 0.1%. Sensitivity phono 3mV, line 150mV. Requires an external transformer (22-36V x 2 at 1A/winding) and case to complete a good quality stereo amplifier. Size approx. 185 x 145 x 40mm. **Price £25.00 + £2.50 P&P**



Payment by Cheque/Postal Order made payable to: Platinum Audio Ltd. Goods will be dispatched the same day as the receipt of the p.o. or clearance of the cheque. (All prices include VAT)



TA 800MK2 Stereo pre/power amplifier incorporating phono equalisation, three band tone controls and a loudspeaker protector/anti thump circuit. Output power 72 Watts x 2 into 8 Ohms. Sensitivity phono 3mV, line 300mV. Requires only an external transformer (28-0-28V at 3 Amps/winding) and case to complete a quality Hi-Fi amplifier. Size Approx. 215 x 265 x 40 mm. **Price £39.90 + £4.00 P&P**

TA 3600 Mono power amplifier for professional/domestic applications requiring high output power. Output Power 300 Watts sine wave into 8 Ohms. Frequency response 10Hz-20KHz (−3dB). T.H.D.0,05%. Sensitivity 1.4V for rated output. Requires only D.C. supply of +/−60 to 75V at 8 Amps and a case to complete a really good quality high power slave amplifier. Size Approx. 225 x 180 x 57mm. **Price £55.00 + £4.50 P&P**

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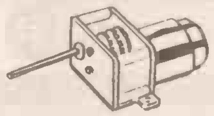
MICROCONTROLLER LIGHT SEQUENCER

EE DEC '90` **KIT REF 838**

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences.. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available.
1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety.
Many other features. Complete kit includes case, PCBs, all components and hardware.
As published in EE Dec '90

£55.95

D.C. MOTOR GEARBOXES



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SMALL UNIT TYPE MGS **£3.99**
Speed range 3-2200 rpm. Size 37×43×25mm

LARGE UNIT TYPE MGL **£4.55**
Speed range 2-1150 rpm. Size 57×43×29mm

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ID35 PERMANENT MAGNET MOTOR — 48 steps per rev. **£16.50**

MD200 HYBRID MOTOR — 200 steps per rev. **£16.80**

MD35 ¼ PERMANENT MAGNET MOTOR — 48 steps per rev. **£12.70**

MD38 PERMANENT MAGNET MOTOR — 48 steps per rev. **£8.95**

EVERYDAY ELECTRONICS KIT PROJECTS

ALL KITS HERE HAVE BEEN FEATURED IN EE AND ARE SUPPLIED WITH MAGAZINE ARTICLE REPRINTS. SEPARATE REPRINTS ALSO AVAILABLE PRICE 80p EACH INCLUSIVE P&P. KITS INCLUDE CASES, PCB's HARDWARE AND ALL COMPONENTS (UNLESS STATED OTHERWISE) CASES ARE NOT DRILLED OR LABELS SUPPLIED UNLESS STATED.

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TEACH-IN PROJECT 1

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Easy to operate and high performance

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+ £50.70 VAT
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EDUCATIONAL BOOKS & BOOK PROJECTS

ADVENTURES WITH ELECTRONICS

The classic Easy to Follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-DEC breadboard. Gives clear instructions with lots of pictures. 16 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-DEC breadboard and all the components for the series.

ADVENTURES WITH ELECTRONICS	£5.25
COMPONENT PACK (less book)	£22.35

FUN WITH ELECTRONICS

From the USBORNE Pocket Scientist series — An enjoyable introduction to electronics. Full of very clear full colour pictures accompanied by easy to follow text. Ideal for all beginners — children and adults. Only basic tools are needed. 64 full colour pages cover all aspects — soldering — fault finding — components (identification & how they work). Also full details of how to build 6 projects — burglar alarm, radio, game, etc. Requires soldering — 4 pages clearly show you how.
The components supplied in our pack allows all the projects to be built and kept. The book is available separately.

FUN WITH ELECTRONICS Book	£2.95
COMPONENT PACK (less book)	£17.55

30 SOLDERLESS BREADBOARD PROJECTS

A book of projects by R. A. Penfold covering a wide range of interests. All projects are built on a Verobloc breadboard. Full layout drawings and component identification diagrams enable the projects to be built by beginners. Each circuit can be dismantled and rebuilt several times using the same components. The component pack allows all projects in the book to be built one at a time.
Projects covered include amplifiers, light actuated switches, timers, metronome, touch switch, sound activated switch, moisture detector, M.W. Radio, Fuzz unit, etc.

30 SOLDERLESS BREADBOARD PROJECTS Book 1	£2.95
COMPONENT PACK	£27.15

ENJOYING ELECTRONICS

A more advanced book which introduces some arithmetic and calculations to electronic circuits. 48 chapters covering elements of electronics such as current, transistor switches, flip-flops, oscillators, charge, pulses, etc. An excellent follow-up to Teach-in or any other of our series. Extremely well explained by Owen Bishop who has written many excellent beginners' articles in numerous electronics magazines.

ENJOYING ELECTRONICS Book	£3.60
COMPONENT PACK	£14.31

Note – A simple multimeter is needed to fully follow this book. The M102 BZ is ideal. £13.98

A FIRST ELECTRONICS COURSE

A copiously illustrated book that explains the principles of electronics by relating them to everyday objects. At the end of each chapter a set of questions and word puzzles allow progress to be checked in an entertaining way. An S-DEC breadboard is used for this series – soldering is not required.

A FIRST ELECTRONIC COURSE BOOK	£4.50
PACK	£22.35

INSULATION TESTER

EE APRIL 85

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

KIT REF 444

£21.89

PET SCARER

EE MAY 89

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

KIT REF 812

Mains Adaptor £1.98

£14.49

DIGITAL CAPACITANCE METER

EE DEC 85

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

KIT REF 493

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3 BAND SHORT WAVE RADIO

EE AUG 87

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

KIT REF 718

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DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

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

KIT REF 563

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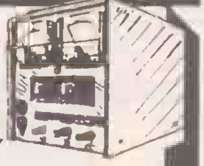


EE FEB 88

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

KIT REF 769

£55.61

MINI STROBE

EE MAY '86

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

KIT REF 529

£15.50

ACOUSTIC PROBE

EE NOV '87

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

KIT REF 740

£19.58

4 CHANNEL LIGHT CHASER

EE Jan '90

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

KIT REF 833

£31.45

EE EQUALISER

EE MAY '87

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

KIT REF 707

£17.37

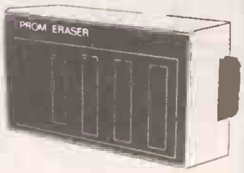
MUSICAL DOORBELL

EE JAN '86

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

KIT REF 497

£20.95



EPROM ERASER

EE OCT '88

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

KIT REF 790

£27.90

LIGHT RIDERS

EE OCT '86

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

KIT REF 559 CHASER LIGHT	£15.25
KIT REF 560 DISCO LIGHTS	£21.93
KIT REF 561 LAPEL BADGE	£11.40

EE TREASURE HUNTER

EE AUG '89

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

KIT REF 815 £41.95

Headphones £1.99

SUPERHET BROADCAST RECEIVER

EE MAR '90

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

KIT REF 835

£16.79

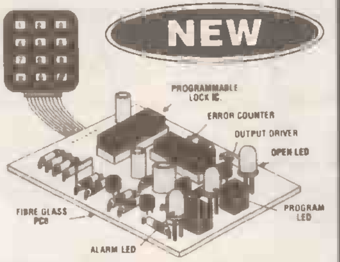
TK FOR KITS

GUARD DOG KIT

One of the best burglar deterrents is a guard dog and this kit provides the barking without the bite! Can be connected to a doorbell, pressure mat or any other intruder detector and produces random threatening barks. Includes mains supply and horn speaker.

XK125 **£21.95**

PROGRAMMABLE ELECTRONIC LOCK KIT



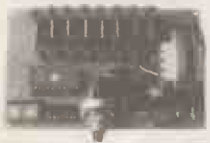
Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4–digit sequence will operate the lock while incorrect entries will sound an alarm. The number of incorrect entries allowed before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and code on the supplied keyboard. Kit includes; keyboard, alarm buzzer, high quality PCB and all electronic components. Supply 5–15V DC. Will drive our Latch Mechanism (701 150 @ £18.98) or relay directly.

XK131 **£19.95**

SUPER–SENSITIVE MICROBUG

Only 45x25x15mm, including built––in mic. 88–100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **XK128** **£6.35**

DISCO LIGHTING KITS



DL8000K 8–way sequencer kit with built–in opto–isolated sound to light input. Only requires a box and control knob to complete £39.95

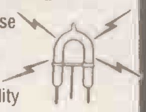
DL1000K 4–way chaser features bi–directional sequence and dimming 1kW per channel ..£23.95

DLA/1 (for DZ1000K) Optional op-to input allowing audio beat/light response....................95p

DL3000K 3–channel sound to light kit, zero voltage switching, automatic level control and built–in mic. 1kW per channel £19.55

XK139 Uni-directional chaser. Zero switching and built-in audio input......................................£12.95

POWER STROBE KIT

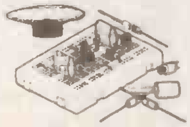


Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.

XK124 STROBOSCOPE KIT. £17.25

SIMPLE KITS FOR BEGINNERS

Especially aimed at the beginner. Have fun with your project even after you have built it and also learn a little from building it. These kits include high quality solder resist printed circuit boards, all electronic components (including speaker where used) and full construction instructions with circuit description.



SK1 DOOR CHIME plays a tune when activated by a pushbutton £4.50

SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command £4.50

SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire–engine siren and machine gun £4.50

XK118 TEN EXCITING PROJECTS FOR BEGINNERS this kit contains a solderless breadboard, components and a booklet with instructions to enable the absolute novice to build ten fascinating projects including a light operated switch, intercom, burglar alarm and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section component identification and function is included, enabling the beginner to build the circuits with confidence £17.25

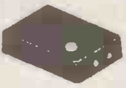
NEW

REMOTE CONTROL DIMMER KIT

Imagine controlling the brightness of your lights or switching them on or off from the comfort of your armchair! This kit contains all the components from front panel to the last screw to enable you to do just that and fit the shallowest wall boxes. Max power 300W (not fluorescents).

XK132..**£19.95**

IR TRANSMITTER KIT



Designed for use with the XK132 and comes complete with a pre-drilled box. A PP3 9 volt battery is required.

MK 6...............**£4.95**

XK136 TOUCH DIMMER KIT.........**£12.95**

VERSATILE REMOTE CONTROL SYSTEM

These kits can switch up to 16 pieces of equipment on and off or control 16 functions depending on the keyboard selected for the MK18 transmitter. MK12 receiver has 16 logic outputs and operates from 12 to 24V d.c. or 240V a.c. via the transformer supplied. The MK18 requires a 9V battery and keyboard. Great for controlling lights, TVs, garage doors etc.

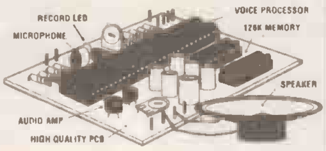
MK12 IR Receiver..........................**£19.55**
MK18 Transmitter..........................**£8.95**
MK 9 4-way Keyboard...................**£2.75**
MK10 16-way Keyboard................**£7.95**
601 133 Box for transmitter **£2.95**

ELECTRONIC WEIGHING SCALE

Kit contains a single chip microprocessor. PCB, displays and all electronics to produce a digfital LED readout of weight in Kgs or Sts/Lbs. A PCB link selects the scale-bathroom/two types of kitchen scales. A low cost digital ruler could also be made.

ES1 **£8.25**

VOICE RECORD/ PLAYBACK KIT

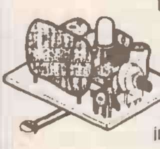


This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or light reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places. In fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daugher's £8 doll to an £80 taking doll!!

Size .... 76 x 60 x 15mm
Message time .... 1–5 secs normal speed, 2–10 secs slow speed

XK129 **£25.95**

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc.

Maximum load 3kW (240V AC). Temperature range up to 60°C. Size 50x40x25mm. **XK140**.....**£8.95**

TK
ELECTRONICS

TK ELECTRONICS

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Fax: 081-566 1916

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TO BABT OR NOT TO BABT

I believe the *MARK Phone-In* project in this issue is a first for any UK magazine – remote control via the telephone network. Let me tell you that, even before we published it, it caused quite a stir!

We were originally hoping to have a tie up with a company who would supply a type approved interface, to which we could connect our project. For various reasons that approach never really got off the ground. However while Chris Walker, the MARC designer, was discussing the problems regarding BABT approval (required for equipment that connects to the public telephone network) with a friendly BT engineer it was suggested that an approved telephone answering machine and an accoustic link, i.e. a microphone to pick up the sounds coming from the answering machine, could solve the problem. The result is the *MARC Phone-In* which is fully described in this issue.

Why has our project caused a stir? The company we had hoped to tie up with are now very upset that we are publishing an article describing such an interface since it is in competition with their products. They have claimed that even accoustically coupled items require BABT approval and they are correct!

However, on 25th April, 1989, the Office of Telecommunications issued a "General Approval" Number NS/G/1234/K/100004 for accoustically coupled signalling devices. So, provided there is no electrical connection to the telecom system and a few other simple requirements are met, the equipment can have automatic approval for indirect connection to public telecommunication systems in the United Kingdom – overseas readers should check local requirements.

This provides a cheap and very effective way of passing signals via the telephone to control just about anything in your home – even a computer. Once again Chris Walker has come up with an exceptional project. Incidentally the heading for this piece was stolen from Chris' article!

ANOTHER FIRST

The *Gingernut 80m Receiver* described in this issue is the first EE project that uses surface mount devices. When such components were introduced many people forecast the doom of electronic construction as a hobby. There is of course no sign yet that normal wire-ended components will disappear, but this article shows that even if they did the hobby would certainly continue.

Working with s.m.d.s requires a higher level of manual dexterity and soldering skill than conventional components, but it adds yet another fascinating aspect to our ever intriguing hobby.

Mike Kenward

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

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

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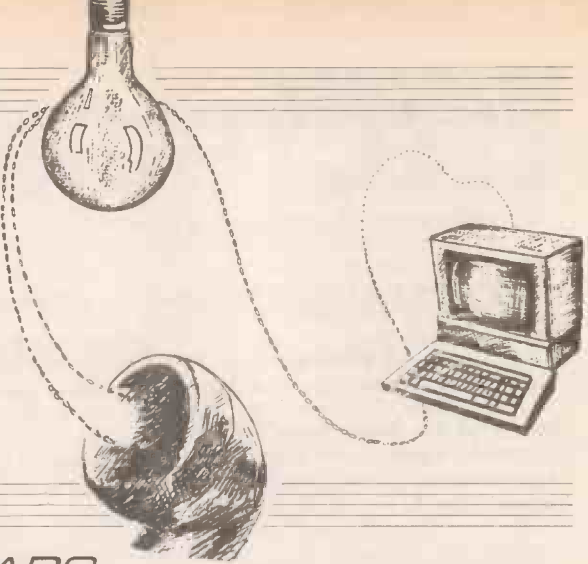


MARC PHONE-IN

CHRIS WALKER

An over the phone data link for MARC, our mains appliance remote controller. Does not require any direct connection to the telephone system. Can also be interfaced to a home computer.

THE Mains Appliance Remote Control (*MARC*) system featured in Everday Electronics June 1990 to September 1990 illustrated just how easy it is to remotely control any mains-connected appliance in your house without running lengths of control wires to each appliance.

The heart of the MARC system is the "Encoder" unit which injects control signals into the house ring main. Decoder units, placed around the house and plugged into the mains, then receive these signals and control power to each appliance.

The Encoder is under the control of a handheld infra-red transmitter which allows the householder to control appliances from the safety of the armchair. In addition, a parallel 8-bit input port provides microcomputer control so that the user can, for example, program appliances to switch on and off at various times or under various conditions to simulate the presence of people in an empty house. Such burglar deterrents are very effective.

There could be times, however, when the householder is unexpectedly caught away from home, perhaps a heavy work load at the office or an exceptionally persuasive host!

PHONE-IN

Under such conditions it would be very useful to be able to 'phone-in' instructions to the MARC system to switch on lights and central heating etc. The ability to control electrical appliances in your house by calling in from a telephone anywhere in the world makes MARC a very powerful system indeed.

Similar 'Phone-In' systems are commercially available but, needless to say, they are rather expensive. This article describes how telephone control can be achieved simply and effectively.

Incidentally, although this project was originally designed for the MARC system, it can be simplified to interface to a computer or any other device to which you may wish to send data via the telephone line. As far as I am aware, this is a "first" for this kind of project in an electronics journal.

To BABT or Not to BABT

The moment we wish to connect anything to our telephone line we hit a snag. Any apparatus connected to the Public Switched Telephone Network (PSTN) has to have been approved by the British Approval Board of Telecommunications (BABT). Such "approved" equipment carries a sticker bearing a large green dot.

It is illegal to connect anything to the telephone network which is not approved. Indeed, let's be honest, it is unfair and dangerous to do so. A badly constructed piece of apparatus could easily place dangerous voltages on the line which would damage sensitive exchange equipment or present a danger to engineers who may have their fingers in the workings!

It has not been unknown for some nameless electronics magazines to publish constructional articles for telephone-related circuits which plug straight in to the British Telecom jack socket in your house. Needless to say Everyday Electronics would not follow this irresponsible trend.

No apparatus which had been home-constructed from such an article would gain BABT approval and, since the approval process costs several thousand pounds, it is beyond the hopes of the "average" reader to ever legally expand his hobby into the realms of the telephone network.

Or is it?

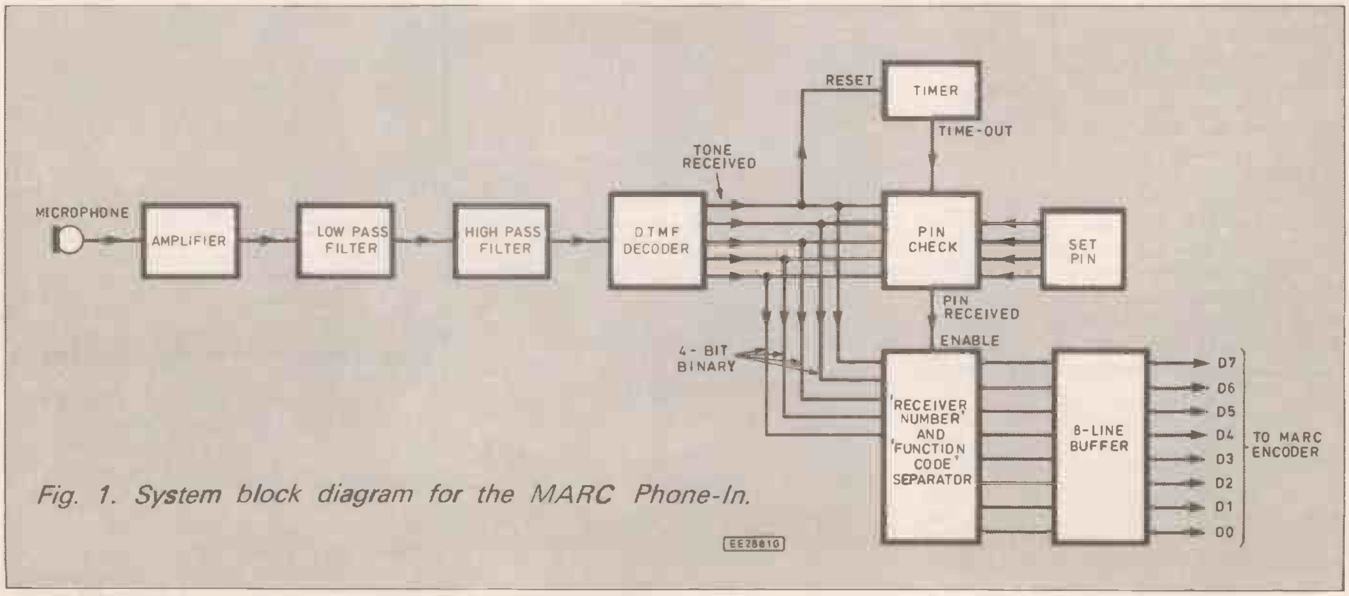


Fig. 1. System block diagram for the MARC Phone-In.

THOSE INFERNAL MACHINES

To achieve Phone-In control of the MARC system we require a ready-made BABT approved device to form an interface between the telephone line and our electronic project. In this application such a device would have to answer the telephone line and keep the line open so that audibly encoded data could be sent to the MARC system.

Of course, such devices exist in the form of the beloved Telephone Answering Machine (TAM). Using a TAM, the user would phone home, listen to the pre-recorded outgoing message and then send various control tones down the telephone line.

These tones will emerge from the loudspeaker of the TAM where they are picked up by a small microphone placed nearby. A tone decoder circuit then converts the tones into a binary code which enters the MARC system via the 8-bit computer port on the Encoder unit.

NO ELECTRICAL CONNECTION IS MADE TO THE TELEPHONE NETWORK AND NO MODIFICATIONS ARE MADE TO THE TAM.

To comply with the BATB requirements the accoustically coupled unit must be hand held and battery powered. To meet this specification the microphone pick-up unit is housed in a small plastic case into which the MARC Phone-In can be plugged. The microphone pick-up is powered by a single 1.5V cell which should last for many months of normal use. The only restriction on using this battery powered handheld pick-up unit is that it is "not capable of connection to other apparatus by means of wireless telegraphy" clearly it complies with this requirement.

For *Everyday Electronics* to comply with the BATB requirements we should tell you that this pick-up"is approved under approval number NS/G/1234/K/100004 for indirect connection to public telecommunication systems in the United Kingdom" and that "satisfactory operation cannot be guaranteed with all types of telephone". Overseas readers should check local requirements.

DTMF

Most new telephones are able to signal to the exchange by both the traditional "pulse dialling" and the new "tone dialing" methods.

Pulse dialling originated with the rotary dial telephones but it is slow and inefficient. Tone dialling is much faster and also, once the call is established, it allows the subscriber to access the numerous remote interrogation features which are offered by telephone-shopping companies and banks, etc.

The British telecommunication companies are in the process of updating their exchanges to accept tone dialling. The tone signalling system used is called DTMF or Dual Tone Multi-Frequency.

Each row of keys on the telephone keypad is assigned a different "low-group" tone frequency, as listed in Table 1. Similarly, each column has a unique "high-group" frequency.

When a button is pressed, the DTMF generator mixes the high-group and low-group frequencies appropriate to that individual button. For example, pressing key 5 generates two tones of frequency 770Hz and 1336Hz. Thus, each key has its own characteristic pair of tones which can be recognised by DTMF decoding equipment at the receiving end.

DTMF tones are the obvious choice for this project since they are easily generated. Don't worry if you do not possess a DTMF phone, *next month* we feature details of a Pocket DTMF Tone Generator which you can use in conjunction with a pulse dialling instrument.

BLOCK DIAGRAM

An overall view of how the MARC phone-in circuit operates can be seen in Fig. 1. The microphone pick-up unit, placed near to the speaker of the Answering Machine, picks up the sound received from the telephone line. A small amount of amplification of the microphone signal is required before it is presented to the low-pass filter.

This filter attenuates signals above the highest DTMF frequency, whilst the high-pass filter in the following stage cuts off signals below the lowest DTMF frequency. The combined effect of the two filter sections is to produce a band-pass filter which helps to remove some of the background room noise which is inevitably picked up by the microphone.

Much more extensive filtering is provided by the DTMF decoder chip. This device separates the low-group and high-group tones which form the composite DTMF signal.

The decoder then uses a digital counting technique to determine the frequency of each tone, and it waits for the tone to be present for a minimum "valid" time before responding. Also, the decoder will ignore short duration tone "drop-outs" which may occur due to a noisy line.

Table. 1: DTMF Frequency Allocation

Frequency in Hz	1209	1336	1477
697	1	2	3
770	4	5	6
852	7	8	9
941	*	0	#

High Group

↑
Low Group

The result is that the decoder is very resistant to false triggering by extraneous tones such as those generated in the voice or due to background noise.

When a valid DTMF tone is received, the binary code for that tone is latched onto the four output lines, and the "Tone Received" output goes high.

SECURITY

In order to prevent any Tom, Dick or Harry from phoning your house and "playing" with your appliances, the circuit will not send any instructions to the MARC system until the caller sends a correct "Personal Identification number" (PIN).

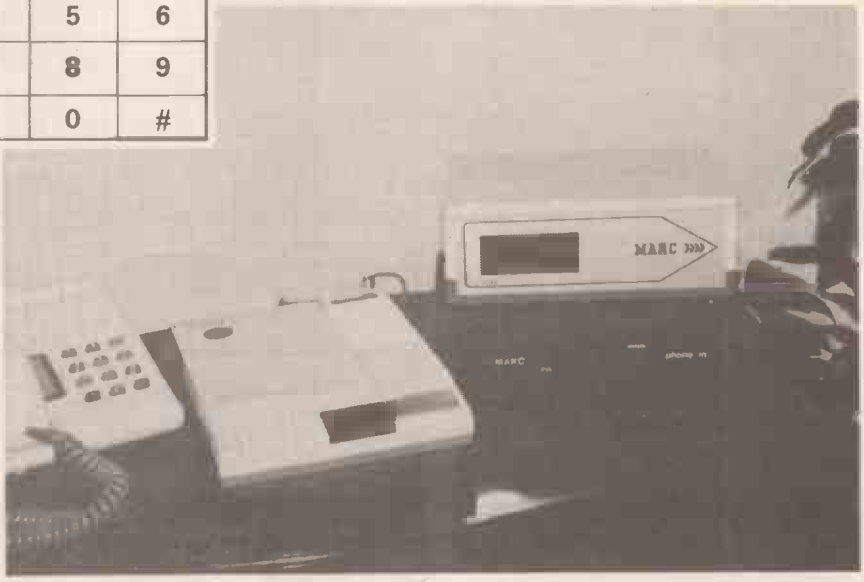
The PIN is entered by pressing the "star" key (*) on the telephone followed by a single digit from 1 to 9. The "PIN Check" circuit compares this number with that preset by the user before he left home. Only if the two match is the "Receiver Number" and "Function Code" separator circuit enabled. See the first MARC article (June 1990) for a full explanation of these terms.

The caller can now control appliances by pressing the "gate" key (#) followed by the "receiver number" and then the "function code" number. For example, if you wish to send function code 1 (ON) to appliance number 2 then the sequence of key presses would be: #, 2, 1. This sequence is repeated for as many other appliances as you wish, always starting the sequence with the # key. A Timer resets the PIN Check circuit about twenty seconds after the last key is pressed so that anybody else phoning your number is denied control access.

The "Receiver Number" and "Function Code" is compiled into a single 8-bit data byte and then buffered before being sent to the opto-isolated MARC Encoder input port.

CIRCUIT DESCRIPTION

The complete circuit diagram for the MARC Phone-In is given in Fig. 2. Mains transformer T1 has two 9V secondary windings. Diode D3 and capacitor C14 rectify and smooth the output from winding (a), and regulator IC12 provides a stabilised +5V for the rest of the circuit.



Winding (b) is used to provide a −5V line which is stabilised by Zener diode D4. This negative supply is used only by the quad operational amplifier IC1.

Microphone MIC1 is an electret type receiving a positive d.c. bias via resistor R1. Signals from the microphone are coupled via capacitor C1 to a non-inverting amplifier based around IC1b (section IC1a is not used).

The gain of this amplifier is determined by resistors R3 and R4, the values chosen result in an amplification factor of about eight. The output signal from this stage should have an amplitude between 30mV and 880mV in order to be accepted by the DTMF decoder.

Resistors R5 to R8, and capacitors C4 and C5 together with IC1c form a "Sallen and Key" low-pass filter with a cut-off frequency of about 2kHz. Above this frequency the response rolls-off at 12dB per octave.

The high-pass filter, formed from capacitors C6 and C7, resistors R9 to R12 and IC1d, has a cut-off at about 500Hz and a 12dB per octave roll-off below this.

Signals from the output of the filter stages (IC1 pin 14) are coupled through capacitor C8 to the DTMF decoder chip IC2. Resistors R13 and R14 set the gain of the on-chip input amplifier to unity. Extra power supply decoupling in the region of IC2 is provided by capacitor C16.

A quartz crystal, X1, provides an accurate oscillator frequency of 3.579545MHz. This frequency is the same as that used in the US television system and suitable crystals are, consequently, easily available.

Resistor R15 and capacitor C9 determine the minimum "valid" time for which a DTMF tone has to be present before the chip responds. This is set at about 30ms using the given values.

DISPLAY

The binary code corresponding to the DTMF tone received is latched onto the four output lines of IC2, pins 11 to 14, with pin 11 as the least significant bit. This binary code is decoded by IC3 and displayed on a seven-segment display, X2. Resistors R17 to R23 are current limiting resistors for this display.

The DTMF tones corresponding to the numeric keys 1 to 9 generate binary codes having values of 1 to 9 and are, therefore, displayed directly on the seven-segment display. Keys 0, * and # are given values of 10, 11 and 12 respectively and IC3 decodes these to give a blank display.

The Tone Received (TR) output from IC2, pin 15, goes high when a valid DTMF tone is recognised. The decimal point on the display is connected to this output via transistor TR1 and will illuminate when a valid tone is being received.

Constructors who do not wish to connect this project to the MARC system can dispense with the remainder of the circuit, which is involved with interfacing to the MARC Encoder. See the construction section for details.

PIN LATCH

The output of NAND gate IC6a goes low when a tone with binary code of value eleven has been received, i.e. the * key. The logic 0 from this gate is latched into IC4c on the rising edge of the TR line.

As the * key is released, the TR line goes low. This is inverted by gate IC6c creating a rising edge on the TR line which ripples the logic 0 from IC4c into IC5c. Therefore, the Q output of IC5c is low after the * key has been pressed and released.

This output is connected to the "input disable" (pin 9) of quad latch IC7. When this input is low, the DTMF binary code is loaded into IC7 on the rising edge of the TR line. Therefore, IC7 will contain the number of the key pressed *after* the * key, i.e. the Personal Identification Number (PIN).

The 4-bit comparator IC8 compares this latched code with the code set in binary on switches S1 to S4. If they are identical, the PIN is accepted and pin 6 of IC8 goes high, switching on transistor TR3 and illuminating l.e.d. D1.

Switches S1 to S4 are actually part of a single binary coded decimal rotary switch. Resistors R24 to R27 are pull-down resistors for the switch outputs.

The collector of TR3 is connected to pins 10 on IC9 and IC10. This connection goes low when the PIN is recognised and this "enables" latches IC9 and IC10.

Every time a DTMF tone is received the TR line pluses high and this switches on transistor TR2. When this happens, any charge on capacitor C10 leaks away through resistor R30.

In between the key presses, C10 charges via resistor R31. The voltage on the capacitor is fed to the reset pin on IC7 (pin 15) and after about twenty seconds this voltage will have risen to a logic 1 level and the PIN is cleared out of the latch, preventing the next caller from accessing the *MARC System*.

APPLIANCE CONTROL

The output from NAND gate IC6b goes low when the # key tone has been received and this logic 0 is clocked into IC4a. As the key is released, the logic 0 ripples into IC5a

COMPONENTS

Resistors

R1, R3, R28, R30	1k (4 off)
R2, R4	6k8 (2 off)
R5, R6, R9, R10	15k (4 off)
R7, R11	47k (2 off)
R8, R12	27k (2 off)
R13, R14	100k (2 off)
R15	330k
R16 to R23	270 (8 off)
R24 to R27	15k (4 off)
R29	4k7
R31	5M6
R32, R35	12k (2 off)
R33	270
R34	1k8

All 0.6W metal film

Capacitors

C1, C8, C9, C16	100n polyester layer (4 off)
C2, C3	10µ tantalum, 16V (2 off)
C4, C5	4n7 polyester layer (2 off)
C6, C7	22n polyester layer (2 off)
C10	4µ7 tantalum, 16V
C11	1µ tantalum, 35V
C12	2µ2 tantalum, 16V
C13	220n polyester layer
C14	1000µ radial elec. 25V
C15	100µ radial elec. 25V

See SHOP TALK Page

Semiconductors

D1	Any light emitting diode
D2	1N4148 signal diode
D3, D5	1N4001 1A 50V rec. diode (2 off)
D4	BZY88C5V6 5.6V Zener diode
TR1, TR2, TR3	BC548 *npn* silicon(3 off)
IC1	LM324 quad op-amp
IC2	MV8870 DTMF decoder
IC3	4511BE bcd to 7-seg decoder
IC4, IC5, IC7, IC9, IC10	4076BE quad D-type latch (5 off)
IC6	4023BE triple 3-input NAND
IC8	4063BE 4-bit comparator
IC11	74LS241 octal buffer
IC12	78MO5 +5V 500 mA voltage regulator
X2	seven-segment common cathode display

Miscellaneous

T1	transformer: mains primary, 0-9V 0-9V secondaries at 500mA
FS1	20mm 0.5A fuse in panel mounting holder
S1-S4	binary coded decimal rotary switch, p.c.b. mounting
MIC1	electret condenser microphone
X1	3.579545MHz quartz crystal
PL1/SK1	phono plug and socket
S5	s.p.s.t. slide switch
B1	1.5V battery and holder

Printed circuit board, available from *EE PCB Service, code EE721; plastic case, size 220mm x 150mm x 64mm (MB6) and 79mm x 61mm x 40mm (MB1); d.i.l. sockets: 14-pin (2 off), 16-pin (7 off), 18-pin, 20-pin; screened cable; ribbon cable; 3-core mains cable; terminal pins; heatsink for IC12; connecting wire; solder etc.*

Approx cost guidance only **£30**

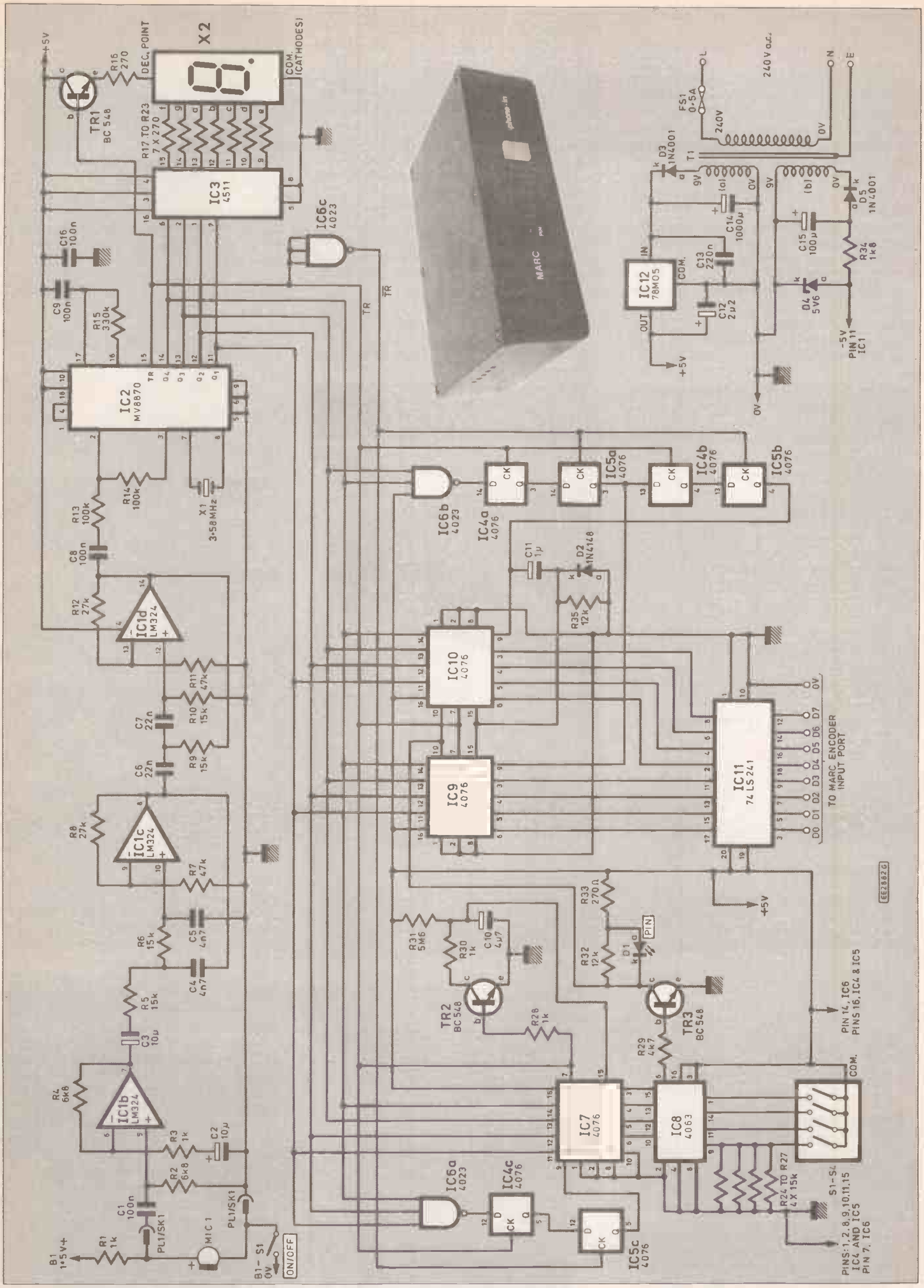


Fig. 2. Complete circuit diagram for the MARC Phone-In. The microphone pick-up is mounted in a small plastic case and plugs into the main unit.

in much the same way as described above for the * key.

The Q output from IC5a connects to the "input disable" (pin 9) of IC9. This line goes low *after* the # key is pressed and released so that the code for the *next* key to be pressed is loaded in to latch IC9.

As this next key is pressed and released, the logic 0 from IC5a ripples through to the Q output of IC5b which then enables latch IC10. Therefore, the code of the *next consecutive* key to be pressed will be loaded into IC10.

Now, assuming that the caller has followed the operating procedure described earlier, that is: # key, followed by receiver number followed by function code, we have a situation where IC9 contains the 4-bit "receiver number" and IC10 contains the 4-bit "function code".

At the instant the function code key is released, the output of IC5b will go high. This creates a positive-going pulse at the junction of capacitor C11 and resistor R35 which is sent to the Reset pins of IC9 and IC10 (pins 15).

Consequently, both latches are cleared of data immediately after the appliance control information has been sent along the phone line.

BUFFER

The opto-isolator on the MARC Encoder port requires a drive current of 10mA per input line. The two 4-bit codes from IC9 and IC10 are buffered through IC11 to provide such a drive capacity.

The outputs from IC11 together with the 0V line are connected directly to the MARC Encoder "computer" input port. Data is loaded into the Encoder as soon as the "function code" is present on data lines D4 to D7.

CONSTRUCTION

The majority of the components are mounted on single-sided printed circuit board. The component layout and full size copper foil master pattern is shown in Fig. 3. This board is available through the *EE PCB Service*, code EE721. Construction is fairly straightforward provided care is taken in correctly locating each component and when soldering onto the fairly crowded p.c.b. pads.

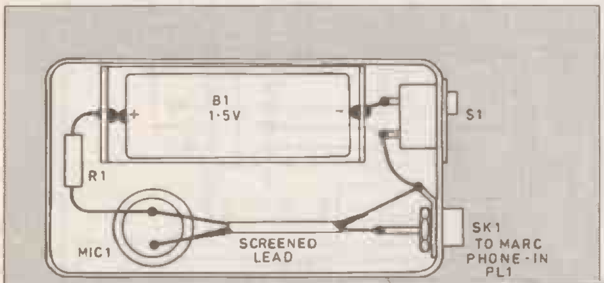


Fig. 4. Layout and wiring of the microphone pick-up unit.

It is recommended that readers follow the constructional sequence described in the next section. This permits some tests to be made before the entire circuit is completed and it also allows constructors to leave the circuit incomplete if connection to the MARC Encoder is not envisaged.

Construction of the pick-up unit is shown in Fig. 4. The two units being connected by means of a flying lead from the MARC Phone-In and PL1/SK1.

When the system is not used with the UK public 'phone network R1 can be fitted to the p.c.b. where the dotted resistor is shown and the microphone connected directly to the p.c.b. with a length of screened lead. The microphone is then powered from the +5V supply (its operating voltage range is 1.5V to 9V) and B1 and S1 are no longer required. The photographs of our prototype show this arrangement.

Some general points are worth a mention; use d.i.l. sockets for the integrated circuits (except, of course, IC12). This practice makes insertion and removal of these devices a trivial matter during the setting-up stages.

The use of terminal pins makes it very easy to make off-board connections at any later time without having to access the underside of the p.c.b, this is very convenient if the board is mounted in its case.

The tantalum bead capacitors, electrolytic capacitors and all diodes are polarised and MUST be inserted the correct way around. Pay careful attention to this. Also, the transistors and integrated circuits must be orientated correctly.

Stage One

Insert resistors R2 to R23 and capacitors C1 to C9. Also insert resistor R34 and capacitors C12 to C16.

Insert diodes D3 to D5 and solder into place the d.i.l. sockets for IC1 to IC3 but leave the sockets empty for now. Quartz crystal X1 should be mounted on the board, try not to overheat this device when soldering. This advice also applies to transistor TR1 which should also be inserted at this stage.

Three wire links need to be inserted, one above IC1 and the two immediately to the right of resistor R15. A small heatsink should be attached to regulator IC12 and this device then soldered in place so that the heatsink side faces towards C13.

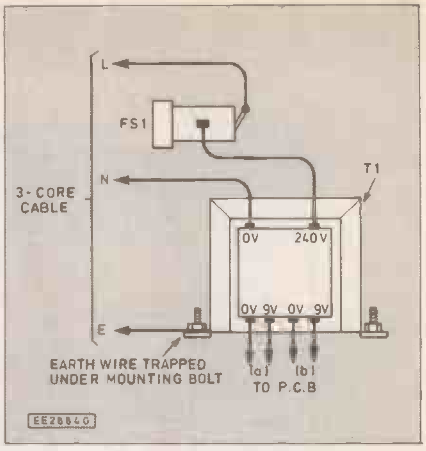


Fig. 5. Wiring details for the mains transformer T1.

Temporarily connect the secondary windings (a) and (b) from transformer T1 to the board and apply mains power to T1 primary. ***TAKE CARE: insulate ALL exposed mains connections on the transformer.***

Connect the negative lead of a digital voltmeter to pin 9 of IC2's *socket*. Now use the positive probe to check for +5V at pin 4 of IC1 and −5.5V at pin 11 of IC1. *Do not continue until this test is passed.*

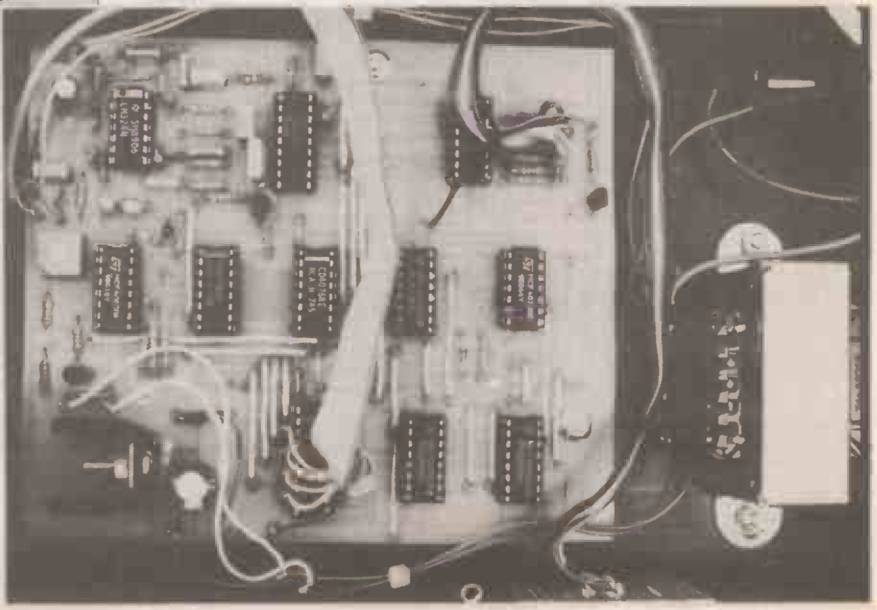
Stage Two

Disconnect power to the board and solder a screened lead between the p.c.b. and microphone pick-up unit with the screen attached to the 0V connection on the microphone (refer to the supplier for details).

A 9-way length of ribbon cable can be used to connect the seven-segment display to the board. In the prototype, the display is mounted onto a small piece of stripboard and the ribbon cable is soldered directly to the *copper* side of this board. Again, refer to your supplier for pinout details of the display.

The connections *a* to *g* on Fig. 3 refer to the segments in the display. Connection is also made to the decimal point and the common (cathode) pin.

Insert IC1 to IC3 into their sockets and re-apply power to the board. Place the microphone near to an audible source of



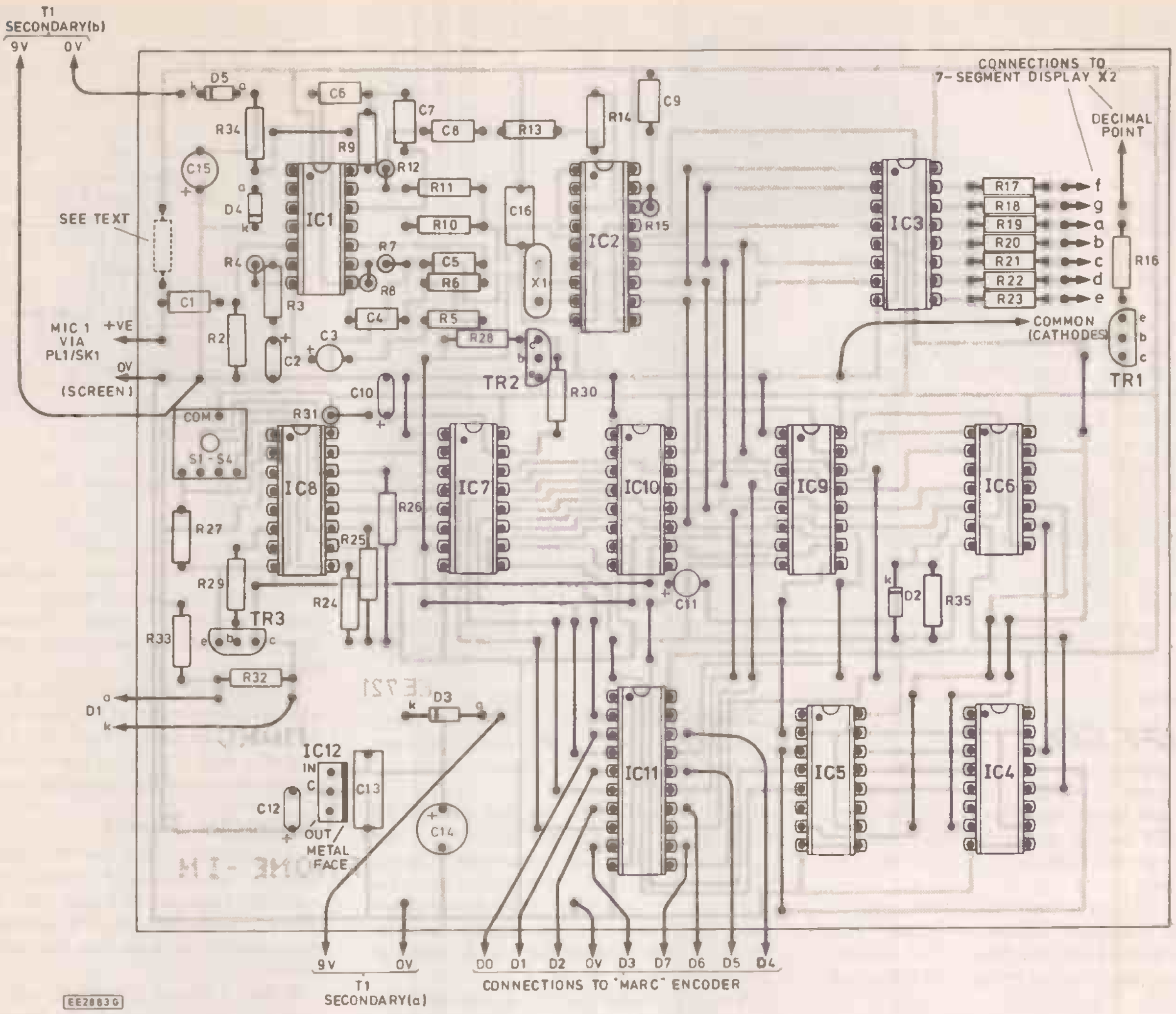
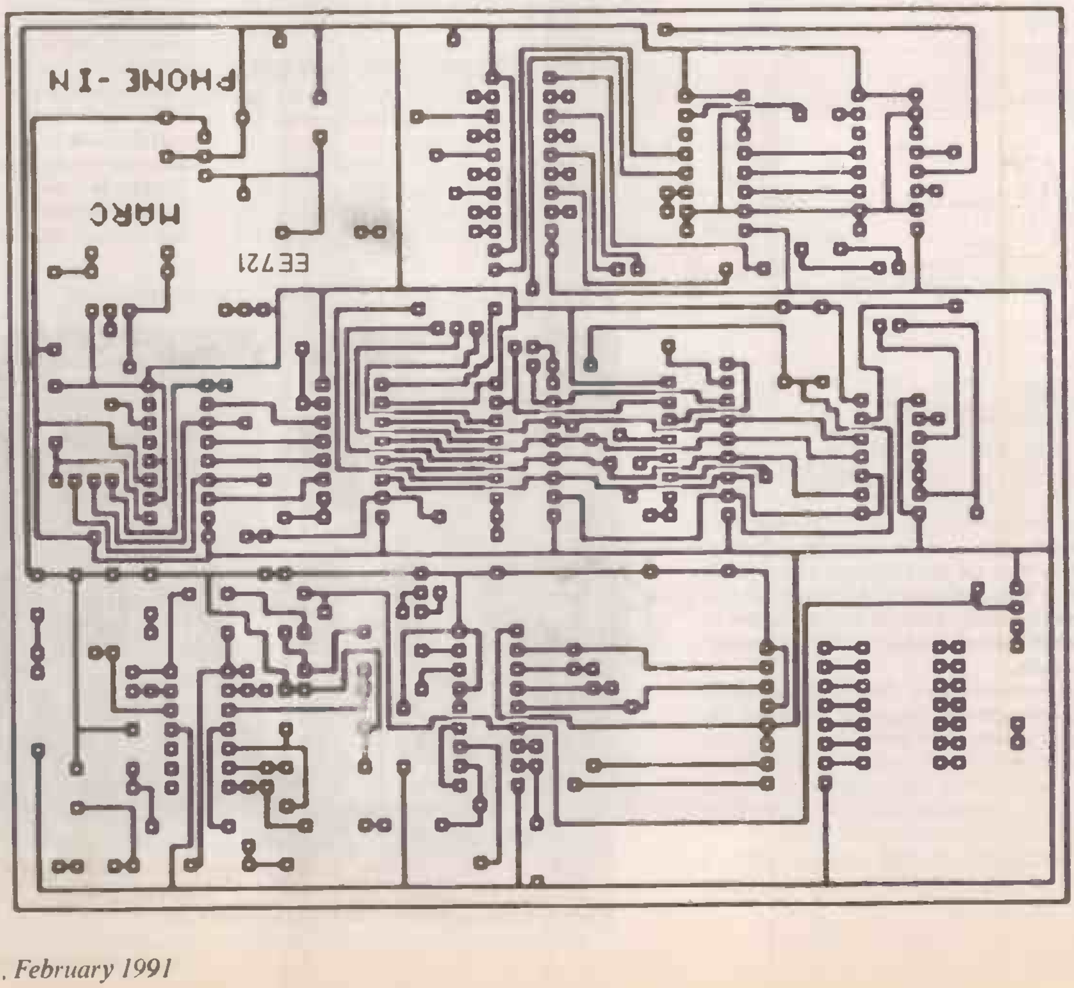


Fig. 3. Printed circuit board component layout and full size copper foil master pattern.



The line-up of already published MARC control system units showing, from left to right, temperature mains interface, decoder, encoder, handheld infra-red transmitter and temperature display. Next month a Pocket DTMF Tone Generator will be described.

DTMF tones, which may be obtained from the earpiece of a suitable telephone or from a pocket DTMF generator (see next month).

The microphone will need to be placed within a few centimetres of the loudspeaker, experiment to find the best position. Every time a tone is received, the decimal point on the display should flash and the number of the key pressed (if between 1 and 9) should be displayed.

If there are problems, first check that the correct value resistors and capacitors have been inserted in the appropriate positions. Inspect the track side of the p.c.b. for solder bridges across adjacent tracks and satisfy yourself that all solder joints are good.

Construction ends here for those of you who do not wish to interface with the MARC system. The 4-bit binary output is available from pins 11 to 14 of IC2 with the "Tone Received" output at pin 15.

Finishing Off

After switching off the power, remove the three i.c's from their sockets and then solder in all the remaining components. Notice that resistors R24 to R26 straddle one of the insulated wire links.

Connect l.e.d. D1 to the board and set the PIN switch (S1-S4) to any number except zero. Insert IC1 to IC8 into their sockets and then apply power to the board.

Once again, the seven-segment display should indicate the received tone but the l.e.d. D1 should not light until the PIN is entered correctly. This is achieved by pressing the * key followed by the number set on S1-S4.

Once D1 switches on it should stay lit until about twenty seconds after the last tone is received. Check that the circuit performs satisfactorily in this respect.

Link the D0-D7 connections between the Phone-In printed circuit board and the MARC Encoder, and also make the 0V return connection. Plug in the remaining three i.c's (IC9 to IC11) and then apply power to the Phone-In board and the Encoder unit.

The Encoder should not respond to any DTMF tones until the PIN has been accepted. After this, appliances are controlled by pressing the # key followed by the "receiver number" and "function code" as described earlier.

The completed circuit board and mains transformer T1 can now be housed inside a suitably sized plastic case with display X2 and l.e.d. D1 protruding through the top panel. Connections to T1 should be made according to Fig. 5.

TAM Compatibility

If life were nice and simple then this article would end here. Unfortunately, the majority of new Telephone Answering machines make use of DTMF tones to control their remote interrogation system.

Some TAM's actually "hang-up" if the caller sends a tone which is not used by the remote control feature. This type of machine is useless for this application.

The designer purchased a Panasonic model KX-T1446BE. This machine does have a tone remote control facility, but remote control mode is only switched on when the caller sends a correct two digit personal code. This code is presettable by the user and, by setting digits which will not be used by the MARC system, the remote control feature will not interfere with the Phone-In project.

There are probably other TAM's on the market which will be suitable, I suggest that you purchase one from a company who can give you some technical details before you buy. If you already own an older machine without tone remote control, then this should work quite happily with none of the above problems.

Unfortunately, there is one more hurdle! New TAM's are "VOX controlled", that is they will keep recording only as long as the caller speaks. The VOX circuit in three machines that the author investigated (including the Panasonic) was not always triggered by DTMF tones. Therefore, after sending tones for about four seconds, the answering machine hung up!

Fortunately, there is an easy way around this problem. The caller has to keep the VOX circuit triggered by speaking at frequent intervals. This is most conveniently achieved by saying out loud which group of buttons you intend to press before actually pressing them.

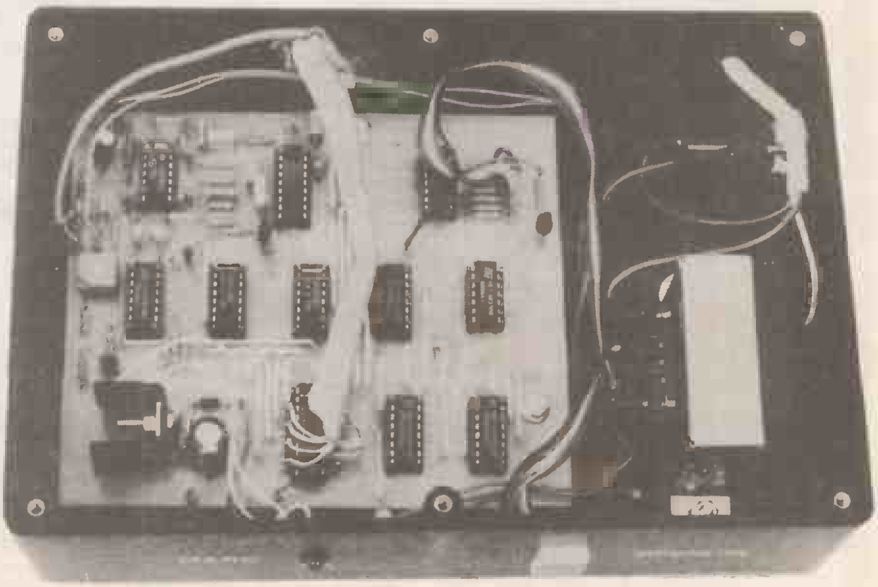
For example, imagine that you have just phoned home and listened to your recorded Outgoing Message. You now have to enter your PIN; let us assume that this is number 5. The procedure would be:

SAY: "Star Five"
PRESS: *, 5

Now, say you wish to switch *on* appliances *one* and *two* and switch *off* (function code 2) appliance number *four*:

SAY: "Gate One One"
PRESS: #, 1, 1
SAY: "Gate Two One"
PRESS: #, 2, 1
SAY: "Gate Four Two"
PRESS: #, 4, 2

It is actually quite easy to do once you have practised the procedure a few times. Remember that the idea is to keep the VOX circuit triggered so you must not stop talking for more than (typically) four seconds. ☐



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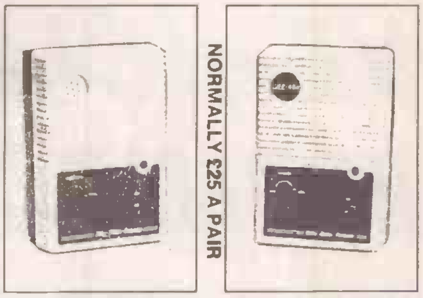

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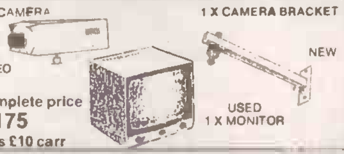

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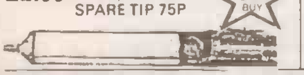

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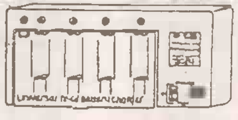

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P007J **PRICE £3.95**

Plug-in 500mA single output non-regulated power supply. Plugs directly into 13A socket. Output via 1.8m lead to 4-way spider plug and PP3 battery clip. Polarity reverse switch. Thermal fuse overload protection.

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Output voltage	9Vdc
Output current	500mA
Stability	40%
Ripple	1V
Dims	74 x 52 x 55mm

WARNING. This unit is not stabilized. Its minimum rating is 500mA and if less current is drawn there is a corresponding voltage rise. At less than 250mA this rise could be considerable

6, 7.5, 9, 12Vdc–1 Amp
Regulated output
P007N **PRICE £9.99**

Regulated power supply with voltage selector and polarity reverse switches. LED 'on' indicator. Input via 1.9m two-core mains lead. Output via 1.8m lead to 4-way spider plug and PP3 battery clip. Overall thermal fuse protection. Glass fuse output protection.

Input voltage	240Vac 50Hz
Output voltage	6, 7.5, 9, 12Vdc
Output current	1000mA
Stability	2%
Ripple	10mV
Dims	122 x 67 x 55mm

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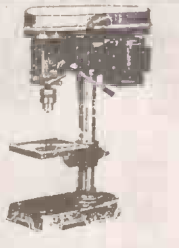

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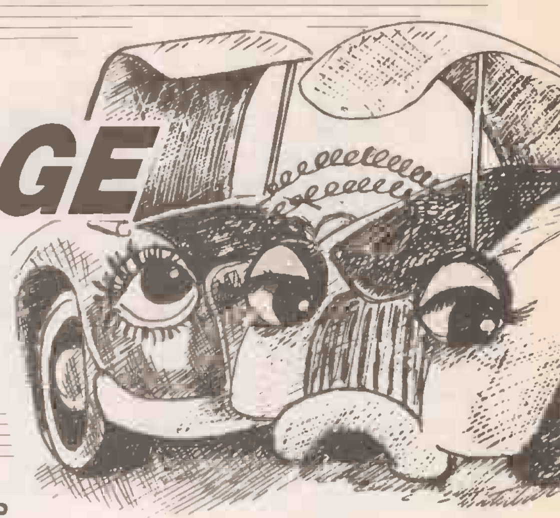


STEVE GARRISON

Keep out of the red and avoid the embarrassment of a flat battery

It is a well known fact that a healthy battery is a priceless asset when it comes to starting a motor vehicle, particularly on a cold, wet night in the middle of nowhere. The voltmeter has all but disappeared on modern dashboards, and the first (and final) warning we get these days is a rapidly dimming red light in the middle of the instrument pack, briefly inviting us to "Seek Dealer Advice" just before everything goes very quiet. And then the inevitable question – *"where is that very nice man?"*

Over the years a number of voltage monitoring circuits have appeared, some resulting in the dash being festooned with l.e.d.s of all shapes and sizes, others with bargraphs of light bouncing up and down, and many others that probably introduce a greater liability to battery discharge than if they weren't fitted at all. The aim of the circuit presented here was to provide a simple visual indication to the driver using a single l.e.d. of the "tricolour" variety.

These devices contain both red and green light emitting junctions and by careful control of the individual currents, a simple spectrum of colours can be achieved, ranging through red to orange to yellow to green. By careful arrangement of the current switching, a quick glance can convey all the information necessary, and since the system is based around a single l.e.d., it can be positioned discreetly on the dashboard without any major engineering.

VEHICLE POWER SYSTEM

The heart of the car electrical power supply generally consists of a lead acid battery and an alternator, which under normal circumstances form a competent and reliable system that can respond to the wide range of demands encountered on a vehicle. Together they support the ever varying levels of power required by the electrical loads, such as at starting – when the battery alone must have sufficient energy reserves to turn the engine over and fire it into life – to normal running, where the alternator takes over the task of power generation and battery (re)charging.

The alternator is an a.c. generator ideally suited to the demands of the car and represents a major improvement over the older d.c. generators or dynamos. In a smaller, lighter package, they have sufficient capacity for charging the battery whilst supplying a moderate selection of car loads. They can achieve this even at low engine speeds, such as idling, keeping the battery charged in winter and when town driving is prolonged.

The alternator also contains voltage regulation circuitry, which is designed to keep the delivered voltage constant, irrespective of load and speed, and protect vehicle systems, particularly the battery which could be damaged by too high a charging voltage. Measurement of the voltage within the system is therefore an important indicator as to its health.

DESIGN APPROACH

When considering the design of the circuit, it was decided that the most common fault (and probably the most inconvenient) was that of a *flat battery*, rather than an overvoltage condition, and that the display of this would be the most advantageous to the driver. This has the added benefit of keeping the circuit simple, and easier to hide under the dashboard.

Two voltages were identified as the thresholds for switching of the circuit, but these were to be points of gradual change of colour rather than hard switching points. This was made possible by the use of transistors and switching them relatively slowly at the points of interest. This would allow variations in the voltage to be monitored more easily, and the trend to a potentially "flat" situation recognised well before judgement day!

COMPONENTS

Resistors

R1, R4	1k (2 off)
R2, R3	220 (2 off)

All 0.6W metal film

See SHOP TALK Page

Semiconductors

D1	Tricolour l.e.d.
D2	13V Zener diode
D3	11V Zener diode
TR1	BC109 *npn* silicon transistor
TR2	BC179 or BC479 *pnp* silicon transistor

Miscellaneous

Stripboard, 0.1in matrix 6 strips x 8 holes; solder pins (2 off); connecting wire; dashboard switch blanking plate (see text); crocodile clips and small plastic case (optional – see text); solder, etc.

Approx cost guidance only **£3** *(excl. case)*

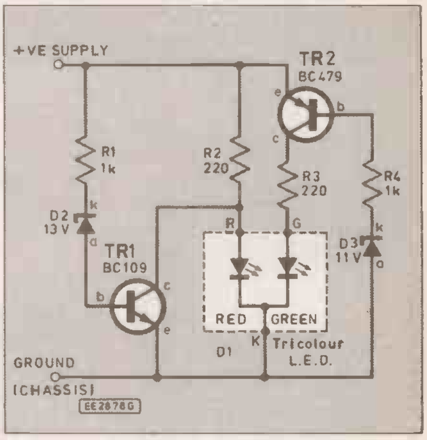


Fig. 1. Full circuit diagram for the Vehicle Voltage Monitor.

The points chosen were approximately 11V and 13V, giving a lower area where the l.e.d. would show red, a middle region of yellow, and the upper region of green. A normal system would show yellow with the ignition off, dropping into the red on engine cranking, then rapidly moving into the green as the engine starts and the alternator voltage rises. A prolonged display of red at any time would indicate a problem with the battery/alternator system.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Vehicle Voltage Monitor is shown in Fig. 1. As mentioned the use of transistors enables us to switch the l.e.d. elements of D1 gradually, thus giving a continuously variable readout of the car voltage that we can interpret to greater depth than a simple rigid three level display.

The voltage thresholds are set by using Zener diodes D2, D3 which are introduced into the transistor base drive circuits. To appreciate how this arrangement works, we must consider the characteristics of a Zener diode in particular, and also the base-emitter junction of the transistor. In the case of TR1, we require that it should begin to turn on at about 13V, and "short" out the red part of the l.e.d., leaving a green display.

To turn the transistor TR1 on, a base current is required, this coming through resistor R1 and Zener diode D2. But this current must be prevented from flowing until the supply is about 13V.

This is the responsibility of the Zener diode. It can operate as a normal diode, conducting current in the direction of the arrow head (forward bias), but there are also conditions where it can conduct in the opposite direction i.e. in what is known as *reverse* bias.

The graph in Fig. 2. demonstrates this. By controlling the way in which the *pn* junction of the diode is manufactured, the voltage at which the device conducts under reverse bias conditions can be set quite accurately. You can see from the graph that there is in effect no current until the voltage reaches this point, shown as V_Z on the graph. When it does the junction in the diode "Zeners" or "avalanches" and current will flow. It is clear therefore that we have some kind of device that can help us with the switching of the transistor.

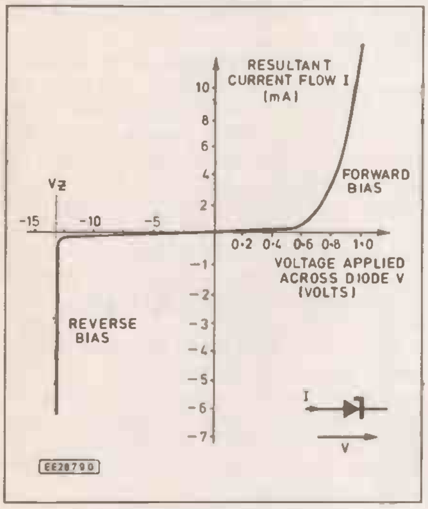


Fig. 2. Zener diode characteristics.

Returning to the circuit diagram Fig. 1, we see that there are two other elements to consider in deciding how and when the transistor TR1 will switch on. The first of these is the base-emitter junction of the transistor which behaves not unlike a forward biased *pn* junction or diode.

Referring back to Fig.2, we see that such a junction requires 0.6V to 0.7V across it before it is fully conducting, and we must therefore remember this when deciding when the transistor actually turns on. The curved (or exponential) rise of current gives us a clue as to why the colour changes are gradual rather than sudden, since the collector current rises in a similar way.

Finally there is the resistor R1, whose major job is to limit the current through the Zener diode and the transistor base, and thus plays no part until the current starts flowing. It should be clear then that TR1 will not begin to turn on until the supply reaches the Zener voltage *plus* the base-emitter voltage of the transistor, and therefore we can fix the voltage thresholds through the choice of the Zener voltage.

The configuration of the components around transistor TR2 may seem a little confusing at first, but their operation is just the same. TR2 is a *pnp* transistor whereas TR1 is a *npn* type, and the semiconductor junctions are simply reversed.

The base-emitter operates the other way round such that the emitter connection must be 0.6V *above* the base for the device to conduct. Transistor TR2 is used to switch current through the green junction of the l.e.d.

HOW IT WORKS

Having considered how the transistor switching operates we can now appreciate how the circuit operates as a whole. It is probably best to consider the supply voltage rising from zero, say, up to 15V. Zener diode D2 is a 13V device, and therefore TR1 will initially be off. This is also the case with TR2, where D3 is an 11V type.

As the voltage rises, current will flow through the red part of the l.e.d. (limited by resistor R2), and it begins to emit light at about 2V, which is its forward bias threshold. This would be an indication of low system voltage.

As the supply passes 11V, transistor TR2 begins to turn on, delivering current to the green half of the indicator, and the colour moves from red to orange to yellow when it is fully conducting. This would generally be the condition the indicator would be in when the ignition is off.

At 13V, transistor TR1 starts to receive base current, and starts to shunt the current flowing through the red side. The light output begins to fall, and finally disappears when the collector-emitter voltage of TR1 is less than 2V, leaving the l.e.d. green, suggesting that the alternator is functioning and charging the battery.

We have, therefore, a circuit capable of responding to the voltage variations of the circuit from which it is supplied, but it is important that we select a sensible measuring point in the car harness if the unit is to be any use. Parts of the wiring that are a relatively long way from the battery, and supplying large loads are likely to suffer from voltage drops in the cables, and this could cause misleading readings from the l.e.d. This point will be mentioned again when we come to installing the finished circuit.

CONSTRUCTION

The circuit has few components and can be built up on a small piece of stripboard. You may be hard pressed to even find a box small enough to fit it in. The board component layout and details of breaks required in the underside copper tracks are shown in Fig. 3.

The prototype was built with the all the components mounted on the board, and the l.e.d. was glued into a hole made in a dashboard switch blanking plate (see photograph). The finished board was light enough for the legs of the l.e.d. to support it quite comfortably in the space behind the switch hole.

The component layout shown fits onto a piece of 0.1in. matrix stripboard size 8 holes by 6 tracks, and is about the smallest size possible without the construction becoming too intricate. The board could of course be increased in area to suit a particular box if it is necessary that the circuit be remote from the l.e.d. due to fitting problems, or if the circuit is to be used as a handheld voltage tester, say.

There are three track breaks shown, and these should be made first, using an appropriate tool. Inspect each break carefully to see that all the copper has been removed. If mounting holes are required, this is also a good time to introduce them into the board.

The components can now be fitted, with careful reference to the layout diagram Fig. 3. The l.e.d. should be mounted so that its body is well above the other components, allowing it to be fitted into the dashboard or box wall quite easily. There is no specific sequence to the assembly since there are so few components, and the major concern should be the polarity and orientation of the semiconductors.

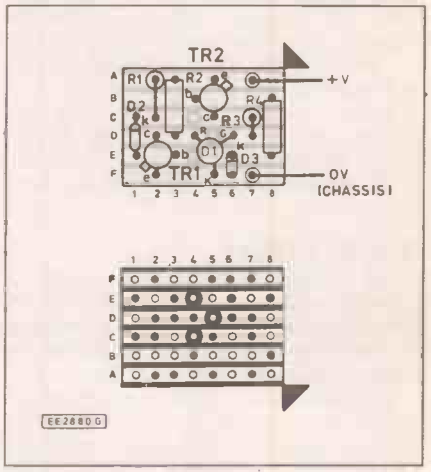
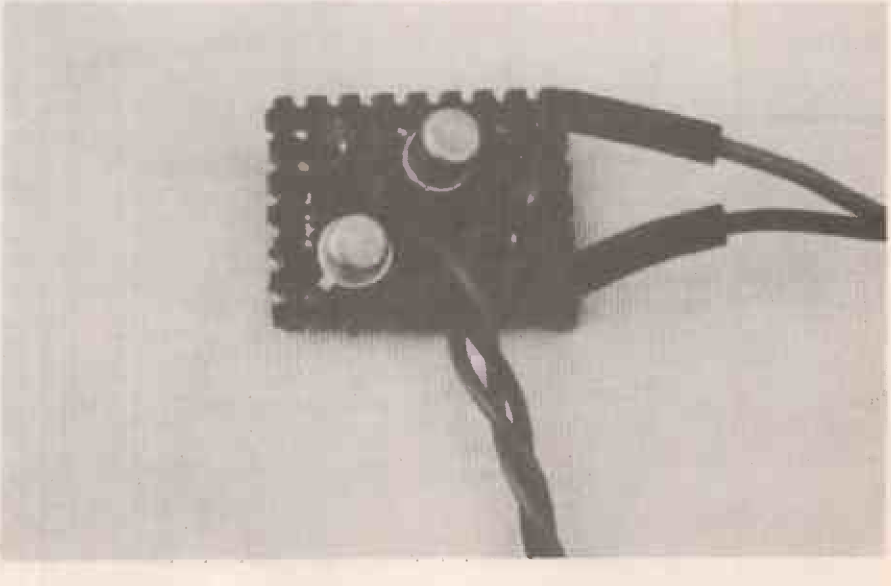


Fig. 3. Component layout and details of breaks required in the underside copper tracks.



Before soldering, the usual preparations to the copper tracks should be made, making sure they are cleaned of any oxide, a clean-up of the soldering iron tip is useful too. This improves the speed and quality of the solder joints, prevents damage to the active components by overheating, and improves the reliability of the finished product.

When the construction has been completed, make a patient and careful check of the board on both sides. On the component side, check that everything matches the layout diagram, and that the 11V and 13V Zener diodes or the transistors haven't been swopped around.

On the underside, have a close look for any dry joints, solder splashes, and track bridges. A magnifying glass or jewellers eyepiece may be useful. Following a satisfactory inspection, attach the power leads to the two terminal pins and allow a generous length to allow them to reach a good monitoring point.

An alternative to mounting the circuit in the dash may be to use it as a simple test meter. In this case, the board could now be mounted in a small handheld box and a pair of long leads attached to the supply pins. These could be terminated in a pair of crocodile clips to allow a system to be checked out at any point.

Before applying any power to the circuit, use a multimeter to measure the resistance across the power leads to check for any shorts that may not have been spotted.

TESTING

The ideal way to test the circuit is by using a variable power supply which gives complete control over the voltage applied to the circuit. This allows precise testing of the voltage thresholds.

The best approach is to set the power supply output to its lowest level before connecting the circuit. Then switch off and attach the power supply leads, taking extra care to get their polarity correct.

Switch the power supply back on and gradually increase the voltage. Once its 2V threshold is reached, the l.e.d. should remain red until about 11.6V, when the green junction starts to switch on.

The effect on the light output will be to introduce a slightly orange tinge to the colour. The colour should turn yellow as the voltage rises further, finally becoming pure green at about 13.8V.

Do not increase the voltage much above 15V. If the indicator fails to perform in the way described, remove the power supply immediately, and repeat the checking procedure outlined in the construction section.

If a variable power supply is not available, then checking is still possible, but the accurate measurement of the thresholds is a little difficult. The safest alternative would be to generate voltages by connecting up a combination of batteries, and use a multimeter to check what is actually being applied to the circuit. By this method you should at least be able to confirm that the transistors are switching correctly.

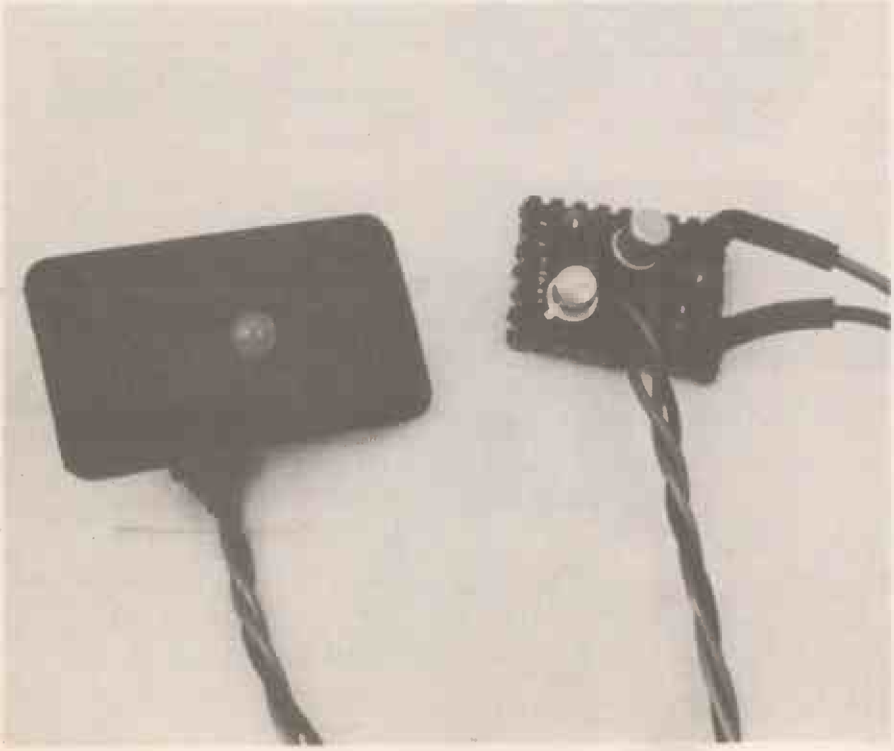
INSTALLATION

When you are happy that the circuit is doing what you expect, it is time to decide how to apply it. The small size of the board allows it to be concealed just about anywhere without too much effort. Also, as mentioned earlier, there is no reason why the circuit shouldn't be used as the basis for a simple handheld tester for the car electrical system.

As the photograph shows the prototype unit is attached to a switch blanking plate. A hole was carefully drilled in the plastic until it was just large enough to push the l.e.d. through and then epoxy resin applied around the base to keep it in place.

When this had set, the assembly was simply clipped back into place in the dash, taking great care, of course, to prevent the possibility of the board shorting against any metal part of the car. If it were impossible to find a mounting spot deep enough to prevent this, then the option of mounting the board remote to the l.e.d. should be seriously considered.

It is worth remembering that the light output of a l.e.d. is not particularly good at competing with direct sunlight, and it is an idea to keep the installation in the lower half of the dashboard if at all possible. If this is not the case, then some shrouding around the lens would keep its message visible.



The other factor to consider is where we connect into the vehicle electrical system. It has already been mentioned that certain points could produce misleading readings due to voltage drops in the harness wiring caused by large loads drawing heavy currents.

The best place to pick up a positive supply is probably at the fuse box, preferably on the load side of a low value fuse, which would ensure that the car was protected if a fault developed in our circuit. There is then a choice as to whether the circuit has a permanent or an ignition controlled supply, depending on which fuse is selected. This is a matter of personal choice – the prototype was permanently lit.

Nowadays the main fuse box tends to be situated inside the car and not too difficult to access. On the other hand, if it is located in the engine compartment, take care that any wiring is attached securely, and is located well clear of any moving parts or chemical hazards.

The "ground" lead needs to be attached securely to the car "chassis" and there are usually a selection of screws and bolts under the dash which provide the facility for such a connection. If there is a question as to whether a particular screw is in fact a good "earth", this can be checked by measuring the resistance between the screw/bolt (scratch off any paint covering) and the battery negative terminal. A good "earth" should provide a reading below 0.2 ohms.

Before unscrewing any fixing, be sure to check that it is not supporting anything major, particularly on the other side of the bulkhead, then once a safe place has been located, expose the bare metal under the bolthead with an abrasive tool to ensure a good connection.

IN USE

The indicator provides an interesting insight into the operation of the car electrical system. The vehicle conditions that are indicated by each colour have already been discussed – after a run, the l.e.d. tends to stay green for a period after the engine is stopped as the post-charging voltage on the battery decays. Variation in the time that this takes may be an indication of how well the battery is accepting and storing the charge.

While the circuit provides a warning of types of failure, it can also be used to develop better habits when it comes to putting unnecessary strains on the battery. Such as during the winter months (when are they?), when you're sat idling in a traffic jam with the windscreen wipers, heater, rear screen, etc. humming away.

The indicator will probably be permanently red, since the alternator, as efficient as it is, just can't keep up, and the battery is having to provide help (=current drain). What you don't want is to reach the head of the queue, stall, then be unable to restart since you've just bled the battery dry.

The application of the circuit is not by any means limited to vehicles, and could easily be adapted for use as a supply status indicator for any piece of equipment by sensible adjustment of the Zener values (and current limiting resistors). ☐

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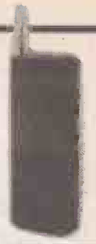

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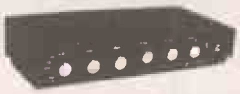

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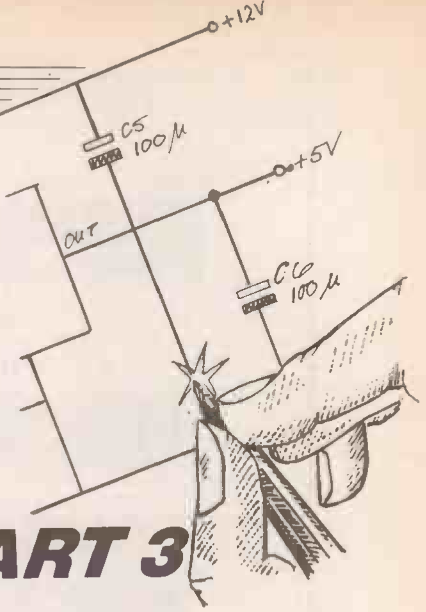


DESIGN YOUR OWN CIRCUITS

Power Amplifiers

MIKE TOOLEY BA

PART 3

This ten part series aims to dispell some of the mystique associated with the design of electronic circuits. This third part deals with power amplification. Our design problem is based on a guitar amplifier whilst our companion project deals with the construction of a bench amplifier/signal tracer.

Introduction

LAST MONTH'S instalment of *Design Your Own Circuits* dealt with a number of important concepts relating to small-signal amplifiers. This month we continue to develop this theme by considering amplifiers which deal with relatively large signals.

By virtue of the magnitude of current and voltage present, such devices are generally referred to as "power amplifiers". In general, any amplifier which is capable of producing an output in excess of a hundred, or so, milliwatts is referred to as a power amplifier. For convenience we shall divide such devices into the following three groups:

Classification	Output Power	typical application
Low power	100mW to 1W	Domestic radio receiver
Medium power	1W to 10W	Small music system
High power	10W to 100W	Large music system
Very high power	More than 100W	Public address system

Power amplifiers are commonly used in a variety of equipment including the output stages of audio equipment (see above). In general, such units should:

(a) provide sufficient power output to drive a load of specified impedance

(b) maintain specified output power over a defined range of frequencies within prescribed limits

(c) exhibit a pre-determined value of input impedance (note that the output impedance of a power amplifier will usually be very much smaller than the impedance of the load to which it is connected)

(d) operate without producing significant distortion or noise (which would otherwise mar the signal)

(e) operate within prescribed limits over a range of supply voltages and ambient temperatures

A typical large-signal amplifier specification may run along the following lines:

Voltage gain:	100
Output power:	10W into 8ohm at 1kHz
Frequency response:	20Hz to 20kHz at -3dB
Distortion:	Less than 0.01 percent THD
Input impedance:	50kilohm
Recommended load impedance:	8ohm
Supply voltage:	±30V at 1A (max.)

Distortion

Last month we mentioned how distortion arises from an amplifier's non-linear characteristics. Since this is particularly important in the case of large-signal amplifiers, we shall look at the effect of non-linearity of the transfer characteristic of a power amplifier.

The transfer characteristic for a typical power amplifier is shown in Fig. 3.1. This characteristic shows output voltage plotted against input voltage and we have assumed that the amplifier operates from symmetrical power supply rails of $+V_S$ and $-V_S$. Note that the characteristic is substantially linear but flattens off as the output voltage approaches the positive or negative supply rail voltage.

The effect of the transfer characteristic on a sinusoidal input signal of relatively moderate amplitude is shown in Fig. 3.2(a). The output signal is a reasonably faithful reproduction of the input. Fig. 3.2(b), on the other hand, shows the effect of overdriving the input of the amplifier. The output signal becomes severely clipped by virtue of the fact that the output signal cannot swing beyond the limits imposed by the positive and negative supply rail voltages.

The clipping of the waveform results in the generation of a number of unwanted harmonic components of the original waveform. These components, which were not present within the original signal, constitute "harmonic distortion". Significant levels of this type of distortion (say five percent or more) are quite unpleasant to listen to and must be avoided at all costs in high-quality audio equipment.

The frequency spectra of the output signals of Figs. 3.2(a) and 3.2(b) are shown in Figs. 3.3(a) and 3.3(b) respectively. These diagrams show the voltage level of the signal plotted against frequency. It should be noted that the frequency spectrum of a pure sinusoidal signal, as in Fig. 3.3(a), comprises of only a single "fundamental frequency" component.

In contrast, the frequency spectrum of the signal in Fig. 3.3(b) contains numerous harmonically related signals which decrease in amplitude as the fre-

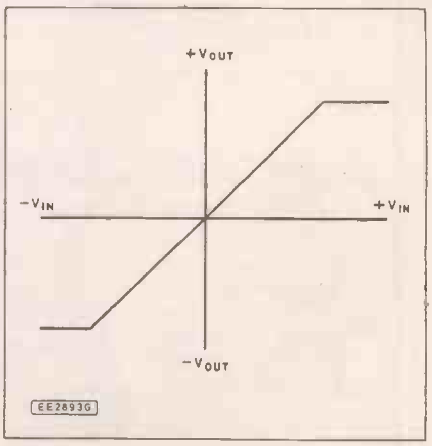


Fig. 3.1 Transfer characteristic for a typical power amplifier

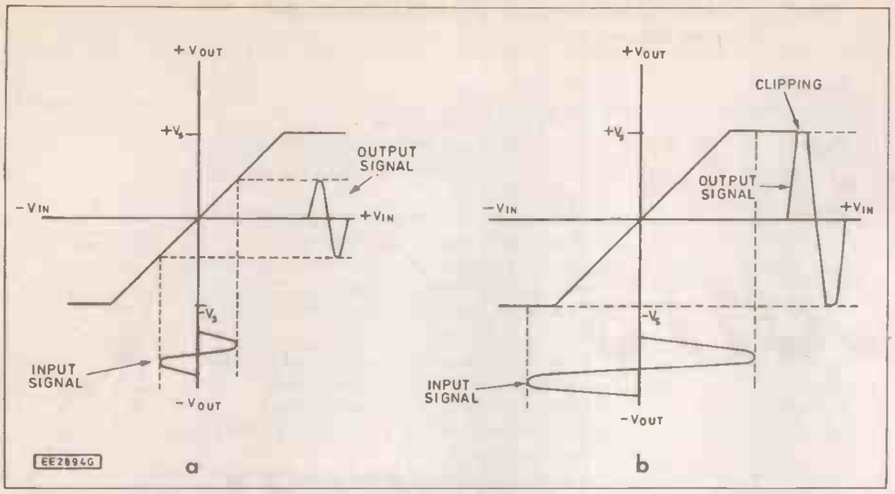


Fig. 3.2(a) Effect of Fig. 3.1 on a sinusoidal input signal of moderate amplitude
Fig. 3.2(b) Effect of Fig. 3.1 on a sinusoidal input signal of large amplitude (amplifier being over-driven)

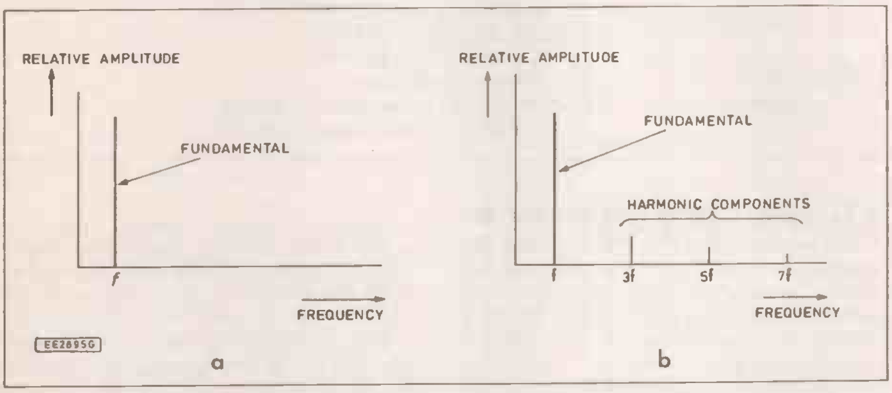


Fig. 3.3(a) Frequency spectrum associated with the output signal in Fig. 3.2(a)
Fig. 3.3(b) Frequency spectrum associated with the output signal in Fig. 3.2(b)

quency increases. The effect of this type of distortion is a rapid increase in total harmonic distortion (THD) at the onset of clipping (the point at which maximum rated power output is usually quoted), as shown in Fig. 3.4.

Another form of distortion which is prevalent in power amplifiers is associated with the transition from positive to negative (and vice versa) which occurs at the zero-axis point. This distortion is known as "cross-over" distortion and it generally arises from incorrect bias conditions within an amplifier's output stage. Fig. 3.5(a) shows a magnified version of the transfer characteristic of Fig. 3.1. In this diagram we have simply enlarged the region either side of the zero-axis crossing.

The effect of the non-linearity of the transfer characteristic of Fig. 3.5(a) is shown in Fig 3.5(b). With this type of distortion (and unlike the previous form of distortion which arises from clipping) the effect becomes increasingly more severe as the level of the signal *decreases*. This is in direct contrast with distortion caused by clipping which *increases* with signal amplitude.

Class of operation

The small-signal amplifiers which we encountered in last month's instalment of *Design Your Own Circuits* are all intended to operate in linear "class A" mode. In this mode, collector current flows throughout the complete cycle of the input signal.

Unfortunately, class A operation (which is inherently distortion free) carries with it a serious penalty when used in the output stages of a power amplifier; since the efficiency of a class A amplifier can never be greater than 50 percent, a very appreciable amount of power will be wasted within the output transistors. This, in turn, will result in the need for larger heatsinks and power supplies.

To put this into context (and assuming an ideal efficiency of 50 percent) a class A power amplifier designed for 120W of output will dissipate 120W of heat (even when no input signal is present!) and will require a power supply capable of delivering at least double the output power (i.e. 240W).

Fortunately, by judicious choice of bias and output stage design, the designer can greatly improve the efficiency of a power amplifier without greatly compromising on distortion. Classes of operation such as B, or AB, offer very much greater efficiency together with minimal power dissipation under quiescent (no signal) conditions.

The following summarises the principal classes of operation which the designer may employ:

Class A: In class A amplifiers, bias is applied so that active devices are operated at the mid-point of their transfer characteristics. In practice, this means that an appreciable value (typically 50 percent of its maximum value under driven conditions) of collector or drain current flows under quiescent (no signal) conditions. Furthermore, collector or drain current flows throughout each cycle of the input signal (i.e. conduction takes place over an angle of 360 deg.). The maximum theoretical efficiency of such a stage is only 50 percent.

Class B: Class B amplifiers are essentially non-linear and the level of bias is adjusted so that, in the absence of a signal, no collector or drain current flows. The conduction angle is thus 180 deg. and hence, in audio frequency applications, class B stages must employ push-pull output stages in which the output transistors are alternately driven into conduction during successive half-cycles of the signal. The maximum theoretical

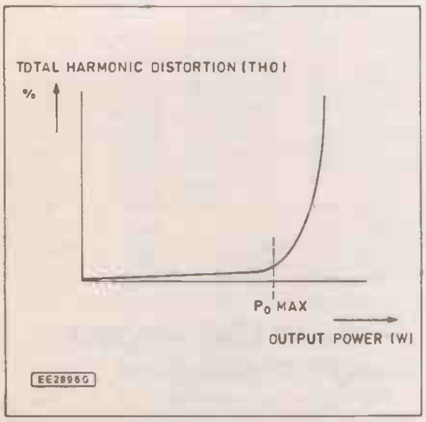


Fig. 3.4 Relationship between total harmonic distortion and output power (note the onset of clipping)

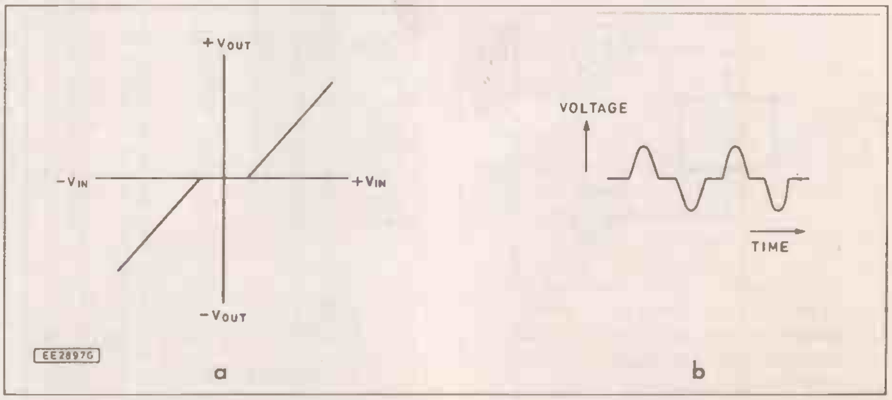


Fig. 3.5(a) Magnified version of Fig. 3.1 at the zero axis crossing point
Fig. 3.5(b) Effect of Fig. 3.5(a) on a signal of low amplitude

efficiency of a class B output stage is approximately 78 percent.

Class AB: In class AB amplifiers, the output stage bias point is adjusted so that the stage is operated with a very small value of collector or drain current (typically 10 percent of its maximum value). The conduction angle is typically between 200 and 220 deg. and efficiency is typically between 55 percent and 70 percent.

Class C: Amplifiers of the class C variety employ a level of bias which ensures that the output stage is operated with no collector or drain current flowing under quiescent conditions. Furthermore, the level of bias ensures that the stage only conducts for a relatively small angle of the input signal (typically between 90 and 120 deg.).

In audio applications (even when connected in push-pull) this mode of operation produces severe distortion. Class C amplifiers do, however, come into their own in RF applications where the "flywheel" action of a tuned circuit load can be used to reconstitute an acceptably sinusoidal output signal. The efficiency of a class C output stage is typically greater than 80 percent.

Class D: In class D amplifiers, the output stage bias point is adjusted as for class C operation but the transistors are operated under staurated switching conditions with signals which consist of rectangular pulses rather than sine waves.

In the case of audio frequency amplifiers, sinusoidal signals may be pulse width modulated onto a high-frequency rectangular pulse train and reconstituted after power amplification by passing the amplified PWM signal though a low-pass filter. The efficiency of a power amplifier using this technique can be expected to be in the region of 90 percent, or more, but there are a number of serious drawbacks to be overcome (including radiation of wideband noise) in the design of such stages.

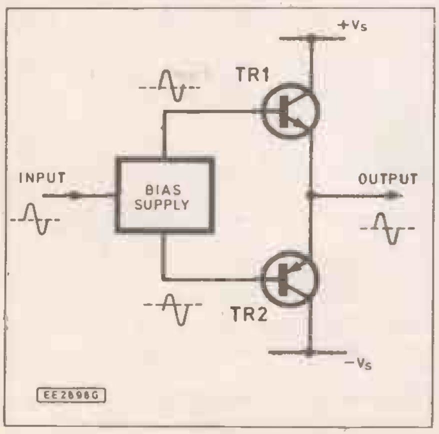


Fig. 3.6 Complementary output stage based on conventional bipolar transistors

Table 3.1 Explanation of column headings used in the tables of transistor selection data

Heading	Meaning
Device	Manufacturer's coding
Type	Transistor type; NPN or PNP for bipolar and Darlington devices, N or P-channel for MOSFETs
I_c max.	Maximum value of collector current
I_D max.	Maximum value of drain current
V_{ceo} max.	Maximum value of collector-emitter voltage with base left open-circuit
V_{cbo} max.	Maximum value of collector-base voltage with base left open-circuit
V_{DS} max.	Maximum value of drain-source voltage
P_t max.	Maximum total power dissipation
P_D max.	Maximum drain power dissipation
h_{fe}	Small-signal current gain (in common-emitter configuration)
at I_C	Value of collector current at which the small-signal current gain is quoted
f_t typ.	Transition frequency (i.e. the frequency at which the common-emitter current gain falls to unity). Note that Darlington devices exhibit relatively low values of f_t (typically less than 100kHz).
g_{fs}	Forward transfer conductance
Case style	Transistor encapsulation
Complement	Complementary transistor with similar electrical characteristics and case style

Output transistors

The prime movers in any power amplifier stage based on discrete components are the output transistors. The designer has various options open when selecting devices for operation in such stages including using:

(a) conventional complementary bipolar transistors
(b) complementary power-Darlington transistors
(c) power MOSFET devices

In all three cases, the circuitry is broadly similar however, since the performance of an output stage is very much dependent upon the technology of the power transistors, it is worth delving a little deeper into these three basic options.

Conventional bipolar output stages

The basic arrangement of an output stage based on conventional bipolar transistors is shown in Fig. 3.6. TR1 and TR2 are complementary transistors (i.e. they have similar specifications but TR1 is an *npn* device whilst TR2 is a *pnp* device). Both transistors operate in common-collector mode and thus they provide unity voltage gain coupled with high current gain (see last month).

The input signal is applied to the bias network which provides suitable bias currents and d.c. potentials at the base of each of the two output transistors. The a.c. component of the input signal is superimposed on these d.c. levels and applied equally to the two transistors. The resultant output signal appears at the junction of the emitters of TR1 and TR2.

Note that, when the input signal goes positive, TR1 will conduct more heavily whilst TR2 conducts less heavily. Conversely, when the input signal goes negative, TR1 will conduct less heavily whilst TR2 conducts more heavily. This form of operation is known as "push-pull" and output circuits of this type based on bipolar transistors are generally suitable for output power levels of up to 50W.

The following table relates to several of the most popular types of bipolar transistor for use in large-signal amplifiers (see Table 3.1 for an explanation of the column headings):

Device	Type	I_c max.	V_{ceo}max.	V_{cbo}max.	$P_T$max.	at T_J	h_{fe}	at I_c	f_t typ.	Case style	Complement
BD131	NPN	3A	45V	70V	15W	60 deg.C	20 min.	2A	60MHz min.	TO126	BD132
BD132	PNP	−3A	−45V	−45V	15W	60 deg.C	20 min.	−2A	60MHz min.	TO126	BD131
BD437	NPN	4A	45V	45V	36W	60 deg.C	40 min.	0.5A	3MHz min.	TO126	BD438
BD438	PNP	−4A	−45V	−45V	36W	60 deg.C	85 min.	−0.5A	7MHz min.	TO126	BD437
TIP31A	NPN	3A	60V	100V	40W	25 deg.C	10 min.	3A	3MHz min.	TO220	TIP32A
TIP32A	PNP	3A	−60V	−100V	40W	25 deg.C	10 min.	−3A	3MHz min.	TO220	TIP31A
TIP31C	NPN	3A	100V	140V	40W	25 deg.C	10 min.	3A	3MHz min.	TO220	TIP32A
TIP32C	PNP	3A	−100V	−140V	40W	25 deg.C	10 min.	−3A	3MHz min.	TO220	TIP31A
TIP33A	NPN	10A	60V	100V	80W	25 deg.C	20 min.	3A	3MHz min.	TO218	TIP34A
TIP34A	PNP	−10A	−60V	−100V	80W	25 deg.C	20 min.	−3A	3MHz min.	TO218	TIP33A
TIP3055	NPN	15A	70V	100V	90W	25 deg.C	20 min.	4A		TAB	TIP2955
TIP2955	PNP	−15A	−70V	−100V	90W	25 deg.C	20 min.	−4A		TAB	TIP3055
2N3055	NPN	15A	60V	100V	115W	25 deg.C	15 min.	4A	800kHz	TO3	PNP3055
PNP3055	PNP	−15A	−60V	−100V	115W	25 deg.C	15 min.	−4A	4MHz	TO3	2N3055

Power Darlington output stages

The basic arrangement of an output stage based on power Darlington transistors is shown in Fig. 3.7. TR1 and TR2 are complementary compound transistors connected internally in a Darlington configuration. Again, TR1 and TR2 have similar specifications but TR1 and TR2 are equivalent to conventional *npn* and *pnp* devices having exceptionally high values of current gain).

Operation is basically the same as that for the previous arrangement with the only difference being in the design of the bias circuit. The arrangement shown in Fig. 3.7 is suitable for power levels of typically up to about 100W.

The following table relates to several of the most popular types of power-Darlington transistor for use in large-signal amplifiers (see Table 3.1 for an explanation of the column headings):

Device	Type	I_c max.	V_{ceo}max.	V_{cbo}max.	$P_T$max.	at T_j	h_{fe}	at I_c	Case style	Complement
BD679	NPN	6A	80V	100V	40W	25 deg.C	2200 typ.	500mA	TO126	BD680
BD680	PNP	–4A	–80V	–80V	40W	25 deg.C	2200 typ.	–500mA	TO126	BD679
TIP110	NPN	4A	60V	60V	50W	25 deg.C	500 min.	2A	TO220	TIP115
TIP115	PNP	–4A	–60V	–60V	50W	25 deg.C	500 min.	–2A	TO220	TIP110
TIP121	NPN	5A	80V	80V	65W	25 deg.C	1000 min.	3A	TO220	TIP126
TIP126	PNP	–5A	–80V	–80V	65W	25 deg.C	1000 min.	–3A	TO220	TIP121
TIP132	NPN	8A	100V	100V	70W	25 deg.C	1000 min.	4A	TO220	TIP137
TIP137	PNP	–8A	–100V	–100V	70W	25 deg.C	1000 min.	–4A	TO220	TIP137
TIP141	NPN	10A	80V	80V	125W	25 deg.C	1000 min.	5A	TO218	TIP146
TIP146	PNP	–10A	–80V	–80V	125W	25 deg.C	1000 min.	–5A	TO218	TIP141
MJ3001	NPN	10A	80V	80V	100W	25 deg.C	1000 min.	5A	TO3	MJ2501
MJ2501	PNP	–10A	–80V	–80V	100W	25 deg.C	1000 min.	–5A	TO3	MJ3001
MJ11016	NPN	30A	120V	120V	200W	25 deg.C	1000 min.	20A	TO3	MJ11015
MJ11015	PNP	–30A	–120V	–120V	200W	25 deg.C	1000 min.	–20A	TO3	MJ11016

MOSFET output stages

The basic arrangement of an output stage based on power MOSFET transistors is shown in Fig. 3.8. Again, TR1 and TR2 are complementary transistors but this time they employ MOSFET rather than bipolar technology. MOSFETs offer a number of advantages over conventional bipolar or Darlington configured output stages. Paramount amongst these is the ability to perform well at high temperatures and immunity from the effects of thermal runaway.

The arrangement shown in Fig. 3.8 is suitable for power levels of up to 200W (thereafter, additional MOSFET devices can be paralleled with the aid of current sharing resistors of appropriate value in the gate and source circuits).

The following table relates to several of the most popular types of MOSFET transistor for use in large-signal amplifiers:

Device	Type	I_D max.	V_{DS} max.	P_D max.	g_{fs} min.	Case style	Complement
2SK135	N	7A	160V	100W	0.7S	TO3	2SJ50
2SJ50	P	–7A	–160V	100W	0.7S	TO3	2SK135
2SK176	N	8A	200V	125W	0.7S	TO3	2SJ56
2SJ56	P	–8A	–200V	125W	0.7S	TO3	2SK176
2SK413	N	8A	140V	100W	1S	TO3P	2SJ118
2SK118	P	–8A	–140V	100W	1S	TO3P	2SK413

Question 1: The following transistors are available: TIP31A, TIP32A, TIP33A, MJ3001, PNP3055, 2N3055, and 2SJ50. Which of the transistors is most suitable for operating:

(a) in a medium power amplifier providing 10W r.m.s. output from a ±20V supply rail?

(b) in a public address amplifier providing 75W output from a ±50V supply rail?

(c) in a complementary configuration in conjunction with a TIP34A?

(d) as TR2 in the circuit configuration of Fig. 3.8?

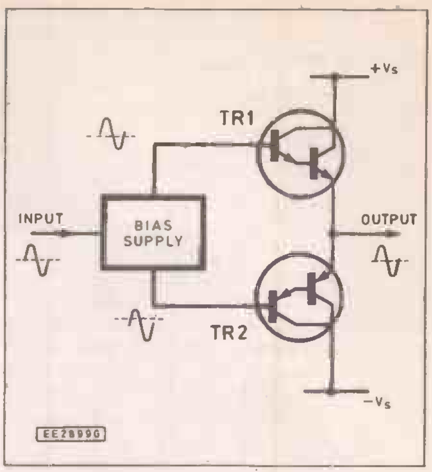


Fig. 3.7 Complementary output stage based on power Darlington transistors

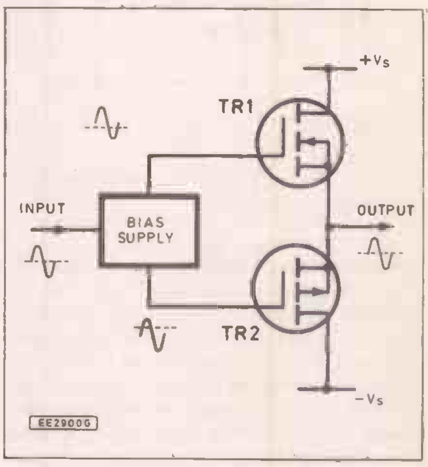


Fig. 3.8 Complementary output stage based on power MOSFET transistors

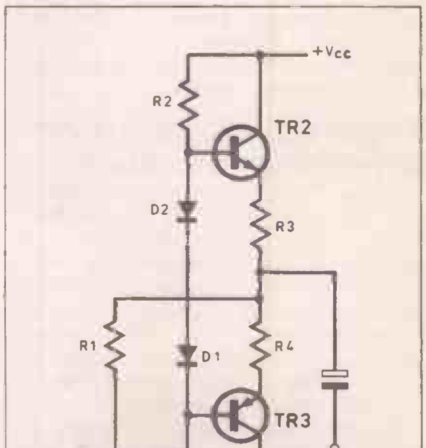


Fig. 3.9 Basic circuit of a practical complementary power amplifier

Practical large-signal amplifier circuits

Having introduced some of the basic output stage configurations employed within power amplifiers, it is time that we introduced some practical circuit designs. Fig. 3.9 shows the basic circuit diagram of a complementary output stage in which the driver stage, TR1 operates in common emitter mode whilst the complementary output pair, TR2 and TR3, operate as emitter followers. Two forward biased silicon diodes, D2 and D3, provide a constant voltage drop of approximately 1.2V to bias the output transistors into class AB mode.

As with all output stages of this type, the output power delivered to the load is a function of the supply voltage and load impedance. The maximum theoretical output power (assuming perfect transistors and neglecting the effect of the two emitter resistors, R3 and R4) is given by the relationship:

$$P = V_{CC}^2/8R_L$$

where VCC is the supply voltage and R_L is the impedance of the load.

Question 2: The circuit shown in Fig. 3.9 operates with BD131 and BD132 transistors from an 18V supply rail. What is the maximum theoretical power that can be delivered to:

(a) a 4 ohm loudspeaker

(b) a 15 ohm loudspeaker.

Question 3: The circuit shown in Fig. 3.9 is to provide an output of 20W. If the loudpeaker is to be a nominal 8 ohm type, determine the minimum value of supply voltage required.

Low-cost applications

The circuit of Fig. 3.9 is ideal for low-cost non-critical applications and will operate satisfactorily with supply rail voltages of between 9V and 45V. The output transistors will require adequate heatsinks (e.g. 3 deg.C/W, or less, for amplifiers of 10W, or greater output). In addition, where the d.c. supply rail exceeds 30V, TR1 should also be fitted with a small heatsink (e.g. a push-fit TO5 type rated at 48 deg.C/W, or less).

In practice, the voltage gain of the driver stage, TR1, can be increased by raising the effective collector load impedance. This technique is illustrated in the improved

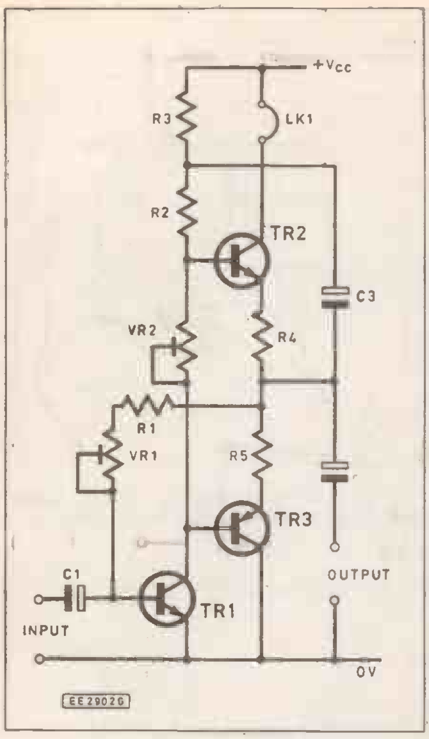


Fig. 3.10 Improved complementary power amplifier

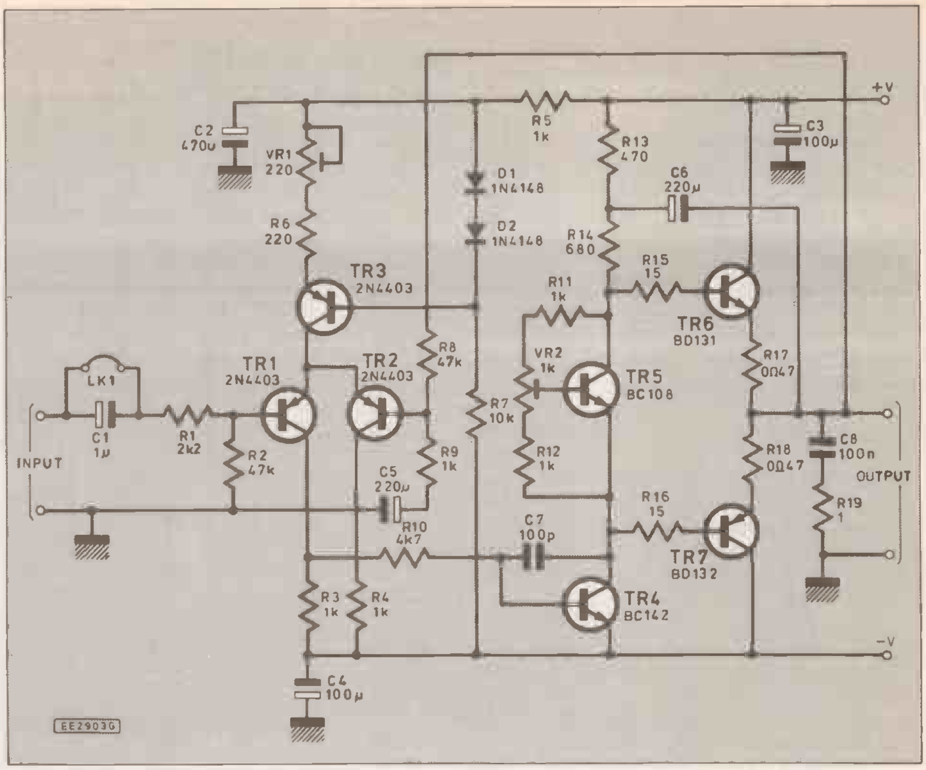


Fig. 3.11 High quality power amplifier module

power amplifier circuit shown in Fig. 3.10. The "bootstrap" feedback is applied by means of C3 whilst the two pre-set resistors, VR1 and VR2, are adjusted under quiescent (no signal) conditions for voltage symmetry across the output transistors (the voltage at the junction of R4 and R5 should be exactly half the supply voltage) and quiescent current, respectively.

In order to accomplish this latter adjustment, LK1 should be broken and an ammeter inserted to measure the output stage collector current. In most applications, VR2 should adjusted for a quiescent collector current of between 20 and 50mA to ensure correct operation in class AB mode. When the adjustment is complete, the link should be replaced.

High quality power amplifier module

Whilst the performance of the circuit of Fig. 3.10 is adequate for many applications, it needs further refinement to be suitable for use in "high-fidelity" equipment. Fig. 3.11 shows the circuit of a high-quality power amplifier based on discrete components. This circuit offers a great deal of flexibility and can be used with a variety of output devices to realise output power levels of up to 50W.

The basic design, based on BD131 and BD132 transistors, has been optimised for high-quality operation and provides an output of 10W r.m.s. into a load impedance of 8ohms when operating from dual positive and negative supply rails of 16V.

Transistors TR1 and TR2 operate as a differential pair (the signal at the collector of TR1 is proportional to the difference between the signals applied to the bases of TR1 and TR2). Note that the input to TR1 can be either a.c. coupled via C1 (LK1 removed) or d.c. coupled (LK1 inserted to bypass C1).

The base voltage of TR3 is held constant by the two forward biased diodes, D1 and D2. TR3 thus acts as a constant current source to the emitters of TR1 and TR2. This ensures symmetry since the *total* collector current of TR1 and TR2 remains constant, i.e. if the collector current of TR1 increases by a certain amount (due to an increase in signal current) the collector current of TR2 must fall by the same amount.

The emitter current of TR1 and TR2 is set by VR1 and, since TR1 is d.c. coupled to the base of TR4, it can be used to adjust the symmetry of the output stage in the same manner as that provided by VR1 in the circuit of Fig. 3.10.

Transistors TR1, TR2 and TR3 all operate at relatively low current levels and thus general purpose *pnp* transistors will be perfectly adequate. It should also be pointed out that, since input signal levels are relatively large (typically 50mV, or more) some form of pre-amplifier will usually be required.

Transistor TR4 operates as a driver stage connected in common emitter mode. This stage operates at a moderate power level and thus an appropriately rated TO39 encapsulated device is used. With this stage, current gain is of less importance than maximum voltage ratings (note that V_{CEO} and V_{CBO} should be at least equal to twice the voltage of a single supply rail).

The bias for the output transistors (TR6 and TR7) is provided by means of the voltage multiplier stage, TR5. This stage produces a constant voltage drop between collector and emitter, the value of this voltage is determined by the setting of VR2.

Output stage

Conventional bipolar transistors are used in the complementary output stage, TR6 and TR7. These transistors must be adequately rated in terms of maximum voltage, current and power dissipation. Fortunately, a wide selection of inexpensive plastic audio power transistors is available.

The BD131 and BD132, TO126 encapsulated devices specified in the components list should be perfectly adequate for output power levels of up to 20W. Beyond that, more rugged transistors (e.g. the TAB encapsulated TIP3055 and TIP2955) should be employed. It is important to note that, in either case, the output transistors will require substantial heatsinks (typically rated at 2 deg.C/W, or better).

The amplifier contains a number of feedback paths. The amplifier is stabilised (in terms of both a.c. and d.c. conditions) by means of negative feedback from the output to the base of TR2. This feedback is applied via R8 and the ratio of R8 to R9 determines the voltage gain of the amplifier.

The low frequency cut-off point (with LK1 connected) is principally determined by the value of C5. The lower cut-off frequency is given approximately by:

$$f_{C1} = 0.159/C5 \times R9$$

In order to maintain stability over a wide range of frequencies, C7 provides high-frequency roll-off by means of negative feedback from collector to base of TR4. C8 and R19 provide a Zobel network which provides compensation at the output of the amplifier.

As with R3 and R4 in Fig. 3.9 and R5 and R6 in Fig. 3.10, low value resistors, R17 and R18, provide some protection for the output transistors against the effects of thermal runaway. These components also provide last-ditch protection in the event of a short-circuit at the output (which would otherwise cause the output transistors some considerable pain when the amplifier is driven!).

The shunt voltage regulator configuration of TR5 provides thermal compensation for the output stage by effectively reducing the base bias voltage for the output transistors as ambient temperature increases. It is thus desirable for TR5 to be mounted in close proximity to the output transistors to provide efficient thermal coupling. Ideally, TR5 should be bonded to the heatsink mid-way between TR6 and TR7.

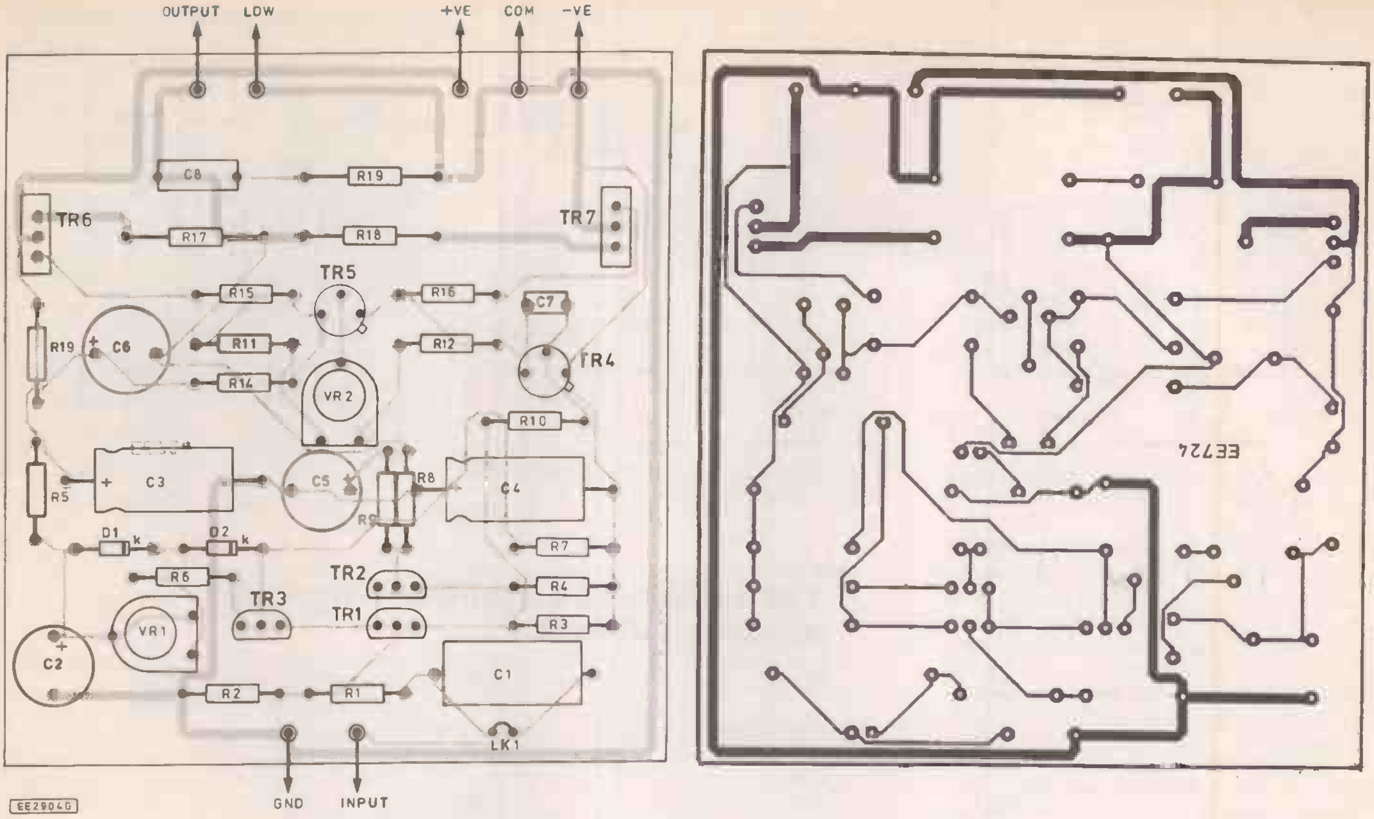


Fig. 3.12 P.C.B. layout for the high quality power amplifier module

The p.c.b. layout for the high quality power amplifier is shown in Fig. 3.12

Integrated circuit power amplifiers

Consumer integrated circuit power amplifiers can make an extremely cost-effective alternative to circuits based on discrete components for audio amplifiers in both the low and medium power categories. The designer can choose from a wide range of devices offering specifications which are adequate for all but the most critical applications. The following data refers to some of the most commonly available devices:

High quality power amplifier module specifications

Output power:	15W at 1kHz into 8ohm (± 20V supply)
	10W at 1kHz into 8ohm (± 16V supply)
	7W at 1kHz into 8ohm (± 12V supply)
Total harmonic distortion:	less than 0.5% at full output, 1kHz
	less than 0.02% at 500mW output, 1kHz
Voltage gain:	50 (approx)
Frequency response:	10Hz to 60kHz at–1dB
	4Hz to 80kHz at–3dB
Input impedance:	5kilohm
Recommended load impedance:	8ohm
Supply voltage:	± 12V to ± 20V d.c.
Supply current:	1A at full output (± 16V supply)

Device	Package	V_S	P_O into R_L	at V_S	Notes
LM380	14-pin DIL	8V to 20V	2W 8ohm	18V	Fixed gain
LM386	8-pin DIL	4V to 12V	0.3W 8ohm	12V	
TBA820M	8-pin DIL	3V to 16V	1.6W 8ohm	16V	
TDA2822	8-pin DIL	1.8V to 15V	1W 8ohm	12V	Dual/stereo device
TDA2004	11-pin TAB	6V to 18V	4W 4ohm	17V	Dual/stereo device
TD2030	5-pin TAB	±9V to ±15V	11W 8ohm	±15V	Requires split supply

The headings used in the table have the following meanings:

Heading	Meaning
Device	Manufacturer's coding
Package	IC encapsulation and number of pins
V_S	Supply voltage range
P_O	AF power output
into R_L	Recommended load impedance at which power output is quoted
at V_S	Supply voltage for quoted output power
Case style	Encapsulation

Practical i.c. power amplifiers

The LM380 offers a very simple solution to the need for providing a fixed block of audio gain with up to 2W output into an 8ohm loudspeaker. The i.c. provides a voltage gain of 50 and is enclosed in either an 8-pin (LM380N-8) or 14-pin (LM380N-14) d.i.l. package. The device incorporates output current limiting as well as thermal shutdown circuitry.

The LM380 operates with supply voltages of up to 22V. The device is, however, unsuitable for operation below 8V and hence, for applications in which a battery supply is to be used, this should be at least 9V. Furthermore, in order to avoid premature output current limiting, it is recommended that the load impedance is not less than 8ohm.

Stability can be assured by placing a decoupling capacitor in close proximity to the positive supply rail input. (This simple precaution is considered good practice where most i.c. power amplifiers are concerned!).

An LM380 can be used in complete low-power audio amplifier stages, this requires an absolute minimum of additional components as shown in Fig. 3.13. Provided that a supply rail of at least 9V is available, this circuit is ideal for use in applications such as intercoms, radio receivers, etc.

Since the LM380 is contained within a plastic package, the device relies on thermal conductivity through its pins to the p.c.b. foil in order to dissipate heat. For high power operation (e.g. 1W to 2W from supply rails of between 12V and 22V) it is, therefore, essential that an adeqate area of p.c.b. foil is provided. Ideally, this should be at least 12 cm^2 connected directly to pins 3, 4, 5, 10, 11 and 12, these are also electrically connected to 0V. Where p.c.b. space is restricted or in applications where sustained high-power operation is envisaged, d.i.l. bond-on or clip-on heat sinks (of 24 deg.C/W) should be fitted directly to the plastic package.

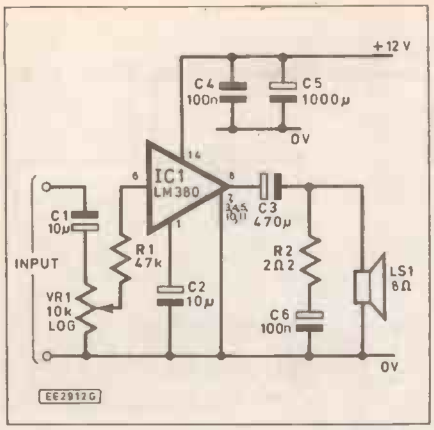


Fig. 3.13 Simple i.c. audio power amplifier using an LM380

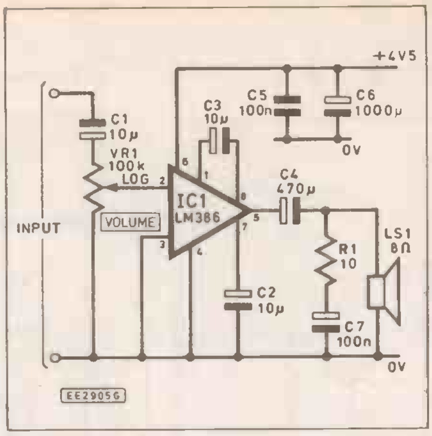


Fig. 3.14 I.C. audio power amplifier based on an LM386

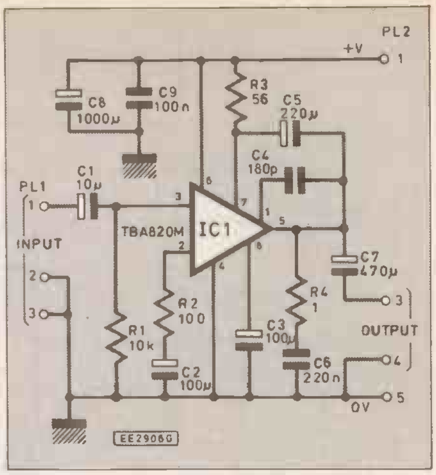


Fig. 3.15 TBA820M power amplifier module

An alternative to the use of an LM380, at the cost of a few additional components, is the use of an LM386. This device is housed in an 8-pin d.i.l. plastic-package and operates successfully at supply voltages as low as 4V. Fig. 3.14 shows the circuit of a simple audio amplifier based on an LM386 which operates from a 4.5V d.c. supply.

The TBA820 is another popular i.c. device for use in low power amplifiers. This chip can provide powers of up to 2W into 8ohm when operated from a 12V d.c. supply. Apart from smaller physical size, the TBA820M offers the following advantages over the LM380 and LM386:

(a) Voltage gain is programmable using a single external resistor.
(b) Operation over a wide range of supply voltages (3V to 16V)
(c) Low quiescent supply current (4mA typical)
(d) High degree of supply-borne ripple rejection (important for mains operated equipment)
(e) High input impedance

TBA820 amplifier module

The TBA820 i.c. is, in many respects, the ideal choice for use in a very wide range of simple audio applications which require an output power of less than 1.6W. Fig. 3.15 shows the circuit of a versatile amplifier module based on the TBA820M. The p.c.b. and component layouts for the module are shown in Fig. 3.16.

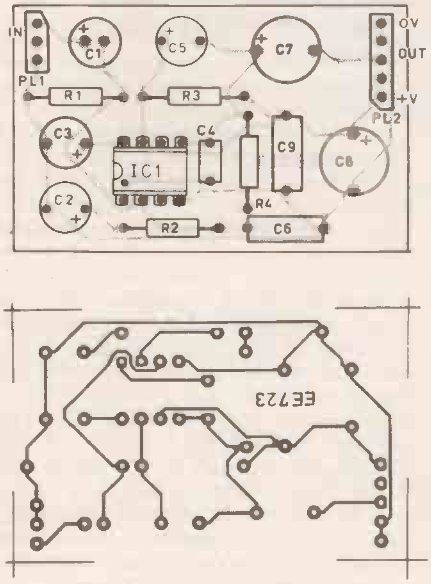


Fig. 3.16 P.C.B. layout for the TBA820M power amplifier module

TBA820 i.c. amplifier module specifications

Output power:	1.2W at 1kHz into 8ohm (12V supply) 250mW at 1kHz into 8ohm (5V supply)
Total harmonic distortion:	1.5% at full output, 1kHz 0.25% at 500mW output, 1kHz
Voltage gain:	80
Frequency response:	50Hz to 13kHz at–3dB 30Hz to 20kHz at–5dB
Input impedance:	10kilohm
Recommended load impedance:	8ohm
Supply voltage:	5V to 15V d.c.
Supply current:	170mA at full output (12V supply)

Stereo amplifiers

A stereo audio amplifier (with "left" and "right" channels) can be realised by simply duplicating two identical amplifier stages. In order to minimise the component count (and to reduce the amount of board area), a better option could be to make use of one of several available dual/stereo power amplifier devices.

For low-power applications, the TDA2822 can provide output powers of up to 1W into 8ohm when operating from a nominal 12V d.c. supply rail. The i.c. is delightfully simple to use and operates from supplies of between 2V and 15V with a typical closed-loop voltage gain of 40dB. Fig. 3.17 shows the complete circuit diagram of a simple stereo amplifier based on a TDA2822 device. This circuit makes an ideal stereo "monitor" amplifier for use with a cassette tape deck or as a means of "boosting" the output of a portable cassette or compact disk player.

When higher levels of output power are required (and where a nominal 12V d.c. supply rail is available) the TDA2004 can be recommended. This device comprises a dual/stereo audio power amplifier contained in an 11-lead tab mounting plastic package. The two amplifiers may be connected separately (e.g. for stereo applications) or wired in a bridge configuration to achieve a four-fold increase in output power. The device incorporates thermal shut down as well as short circuit and safe operating area protection.

The TDA2004 will operate over a range of supply voltages (from 8V to 18V maximum) and can provide a typical output powers of 6.5W into 4ohm at 0.2 percent THD when operated from a 14.5V supply rail. A typical stereo amplifier using the TDA2004 is shown in Fig. 3.18.

The voltage gain of the circuit of Fig. 3.18 is determined by the ratio R3/R1 and R4/R2. With the values quoted, each stage

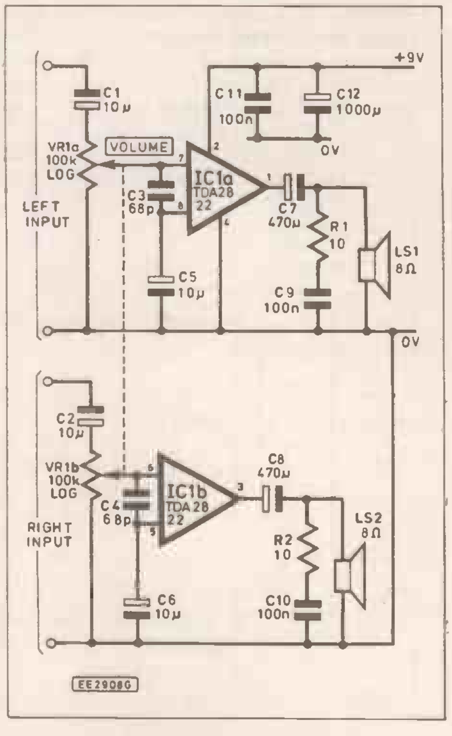


Fig. 3.17 Simple stereo amplifier based on the TDA2822

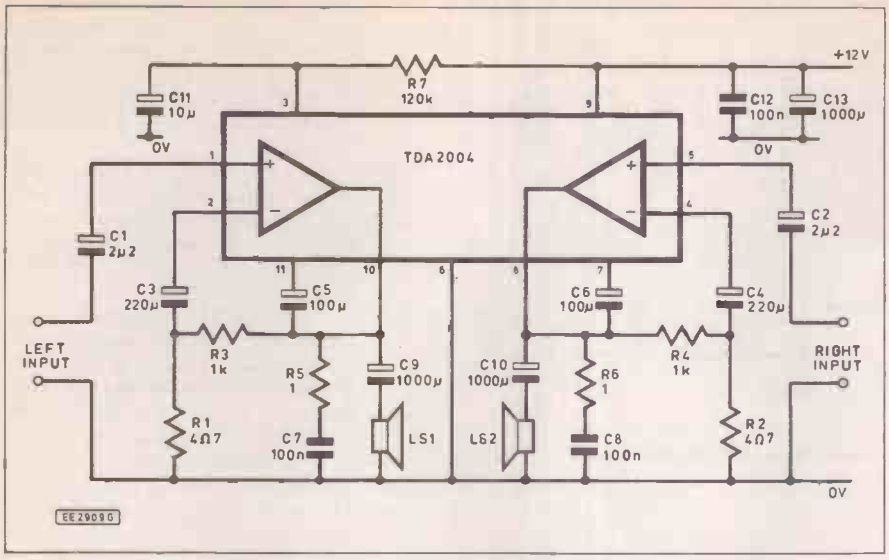
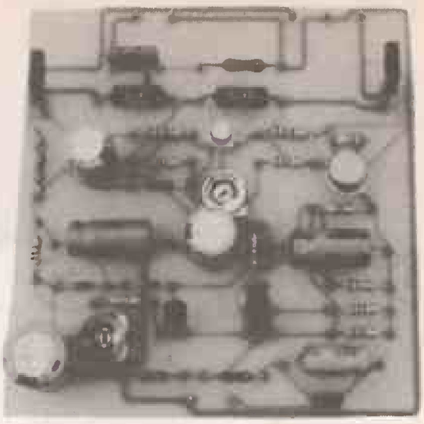


Fig. 3.18 TDA2004 stereo power amplifier



operates with a voltage gain of approximately 200. The frequency response extends from 1Hz to 150kHz at 3dB points and each channel is capable of delivering 4.5W into an 8ohm loudspeaker when operating from a 12V supply rail. Note that a heatsink of 4 deg.C/W, or less is essential (note that the heatsink tab is internally connected to 0V).

High power i.c. amplifiers

The previously described circuits provide outputs of up to 4W and, whilst this level of output power may be adequate for portable equipment (such as radio receivers, tape recorders, etc) there will be many applications in which increased output power is required. Such equipment will generally derive its power either from the mains or from a 12V car battery.

In medium power applications, the TDA2030 can provide a cost effective solution. The TDA2030 is an integrated circuit power amplifier capable of producing output powers of up to 20W into a 4ohm load. The device incorporates short circuit protection, thermal shut down and safe operating area protection.

The TDA2030 is housed in a 5-pin TO220 package, the metal tab of which is bolted to a suitably rated heat sink (note that, like the TDA2004, the tab is internally connected to the negative supply rail). The voltage gain of the TDA2030 is fixed by two external resistors. The supply voltage may range from +6V and +18V for dual supply rail operation and 12V to 36V for single rail operation.

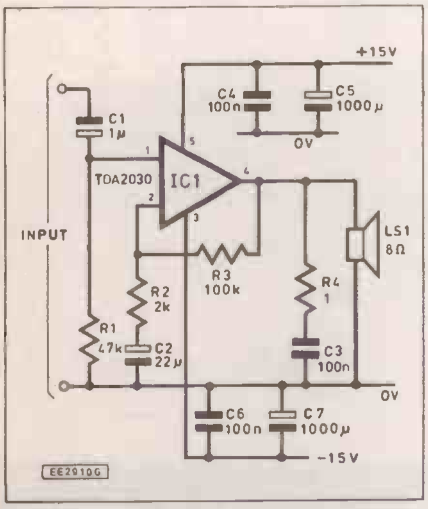


Fig. 3.19 TDA2030 power amplifier (dual supply)

The TDA2030 is shown in Fig. 3.19 and 3.20 respectively operating with dual and single supply rails. The performance of these circuits is almost identical and, using the supply rails quoted, outputs of 6.5W into 15ohm, 10W into 8ohm, and 13W into 4ohm may be realised at a THD of less than 0.1 percent. Both circuits exhibit a voltage gain of 50 and have a frequency response extending from approximately 10Hz to over 100kHz.

The TDA2030 requires a heatsink rated at 4 deg.C/W, or less. Furthermore, it should be noted that, since the heatsink tab is internally connected to pin-3 (the negative supply rail), it will normally be necessary to use an insulating kit in conjunction with the circuit of Fig. 3.19.

Design Problem

This month's design problem (as with all of the design problems presented in this series) is designed for readers who would welcome the opportunity of tackling a little "homework". The exercise may be tackled purely "on paper" or may be used as the basis of a complete constructional project.

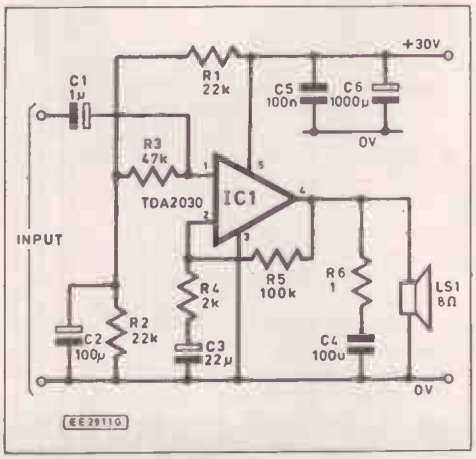


Fig. 3.20 TDA2030 power amplifier (single supply)

This month's problem arises from the need for a means of amplifying the signal from a guitar:

A low-cost guitar amplifier is to be designed according to the following target specification:

Output power:	*30W*
Frequency response:	*20Hz to 20kHz at –3dB (or better)*
Input impedance:	*50kilohm*
Output load impedance:	*8 ohms*
Voltage gain:	*50 (minimum)*

Design a suitable power amplifier circuit based on 2N3055/PNP3055 complementary output transistors.

Answer to last month's design problem:

A public address amplifier provides full rated output from a nominal line input of 1V r.m.s. The amplifier is to be fitted with a microphone input facility which will match a 50kilohm impedance dynamic microphone. If the microphone produces a nominal output of 2mV r.m.s., design a simple pre-amplifier based on a dual operational amplifier.

One solution to last month's design problem is shown in Fig. 3.21. The rationale behind this circuit arrangement is as follows:

(a) The overall voltage gain required will be given by:

$$A_V = \frac{1V}{2mV} = \frac{1000mV}{2mV} = 500$$

This value of gain could be achieved from a single stage i.c. operational amplifier, but only at the the expense of bandwith (note that the product of gain and bandwidth is constant for any particular type of operational amplifier). In practice, a gain of 500

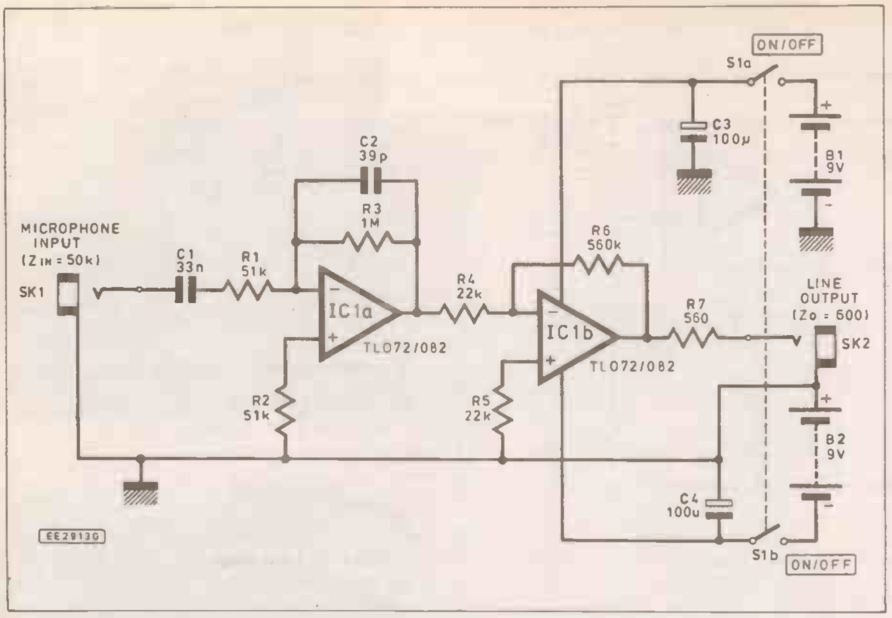


Fig. 3.21 Microphone preamplifier (solution to last month's Design Problem)

from a standard 741 operational amplifier would result in a bandwidth of only about 4kHz.

Hence we shall attempt to achieve the necessary value of gain over two stages. We shall aim for a gain of 20 in the first stage (IC1a) and 25 in the second stage (IC1b). Note that 20 × 25 = 500.

(b) The required input impedance is 50kilohm. Hence, we shall make R1 50kilohm and R3 1M (note that R3/R1 = 20 approx). To preserve symmetry, we should make R2 50kilohm. In practice, performance would be almost identical with R1 and R2 both taken from the nearest preferred value (either 47k or 51k).

(c) The corresponding gain setting resistors in the second stage (IC1b) will be 22k (R4) and 560k (R6). Note that R6/R4 = 25 (approx). Again, to preserve symmetry we shall make R5 22k.

(d) A reasonable frequency response for a microphone preamplifier for use in a public address system would be from about 100Hz to 4kHz. In order to improve the overall noise performance, we shall define the frequency response of the pre-amplifier entirely within the first stage.

(e) The upper cut-off frequency of the first stage is determined by C2 and the required value of C2 is given by:

$$C2 = \frac{0.159}{4kHz \times 1M} = 40pF \text{ (approx)}$$

The lower cut-off frequency, on the other hand, is determined by C1 and thus:

$$C1 = \frac{0.159}{100Hz \times 50k} = 32nF \text{ (approx)}$$

The nearest preferred values for C1 and C2 are 39p and 33n, respectively.

COMPONENTS

High Quality Power Amplifier

Resistors

R1	2k2
R2,R8	47k (2 off)
R3,R4,R5,R9,R11,R12	1k (2 off)
R6	220
R7	10k
R10	4k7
R13	470
R14	680
R15,R16	15 (2 off)
R17,R18	0Ω47 (2 off)

All 0.25W 5% carbon types (with the exception of R17 and R18 which are miniature wirewound types)

Potentiometers

VR1	220 min. horizontal mounting skeleton preset
VR2	1k min. horizontal mounting skeleton preset

Capacitors

C1	1µ axial elect. 63V
C2	470µ radial elect. 35V
C3,C4	100µ axial elect. 25V (2 off)
C5,C6	220µ radial elect. 35V (2 off)
C7	100p ceramic
C8	100n polyester

Semiconductors

D1, D2	1N4148 (2 off)
TR1,TR2,TR3	2N4403 (3 off)
TR4	BC142
TR5	BC108
TR6	BD131
TR7	BD132

Miscellaneous

LK1	2-way straight p.c.b. header (0.1 pitch) with jumper

Printed circuit board, available from the *EE PCB Service*, order code EE724; terminal pins (7 off); haeatsinks (see text)

Approx cost guidance only **£11**

COMPONENTS

TBA820 Amplifier Module

Resistors

R1	10k
R2	100
R3	56
R4	1

All resistors are 0.25W 5%

Capacitors

C1	10µ radial elect. 16V
C2,C3	100µ radial elect. 16V (2 off)
C4	180p polystyrene
C5	220µ radial elect. 16V
C6	220n polyester
C7	470µ radial elect. 16V
C8	1000µ radial elect. 16V
C9	100n polyester

Semiconductors

IC1	TBA820M

Miscellaneous

PL1 3-way straight p.c.b. header (0.1 inch pitch); SK1 3-way socket housing (0.1 inch pitch); PL2 5-way straight p.c.b. header (0.1 inch pitch); SK2 5-way socket housing (0.1 pitch); 8-pin low-profile d.i.l. socket; Printed circuit board, available from the *EE PCB Service*, order code EE723.

See SHOP TALK Page

Approx cost guidance only **£7.50**

(f) The second stage (IC1b and associated components) will just provide "straight gain" with no frequency response correction. R7 is used to provide an output impedance of approximately 600ohm (this also helps to make the output short-circuit proof!).

The two stages, IC1a and IC1b can be realised from a single dual operational amplifier (either TL072 or TL082) operating from a dual ±9V supply derived from two PP3 batteries (thus reducing the risk of supply borne hum and noise which would otherwise be prevalent in a mains powered unit). C3 and C4 provide supply decoupling.

Answers to questions in Part Three

Question 1:

(a) TIP31A, TIP32A
(b) 2N3055, PNP3055
(c) TIP33A
(d) 2SJ50

Question 2:

(a) 10W
(b) 2.7W

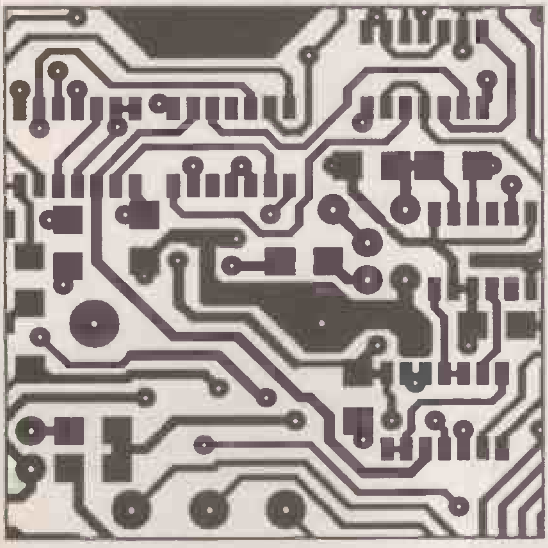
Question 3:

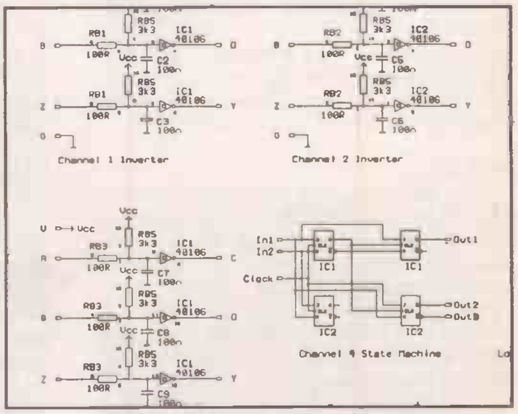
36V

Next month: Next month's instalment deals with oscillators. Our design problem involves a signal injector whilst our accompanying constructional project features a versatile waveform generator.

Cumulative index to modules

Title	Part	Function/specification
Dual output power supply module	1	Dual ± 5V, ± 12V or ± 15V regulated power supply rated at 1A max. output
723 variable power supply module	1	Single variable output of + 2V to + 37V at up to 5A max. Output voltage and current limit are set by means of preset controls.
L200 variable power supply module	1	Single variable output of + 2.7V to + 35V at up to 2A max. Output voltage and current limit are set by means of variable controls.
General purpose transistor amplifier module	2	Pre-defined voltage gain and frequency response. Low/medium input impedance, low output impedance. Requires a single 9V d.c. supply at 2mA nominal.
General purpose operational amplifier module	2	Pre-defined voltage gain and frequency response. Two stages may be used independently (e.g. for stereo operation) or connected in tandem. Requires a dual supply of between ± 5V and ± 15V at 10mA nominal.
High-quality power amplifier module	3	Fixed gain medium/high power class AB audio amplifier capable of operating with very low distortion. Recommended load impedance 8ohm. Requires a dual supply of between ± 12V and ± 20V at up to 2A.
TBA820 i.c. amplifier	3	Versatile i.c. low/medium power for general purpose applications. Requires a single supply rail of between + 5V and + 15V.





ACTUALLY DOING IT!

by Robert Penfold

A COMMON question from those who are about to undertake electronic project construction for the first time is *"what tools will I need?"*

This is a question in the "how long is a piece of string?" category. The tools you need will vary from one project to another.

For this reason I would have to advise simply going out and buying a likely looking selection of tools, you would probably buy some items that you will not use for some time, if ever, while missing out some items that you will need quite early on.

TOOLS OF THE TRADE

Although it is probably not possible to predict exactly which tools you will need, there are a number of standard tools which are used in the construction of all or most projects. Probably the best way of handling things is to first make sure that you have this basic set of much used tools, and to then buy further tools when and if they are needed.

With luck you will have a fair percentage of these tools already, as many of them are normal household items. However, one item that few people will already own is a small electric soldering iron.

There is insufficient space available here for a full discussion of soldering, but you will need an electric iron having a power rating of about 15 to 25 watts. There is no need to buy an expensive temperature controlled type. An ordinary type of good quality is perfectly adequate.

These days most electronic soldering involves small joints on crowded circuit boards. This requires a small bit of about 1 to 2.5 millimetres in diameter.

SOLDER

You will also need some solder, which should be a proper electrical type having 60 percent tin/40 percent lead content, plus multiple cores of flux. Electrical solder is generally sold in two thicknesses. The thinner type (22s.w.g.) is now the more common, and is the one that is better suited to small joints on printed circuit boards.

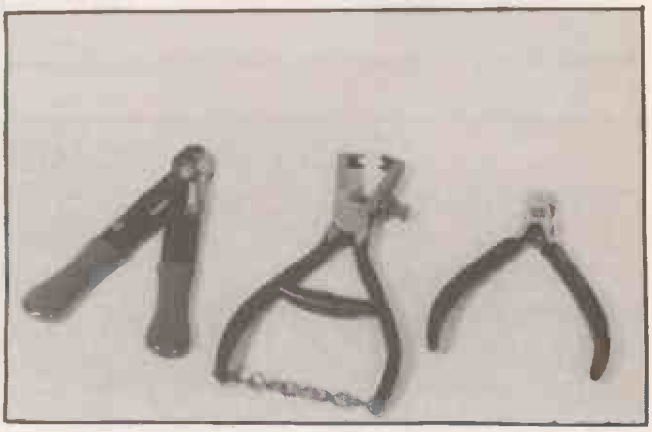
The heavier (18s.w.g.) type is better suited to larger joints, such as hard wiring to sockets and controls. Ideally you should have a large reel of the thinner gauge, but a small reel of the thicker type should suffice.

An essential accessory for a soldering iron is a stand that will hold it safely while it is hot. It is not too difficult to improvise something, but it would be better to pay the modest cost of a proper ready made item than to improvise something that might be slightly dangerous.

Some form of soldering iron tip cleaner is an accessory that is well worth having. Many soldering iron stands are fitted with sponges for cleaning the bit, but these must be kept wet and are not terribly convenient. Bit cleaning blocks are probably a better means of keeping the bit clean.

STRIPPERS

About the only other essential items for the electrical side of construction are a pair of wire clippers and a pair of wire strippers. Scissors are not really suitable for wire cutting. They are likely to blunt quickly, and in all probability will simply fall apart before too long.



From left to right, combined wire strippers and cutters, wire strippers and wire cutters. (Scissors are definitely not a suitable alternative.) To this should be added "long- and snub-nose pliers and a 15W to 25W soldering iron.

Also, they do not permit wires to be trimmed short on the underside of circuit boards, and will generally lack the sort of precision needed for modern electronic construction. Any small to medium size wire clippers of reasonable quality should do the job well.

Using scissors or a knife to strip the p.v.c. insulation from the end of connecting wire is not to be recommended either. If you are lucky you will only damage the wire, which will then be prone to breaking. If you are unlucky you will lacerate yourself.

Proper wire strippers can be adjusted so that they will only cut the insulation, and will not damage and weaken the wire. They are also safe to use.

As an economy measure you can buy a combined wire stripper and cutter tool. In my experience these work well as strippers, but are less good as cutters. In particular, it can be difficult to cut fine wires that present no problems when using ordinary wire cutters. However, they are adequate for most purposes, are convenient in use, inexpensive, and are mostly quite long lasting.

CUTTING AND DRILLING

Probably most households are equipped with a hacksaw (or a junior hacksaw), plus a drill of some kind and a range of bits. These are tools that are needed a great deal for project construction, and will have to be bought at an early stage if you do not already have them.

I prefer to use a hand drill rather than a power type, because a hand drill is more controllable when working the soft materials that are often encountered in project construction. An electric drill is usable, but should preferably be one that can be run at a slow speed.

Some plastic cases are quite soft and need to be drilled slowly and carefully. High speed power drills can tend to rip straight through these, making rough holes of excessive size.

Ideally you should have a large set of HSS drill bits covering sizes from about two millimetres up to about 10 or 12 millimetres. Sizes you are likely to need quite a lot are 2.5, 3, 3.3, 4, 5, 6.35, and 10 millimetres. These represent about the minimum that will enable you to tackle most projects.

With drill bits it is probably worth paying the extra for good quality types. Inexpensive bits often blunt relatively quickly, and the smaller types tend to be easily broken.

GETTING TO GRIPS

Pliers are another standard household item, but you may find that any you have already are something less than ideal for project construction. Probably the most useful type in the current context are "electricians" pliers, which I suppose is not surprising. These are smaller and longer "nosed" than the average pair of general purpose pliers.

It can be useful to have a large pair of pliers as well, and possibly a miniature pair. These are not essential items though.

When in the past I have suggested that tweezers are something less than the best thing since sliced bread, I usually receive a few readers' letters politely explaining that I have made a mistake. Clearly a great many project constructors find these very useful, and they would seem to find particular favour with those whose fingers are less nimble than they once were.

Provided you do not cut (or bite) your finger nails very short, you will probably find that you can easily pick up and position miniature resistors and the like without resorting to tweezers. This makes life a lot easier than if you have to keep reaching for the tweezers.

Tweezers can be useful when manoeuvring nuts or screws into otherwise inaccessible places, or for retrieving small items that have been accidentally dropped into the dark recesses of a project. For this type of thing I prefer to use a "pearl catcher" tool, and these are to be found in many electronic component catalogues at low prices.

Operating a plunger at the top end of the tool results in four wire claws emerging from the bottom end. These are spring-loaded, and can easily be made to grasp small screw heads, nuts, etc.

They live up to their name, and can even hold something smooth and round such as a pearl or a ball-bearing. As an inexpensive alternative you can try the old ploy of using a blob of Plasticine or Blue-Tack on the end of a screwdriver.

A small vice is more than slightly useful. One of these makes tasks such as trimming control spindles to length and making small mounting brackets very much easier. At a pinch you can probably get by without one for most project construction, but if you do not already have a vice, it is probably worthwhile getting one sooner rather than later.

It is possible to use pliers when tightening the mounting nuts for controls and sockets, but it is difficult to get the nuts really tight. Also, it is all too easy to slip and very badly scratch the case. A small adjustable spanner provides a more reliable method of tightening mounting nuts, and is a tool I would want as part of my basic electronics toolkit.

TO THE POINT

In order to accurately drill holes in panels the centres must be marked with small indentations. A small hammer and a centre punch is needed when working on metal cases. It is definitely not a good idea to use this method when dealing with plastic cases.

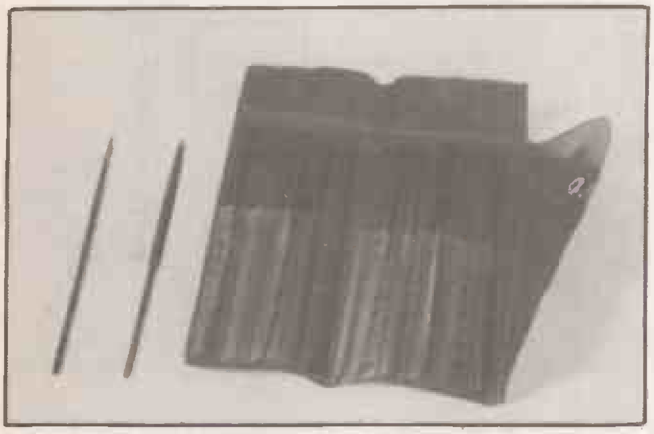
Cases made of brittle plastics are (thankfully) rare these days. These need to be worked with great care, and using a centre punch on one is a good way of smashing it to pieces! With some soft plastics a centre punch will often make more than a slight indentation, and could seriously damage the case.

Many of the plastic cases currently available seem to be made from quite a soft but very tough plastic. It might be possible to use a centre punch successfully one on of these, but there is probably a real risk of the hammer bouncing back and hitting you in the face.

For plastic cases a pointed tool such as a bradawl represents a safer option. Use no more pressure than is really necessary.

Screwdrivers are another type of tool that is likely to be present in most households, but they might not be of a suitable type for present purposes. You will occasionally need large types, and will probably already have something suitable.

Most often you will require small or medium size electrical screwdrivers, and these are readily available at quite low cost. Stocking up with a good range of flat and crosspoint screwdrivers should not "break the bank", and they will probably all get used a great deal.



A set of miniature files is one of the most useful items for electronic project construction.

Sets of small screwdrivers are available, but you need to be a bit cautious about buying these. At one extreme you have the sets of very high quality miniature types which are quite expensive. These are great for camera repairs, but are less than ideal for project construction, and are rather over-specified for this application.

At the opposite extreme there are very cheap sets which have blades constructed from a rather soft metal, and handles made from a brittle plastic. These are not likely to be long-lived with normal use. In my experience, buying a selection of low cost screwdrivers individually is the best bet.

FILES

One of the most useful tools for project construction is a miniature round file, or "needle" file as they are sometimes called. In fact it is probably worthwhile investing in a set of miniature files which will include a variety of shapes (square, triangular, flat, and flat tapered).

These can be used for slightly enlarging holes to the right size if you do not have a drill bit of the correct diameter. They are also good for tidying up holes that are not quite right in some way, and for generally "cheating" where you have managed to get things slightly wrong.

They can also be used to make large cutouts, including types that are irregular in shape. They represent a rather slow method of making large cutouts, but they provide about the cheapest means of making practically any large hole in a metal or plastic panel.

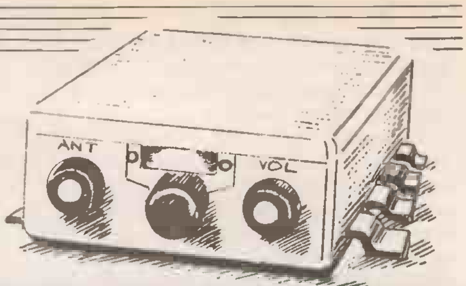
A large half round file and other large files can be useful. However, for electronic project construction miniature types are likely to be by far the most useful.

A few further but minor items will be needed. These are just things like pencils, paper, rulers, adhesives, etc., which you will presumably have already.

The items mentioned here represent a good basic toolkit, but next month we will consider tools that can be invaluable as you get more deeply involved in project construction.

Constructional Project

GINGERNUT 80m AMATEUR BAND RECEIVER



BILL MOONEY BSc(Hons) G3VZU

A fun receiver for the 80m amateur band using surface mount components. Based on the ZN416 TRF a.m. radio i.c.

If you were to design a simple receiver for the low frequency amateur bands you probably would not start from here! Bending the rules is a common amateur practice whereby devices are made to perform duties for which they were not intended. Such activities can lead to new discoveries and lead to better understanding of the subject, even finding a place in tomorrows textbooks.

This receiver does not represent such a grand leap, in fact quite the opposite, but it was born of such a whim. The ZN414 is a well known building block for medium wave amplitude modulation broadcast work. A more advanced version of this chip is now available in a surface mount package with the designation ZN416.

A device with 70dB's of r.f. amplification and 18dB's of audio gain on board must be of some use for the amateur bands. The ZN416 is specified to 3MHz and we are therefore looking at the 160 metre, 80 metre or even the 40 metre bands. So can we use this chip as the basis of a receiver capable of resolving s.s.b. and c.w.?

RESULT

The Gingernut is a delightful little receiver and its existence shows that the above is indeed possible. Not only does it work, but the results are truly amazing. In its first evening, stations from all over Europe and the UK were heard on its internal ferrite rod aerial. For daytime use when signal levels are very low, a *sou'pcon* of r.f. from even the most basic external aerial system works wonders.

Sure it's no communications receiver but it will give a beginner a good idea of what's happening on the band and bring in the RSGB news on Sunday mornings – what more do you need!

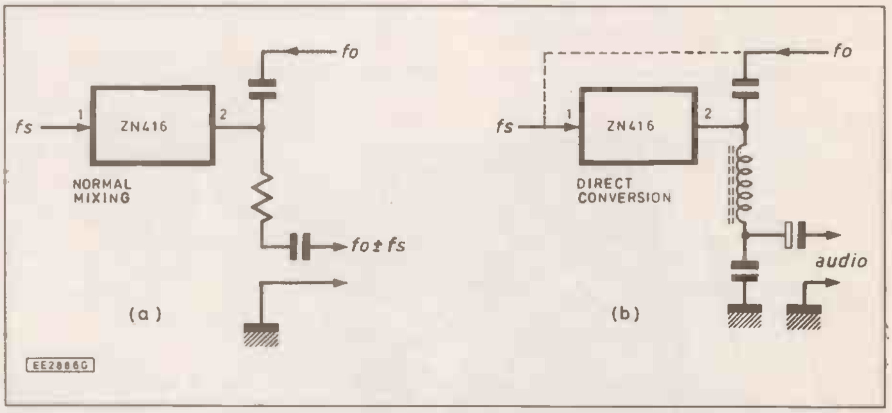
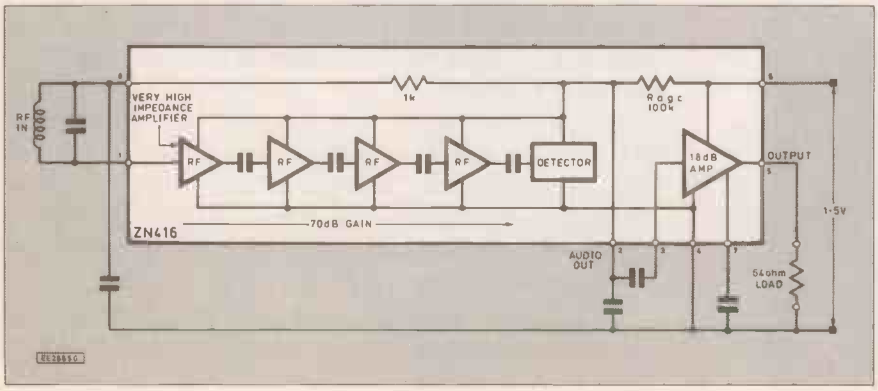


Fig. 2. Using the ZN416 detector as a high level mixer. (a) Normal mixing and (b) direct conversion.

What we should however point out is that this design does use surface mount components and construction **should not** be undertaken by anyone who is not fully competent with a miniature soldering iron.

Fig. 1. Internal structure of the ZN416 a.m. radio i.c.



DESIGN CONSIDERATIONS

In the early days of s.s.b. most receivers were essentially amplitude modulation sets and they contained an internal b.f.o. (Beat Frequency Oscillator) which was switched on to resolve c.w. This oscillator served as a c.i.o. (Carrier Insertion Oscillator) when s.s.b. began to appear on the scene. The system worked quite well for resolving s.s.b. especially when the b.f.o. injection level was increased slightly by an internal modification. Here we have a clue as to one possible way of using the ZN416.

The internal functional elements in the ZN416 are shown in Fig.1. A few experiments soon demonstrated that it was possible to use the a.m. detector as a mixer using the arrangement shown in Fig.2a. This worked very well provided the injected carrier was well separated in frequency from the signal going down the 70dB amplifier chain.

When the injected carrier is very close to the signal frequency, as is the case when we are using direct conversion, Fig.2b, we get problems. A high signal level is needed for injection at the detector and it is very difficult to avoid stray oscillator r.f. from getting to the input of the r.f. amplifier, which is just down the block at pin 1. Here we have a signal level of –70dB referred to that at the detector.

In these circumstances the oscillator voltage getting to the input is amplified some 3000 times and results in desensitisation and blocking. The ZN416 has a limited internal a.g.c. system with control ranging over about 20dB.

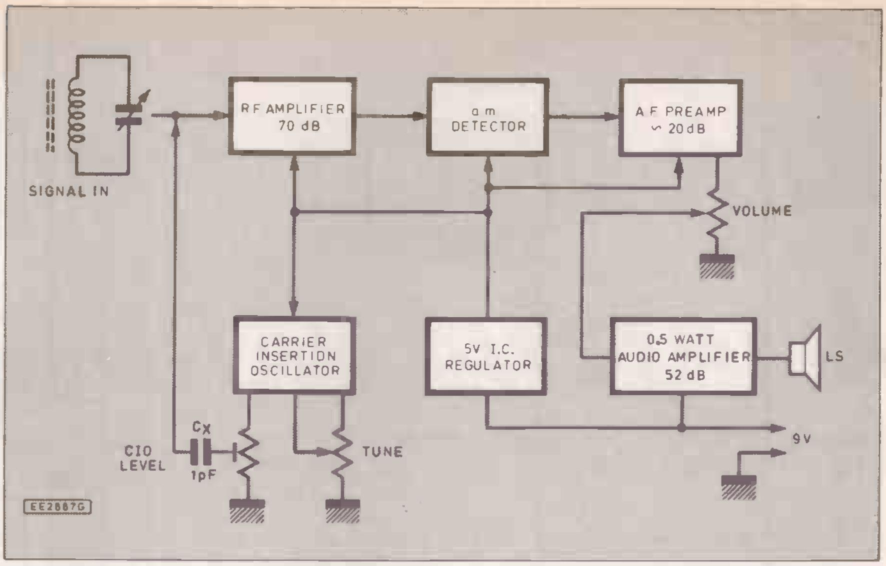


Fig. 3. Block diagram of the Gingernut receiver showing the major functional elements.

DIFFERENT

If a slightly different approach is taken the problem can be overcome. In essence we want to inject the carrier at the input along with the received s.s.b. signal and at the same level. This can be considered as an a.m. signal and the ZN416 may be used in the normal a.m. detector configuration. Theory suggests that this approach requires a reasonably good match of carrier level to signal level but in practice this was not found to be the case.

Getting a carrier at such a low level without special screening was achieved by running the oscillator at a subharmonic of the desired injection frequency. The v.f.o. runs from 1.75MHz to 1.9MHz on the fundamental so that the second harmonic covers the 80 metre band from 3.5MHz to 3.8MHz.

An advantage of low level injection is the minimal loading of the oscillator, obviating the need for the usual buffer stages. Even the best v.f.o. will have an adequate harmonic content for our needs. The use of surface mount construction also helps here because the oscillator fits on a small corner of the p.c.b. and there are no leads to radiate r.f. energy.

Our design therefore consists of a TRF receiver for s.s.b. and c.w. where the carrier is injected at low level along with the signal. This allows us to have plenty of r.f. signal amplification before the detector, unlike the normal direct conversion receiver where this would be impossible for reasons discussed.

CIRCUIT IN DETAIL

Putting the above into practice is quite easy and, with a few embellishments, like a voltage regulator and an audio output module we have a worthwhile receiver. The functional block diagram is shown in Fig.3 and the operation may be briefly summarised as follows: Signals are selected by a high Q tuned circuit and applied to the r.f. amplifier. A low level carrier is also applied to this input effectively converting the s.s.b. signal into a.m.

After amplification the signal is applied to the a.m. detector which produces low level audio. A preamplifier brings the audio up to a suitable level to drive the audio power module via the volume control potentiometer. The audio power amplifier module requires only a few millivolts input to drive an 8 ohm speaker to 0.5 watts. A 5V regulator supplies all the small signal stages.

FINAL CIRCUIT

Looking at the circuit, shown in Fig. 4, in more detail we consider first the r.f. section and start again at the antenna input. A short ferrite rod forms the sole means of signal selection as part of a high Q tuned circuit. The Q is maintained because the input resistance of the ZN416 is very high and has little loading effect.

A Q of about 200 means that the bandwidth is of the order of 20kHz and the antenna will need to be re-peaked frequently as you tune across the band. This is in effect a good means of r.f. gain control which is useful when strong local signals are a problem.

A high impedance connection is made to the "hot" end of this tuned circuit for short whip aerials or a few feet of wire. More useful is the one turn link L2 which can be connected to a normal coax line. The "cold" end of L1 and VC1 must be connected to pin 8 of IC1 and not the ground plane, otherwise instability can occur.

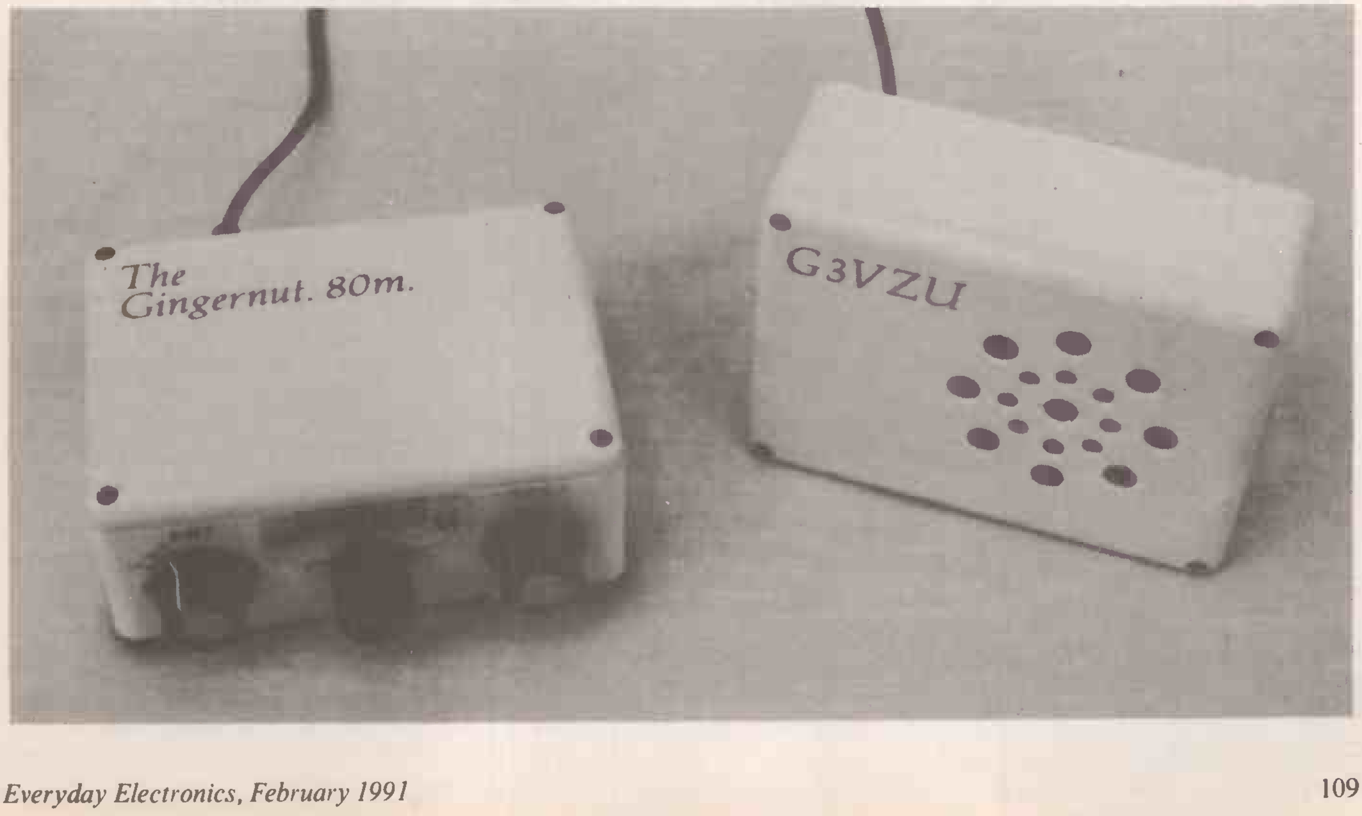
The response of the input tuned circuit governs the out of band performance. One tuned circuit in the Gingernut receiver does not give full protection against strong out of band amplitude modulated signals, especially if large, low Q, external aerials are used.

OSCILLATOR

The oscillator is a popular Colpitts type using an f.e.t. TR2, for good stability. Varicap tuning is used and two diode packages are needed to give the required frequency coverage.

We would normally limit the tuning voltage to about 1.5V minimum because the frequency variation with applied tuning voltage becomes very non linear at low bias

The completed Gingernut receiver together with a "matching" case housing a small plug-in loudspeaker.



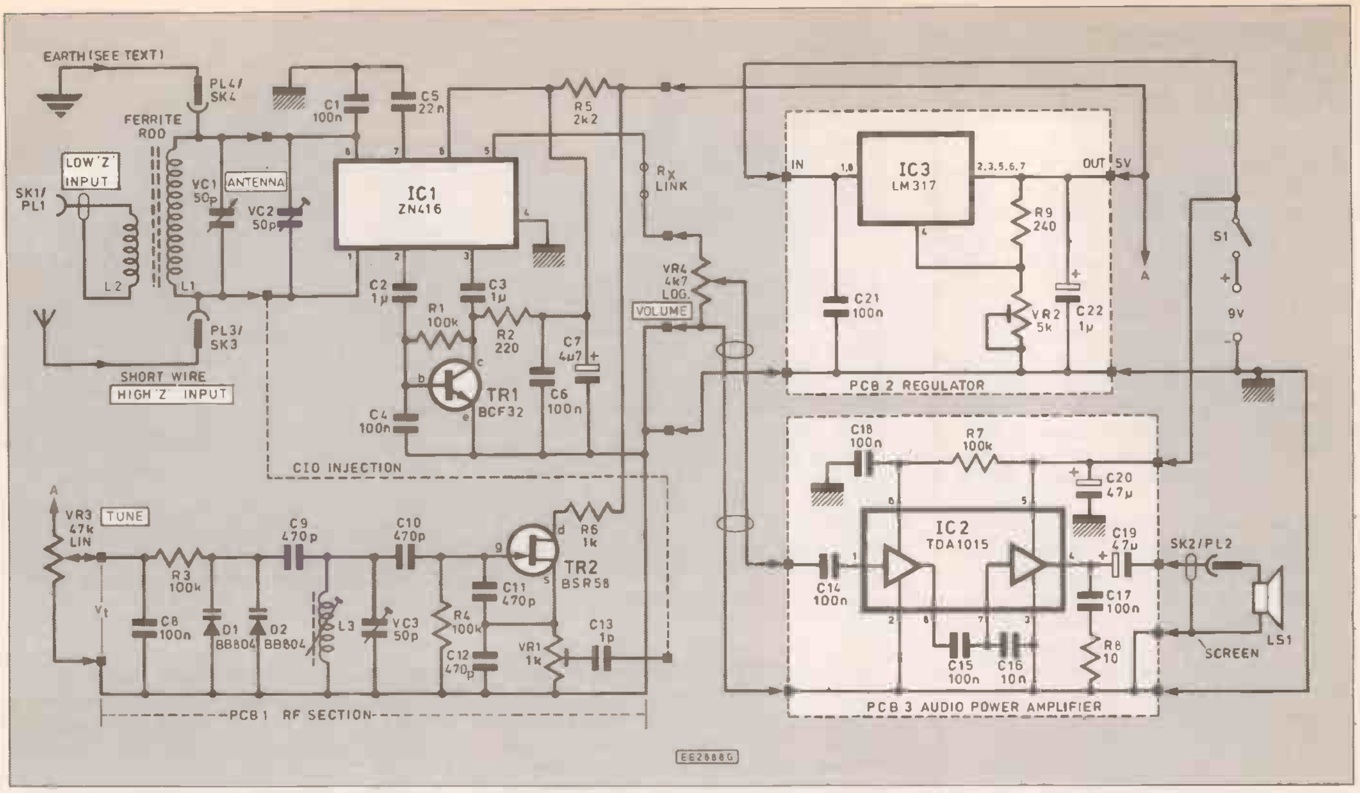


Fig. 4. Complete circuit diagram of the Gingernut. The three printed circuit boards are indicated by the dotted section.

levels due to conduction. In this circuit we accept this slight imperfection. Non linearity in the f.e.t. transfer characteristic and the varactor effect of the tuning diodes will ensure an adequate second harmonic content in the output.

The source load resistor for TR2 doubles as the output potentiometer. This gives good control of the injection signal level. A 1p capacitor, C13 (Cx in Fig 3) will pass sufficient voltage to the r.f. amplifier input for carrier re-insertion, 100µV or so being needed. The carrier is injected at pin 1 of the ZN416 with minimal damping of L1.

R.F. AMPLIFIER

The r.f. amplifier in the ZN416 boosts the amplitude by 70dB before it is applied to the detector. Audio appears at pin 2. Residual r.f. on pin 2 is decoupled by C4. A little extra audio gain is provided by TR1 in order to recover the falling response of the ZN416 at the high end of its frequency range.

The gain of this stage can be altered by selection of the collector load resistor R2. Why would we need to do this? There are many amplification stages in the circuit and the final gain is the product of the individual gains. The gain of each stage will vary from model to model and as no overall feedback is built in, there could be a need to adjust the total gain in some cases. A trial and error approach is the best option.

The output section of IC1 drives the volume control. This is a d.c. load for an open collector output and must be connected as such without a coupling capacitor.

REGULATOR

Considering the huge audio gain in this circuit it is very difficult to avoid instability, due to ripple on the supply line to earlier stages, without the use of a large electrolytic capacitor. The ZN416 and the oscillator are therefore supplied from a 5V regulator.

The dropper resistor R5 reduces the voltage to the ZN416 to 1.5V and provides extra isolation. An i.c. regulator may seem a little extravagant here but it gives the circuit remarkable stability for a few extra, low cost, components.

The LM317 is an adjustable regulator which is fixed at 5V in this application. With this device in use the receiver performance, particularly frequency stability, is consistent over wide variations in the supply voltage. Battery life is also optimised.

A PP3 sized 9V battery is suggested for neatness but an external 12V high capacity unit will give a more satisfactory life span. The receiver quiescent current is about 20mA and therefore a rechargable NiCad, or an alkaline battery should be used. If using an external mains power supply, be careful to note whether mains born noise pickup is acceptably low.

AMPLIFIER

Simple circuits like this one are often left with headphone only output. In fact the ZN416 will drive a pair of 64 ohm phones from pin 5. However a half watt audio power amplifier, also using surface mount components, is used in this design to take care of most of the audio requirements. This gives all the advantages of loudspeaker output for little extra effort.

The amplifier is based on the TDA1015 i.c. which offers an audio gain of 52dB and contains an accessible preamp in the same SO8 package. An audio filter could easily be added if required just after this preamp in place of C15. The regulator module works with a supply as low as 3.5V to over 15V and is ideal for this project.

CONSTRUCTION

The Gingernut circuitry is fabricated on three p.c.b. modules using surface mount components in all cases. PCB1 is the r.f. section of the receiver and therefore the most important. This is the heart of the project and could in fact stand alone as a functioning receiver. The voltage regulator is on PCB2 and PCB3 is an audio output amplifier to drive the loudspeaker.

For all "surface mount" circuits of this type the use of a double-sided p.c.b. is highly recommended for best physical and

COMPONENTS

See SHOP TALK Page

Resistors

R1, R3, R3, R7	100k (4 off)
R2	220k
R5	2k2
R6	1k
R8	10k
R9	240
RX	Zero ohm jumper

All size 1206 SMD chips

Potentiometers

VR1	1k type 3204 preset
VR2	5k type 3204 preset
VR3	47k miniature lin.
VR4	4k7 miniature log.

Capacitors

C1, C4, C6, C8, C14, C15, C17 C18, C21	100n ceramic, 50V Y5V (9 off)
C2, C3	1µ Y5V (2 off)
C5	22n Y5V or X7R
C7	4µ7µ tantalum, 16V case size B
C9 to C12	470p COG (4 off)
C13	1p COG
C16	10n Y5V or X7R
C19, C20	47µ tantalum, 10V case size D
C22	1µ tantalum, 10V case size A

Size 1205 SMD chips except where stated.

Variable Capacitors

VC1	50p air spaced variable type C804A
VC2, VC3	50p type TZB04 trimmer (2 off)

Semiconductors

TR1	BCF32 *npn* transistor in SOT23 package
TR2	BSR58 *n*-channel f.e.t. in SOT23 package
IC1	ZN416 a.m. radio i.c. in SO8 package
IC2	TDA1015 audio amp i.c. in SO8 package
IC3	LM317 voltage regulator i.c. in SO8 package
D1, D2	BB804 dual varicap diode (2 off)

Miscellaneous

LS1	8ohm miniature loudspeaker
S1	single pole min. toggle switch
SK1,SK2	chassis mounted phono sockets (2 off)
SK3,SK 4	minature 1mm wander sockets (2 off)
L1, L2	Ferrite rod, 1cm dia. cut to length, 20 s.w.g. enamelled copper wire – see text for winding details
L3	TOKO 5CD variable inductor
M2	countersunk/round head nuts and bolts (18 off);

Plastic case, size approx. 100mm x 75mm x 38mm (2 off); miniature knob (3 off); 30s.w.g. Kynar wire; T-section aluminium extrusion; 2.6cm dia. tuning dial, see text; miniature 10:1 drive (see text); printed circuit boards available from the *EE PCB Service* order codes PCB1-EE726, PCB2-EE727, PCB3-EE728.

Approx cost guidance only **£35**

electrical stability. The track pattern and component layout on PCB1 is shown in Fig 5.

Drill the M2 mounting holes in the corners of the board before populating it. Holes can be drilled in a populated board because the chips are quite tough. But it is good working practice to subject the chips to minimal strain.

WORKING WITH SMD'S

You will develop your own techniques for hand working with SMD's (surface mount devices) but a few suggestions may be in order. An assembly jig is quite essential for good soldering. The solder joint is smaller in SMD work and there is less room for error. The correct method of soldering dictates that the iron and the solder are applied to the job at the same time. It is therefore necessary to hold the chip in place whilst soldering.

The jig will also ensure that the chips are kept nicely aligned, making for a better looking board. A fine tipped soldering iron and 26s.w.g., or finer, LMP solder should also be used. Aim to apply the smallest possible quantity of solder. Non-magnetic tweezers will allow you to manipulate the chips to the desired position and reduce handling.

The simplicity of using these components cannot be overemphasised. This p.c.b. can be assembled in the time it would take just to drill the holes in a leaded p.c.b.

Spray the board, before component addition, with a light coating of Electrolube solder through lacquer. This will dry, propped up on a radiator, in the time it takes to have a cup of tea. The coating will keep the copper looking good but more important will make assembly easier.

There is no preferred order of addition of the components, but when placing each device make sure there is room left for its neighbours. For example place D1 and D2 close together leaving room for R3. Note the polarity of the tantalum, the positive end being banded. Note pin 1 of the SO8 i.c.'s is indicated by the chamfered edge on the package. Solder the corner i.c. pins first.

When all "chips" are soldered in place give a second lacquer coating. The silicone rubber which protects the trimcap adjuster for reflow soldering may now be removed and likewise the plastic cover of the trimpot.

The layouts for the voltage regulator and audio amplifier p.c.b.s (PCB2 and PCB3) are shown in Fig. 6 and Fig. 7. It is, of course, quite in order to make your own p.c.b. layouts for both these circuits. Component positions are not critical but don't be tempted to leave out the capacitors around the regulator. These are manufacturers recommendations and are vital for stability. Don't forget to make a couple of connections from the 0V track to the reverse side of each p.c.b. so that it is at ground potential.

BOXING UP

The receiver is built into a plastic box because the ferrite rod cannot be screened if it

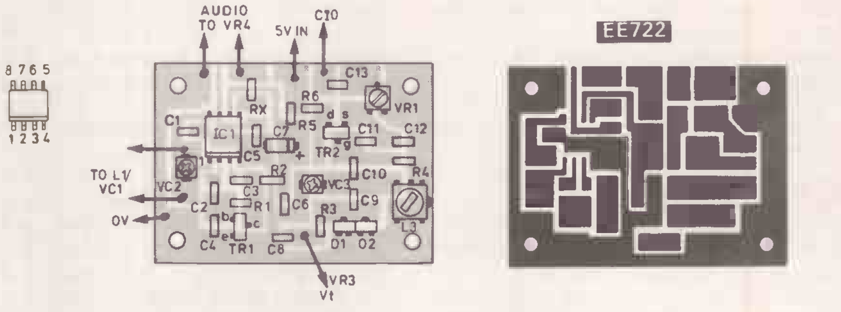


Fig. 5. Component layout and full size copper foil master pattern for the r.f. stages.

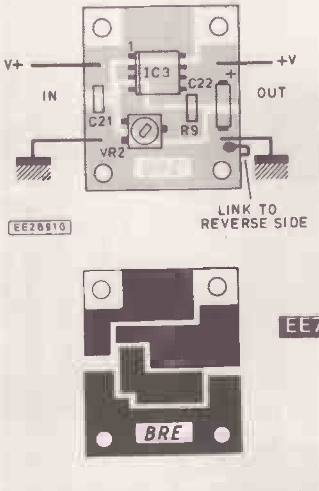


Fig. 6. Regulator component layout and master pattern.
Note all boards are double-sided types.

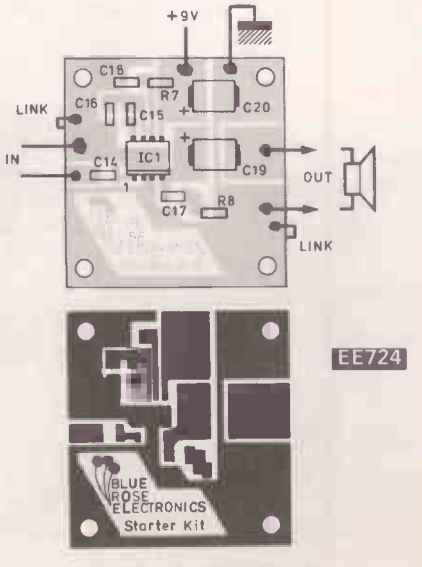


Fig. 7. Audio amplifier component layout and foil master.

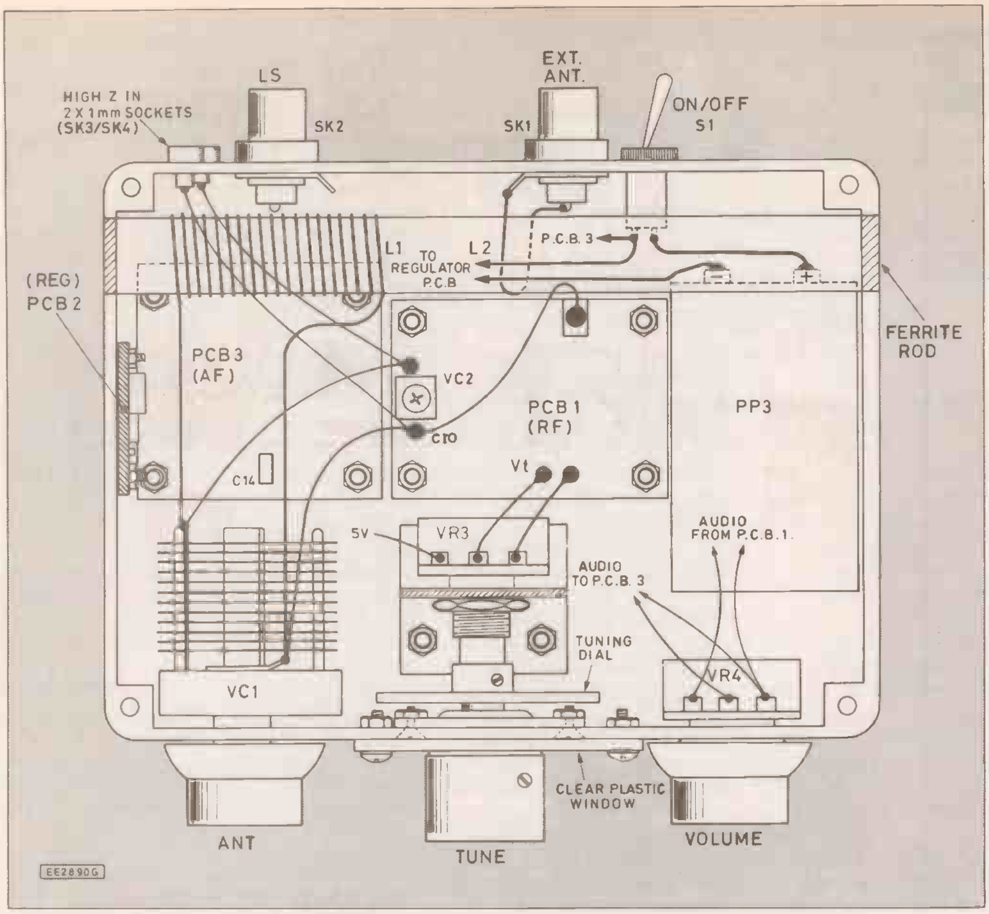


Fig. 8. The completed receiver showing board positioning and wiring to support hardware (full size).

is to be used as an aerial and not just a high Q tuned circuit. The mountable box type 3415 measuring 102mm by 76mm by 38mm is ideal for the purpose. The plastic used is particularly easy to work.

The suggested positioning of the modules is shown in Fig. 8. Keep the wiring neat and use common sense by not routing outputs near to inputs, yet keeping wires as short as possible.

Use Kynar 30s.w.g. miniature wire for interconnections. This wire is available in various colours and is perfect for surface mount work. It is easy to strip and the insulation does not melt back when soldering. The wire is lightly silver plated and therefore has excellent solderability. Twisted pairs of Kynar wire may be used for routing the audio signals.

It will be noted that an external loudspeaker is recommended. This is because larger external speakers produce better audio readability in this type of receiver where there is no audio filtering. More important however, the circuit is succeptable to vibration which modulates the injected carrier and causes feedback.

All circuits and other hardware are held in place with M2 countersunk bolts. The tuning potentiometer is mounted on a short piece of "T" section aluminium extrusion. A miniature 10:1 ball drive is used to give sufficient bandspread for the 300kHz of 80m band.

A 2.6cm diameter tuning dial was fabricated from a piece of fiberglass p.c.b. This has a slot cut in it in order it fit over the spindle and may be soldered to the brass coupling. The scale may be made from white paper or painted.

A small window can be cut in the front of the box to expose the tuning dial. A clear plastic cover can be bolted on, as shown, for protection.

The input coil, L1, consists of 17 turns of 20s.w.g. enamelled wire wound over a length of about 3.5cm on a 1cm diameter ferrite rod. This refers to a 10cm long rod. The "earthy" end of the winding is best kept towards the centre of the rod. An insulated former may be used but the wire can be wound directly on the ferrite.

The coil is best connected directly to the tuning capacitor and thinner wire used to connect to the circuit board. The low impedance input winding, L2, is a single turn over the centre of the rod.

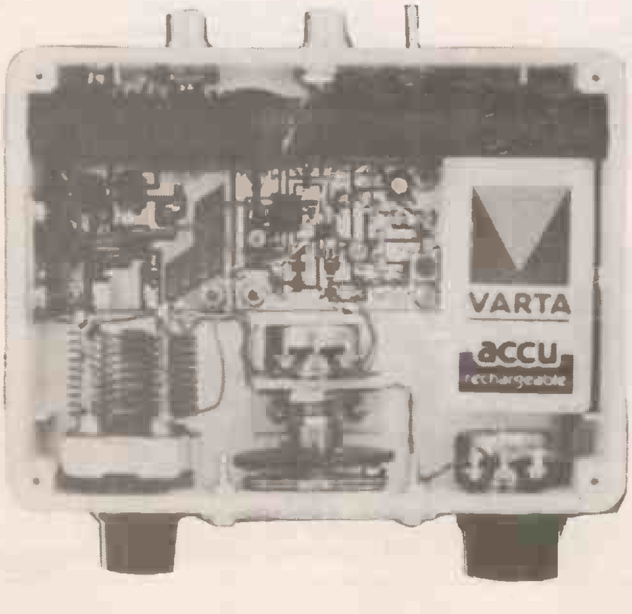
The rod may be cut to length by filing or sawing a deep line around the full circumference and giving it a sharp tap. Two holes cut in the plastic box will hold the rod in place. A full length rod can be used, allowing it to protrude from each side of the box. These extra inches are useful for reception during weak signal conditions.

The type of ferrite material should in theory make a difference to the signal pickup but this has not shown up in subjective listening tests with several types of rod.

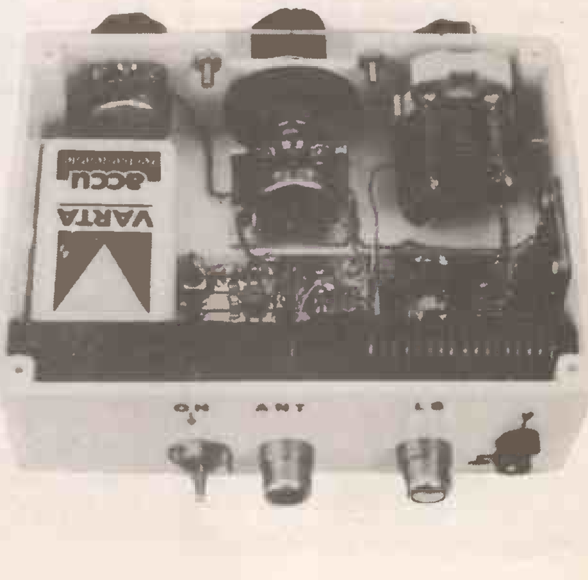
GETTING IT GOING

The modular method of construction is useful when it comes to getting the Gingernut working. Start at the output and work back. Apply power to the audio circuit first and check that the current drain is about 10mA. Connect an eight ohm speaker and test whether the amp is doing its job by touching the top end of the volume control

Layout of circuit boards inside the finished unit.



Wiring to the front panel controls.



to inject some noise or by connecting an audio signal generator.

It should be stated here that the TDA1015 is very robust but it can only dissipate about half a watt in the SO8 package. It will not over dissipate with a 9V supply but if a 12V or higher voltage is used and it is driven hard it may get too hot. If using a higher voltage check the power and limit it with a resistor in the speaker line if required.

Set up the regulator next. Again the quiescent current is a useful indication that all is working correctly and this should be about 3.5mA. Adjust the output to 5V with the trimpot VR2. Variation in supply voltage should have no measurable effect on the voltage output. Similarly a current drain of 50mA or so should have no effect on the 5V output. A voltage headroom of 2.5V is required with the LM317 so the stabiliser will not fail until the battery drops to 7.5V which is fine for a Nicad PP3. When the battery voltage drops below 7.5V the Gingernut will start to "howl."

You now have a 5V supply for the r.f. p.c.b. and an audio amplifier to hear what it produces. A couple of voltage tests will indicate whether all is well. Pin 6 on IC1 should have 1.5V on it. The collector of TR1 should be around 1V. The drain of TR2 should read about 2V.

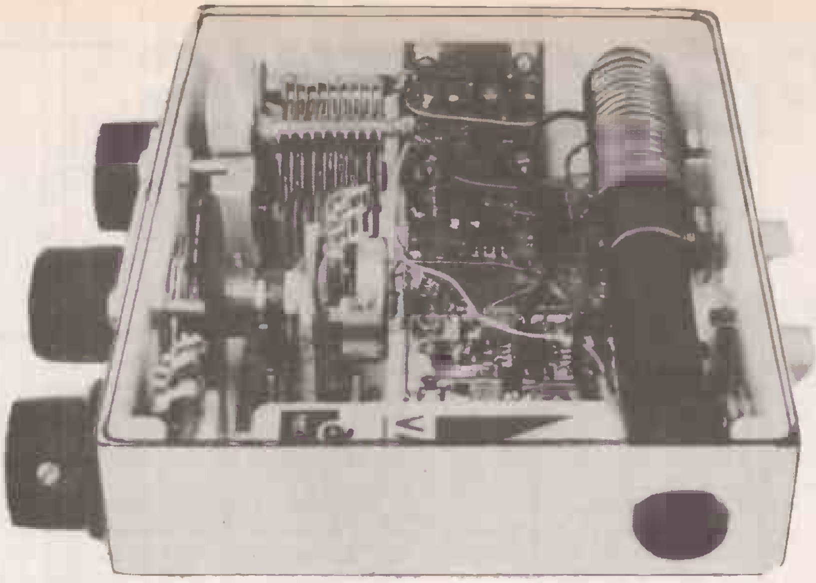
Leave out the CIO link wire and the ZN416 should work as a TRF receiver. Swinging VC1 across the range should bring in plenty of "short wave type" noise and one or two strong broadcast stations if it is working correctly.

This part of the spectrum can be quiet at times so connect a few feet of wire to the "hot" end of VC1 (or the high "Z" input) if needed. Note that the "cold" end of L1 is not at d.c. ground so that for an external "earth" connection a series 100p capacitor may me needed.

SETTING THE BAND

The best way to get to the required band is to set a modalated signal generator on say 3.7MHz and find the signal with VC1. Backing off the generator should reveal good sensitivity and a quite critical setting of VC1 which covers a wider range than the 80m band. Some s.s.b. stations may be received at this stage but will be unintelligible without the CIO.

To set up the CIO connect the wire link and set VR1 near the low end of its track. Set the signal generator to 3.8MHz. Set the tuning potentiometer to the high frequency end, that is with maximum tuning voltage output. Now adjust VC3 and the core of L1 to get zero beat.



Set the signal generator to 3.5MHz and follow it down with the v.f.o. to make sure the whole band is covered. VC2 and L1 may be adjusted to get most of the band in the higher tuning voltage range. The tuning dial can be calibrated at least every 50kHz or so. The scale will not be linear being compacted at the low end.

Swinging the aerial tuning capacitor across the range will produce a quieting effect as the CIO is tuned in. The correct setting will be a compromise between having sufficient carrier to match the incomming s.s.b. and avoiding desensitising which takes place at high CIO levels due to the a.g.c. reducing the r.f. gain.

A good setting for CIO level is where an increase in noise is heard when VC1 is peaked on frequency. A degree of microphony is normal at the best setting. As you tune around the band VC1 will need frequent resetting and it can be left off tune as a means of r.f. gain control.

CONCLUDING REMARKS

A simple experimental receiver like this will inevitably have drawbacks compared to a state of the art engineering design. However there is scope for optimisation and experimentation with this approach.

The receiver has been made to work on top band and 40 meters with excellent results. In fact the input tuned circuit can easily be made to cover all three bands without switching by using a 500pF capacitor for VC1. In this case the third harmonic of the oscillator is sufficient to resolve 40 meter signals, so again no switching is needed.

A very simple three band receiver can be made in this way. This approach does however produce rather too much carrier for top band.

A ferrite rod aerial is an excellent receiver of TV timebase harmonics. The best way to cure this is to switch the TV to the off position!

The skirt selectively of a single tuned circuit is not so good and at times there may be some sensitivity to strong short wave broadcast stations which are way outside the band. Any a.m. signal reaching the detector will be demodulated. Extra tuned circuits are the answer here.

Late mixing in this fashion is contrary to current engineering practice and there will be considerable intermodulation. The signal levels at the input should therefore be kept as low as possible as with more up market receivers. A one kilohm potentiometer in the low impedance input line will help if a full sized aerial is in use.

A simple way of coupling signals into the unit is to place the ferrite rod close to the main a.t.u. coil when sufficient r.f. will be picked up. The sensitivity should be much better than most d.c. receivers due to the pre-detector gain.

The small amount of a.g.c. claimed for the ZN416 means that the listener will still be subject to the large, short term and medium term (night to day) signal variations on the band. At low signal (day) times a better aerial will be needed.

It was never intended to use the Gingernut as a companion to a transmitter but in the light of experience it has the potential to fulfil the receiver needs of a low cost QRP (low power) setup. This is particularly so if some audio tailoring is added and perhaps a filter for c.w. □

REPORTING AMATEUR RADIO

Tony Smith G4FAI

DEREGULATION

As from 1st October, 1990, Canadian amateurs are permitted to use any mode or emission on any amateur frequency, subject only to maximum emission bandwidths, defined for each band, up to 1.215 GHz, above which the bandwidth is "not specified". This allows the Canadians to use new technologies as soon as they become available without waiting for government regulations to implement them.

Another deregulation, which initially caused alarm in the USA, has resulted in the traditional sub-bands allocated to specific modes disappearing. According to the *W5YI REPORT* of 1 November however, this has not so far resulted in the anticipated chaos breaking out.

"While amateurs may now use any mode on any band (including voice on historically CW spectrum)", says the report, "Canadian amateurs are universally observing the traditional mode sub-bands as requested by their amateur organizations."

Band-plans, which divide amateur bands into sections allocated to or shared between specific modes, are compulsory in the USA but are merely a "gentleman's agreement" in many other countries, including the UK. Their purpose, amongst other things, is to ensure that modes likely to cause interference to each other are kept apart. Most operators respect the sense of this arrangement but, as in most activities, there are always a few who see no need to observe such agreements.

TRIP TO EGYPT?

The latest issue of *"Egyptian Echos"* newsletter of EARS, the Egypt Amateur Radio Society, announces a nice idea for those contemplating a visit to Egypt. "EARS thinks that foreign amateurs would feel more at home when accompanied in Egypt by fellow amateurs than when accompanied by representatives of commercial travel agencies. If there is enough interest from foreign amateurs, EARS could arrange a deal for, say, a bus load of them during the Christmas vacation or the next summer."

At present foreigners are not allowed to transmit from Egypt so the trip would be purely for fun and sightseeing. Enquiries about this proposal should be addressed to Dr Hamed Nassar SU1HN, PO Box 1578, Alf Maskan, Cairo, Egypt.

HINTS AND KINKS

"QST", the journal of ARRL, America's national society, the American Radio Relay League, has a monthly column called "Hints and Kinks" containing readers' gimmicks, gadgets, equipment modifications, circuits, and so on. Since 1933, these ideas have been brought together in an occasional publication, *"Hints and Kinks for the Radio Amateur"*, and I have just been browsing through the 12th edition, 1989, which includes items which have appeared in *QST* since the last edition of the book was published in 1982.

Although about 25 per cent of the items relate to radio transmission and are of interest mainly to licensed amateurs, there is much in this volume of interest to shortwave listeners or other electronic hobbyists. Chapter one, "In and around the Station", for instance, contains a home-made equipment stand and an operating table, hints on extending the life of calculator batteries, a burglar alarm, dust covers for equipment, and advice on types of fire extinguisher to use on electronic apparatus.

Chapters two, three and four cover transmitting, receiving, Morse topics, computers and digital modes, while Chapter five provides a good selection of antenna and feeder designs, modifications to existing installations and construction and matching hints. There is even advice on how to keep birds off antennas!

Workshop hints for the constructor, including improving soldering techniques, making low value capacitors from ribbon cable, making circuit boards with copper-foil tape, using a pair of pliers as a vice to hold small components (by stretching an elastic band round the handles!), and various methods of tapping coils are given in chapter six.

The remaining chapters contain ideas and practical applications for v.h.f. and u.h.f. operation; power supplies, including tips on converting old battery chargers to power supplies, restoring NiCads and using 35mm film cans as 9V battery holders; and a final chapter of "Miscellanea", which includes a world-time-finder slide rule.

Although this is an American publication, the use of unfamiliar circuit layouts or nomenclature is no real disadvantage. For those who like experimenting, making electronic devices from the contents of their spares box or from everyday items lying around the house, or improving the performance of existing equipment, this 160-page ideas book is for them.

Obtainable from the *Radio Society of Great Britain (Publications), Lambda House, Cranborne Road, Potters Bar, EN6 3JE,* its price (for non-members) is £5.75 including p&p.

WARC COUNTDOWN BEGINS

National amateur radio societies around the world are preparing for the 1992 World Administrative Radio Conference (WARC) which, among other matters, will have authority to re-allocate international frequencies currently allocated to amateur services. Specific proposals from individual countries must be submitted eight months before the Conference convenes on 3rd February 1992, but the Administrative Council of the International Amateur Radio Union, met in Boston, USA, last July, to review the broad aspects of the agenda to assess its possible impact on the hobby.

The greatest threats could be to the 3.5MHz, 7.0MHz, 10.1MHz, and 14.0MHz bands due to possible expansion of the present exclusive allocations for h.f. broadcasting. The 144MHz and 420MHz bands could be affected by low-orbit mobile service satellite services seeking spectrum to share with existing services.The microwave bands are also expected to be subject to pressure from new or expanded services including satellite sound broadcasting, public land mobile telecommunications systems, an aeronautical public correspondence service, mobile satellite services, and high definition satellite TV broadcasting.

The IARU has established a regular exchange of information and news between all national societies with the intention of producing documentation for the Conference on the value of amateur radio to the world community. At the same time individual societies are seeking to persuade their government delegations to take account of the importance of amateur radio when considering their position on the various proposals to be discussed at *WARC 92.*

During every radio conference amateur radio is threatened in one way or another, which is why national societies, linked together by an international organisation, are so important to the hobby.

WHY EXTRA BROADCAST FREQUENCIES?

In the USA the FCC recently sought comments from interested organisations on matters to be covered by the WARC. According to the *W5YI REPORT,* several commentors questioned the need for additional h.f. broadcast allocations following political changes in the Soviet bloc.

ARRL commented that some h.f. broadcasters unnecessarily use several frequencies simultaneously to increase the probability of reception in target areas. They suggested that this practice can be self-defeating, producing co-channel interference, and concluded that if broadcasters reduced the number of simultaneous transmissions better reception would result.

They also suggested that, as propagation changes hour by hour, broadcasters should move to real-time dynamic signal selection methods rather than rely on propagation predictions and published schedules. According to ARRL, monitoring of reception in the target area with immediate feedback to the broadcaster would reduce interference by de-activating frequencies that cannot be heard in the intended reception area.

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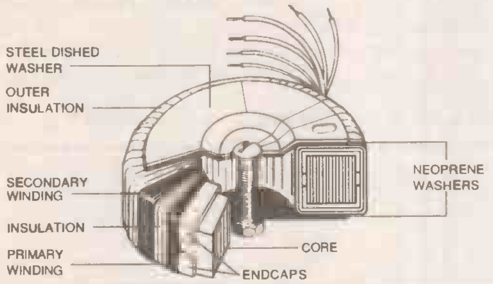

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15VA	03010	6+6	1.25
£10.45	03011	9+9	0.83
	03012	12+12	0.63
	03013	15+15	0.50
	03014	18+18	0.42
	03015	22+22	0.34
	03016	25+25	0.30
	03017	30+30	0.25
30VA	13010	6+6	2.50
£11.95	13011	9+9	1.66
	13012	12+12	1.25
	13013	15+15	1.00
	13014	18+18	0.83
	13015	22+22	0.68
	13016	25+25	0.60
	13017	30+30	0.50
50VA	23010	6+6	4.16
£13.55	23011	9+9	2.77
	23012	12+12	2.08
	23013	15+15	1.66
	23014	18+18	1.38
	23015	22+22	1.13
	23016	25+25	1.00
	23017	30+30	0.83
	23028	110	0.45
	23029	220	0.22
	23030	240	0.20
80VA	33010	6+6	6.66
£15.10	33011	9+9	4.44
	33012	12+12	3.33
	33013	15+15	2.66
	33014	18+18	2.22
	33015	22+22	1.81
	33016	25+25	1.60
	33017	30+30	1.33
	33028	110	0.72
	33029	220	0.36
	33030	240	0.33
120VA	43010	6+6	10.00
£16.10	43011	9+9	6.66
	43012	12+12	5.00
	43013	15+15	4.00
	43014	18+18	3.33
	43015	22+22	2.72
	43016	25+25	2.40
	43017	30+30	2.00
	43018	35+35	1.71
	43028	110	1.09
	43029	220	0.54
	43030	240	0.50
160VA	53011	9+9	8.89
£18.80	53012	12+12	6.66
	53013	15+15	5.33
	53014	18+18	4.44
	53015	22+22	3.63
	53016	25+25	3.20
	53017	30+30	2.66
	53018	35+35	2.28
	53026	40+40	2.00
	53028	110	1.45
	53029	220	0.72
	53030	240	0.66
225VA	63012	12+12	9.38
£20.60	63013	15+15	7.50
	63014	18+18	6.25
	63015	22+22	5.11
	63016	25+25	4.50
	63017	30+30	3.75
	63018	35+35	3.21
	63026	40+40	2.81
	63025	45+45	2.50
	63033	50+50	2.25
	63028	110	2.04
	63029	220	1.02
	63030	240	0.93
300VA	73013	15+15	10.00
£22.45	73014	18+18	8.33
	73015	22+22	6.82
	73016	25+25	6.00
	73017	30+30	5.00
	73018	35+35	4.28
	73026	40+40	3.75
	73025	45+45	3.33
	73033	50+50	3.00
	73028	110	2.72
	73029	220	1.36
	73030	240	1.25
500VA	83016	25+25	10.00
£28.95	83017	30+30	8.33
	83018	35+35	7.14
	83026	40+40	6.25
	83025	45+45	5.55
	83033	50+50	5.00
	83042	55+55	4.54
	83028	110	4.54
	83029	220	2.27
	83030	240	2.08
625VA	93017	30+30	10.41
£31.95	93018	35+35	8.92
	93026	40+40	7.81
	93025	45+45	6.94
	93033	50+50	6.25
	93042	55+55	5.68
	93028	110	5.68
	93029	220	2.84
	93030	240	2.60

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Nigel Clark

SHOW OF ACTIVITY

The implementation of the National Curriculum in design and technology in September set off a flurry of activity in the companies supplying equipment to schools. Almost without exception the reason given was the need for teachers and pupils to have the proper equipment to make sure that the National Curriculum requirements were met.

This was reflected at the *Design and Technology Education Show* at the National Exhibition Centre in Birmingham last autumn, which was the biggest in its 13-year history in terms of exhibitors and visitors, with more than 200 and 9,500 respectively.

There were a number of new developments in the robotic and control technology area particularly in the kits on offer. NES Arnold, created by the takeover by Nottingham Educational Supplies of EJ Arnold, was promoting the Microtec control and output packs and the Technology Clixi kit.

Penn Pax launched the TacTic Active range of kits and Lasy added motors to its collections of plastic components. Unilab introduced its Beaver Primary Technology series.

Microtec's control pack is based around Calsystems' Microtec interface for BBC microcomputers and includes heat, light and moisture sensors, multi-level control software and a user guide.

Joe Kellett, a Leeds teacher who developed the pack with the help of some of his colleagues, said that it was intended for younger pupils. The inputs and outputs had been kept to a minimum, with six outputs and up to four inputs, to keep the interface simple.

The simplicity theme extended to the software which had different levels allowing pupils of differing ages and abilities to use the interface and sensors. All levels are compatible with each other enabling programs written in the simplest level to be extended in the higher levels.

The complete Microtec control system comes for a price of about £150. An output pack has also been produced for about £16. It contains two motor/gearbox units, wheels and axles, bulbs and bulb holders and a buzzer.

The new packs have been added to the existing sensor pack, which has been available from Arnold for some time at a cost of a little less than £100. In essence it is the control pack without the controller as it has a large range of support material as well as the three sensors.

Technology Clixi is a small expansion of the Clixi set of modelling components. The main change is the improvement of the two types of gear and axles and wheels and the inclusion of parts needed for a differential.

Previous kits contained toothed wheels but in the new set the ratios of the various wheels have been calculated so that they can be combined to form gears. However the kits do not include motors or wiring.

To go with the extended kits workcards have been produced to stimulate ideas for models which can be built.

WORKSHEETS

Further design and technology ideas have been provided by NES Arnold in a series of booklets written with the National Curriculum in mind, being most suitable for the five-to-13 age range. Under the general heading of Teaching Technology they include a series of suggested activities for the children matched by a companion teachers' guide which expands on the themes of the suggestions.

The company is also packaging ProCom's SEQ controller for the schools market. At a cost of about £100 the pack contains the controller, a teacher's guide, instruction cards and poster and planning sheets.

Penn Pax Products has created TacTic Active Technology which consists of a variety of large plastic components said to be ideal for the National Curriculum in mathematics and science as well as Craft, Design and Technology.

The components include basic rods and connectors with wheels, gears, pullies and drive belts from which large, impressive constructions can easily be made. There are no motors because the size of the kit would require such a large amount of power that the cost would be prohibitive. Motion can be provided manually by handles.

The kits come in three sizes, more than 150 components at £55, more than 300 for £105 and more than 450 for £155. They are available from Commotion.

The TacTic kit is so new that the accompanying literature has not been completed. Building instructions come with the kits but the intended worksheets to give teachers ideas on how best to use the equipment are not yet ready.

Not to be left out in the great curriculum rush, Lasy, the German kit distributed here by Spectrum Educational Supplies, has added motors to its range. The motor kit includes designs for a number of mobiles, including cranes and vehicles of various types. The motors are controlled by a simple on-off switch but a new switch is being developed which should be ready in the next few months.

Meanwhile, Proops Distributors has dropped its Perci robot arm, but at the same time has been extending its range of kits. Perci was the electro-mechanical arm designed to show that a simple repetitive procedure could be carried out without the need for computer control. However it did not prove popular.

OPEN-ENDED

Finally, Unilab has introduced the Beaver Core Resource. It is a "self contained workpack" of tools, materials, teacher books and pupil reference cards, which aims to enhance current primary school design and technology.

It has all the usual components and teacher and pupil information except that it does not contain plans for models. This, it was said, is because it does not fit in with the open-ended problem-solving approach adopted by the company. The major area of difference with other kits is the inclusion of necessary tools such as saws and special jigs.

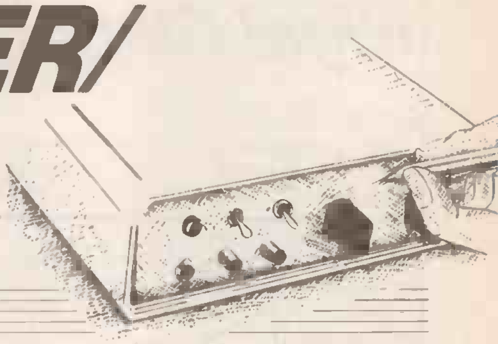
The resource was developed by Unilab and the National Council for Education Technology. Before its launch it was tested extensively in the north west of England and a casebook of experiences is included in the teacher information.

Further work is being carried out to supply other modules for motor, power, electronic and computer control. The core resource is available for a little less than £200.

Microtec's control pack is based around Calsystem's interface for BBC micros.

Teach-In '91 Project

BENCH AMPLIFIER/ SIGNAL TRACER



MIKE TOOLEY BA

The third constructional project to accompany our Design Your Own Circuits series takes the form of a Bench Amplifier/Signal Tracer. This simple but versatile unit provides a means of amplifying low-level audio signals and can prove to be an invaluable fault finding aid in conjunction with a wide variety of audio and radio circuits. As with all of the practical constructional projects in this series, a number of modifications are suggested so that the more intrepid constructor can customise the unit to his or her own particular requirements.

WHEN bench testing audio and radio equipment, one often realises the need for a means of listening to the signals which are present in the various stages under examination. In order to examine signals in this way, all that is required is an audio frequency amplifier and loudspeaker together with a means of attachment to the equipment under test.

This approach to fault finding has much to commend it, not least of which is that it provides a highly cost-effective alternative to the use of an oscilloscope. Indeed, when tracing signals from one stage to another, one is seldom concerned with absolute values and thus the measuring capability of an oscilloscope is rarely necessary.

Our bench amplifier/signal tracer thus makes a valuable addition to any workshop. The unit can be built for a very modest capital outlay yet will repay the investment many times over by greatly speeding up the testing process.

CIRCUIT DESCRIPTION

The block diagram of the Bench Amplifier/Signal Tracer is shown in Fig. 1. In order to minimise loading upon the circuit to which the unit is connected, the unit can be switched to cater for either high or low impedance inputs. In the former case, a high-impedance (unity gain) buffer stage is introduced in the input signal path.

Gain and tone controls are provided in order to cope with a wide range of input signal amplitudes and characteristics. The tone control, in particular, allows the user to "roll-off" the high frequency response at frequencies between 4kHz and 10kHz, thus reducing the high frequency content of a signal which may, in some cases, be excessive.

The complete circuit of the Bench Amplifier/Signal Tracer is shown in Fig. 2. An *n*-channel field-effect transistor, TR1, acts as a high-impedance unity gain input buffer. The output of the buffer amplifier is applied, together with the direct (low-impedance) input to the input selector switch, S1. VR1 and VR2 act as tone and gain controls respectively whilst IC1 (a TBA820M) provides the necessary voltage gain and power amplification.

Resistor R4 sets the overall voltage gain of IC1 whilst C9 provides boostrapped feedback. C8 ensures unconditional high frequency stability and R6/C7 act as a Zobel network across the output of the power amplifier stage. The supply rail is decoupled at high and low frequencies by means of C11 and C12 respectively.

Specification

Output power:	1W r.m.s. into 4 ohm (9V supply)
Frequency response:	50Hz to 10kHz at -3dB (max. treble) 50Hz to 4kHz at -3dB (min. treble)
Sensitivity:	50mV pk-pk for 1W output (either input)
Maximum d.c. level at the input:	100V (either polarity, either input)
Voltage gain:	150 approx.
Input impedance:	1M (high-Z input) 10k (low-Z input)
Supply voltage:	9V
Supply current:	23mA (standby) 270mA (full output)

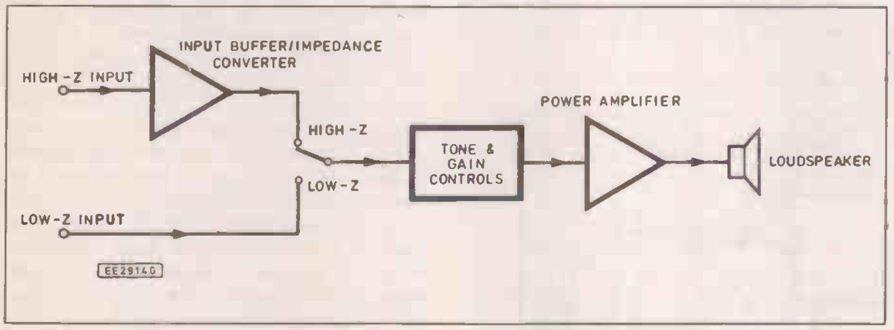


Fig. 1. Block diagram of the Bench Amplifier/Signal Tracer

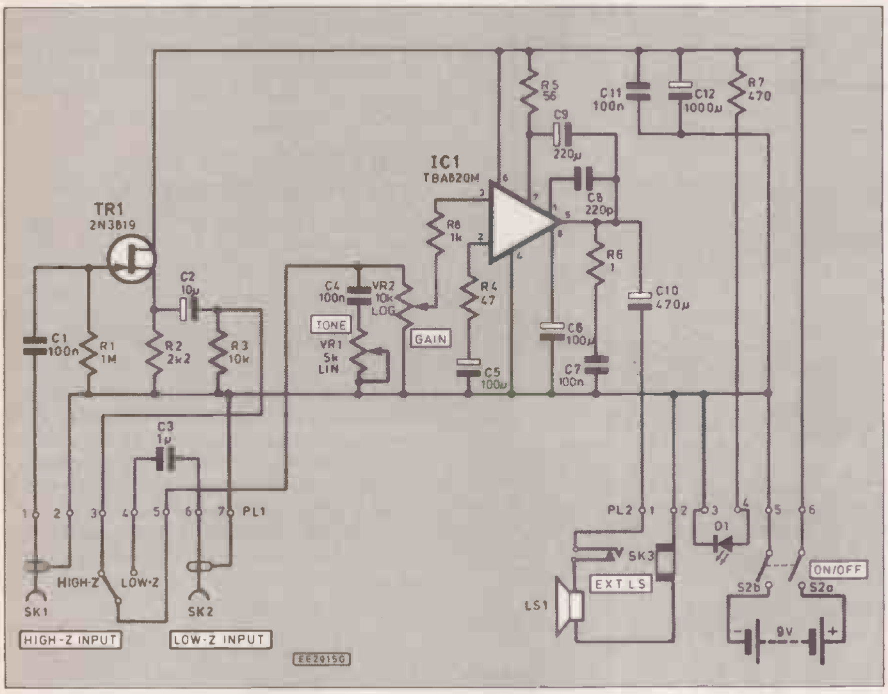


Fig. 2. Complete circuit of the Bench Amplifier/Signal Tracer

COMPONENTS

Resistors

R1	1M	**See SHOP TALK Page**
R2	2k2	
R3	10k	
R4	47	
R5	56	
R7	470	

All ¼W ±5% carbon film

Potentiometers

VR1	5k lin. p.c.b. mounting
VR2	10k log. p.c.b. mounting

Capacitors

C1,C4, C11	100n 100V polyester (3 off)
C2	10µ radial elect. 16V
C3	1µ miniature polyester 100V
C5,C6	100µ radial elect. 16V (2 off)
C9	220µ radial elect. 16V
C10	470µ radial elect. 35V
C12	1000µ radial elect, 16V

Semiconductors

TR1	2N3819
IC1	TBA820M
D1	red l.e.d. (with mounting bezel)

Miscellaneous

S1	SPDT miniature toggle switch
S2	DPDT miniature toggle switch
LS1	4 or 8 ohm 4" speaker
PL1	7-way straight p.c.b. header (0.1" pitch)
PL2	6-way straight p.c.b. header (0.1" pitch)
SK1	Phono socket (red)
SK2	Phono socket (black)

Enclosure ABS enclosure (measuring 220 x 230 x 70mm approx. see text); printed circuit board available from the *EE PCB Service* order code EE725; plastic p.c.b. fixing pillars with self-tapping No. 6 fixing screws (2 required); snap-fit battery connector; 8-pin low-profile d.i.l. connector; connecting wire; fixings, etc.

Approx cost guidance only **£14** *plus case*

The circuit operates from a single positive supply rail of nominally +9V. This supply may be derived from dry batteries or from a suitable mains adapter (the unit will operate successfully from any regulated d.c. supply capable of delivering an output in the range 6V to 12V).

CONSTRUCTION

Construction of the Bench Amplifier/Signal Tracer is very straightforward and the vast majority of the components are assembled on a single-sided printed circuit board measuring approximately 54×104mm. The layout of the printed circuit board is shown in Fig. 3.

Components should be assembled on the printed circuit board in the following sequence; p.c.b. headers, d.i.l. socket, resistors, capacitors, and transistor. As with all of our projects, it is important to ensure that all of the components are correctly located. Furthermore, in the case of the polarised components (such as electrolytic capacitors, transistors and i.c.) it is absolutely essential to ensure that each component is correctly orientated.

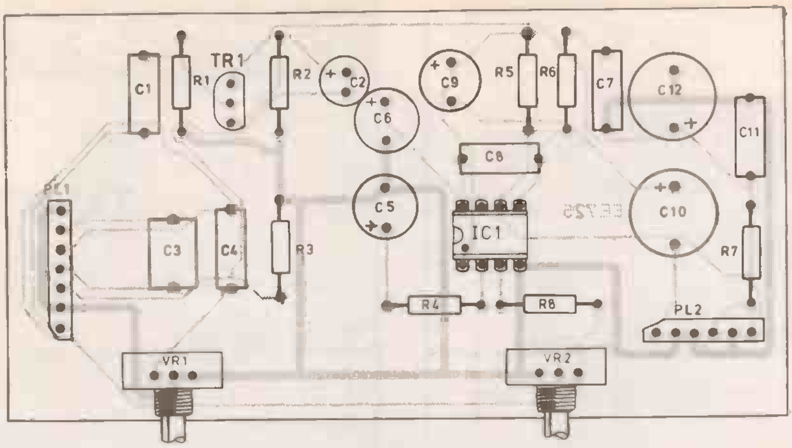
When construction of the printed circuit board has been completed (and before inserting IC1 into its socket) it is well worth carrying out a careful visual check of both the upper and lower sides of the board. The upper (component) side of the printed circuit board should be examined to ensure that the components have been correctly located whilst the lower (copper track) side of the board should be checked to ensure that there are no dry joints or solder bridges between adjacent tracks. This precaution will only take a few minutes to carry out but can be instrumental in preventing much heartache at a later stage!

When assembly of the printed circuit board has been completed, IC1 should be inserted into its socket (taking care to observe the correct orientation).

HOUSING

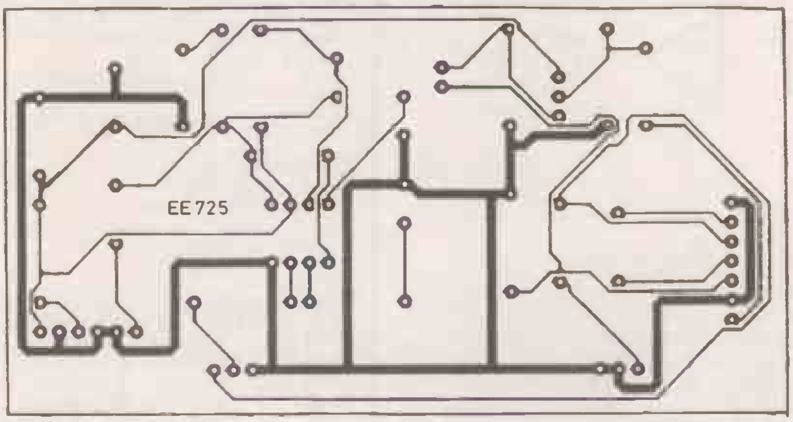
The bench amplifier/signal tracer should be housed in an ABS enclosure measuring approximately 220×230×70mm. The precise dimensions of the enclosure are unimportant provided adequate room is made available on the front panel and the unit is large enough to accommodate a 9V battery and loudspeaker of reasonable size.

The front panel should be carefully marked out before drilling and cutting takes place. As usual, there is nothing particularly critical about the layout of the unit and constructors may wish to experiment with the location of the front panel



EE2916G

Fig. 3. P.C.B. copper foil and component layout



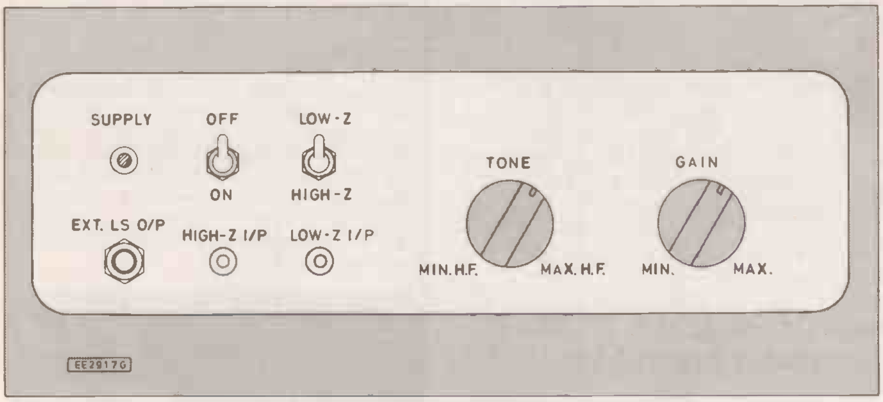


Fig. 4. Recommended front panel layout

controls, input/output connectors and l.e.d. indicator. Fig. 4 shows the front panel layout and markings used in the prototype.

Once the front panel has been drilled to accommodate the controls and input/output connectors, the p.c.b. can be mounted (by means of the control shafts of VR1 and VR2). The rear of the p.c.b. should be supported above the base of the plastic enclosure by means of two snap-fit p.c.b. mounting pillars.

LOUDSPEAKER

The loudspeaker should be mounted on the upper case half whilst the controls and input/output connectors should be located on the aluminium front panel of the enclosure. The loudspeaker will require a round hole of suitable diameter (80mm on the prototype). Such an aperture may be cut by means of a tension file and then filed (using a half-round file) to an exact circular profile. Alternatively, an adjustable tank-cutter can be used (such a tool was used in the construction of the prototype).

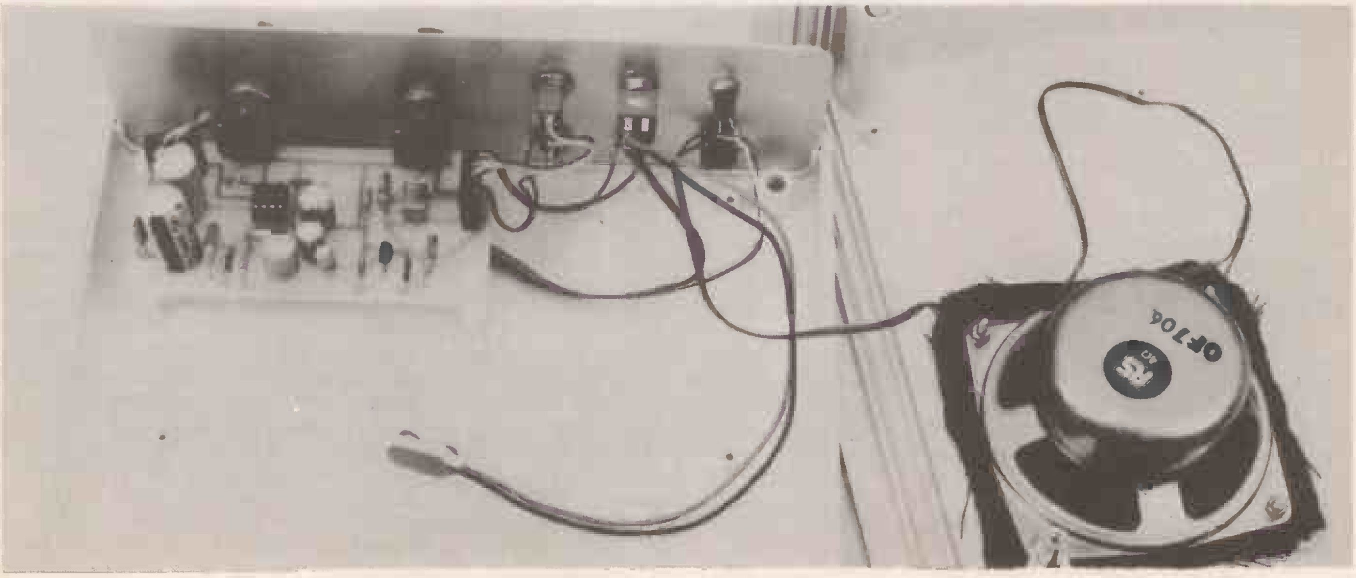
As with last month's project, use of a loudspeaker of relatively large size (i.e. 4 inch diameter) is highly recommended since, in the author's experience, smaller units are rarely satisfactory on the grounds of both sensitivity and sound quality. The loudspeaker should have an impedance of between 4 ohm and 8 ohm.

A battery holder (for 9V battery or an equivalent number of AA size cells) can be manufactured from a simple L-shaped aluminium bracket secured to the base and/or rear of the case.

INTER-CONNECTION

Connections to the printed circuit board should be made using two 0.1 inch pitch printed circuit board headers. A seven-way header (PL1) is used for the input connectors and input selector switch whilst a 6-way header (PL2) is used for the external speaker jack, l.e.d. indicator, and supply. The procedure for terminating the female connectors which mate with the headers was described in the first of our constructional projects which appeared in the December 1990 issue of *Everyday Electronics*.

Coloured stranded 0.1 inch pitch ribbon cable is used to make connections to the front and rear panels. The following colour coding is recommended:



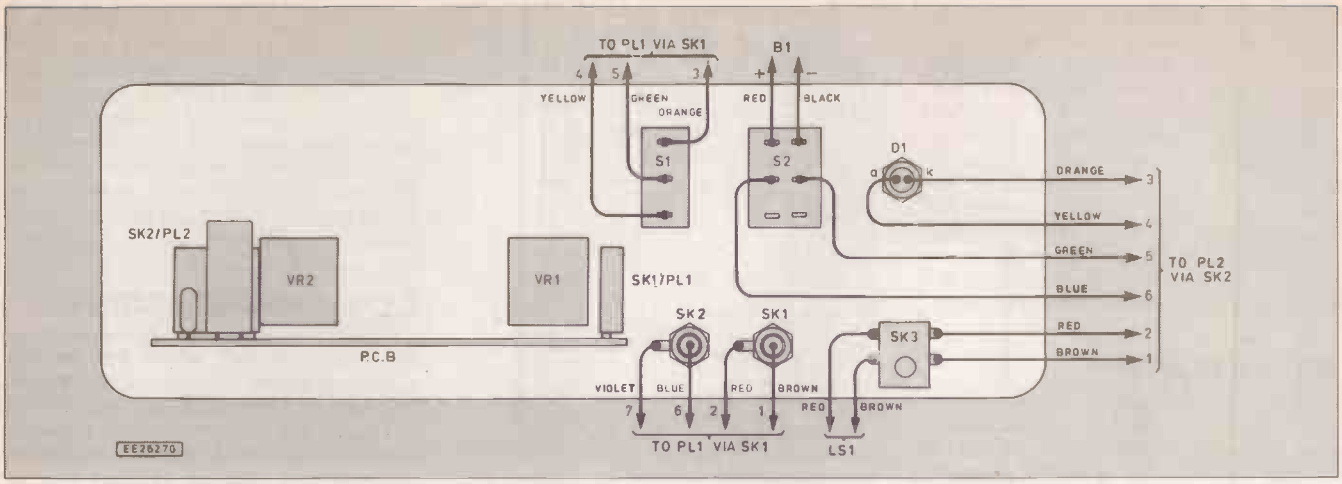


Fig. 5. Internal wiring of the Bench Amplifier/Signal Tracer

PL1

Pin	Colour	Connection to:
1	Brown	SK1 (signal)
2	Red	SK1 (earth)
3	Orange	S1 (high-Z input position)
4	Yellow	S1 (low-Z input position)
5	Green	S1 (selector)
6	Blue	SK2 (signal)
7	Violet	SK2 (earth)

PL2

Pin	Colour	Connection to:
1	Brown	SK3 (signal)
2	Red	SK3 (earth)
3	Orange	D1 (cathode)
4	Yellow	D1 (anode)
5	Green	S2a (negative supply)
6	Blue	S2b (positive supply)

The internal wiring of the bench amplifier/signal tracer is shown in Fig. 5.

TESTING

Before testing the Bench Amplifier/Signal Tracer, it is important to carefully check the wiring of the p.c.b. and front panel mounted components. A 9V supply should then be connected to the battery connector with a milliammeter inserted in one lead to the battery in order to measure the supply current to the unit. Now switch the unit on and measure the supply current. This should be in the range 20mA to 28mA. If this is not the case, disconnect the supply and carefully check the wiring and p.c.b.

If the supply current is correct, switch S1 to the "high-Z" position, turn both VR1 and VR2 to their maximum clockwise position) and place a finger on the the signal connection of SK1. A loud buzz (mains hum) should be heard from the loudspeaker.

Adjustment of the "gain" control (VR2) should alter the volume of the signal produced by the loudspeaker whilst adjustment of the "tone" control should alter the "sharpness" of the buzz. If no signal is heard, carefully check the wiring to PL1 and PL2.

MODIFICATIONS

A number of useful modifications may be made to enhance the performance of the basic Bench Amplifier/Signal Tracer. The suggestions made here are provided as "food for thought" and should make a starting point for further development. Constructors are invited to report their own modifications to be incorporated in the Readers' Feedback which will appear in the final part of our Design series.

MAINS OPERATION

The Bench Amplifier/Signal Tracer can be very easily adapted for mains operation. A suitable mains supply is the 723 variable power supply module which appeared in Part One of the series. The output voltage control (VR2) should be set to provide 9V d.c. output whilst the current limit control (VR1) should be adjusted to approximately 10 percent of its clockwise travel (i.e. approx. 1A current limit).

The rectifier can be down-rated to a 2A type and the series regulator transistor can be mounted on the rear aluminimum panel of the unit (this should provide adequate heatsinking for the transistor as the supply current required by the Bench Amplifier/Signal Tracer unit is very modest). Fig. 6 shows the necessary circuit modifications.

MAINS/BATTERY OPERATION

If desired, the bench amplifier may be adapted for dual mains/battery operation with automatic changeover to battery operation in the event of supply failure or disconnection of the mains. The output of the mains supply unit should be increased to approximately 10V for use with this circuit modification. Fig. 7 shows the necessary changes to the circuit.

INPUT PROBE

When used for general signal tracing, the Bench Amplifier/Signal Tracer will benefit from some form of input probe which

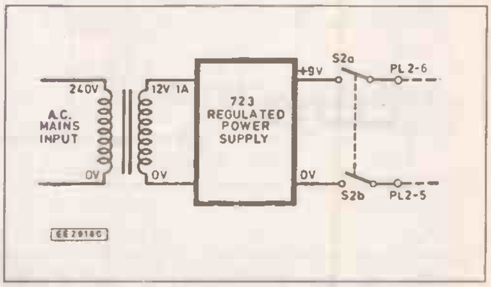


Fig. 6. Modifications for mains operation

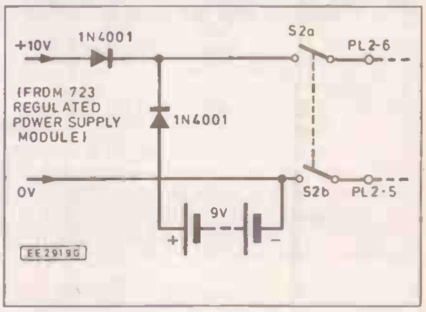


Fig. 7. Modifications for dual mains/battery operation

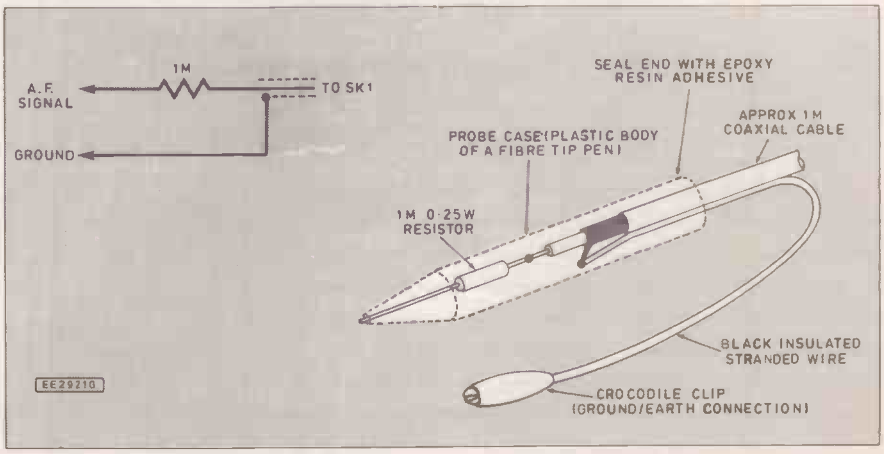


Fig.8. Input probe

minimises the loading (both resistive and reactive) on the circuit under investigation. Such a probe can be easily constructed using the barrel of a fibre-tip pen, as shown in Fig. 8.

Note that the cable from the probe to the unit should be kept to less than 1m, or so, and that the cable should be of the coaxial type with the outer braid connected to earth/ground by means of an insulated crocodile clip. Note that the input probe should normally be used only with the high-Z input of the Bench Amplifier/Signal Tracer.

RF PROBE

When signals are to be traced in equipment such as a.m. radio receivers, it is often necessary to demodulate signals in order to recover the amplitude modulated audio information. This can be achieved by means of a diode probe such as that shown in Fig. 9.

The construction of this probe is similar to that of the unit previously described however a larger diameter enclosure will usually be required in order to accomodate the additional components. It is important to note that the r.f. probe has a relatively low input impedance and it should normally be used in connection with the low-Z input on the Bench Amplifier/Signal Tracer.

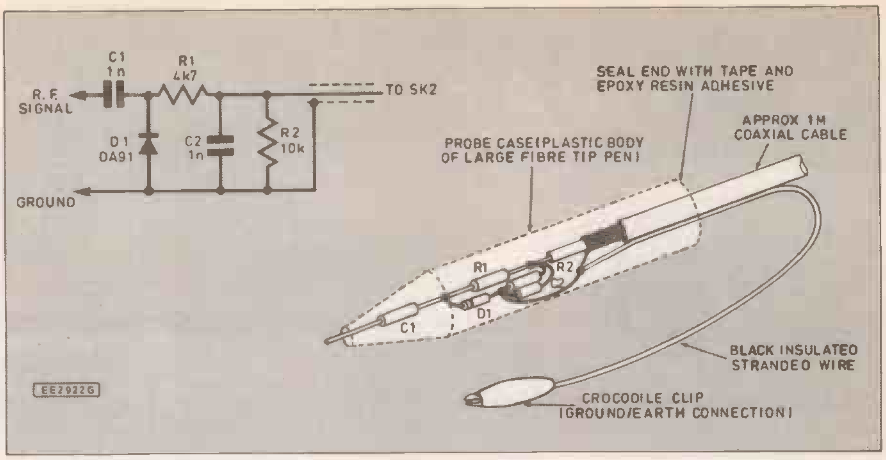


Fig. 9. R.F. probe

SIGNAL LEVEL METER

Despite the fact that the Bench Amplifier/Signal Tracer is designed for qualitative rather than quantitative measurements, the addition of a meter to indicate signal level can be extremely useful in a number of situations (e.g. when adjusting a circuit to provide maximum gain). Fig. 10 shows how a level meter can be incorporated.

The capacitor, C, determines the "hold" time of the meter whilst the variable resistor, VR, may be adjusted to determine the sensitivity of the arrangement (a 5kilohm component is recommended for a 1mA meter movement whilst a 50kilohm preset should be used for a meter having full-scale deflection of 100μA, or less). If desired, the meter scale should be calibrated against a known a.c. voltmeter however, in many cases, a simple relative indication of signal level will be all that is required. ☐

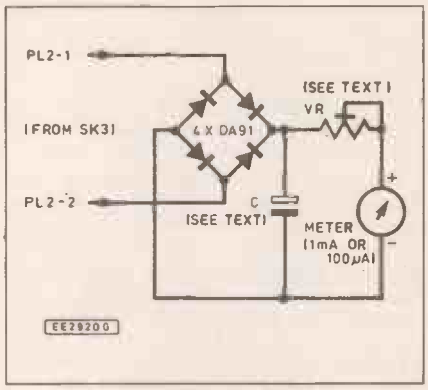


Fig. 10. Lever meter

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WANTED user manual and circuit diagram for Commodore 8296 computer. Photo copies acceptable. Phone 092-825788.

WANTED circuit diagram servicing information for Tandy Concertmate 500 sampling keyboard. Costs paid. A.S. McGuchan, 137 Belgrade Square, Coventry CV1 1GU. Tel. (0203) 550381.

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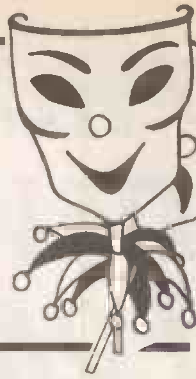


by Barry Fox

DAT's Some Confusion

There is now widespread confusion over what the DAT SCMS (serial copyright management system) actually does.

Although SCMS circuitry will only be built into domestic DAT recorders, these will be much cheaper than professional models. So broadcasters will without doubt try to save money by buying domestic decks. Dealer HHB (which has now sold over 5000 pro DAT decks) acknowledges that it will be forced to sell domestic DAT decks.

Because SCMS limits copying options, broadcasters will end up with a library of tapes, some of which can be copied and some of which can't. HHB is advising broadcasters to buy SCMS decks to use only as playback units but in the real world it is inevitable that they will be used to record as well. This is where the situation gets messy.

An SCMS deck will record digitally from any digital source at the sampling frequency of the original, e.g. 44.1kHz for CD, 32kHz for satellite radio. If the digital source signal conforms to the Digital Audio Interface standard (IEC 958) but is not copyright protected (e.g. is a CD without a copyright flag in the Q sub-channel code) then the SCMS deck makes a digital tape which can be copied as many times as you like.

If, as is more likely with CDs, the Q code contains a copyright flag, the recorder will make a digital copy which cannot then be copied. The same thing will happen if the digital source signal does not conform to the IEC standard.

But there is, of course, nothing to stop the user making a limitless number of original digital dubs from the same source onto different tapes. This is what most home tapers of CDs will do, negating the record companies' prime reason for agreeing to SCMS!

If the source signal is analogue (an LP deck, the analogue output of a CD player, an analogue radio tuner or a microphone) the DAT deck will produce a digital tape at 48kHz. This tape can then be digitally copied once, but not a second time.

This is why a radio station will end up with a shelf full of tapes, some of which will copy digitally once and some of which won't copy digitally at all.

Escape Route

The situation is made even more confusing because some manufacturers may sell domestic decks which are labelled SCMS but do not actually have SCMS circuitry inside. Although Matsushita and Sony make their own chips, other manufacturers buy from Hitachi and Toshiba. Trade sources say that Toshiba's chips did not have SCMS implemented in time for the domestic launch.

One clumsy escape route from the shelf full of mixed tapes will be for the user to make an analogue copy instead of a digital copy, and then copy that digitally.

Another route is to use a circuit which strips out the SCMS code. Although a Japanese hifi magazine has reported the availability of a US-made $50 stripper chip, it's unclear whether this report refers to a chip which actually exists or is based on speculation of the feasibility of such a chip during the Senate hearings on US copyright law.

Either way it's academic. No-one doubts that an SCMS-stripper will eventually go on sale, albeit under some weasel name like "recording enhancer" to stay within the law. But HHB says it has "no plans to sell one".

At the IBC in Brighton, Roger Lagedece of Sony's professional division had this to say:

"Speaking as a manufacturer of professional equipment I have to ask you a simple question. What is SCMS? A professional recorder will simply ignore any SCMS codes".

With a mischievous nod at the late, unlamented Copycode system, Lagedec adds:

"The SCMS codes will simply disappear into the notch of history".

From the IBC an interesting theory emerged that if anyone wants to dub tapes made on an SCMS machine all they will have to do is copy them once onto a professional DAT recorder. The SCMS code is then stripped off.

When the stripped recording is copied onto an SCMS deck, the copy will be marked as not copyright protected. So the copy can then be copied ad infinitum even on SCMS decks.

Widescreen

I was interested to hear that B and O of Denmark agrees with Grundig's estimate of the cost of HDTV – that wide screen IDTV ("improved definition") sets will cost five times as much as conventional TV's. This level will be maintained for around five years.

The Danes add the warning that because a wide screen 16:9 tube needs much more glass to make it safe from implosion, it will be almost twice as heavy as a conventional 4:3 set of similar diagonal size. So a wide screen TV set will need two to three people just to lift it.

Then there is that thorny question of how to convert conventional 4:3 transmissions into wide screen format. Especially widescreen films broadcast in letter-box format with black bands at the top and bottom.

Thomson of France promise a widescreen IDTV set by the end of this year for £3,000. This will electronically zoom and letter box film broadcast by conventional 4:3 systems so that the expanded image fills the 16:9 screen. But then definition is lost because fewer lines are building the visible picture. Any subtitles at the bottom of the picture will be lost too.

Audio Trends

Several hifi companies were showing DAT at the annual hi fi meet at the Heathrow Penta Hotel organised by *Hi Fi News*. Most interesting on the pro front, Trio Kenwood had a prototype (L-712) four head unit and a very small portable with reduced size (20mm) drum, the DX-7. But both were in a glass case, and neither working. No one on the Kenwood stand knew anything about them.

Meridian is moving closer towards the all-digtal system. The D-600 "digital active loudspeaker" incorporates a Bitstream digital-to-analogue decoder, and analogue amplifier. You just plug in the digital output of a CD player.

The next step is the D-6000, demonstrated for the first time at the Penta. This has on-board Motorola Digital Signal Processing chips which provide a digital crossover for the speaker units. The D-600 costs £2,750, the D-6000 £6,900.

Every few years the hi fi trade adopts a new, favourite demonstration recording. Remember the direct cut recording of the *1812* which no gramophone stylus could ever track?

The latest favourites are the Chesky CDs from New York. Chesky Records is run by David (a pianist) and brother Norman (music and hifi buff). They record classical music at the Academy Hall up in Harlem, and jazz at RCA's Studio A in New York.

Everything is done with a very simple microphone set-up, usually a pair of AKG capsules arranged in Blumlein figure-of-eight pattern. The signal then goes through a transformerless valve amplifier, into an analogue-to-digital converter and from there direct onto either Sony 1630 U-Matic tape or a 600 megabyte hard disk recorder based on an Apple Mac (with parallel recording onto old Ampex 300 recorders re-built with valves and a more modern recorder using Dolby SR processing).

Everything is recorded straight into stereo, without any mixing or any signal processing, usually from just a single miked pair. It takes a full day to get the balance right and there is no over-dubbing.

What you hear is what was played in the natural acoustic. The end result, both for jazz and even some electric pop, really is remarkable.

PROJECT DEVELOPMENT FOR GCSE

In this, the second of a six-part series, a GCSE assessor looks at the best way of starting your electronics project.

MOST examinations boards allow you a free choice of project-although most require approval before you actually begin construction work (Midlands Examination Group, Southern Examining Group, Northern Examining Association and Welsh Joint Education Committee). If you are entering for London East Anglian Group GCSE Electronics you will have only a limited choice. For this exam, you will receive in January a booklet containing six outline circuits. You choose one of them as a basis for your project. Your school may not be able to offer all six but must allow you a choice of at least four.

Project Choice

It is essential to choose a project which is within your ability and here the advice of your subject teacher is crucial. I have seen time and again misdirected "enthusiasm" ending in dismal failure. You can obtain an excellent mark for a modest project providing you treat it properly.

GCSE assessors are not really concerned with the degree of difficulty of the project. Most marks are awarded for the way you develop your ideas, solve problems, construct the circuit and – **most important** – present the written report.

I have seen many wonderful projects but unless supported by a clear report of all development work, they receive a poor mark. A lower mark, that is, than someone who produces a mediocre artefact which barely works, yet supports it with a clear step-by-step account written in good English. With no written report produced at all you may forfeit the entire examination.

Articles and Kits

By all means, check magazine articles and books for ideas. This is an expected part of your research. If you use a published design, make sure that you acknowledge the source, stating the name of the magazine and month of publication. This may be done in the body of your written report or (better) in a bibliography at the end.

It is better to avoid using a project sold as a complete kit. You will obtain less marks because all the development and problem-solving has been done for you. On the other hand, for a weaker candidate, it may be the only way forward. Do check with the regulations, though, to make sure that this is acceptable.

Of course, feel free to use sections of published designs which you will build together to make a new circuit with a different purpose. This is a good approach and can receive full credit.

Talking to your teacher or supervisor to clarify your ideas and to obtain further suggestions for research is perfectly acceptable and will certainly not result in lower marks. Again, such conversations with teachers and, perhaps, specialists in industry, etc. should be acknowledged in your written report.

Most candidates draw their ideas for a project from an interest or hobby – you will always make a better project where personal interest is involved.

Your Own Work!

At this point I will relate a story about an examination (now defunt) which required a project to be built on the free-choice basis. I remember one particular artefact which I had to assess and it looked very good.

The written report was also clear and described in detail how the student had supposedly developed the final circuit from small beginnings. It was certified as his own work but I knew differently! *It was a project of mine* which had been written for a magazine a year or two previously!

Complexity

The more complicated a circuit is, the more chance there is of one or more of the sections not working together properly. A well-documented project containing two or three well-defined sections, using a few transistors and ten or so passive devices – resistors, etc – or based on two integrated circuits would certainly meet with approval.

Obviously, the circuit must be "electronic" rather than simply "electrical". One containing just bulbs, switches, relays and pieces of wire would not be enough.

Apart from that, you have a free choice. Free, that is, apart from LEAG students who need to use one of the "given" circuits as the starting point. On the other hand, being directed in this way is no bad thing. By the way, LEAG do not insist on your final circuit being a development of their circuit. Any design which would fulfil the same purpose is acceptable. This, in practice, allows you quite a lot of freedom.

Idea

Start with an idea – an electronic device which serves some useful purpose. Such a purpose could be an aid for the handicapped or a security alarm, for example. Be clear in your mind what the need is and what personal interest you have in it.

A valid reason for making an illuminated sign to tell a deaf person that the doorbell is ringing is that you have a friend or relative who is hard of hearing. Avoid ideas which will involve you in using triacs and thyristors which operate from mains voltage direct. "Sound to light" units come into this category. Some boards forbid such circuits on safety grounds.

If you intend using a low-voltage supply derived from a step-down mains transformer you will need to follow all safety regulations. More will be said in a future article about this. Now write a rough draft specification for the device. This means a statement of the purpose, together with some facts and figures expected from its performance.

Next, do a feasibility study of ways of fulfilling your specification. I say "ways" here rather than a single way because looking at alternative solutions will gain much credit. To decide which is the best way, you will need to build some basic circuits – nothing elaborate – and do some tests before reaching a decision. One or two laboratory sessions will be sufficient for this. If possible, use ready made plug-together modules or make quick circuits on a prototype board – for example, an S-Dec.

Think about your reasons for rejecting some of the possible designs – it may be because the level of difficulty is too high (the simplest circuit for a given job is best), high cost (the cheapest circuit for a given specification is best), difficulties with the power supply, or availability of components. Aim for three or more alternatives. Make some notes as you go along.

Diary approach

Now it is time to consider how your written work will be presented. Your teachers and exam assessors are not clairvoyant – you will receive credit only for what is clearly expressed.

The best way is to use a diary. By diary I don't mean an actual book. Your diary will be in the form of A4 sheets (some boards actually specify this size) in a folder. In this sense "diary" just means that there are well-defined entries in sequence – one for each laboratory session.

The diary approach has the advantage that sheets may be re-arranged, added to, re-written or removed altogether. Plain paper for diagrams and graph paper may also be included. The diary directs your attention to the aim of each working session. This aim will be stated along with your plan for achieving that aim. In this way, your diary will provide an account of your project development work from start to finish.

Perhaps the biggest advantage of a diary is that it forms the written report. By doing it as you go along, you are relieved of a lot of pressure at the end. MEG require a fuller written report to be submitted in addition to a diary. Although not essential you will lose credit without it.

Begin your diary with a title page (although you might decide to do the finished one only when you have definitely decided on the project). Suppose you decide on an Elderly Person's Alarm. Your diary entry might then be as follows.

Date: 4th January, 1991

Title: Elderly Person's Alarm

Purpose: To summon help if the person falls.

Personal interest: I have an elderly relative who fell and couldn't attract attention. She helped me with the specification.

Specification: A device attached to a walking stick and powered by a 9V battery. The device sounds loudly for 1 minute when the person falls over. The alarm must be capable of being heard at a distance of 10m in loud traffic noise. A possibility is to provide a pulsed tone which would be better at attracting attention.

Possible solutions

(a) A switch which operates with sudden deceleration i.e. on hitting the ground – this would trigger a timing circuit and hence operate the buzzer.
(b) A sound-operated switch which would sense the noise as the device struck the ground. This would trigger a timing circuit and operate the buzzer.
(c) A mercury tilt switch. So long as the walking stick is within 45° of vertical the timing circuit will receive no current and the alarm will be off.

Which one to select?

(a) No catalogue seems to list a suitable ready-made switch. The switch may not be sensitive enough to trigger the unit on a soft surface or, if it was, may trigger with normal movement.
(b) Operation by sound would be unreliable. It would be likely to trigger with other loud noises. It would be expensive to construct and involve a complex circuit. The circuit would be on standby so consuming current all the time – this would be a disadvantage as far as the battery life is concerned.
(c) Mercury tilt switches are freely available and are inexpensive. The mercury switch would be connected in the main battery line so while the walking stick was near-vertical, no current would be consumed.

Method (c) will therefore be the one chosen for initial tests.

Note:
My electronics teacher confirms that the circuit would be within my capability and within the resources of the school.

Evaluation

Now think – does your idea lend itself to evaluation later? If it doesn't, scrap it and do another project! Without some testing and evaluation involving measurements you will miss out on marks. The above project may be evaluated very well because you introduced in the specification three ideas involving measurements (a) that it must be heard at a distance of 10m under conditions of loud traffic noise (b) it should operate from a 9V supply (c) it will operate for 1 minute. These ideas would all be tested at the end.

Performance could be evaluated against the voltage of the supply by using a variable voltage power unit, for example. As a further thought, you could use buzzers operating at different frequencies and make measurements to show which frequency best met the specification. If you go ahead with the pulsed tone idea, there are even more possibilities for evaluation.

The important point is that you have chosen a circuit where several good tests are possible – a minimum of three should be suggested in the specification, all involving some form of measurement. Even the maximum weight, size, current or power requirement of the proposed circuit could be mentioned.

Important

Most students are eager to get their hands on the soldering iron and wish to start circuit-building before the preparation work has been done. I have seen this many times. Like so many other things, however, **the ground work is more important.**

Your aim is to obtain the highest marks for your project. This will only be achieved if you plan ahead and write everything down in your diary as you go along.

That's all for this month. Next time we shall look as the design of an actual circuit for our fictitious Elderly Person's Alarm.

INTERFACE

Robert Penfold

IN LAST month's *Interface* article we progressed as far as address decoding for PC add-ons. This month we will consider simple parallel input and output ports for use with these decoder circuits, and the mechanical problems involved with do-it-yourself PC cards.

Ins And Outs

In order to produce basic input/output ports from the address decoder circuits it is merely necessary to add a tristate buffer to provide an eight bit input, and an octal latch to provide an 8 bit latching output. A suitable circuit is shown in Fig.1.

On the input side there is a 74LS244 (IC2) octal tristate buffer. Normally this has its outputs in the third (high impedance) logic state, so that it has no effect on the computer's data bus. However, when a negative pulse is received from the address decoder, its outputs are activated, and couple the logic pattern on the inputs through to the data bus. Note that the decoded read and write lines must both be normally high, and pulse low when activating a port.

The output port utilizes a 74LS273 (IC1), which is actually an octal "D" type flip/flop. It works as an eight bit latch when used with the data bus feeding into its data inputs, the outputs taken from its "Q" outputs, and the "write" pulse from the address decoder fed to its clock input. Pin 1 is a master reset input, which is connected to the positive supply so that it is held in the inactive state. Alternatively, it could be fed from a C – R network across the supply lines so that it is fed with a negative reset pulse at switch on. This would ensure that the outputs always start out at logic 0.

Other Chips

There should be no difficulty in interfacing other 74LS or 74HCT series integrated circuits to the PC's data bus. Also, any TTL compatible peripheral chips, such as many of the analogue to digital and digital to analogue converters, should interface with the data bus without any difficulties.

As pointed out last month, the standard 82** series of peripheral chips (such as the 8255) are bus compatible with the 8088 series of microprocessors, and should readily interface with the PC buses. These chips were originally designed for operation with the 8080 series of microprocessors, and I would have thought that they might be too slow for operation on PC buses. However, it would seem that chips such as the 8255A are used in PC expansion cards without any extra wait states added, and without any speed problems arising.

On The Cards

From the electronic point of view, interfacing to the PCs is pretty straightforward. In fact it lacks the non-standard complexities associated with many eight bit home computers, and is about as uncomplicated as it could be. Mechanical aspects of PC interfacing are far less straightforward. As pointed out in a previous *Interface* article, out-board units connected to the computer via a ribbon cable and suitable connector are *not* likely to work properly.

This approach is actually usable, but only if the cable is kept very short indeed. The higher the clock frequency of the computer, the shorter the cable has to be. This means that with most PCs the cable would actually have to be kept so short that this system becomes inconvenient at best, and totally impractical at worst. If you have a slow PC, or a "turbo" PC that you are prepared to run at a slow clock speed, this method may be satisfactory, and represents the simplest approach to DIY (do-it-yourself) add-ons.

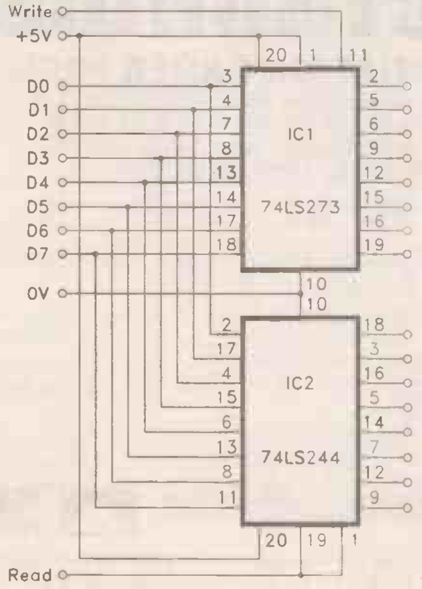


Fig. 1. Simple circuit for providing 8-bit input and output ports for use with the address decoder circuits provided last month.

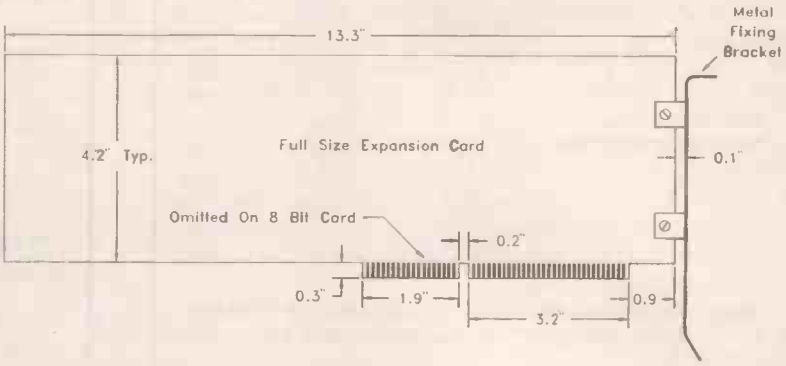


Fig. 2. Basic mechanical details of a full length PC expansion card.

The standard approach to PC add-ons is to have expansion cards that fit inside the computer, just like the standard interface cards (disk controllers, display boards, etc.). The card is not only held in place by fitting it into an expansion slot, but it also has a metal bracket that bolts to the rear casing of the computer. Connections to the outside world are made via a socket or sockets mounted on this metal bracket.

Card Details

The basic details for a full length PC expansion card are shown in Fig. 2. This includes the additional edge connector for AT style machines, but will obviously be absent from most DIY expansion cards.

Note that the card does not have to be full length. In general, cards are about one third to half the length where this is adequate to accommodate everything. If they need to be more than about half size, it is normal to make the card a full length type. The front edge of the card is then supported by the guide rails in the computer, giving better mechanical strength to the overall assembly.

There is no standard height for expansion cards either. It is advisable not to go much over the figure of 4.2 inches shown in Fig.2, since many computers now have slim-line cases which will not take boards much higher than this.

If the height is made significantly less than about four inches, it might be difficult to reliably fix the board to the mounting bracket. It would also be difficult to fit and remove a card of less than about four inches height.

The metal mounting bracket is a fairly intricate shape which is not too easy to make. Computers usually come equipped with metal blanking plates for any unused expansion slots, and it is much easier to use these than to make your own brackets. If you do decide to produce a do-it-yourself bracket, accurately copy a blanking plate or the bracket on an existing expansion card.

Two-Sided

Probably the main difficulty for most constructors of PC add-ons is that the printed circuit board needs to be a double-sided type. Commercial printed circuit boards tend to be drawn up as double-sided types as a matter of course these days, but even the more simple two-sided types can be difficult for the average home constructor.

Once a design is finalised, I suppose that by putting your mind to it, and taking due care, it is possible to produce neat do-it-yourself PC cards. The real difficulty is in dabbling with prototype circuits, where you do not usually want to dive straight in with expensive, difficult, and time consuming, custom double-sided printed circuit boards.

Prototyping Systems

There are a number of PC prototyping systems manufactured, but many of these would not seem to be available in the U.K. Also, those that are available here seem to be quite costly. In some cases this is because the system is a fairly complex one which includes address decoding circuitry, buffers, etc. In other cases the boards are supplied with no circuits ready fitted, and there is no obvious reason for their high cost. No doubt all these PC prototyping systems are very good if you can afford them, but they would seem to be too costly for most electronics hobbyists.

I am indebted to *Mr. D. J. Stanton* of Worcester for his suggestion of using a Tandy circuit card which has a 72-way edge connector (part No. 276-192). Apparently this will fit a PC eight bit expansion slot if part of the edge connector is cut away.

The board measures about 4.5 by 5.7 inches, and may need to be cut down slightly in order to fit into some PCs. Obviously the area of the card is limited, but it should be adequate for much PC prototyping. I have not had a chance to try out one of these boards, but at £3.79 they seem worthwhile investigating if you would like to experiment with PC interfacing.

Make Your Own

The alternative low cost approach is to make your own prototype card. This does not need to be anything particularly complicated. At its most basic level it could consist of a blank printed circuit board and PC edge connector.

The edge connector would only need to have copper "fingers" at those positions which connect to something you will actually need (data bus, address bus up to A9, etc.). Each "finger" of copper would connect to a solder pin so that connections could be readily made to the required expansion bus lines.

The prototype circuits would be constructed on plain matrix board, stripboard, or whatever, bolted in place on the plain card, and then wired to the solder pins. Sockets could be included on the otherwise blank card, and wired to the prototype circuit, in order to permit easy access to any inputs or outputs of the prototype circuit.

This is obviously a rather rough and ready way of handling things, and is far from neat. However, when testing prototype circuits the main concern is whether or not it works, not how pretty it looks.

I have experimented with a system of this type and have had some success. If a "deluxe" version can be brought to a presentable state, details will be provided in a future *Interface* article.

This idea can be taken a stage further, with the address decoding being included on the card so that it does not have to be included on every prototype circuit that is used with the unit. Matters are not quite as easy as they might at first appear, since the address decoding requirements will vary significantly from one circuit to another.

The address decoder must therefore be designed to, as far as possible, leave your options open. This is an idea I will certainly pursue in due course, and details will be furnished in a future article if it proves to be successful.

Next month we will conclude our present coverage of PCs by taking a look at some of the low cost public domain and shareware software that is available for these computers.

There is a surprisingly large amount of technical software that is of special interest to the electronics enthusiast. Linear and logic circuit analysis, printed circuit design, and much amateur radio software is available, but is it of any real use?

ELECTRIC BLANKET SHUTDOWN

T. R. de VAUX-BALBIRNIE

Prevent electric blankets being left on accidentally

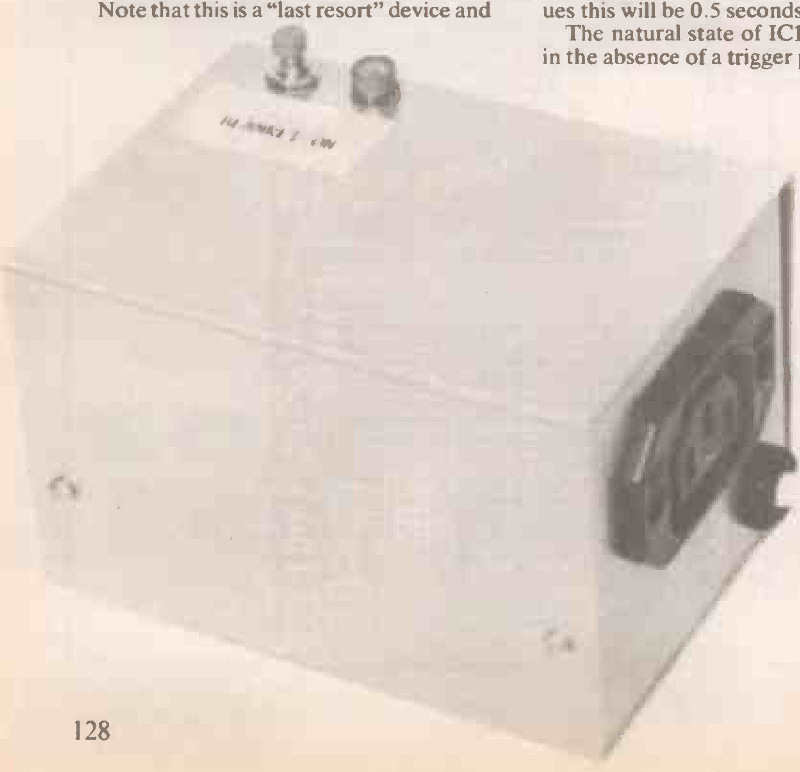
ONE PROBLEM with electric under-blankets is that they are easily left on by mistake. This is very dangerous and can result in fire, electric shock or, at the very least, an uncomfortably hot night. Elderly people are especially likely to forget to switch the blanket off before going to bed.

The author's teenage son sometimes sits on the bed using the telephone with the blanket switched on. This is also very bad practice which can easily lead to damage and local overheating.

This device is an automatic shut-off circuit built in a metal case and fitted with a socket in which to plug the blanket. A second socket connects a sensor placed beneath the mattress and housed in a thin case.

The blanket is switched on by pressing a push-button switch momentarily. When the sensor detects movement, it triggers the circuit and cuts off the supply. The blanket can then only be re-activated by pressing the ON switch again.

Note that this is a "last resort" device and must not be used simply as a lazy way of switching off. The unit is fitted with a neon indicator to show when the circuit is operating. While off, it consumes no power.



CIRCUIT DESCRIPTION

The complete circuit for the Electric Blanket Shut-Down is shown in Fig. 1. With switch S2 (ON) pressed, mains current flows through transformer T1 primary. Diodes D2 and D3 operate as a conventional full-wave rectifier in conjunction with the centre-tapped secondary winding of T1. Capacitor C2 smooths the d.c. supply to the rest of the circuit. Fuse FS1 protects the low-voltage section.

When the monostable IC1 is triggered by making pin 2 (trigger input) low, the output, pin 3, goes from low to high (positive supply voltage) for a fixed time then reverts to low. Resistor R2, keeps pin 2 normally high which prevents false triggering. The operating time is determined by resistor R3 and capacitor C1 — with the specified values this will be 0.5 seconds approximately.

The natural state of IC1 output (that is, in the absence of a trigger pulse) is low and when this is applied to transistor TR1 base, via resistor R4, results in the transistor being turned on — this is because TR1 is a *pnp* device. The relay coil is therefore energized and both pairs of "make" contacts, RLA1 and RLA2, operate.

Relay contacts RLA1 bypasses push switch S2 so that this may now be released and the mains supply to T1 primary winding maintained. Contacts RLA2 direct mains current to the blanket and operate the neon indicator LP1. Diode D1 bypasses the high-voltage "spike" which appears as the relay coil switches off. Without it, semiconductor components may be damaged.

VIBRATION SENSOR

A special type of mercury switch S1, having normally-open contacts which close momentarily when it senses vibration, is used as the "shut-down" sensor. This will happen when the bed is sat upon, upsetting the balance of the mercury switch.

When triggering occurs, IC1 pin 2 goes low via resistor R1 and pin 3 goes high in the manner already described. The high state of IC1 output turns transistor TR1 off and current to the relay coil is interrupted.

Both sets of relay contacts now open. Contacts RLA1 switch off the current flowing to the transformer primary while contacts RLA2 switch off the blanket. In the absence of a supply, the circuit will now remain off until push switch S2 is pressed again.

The purpose of IC1 monostable is to ensure that the triggering pulse delivered by sensor switch S1 is sufficiently long for capacitor C2 to discharge — that is, for the supply to completely disappear. This allows reliable "dropping out" of the relay.

Transformer T1 and the relay RLA isolate the mains and low-voltage sections of the circuit. It is therefore practically impossible for mains voltage to appear at the sensor. However, even if it did, resistor R1 has a sufficiently high resistance to limit the current to a negligible value and prevent electric shock. On the grounds of ultimate safety, therefore, R1 should NOT be omitted or its value reduced.

CONSTRUCTION

This circuit must be built in an Earthed metal case. Do not use a plastic box and on no account use a non-earthed supply. Also, since mercury is a toxic substance, switch S1 must not be cut open.

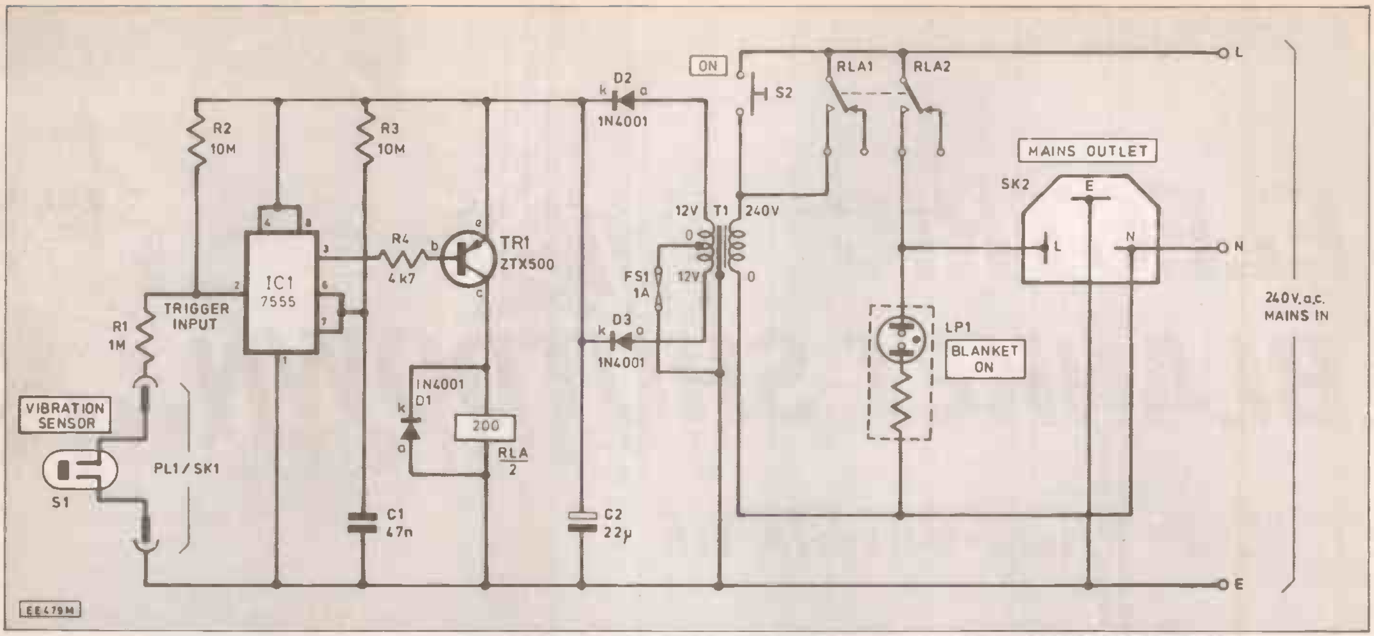


Fig. 1. Circuit diagram of the Electric Blanket Shut-Down.

Construction is based on a circuit panel made from a piece of 0.1 in. matrix stripboard, size 13 strips × 24 holes. The component layout and details of breaks required in the underside copper tracks is shown in Fig. 2.

First cut the board to size, drill the two mounting holes and make all breaks and inter-strip links as indicated. Note the double rows of broken tracks around the relay position. These are required to isolate the mains connections. ***It is essential, for safety reasons, to check that the tracks here are completely broken before proceeding.***

Solder the on-board components into position paying particular attention to the polarities of the three diodes and capacitor C2. However, do not insert IC1 into its holder until the end of construction. Note the way in which diode D1 is connected in parallel with the relay coil. If capacitor C1 has short leads, do not bend them excessively since this could cause damage — solder extension leads instead.

Solder 6cm pieces of light-duty stranded connecting wire to copper strips *G* and *K* at the left-hand edge of the circuit panel. Solder 10cm pieces of light duty mains-type wire *direct* to the relay "make" contacts as indicated — that is, *NOT* through the copper strips.

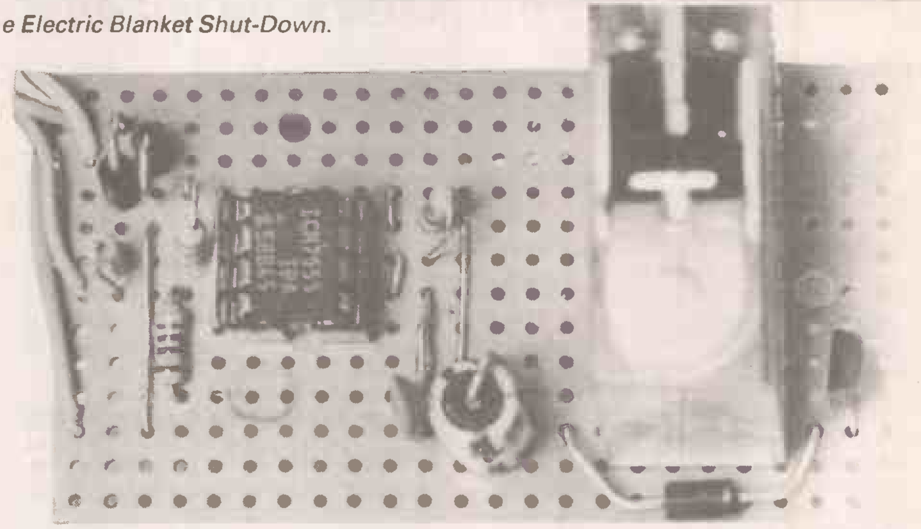
Make the common connection to the moving contacts using similar wire. To do this, strip off 6mm of insulation and make a "bridge" to re-inforce the copper strip. Check these wires to make certain that they are secure and cannot pull free in service.

CASE

Prepare the box by drilling holes for SK1 (sensor socket) and for SK2 (mains output socket). The easiest way to make the hole for SK2 is to draw the outline, drill several small holes around it and join these together with a small hacksaw blade.

Drill a hole for the mains input wire making this large enough to accommodate the strain relief bush to be fitted later. This bush is essential to prevent the metalwork cutting the wire and also to prevent it from pulling free in use.

Drill holes in the base for the mains transformer T1, fuse FS1 and also holes to align with those already made in the circuit board (see photograph and Fig. 2.). Attach



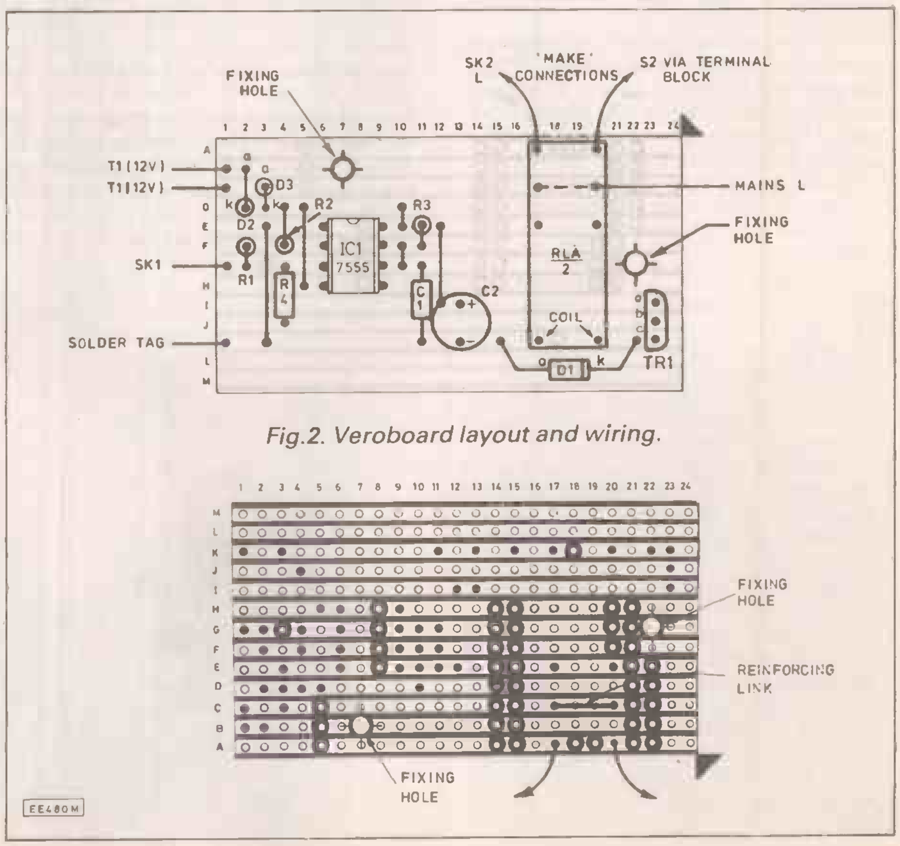


Fig.2. Veroboard layout and wiring.

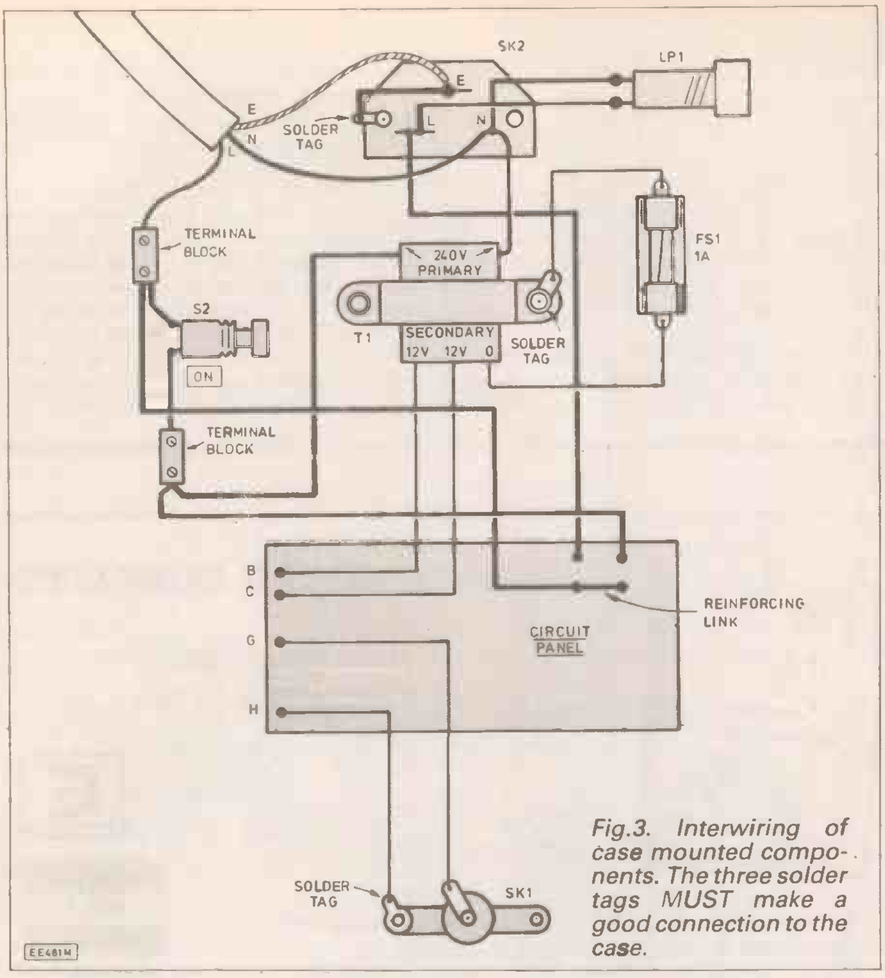


Fig.3. Interwiring of case mounted components. The three solder tags MUST make a good connection to the case.

the circuit panel to the base of the box using short fixings and stand-off insulators. Make certain that all connections on the copper track side of the panel remain well clear, at least 4mm, of the case bottom. Place a piece of thick cardboard between the board and metalwork.

Refering to Fig. 3, attach all remaining components, and complete the internal wiring. Note that everything apart from S2 and LP1 are mounted on the box main section. Drill holes in the lid for these latter components. Make certain that their connections cannot cause a short circuit to the metalwork. Use a piece of wide p.v.c. tape as an additional precaution (see photograph).

All wiring shown in bold (thick) lines must be made with light-duty mains wire. The rest is done with light-duty stranded connecting wire. Note that LP1 must be of a type having an inbuilt resistor making it suitable for direct connection to the mains. Note also the pieces of terminal block used for certain connections.

Three solder tags are used, the first at one transformer fixing which is used for fuse FS1 connection, the second to earth the mains output socket and the third at the sensor socket, SK1. Fit the strain relief bush to the mains input lead and secure it in the hole. Fit the free end with a standard plug carrying a 3A fuse.

Insert fuse FS1 and place IC1 in its holder taking care over the orientation. This should be done without touching the pins since it is a CMOS device and there is a risk of damage due to static charge, on the body. Finally, fit the base of the box with self-adhesive plastic feet to prevent scratching.

SENSOR PREPARATION

With the specified mercury switch S1, the orientation does not matter since the contacts are always open except when vibration occurs. It is possible to use other types of mercury switch and these are sometimes preferable. However, they are position sensitive and the correct orientation would need to be found by trial and error.

Drill a hole 3mm in diameter in one side of the "sensor" box for the connecting wire to pass through then attach the small spring clip which secures the switch and is also used to make one of the connections through a solder tag. Measure a piece of light-duty twin stranded wire to reach the sensor from the main unit position, pass it through the hole in the box and fix the lead with a "P-clip" do that it cannot be pulled free.

COMPONENTS

Resistors

R1	1M
R2, R3	10M (2 off)
R4	4k7

All 0.25W 5% carbon

See SHOP TALK Page

Capacitors

C1	47n ceramic
C2	22μ elec. 25V

Semiconductors

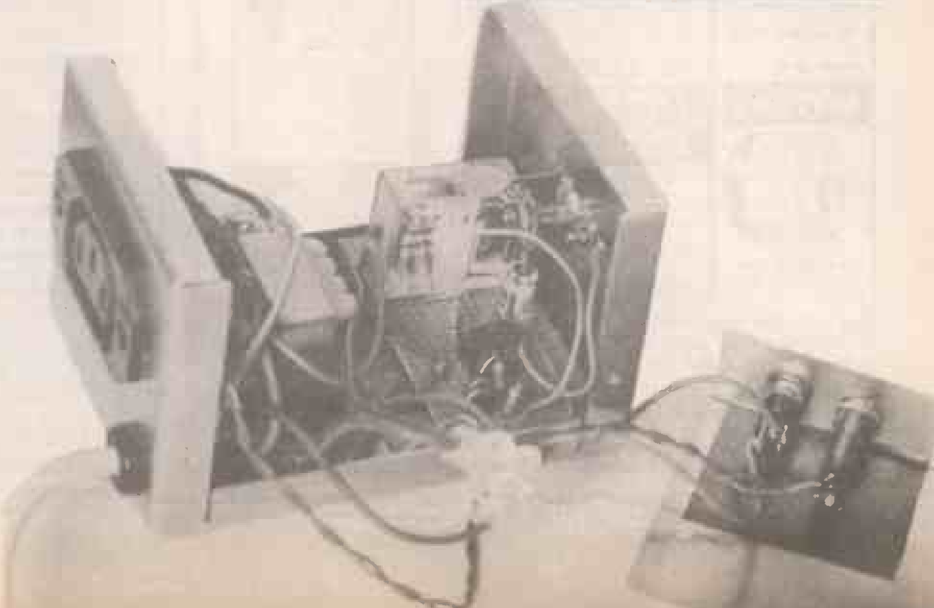
D1, D2, D3	1N4001 1A 50V rec. (3 off)
TR1	ZTX500 *pnp* silicon
IC1	ICP7555 CMOS

Miscellaneous

RLA	Miniature 12V 200ohm coil relay, with 2 pairs of normally open (or changeover) contacts rated at 250V 1A
T1	Min. mains transformer, 240V primary and 12V-0V-12V centre-tapped sec. (or two 12V secs.) rated at 100mA
S1	Mercury vibration switch
S2	Min. push-to-make switch, 240V 1A minimum
LP1	Min. mains neon indicator, inbuilt resistor for 240V a.c. operation
PL1/SK1	2.1mm "power-in" plug and matching chassis socket
PL2/SK2	Euro-type 3-pin mains chassis socket and matching line plug (Bulgin)

Stripboard, 0.1in matrix 13 strips × 24 holes; aluminium box, 102mm × 70mm × 64mm (main unit); plastic case 50mm × 37mm × 24mm (sensor); 20mm chassis fuseholder (FS1) with 1A fuse; 8-pin d.i.l. socket; spring clip (7mm dia.) for S1; strain relief bush; P-clip; two sections of 3A terminal block; self-adhesive plastic feet (4 off); solder tags (4 off); solder; connecting wire, etc.

Approx. cost guidance only **£12**




The sensor unit.

Make the sensor connections (polarity unimportant). Excessive heat should not be applied so soldering should be done quickly. Secure the switch in the clip and attach the lid. Solder the "power in" type connector to the other end of the sensor connecting wire and fit the blanket with the correct type of plug for SK2.

Attach the lid of the main unit checking carefully for trapped wires and short-circuits. Note that there are live mains connections inside the box so whenever the unit is plugged into the mains, the lid must be on.

Connect the sensor, plug in the blanket and connect the unit to the mains. Switch on the existing blanket switch and press S2. RLA/2 should click and the "Blanket On" indicator LP1 should light. Tap the sensor box — the relay should click and the neon indicator go off again. Check that the sensor plug and socket are secure since, if the wire is disconnected, the blanket will remain on once triggered.

If all is well, the box may be labelled and the Electric Blanket Shut-Down put into permanent service. The correct position for the sensor is found by trial and error. Remember, the specified mercury switch responds best to fairly rapid vibration. This is often found at the foot of the bed where less weight is applied to the spring. In cases of unreliable triggering, the alternative type of mercury switch could be used. ☐

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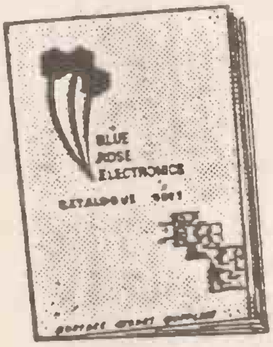


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DOWN TO EARTH

George Hylton

RESISTANCE CALCULATIONS

THE RANGE of resistance found in quite ordinary circuits is very wide (1 ohm to 10 megohms). This presents a problem. The experimenter wants to stock all the likely values, but finds that this calls for an enormous number of resistors. Taking only values in the E12 sequence (1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, ohms and their multiples) calls for 12 values per decade.

To cover the seven decades 1-10 and 1M-10M calls for 85 values. Even if you buy only the commonest type of resistor (1/4W, 5 per cent) and only 10 of each you need 850 resistors, and of course, you inevitably find that you sometimes need values or wattages not covered by your stock.

REDUCED RANGE

Taking a hint from manufacturers of potentiometers you might economise by taking only three values per decade: 10, 22, 47 . . . 100, 220, 470 . . . etc. You might even go further and buy only two: 10, 33 . . . 100, 330 etc.

Restricted though these ranges are they are good enough for many purposes. Personally, I regard the 10, 33 series as "preferred", and the 10, 22, 47 as "next choice", stocking these in large quantities but keeping small stocks of other E12 values. When other values are required they can often be obtained by series or parallel combinations of, at worst, E12 values.

How can you find the right combination? For series connections the arithmetic is very easy. If you require 30k, for example, you can use 10k + 10k + 10k.

This is rather wasteful, however, and in any case series strings often don't fit the space allocated on a circuit board. A parallel pair stacked one above the other is usually better.

It so happens that 33k and 330k in parallel give 30k exactly. There is a hidden advantage here. If you require precision, a dissimilar parallel combination may be cheaper.

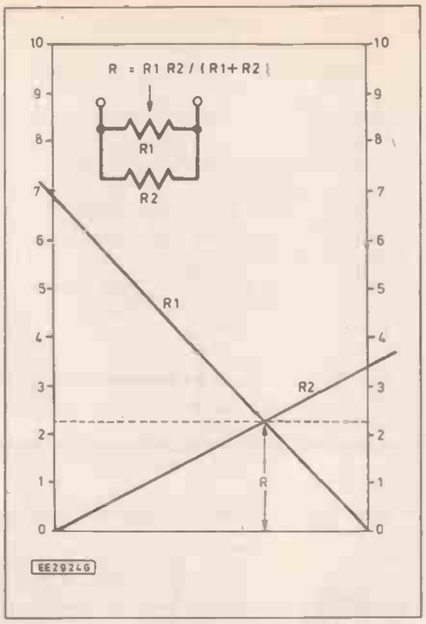


Fig.1. Parallel resistance calculator. The lines between 0 and R1, 0 and R2 intersect at a height which gives R.

In the present instance, since 330k has ten times the resistance of 33k its tolerance has only about one-tenth of the effect of the 33k's. Suppose the 33k to be of 1 per cent tolerance and 330k of 5 per cent. If both are at the extreme high limit of tolerance the combination gives 30.4k, which is only a shade over 1 per cent high.

QUICK CALCULATIONS

A simple graphical aid helps to indicate promising parallel combinations, see Fig. 1. The two vertical scales (R1, R2) are identical.

Use two lengths of thread fixed at the 0 points as the sloping lines. Hold the free ends to the appropriate points on the R1, R2 scales. The intersection height can be read off at either side and gives the parallel equivalent.

The method is not very accurate in practice but is a quick way of finding promising values. The exact resistance can then be found with a pocket calculator. If this has only ordinary arithmetical functions the best formula for the parallel equivalent *R* of the two resistances R1, R2 is:

R = R1R2/(R1 + R2).

OHM'S LAW

However, if your calculator has a memory and reciprocal (1/x) key, you can use Ohm's Law in its classical form:

1/R = 1/R1 + 1/R2 + . . .

Just take the reciprocal of R1, put it in the memory, take the reciprocal of R2, add what's in the memory and you have the reciprocal of the answer. To obtain the answer you take the reciprocal of this.

Example: 10 ohms and 100 ohms in parallel. 1/10 = 0.1, 1/100 = 0.01. Adding, 0.11. Reciprocal (1/0.11) = 9.09 ohms.

The reciprocal form of Ohm's Law can be used for any number of parallel resistances. This is useful in cases similar to that shown in Fig. 2. Here the a.c. input resistance is made up of three resistances in parallel: r_{in}, (the actual input resistance of transistor TR1), R1 and R2. (Resistors R1 and R2 are in parallel to a.c. signals because their far ends are connected together by the battery, which has no impedance to signals.)

Of these, r_{in} is imprecise but in this circuit is high because of resistor R4, so its "tolerance" has only a small effect. With the values shown, the input resistance is the reciprocal of 1/10000 + 1/22000 + 1/100000 = 6.4k.

ALTERNATIVE FORMULAE

But I digress. Suppose you know one resistance (R1) and you know what parallel value the parallel combination must give (R) how do you find the second value (R2)?

Like this:

1/R2 = 1/R − 1/R1.

Example: You have 22k (R1) and you need 9k(R). Then 1/R2 = 1/9 − 1/22. Inverting this gives 15.2k and the E12 value 15k is close. If you are stuck with our 10k, 22k, 47k series then 22k and 47k in parallel give 14.99k which is of course well within the usual tolerance range.

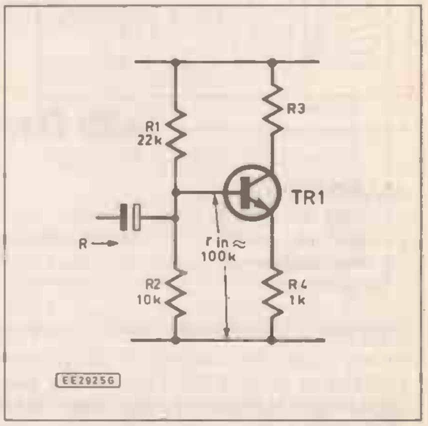


Fig.2. A calculator with a reciprocal function makes it easy to find the a.c. input resistance of this amplifier.

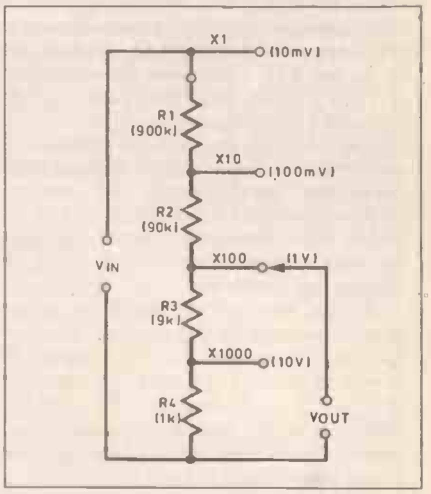


Fig.3. (a) Step attenuator for millivoltmeter, with resistance values for an impedance of one megohm.

UNUSUAL VALUES

If you need to make measuring equipment then you are likely to need unusual (or at any rate non − E12) values, of high precision. A common requirement (Fig. 3a) is for a voltage divider giving

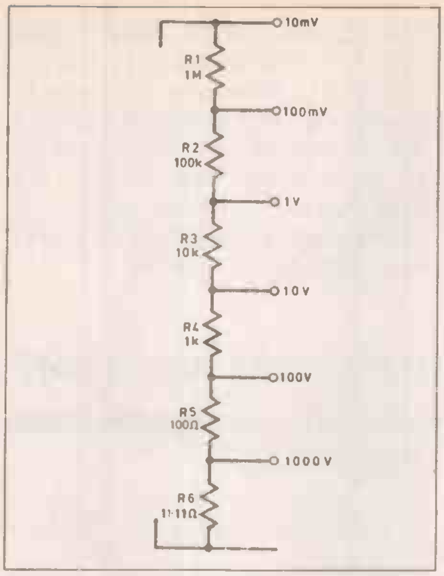


Fig.3.(b) right. Alternative arrangement enabling awkward multiples of nine to be avoided.

units, tenths, hundredths, etc. Such a divider may form the input attenuator of a f.e.t.-input voltmeter, enabling it to be set up for ranges of, say, 10mV to 10V as shown (or any multiple of these).

The conventional arrangement has the resistances indicated. They add up to 1000k (1M) which is a nice round figure for the input impedance of a measuring instrument. However, 900k, 90k, etc. are outside the E12 range. It is of course possible to find the right values, and with the right tolerance (1 per cent or better) at specialist suppliers. But there are other suppliers who stock only E12, though with a 1 per cent tolerance option.

The obvious answer is to make the 900k from two 1.8M in parallel, and so on. Fine, but possibly expensive. If each value is multiplied by 1.11 . . . the requirement becomes 1M, 100k, 10k, 1.11 . . k. True, the input resistance is now 1.11M, but who cares, so long as it's high? The only awkward value is 1.11 . . k. A bit of fiddling with my calculator shows that it is obtained exactly from 1.2k and 15k in parallel (both E12 values).

MORE STEPS

This kind of input attenuator can be extended to give more steps simply by continuing the pattern of values. Arrangement (Fig. 3b) shows how the range can be made to cover 10mV to 1000V. Note, however, that resistor R1 may now have nearly 1000V across it, and dissipate nearly 1W. (R6 can be made up from 12 ohms and 150 ohms.) The same values could be used for 1mV to 100V or the useful 3mV to 300V, which covers mains voltages while requiring resistor R1 to dissipate only 90mW.

SHOP TALK

with David Barrington

MARC Pone-In

There are one or two "special" components required for the *MARC Phone-In* that may be difficult to purchase from a local supplier.

The MV8870 Dual Tone Multi-Frequency (DTMF) decoder i.c. and the binary coded decimal switch (BCD) were purchased from **STC Electronic Services** of Harlow, Essex (☎ *0279 62677*). These can be ordered as codes 091320E and 027703D respectively.

The frequency of the quartz crystal is the same as that used in American colour NTSC receivers and should be available from various sources. However, todate we have only located two sources and these are STC Electronic Services, code 017977F, and **Maplin**, code UJ03D (Crystal 3·5794MHz).

The electret microphone should be generally available and is usually listed under the "microphone insert" sections of most component catalogues. The rest of the semiconductor devices appear to be stock lines and should not cause any purchasing problems.

If you have to purchase an answer phone machine for this project, remember to ask the sales person about the points raised in the article. The designer purchased a Panasonic KT-T1446BE machine, with a two digit personal code facility, from the Phone Centre, East Lancs (☎ 0706 874180).

The single-sided printed circuit board for the MARC Phone-In is available from the *EE PCB Service*, code EE721 (see page 138).

Vehicle Voltage Monitor

We do not expect readers to encounter any component buying problems when undertaking the *Vehicle Voltage Monitor* project. The use of tri-colour l.e.d.s in circuit designs is very popular at the moment and most of our advertisers are now carrying stocks.

The car dashboard switch blanking plate called for in this project should be readily available from motor spares stores or garage spares counters. Although it is not essential, it might be a good idea to use auto-connecting wire and connectors when installing the unit in a vehicle.

Gingernut 80m Amateur Band Receiver

All the surface mount devices (SMDs) called for in the *Gingernut 80m Amateur Band Receiver* are available from **Blue Rose Electronics.** This company tends to specialise in surface mount components and stock an assembly jig, miniature Kynar connecting wire and soldering irons suitable for SMD work.

The ferrite rod, Jackson C804A air-spaced tuning capacitor and miniature 10:1 dial ball drive coupling are currently listed by **Maplin** and **Cirkit**. The tuning capacitor should be available generally but the price seems to vary quite considerably, from about £7 up to £9.

A complete kit of parts for all "on-board" components, including double-sided printed circuit boards, for the three modules are available from **Blue Rose Electronics, Dept EE, 538 Liverpool Road, Great Sankey, Warrington, Cheshire, WA5 3LU.** (☎ *0925 72 7848*). Post and packing is Free on orders over £5 but add 60p for orders of less value.

The r.f. kit cost £12.95 and the Voltage Regulator kit cost £4.75. The little Audio Amplifier kit is sold as a "Surface Mount Starter Kit" and cost £6.95.

The three double-sided (for screening and r.f. stability) printed circuit boards are obtainable from the *EE PCB Service*, codes EE726, EE727 and EE728 (see page 138).

Bench Amplifier/Signal Tracer

Looking through the components list for the *Bench Amplifier/Signal Tracer*, this months *Teach-In '91* project, we cannot forsee any component buying problems. The choice of case is left to the individual, however if you wish to use the one in our prototype it is an RS type and was purchased through Electromail (☎ 0536 204555) code 503-622, their mail order arm for the sum of £18.67!

The TBA820M 2W Power Amplifier chip should be available from most component advertisers and is certainly listed by **Maplin**. When ordering the potentiometers do not forget to quote both the "lin" and "log" types.

The 0.1in. pitch p.c.b. headers are now fairly common items and should be available "over the counter". The printed circuit board for the Bench Amplifier is available through the *EE PCB Service*, code EE725 (see page 138).

For those wishing to build up the two Teach In '91 – *Design Your own Circuits* – demonstration amplifiers, the printed circuit boards are obtainable from the *EE PCB Service*. Quote codes EE723 for the TBA820M Amplifier and EE724 for the High Quality Power Amplifier.

Electric Blanket Shutdown

It is most important that the circuit board and mains transformer used in the *Electric Blanket Shutdown* are housed in an "Earthed" *metal* case, on no account use a non-earthed supply. Because there are mains voltages on the circuit board it is vital that all copper track breaks are double-checked and whenever working on the board it must be disconnected from the supply.

The mercury vibration switch may prove a little difficult to locate locally. The one used in our model was purchased from **Maplin** and is listed as order code UK57M (Vibration Switch). The "switch" contacts are always open (off) when stationary, but when vibrated or tilted it triggers the circuit. Note that the case of the mercury switch forms one of the contacts, hence the use of the spring/Terry clip.

The Bulgin Euro 3-pin mains chassis socket and line plug are now stocked by most good component suppliers. There should be plenty of suitable relays on the market and should not cause any local sourcing problems provided they are of similar ratings; contacts rated at 1A 250V or better.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full details are given on the last book page.

For another selection of books see next month's issue.

MORE BOOKS NEXT MONTH — MORE BOOKS NEXT MONTH

PROJECT CONSTRUCTION

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING

R. A. Penfold

We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

96 pages Order code BP110 £2.50

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s

R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

80 pages Order code BP121 £2.50

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS

R. A. Penfold

Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.

112 pages **Order code No. 227** £1.95

ELECTRONIC SCIENCE PROJECTS

O. Bishop

These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.

144 pages Order code BP104 £2.95

ELECTRONIC PROJECTS — BOOK 1

Published by *Everyday Electronics* in association with Magenta Electronics.

Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

128 pages (A4 size) Order code EP1 £2.45

A BEGINNERS GUIDE TO MODERN ELECTRONIC COMPONENTS

NEW

R. A. Penfold

The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between different components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.

166 pages Order code BP285 £3.95

CIRCUITS & DESIGN

PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 1
PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 2

R. A. Penfold

These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.

BOOK 1 contains: Oscillators—sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers—simple monostable circuits using i.c.s, the 555 and 7555 devices, etc. Miscellaneous—noise generators, rectifiers, comparators and triggers, etc.

BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—I.c. power amplifiers, mixers, voltage and current regulators, etc.

BOOK 1 *128 pages* **Order code BP117 £1.95**
BOOK 2 *112 pages* **Order code BP118 £1.95**

ELECTRONIC ALARM CIRCUITS MANUAL

R. M. Marston

One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.

Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.

124 pages Order code NE11 £10.95

DESIGNING DC POWER SUPPLIES

G. C. Loveday C.Eng MIERE

Covers all aspects of the design of regulated power units, using discretes, i.c. regulators and switched units. It also covers protection circuits and reference supplies. Many design examples and exercises all with fully worked solutions are given.

131 pages Order code BM2 £6.95

ELECTRONIC POWER SUPPLY HANDBOOK

Ian R. Sinclair

This book covers the often neglected topic of electronic power supplies. All types of supplies that are used for electronics purposes are covered in detail, starting with cells and batteries and extending by way of rectified supplies and linear stabilisers to modern switch-mode systems, IC switch-mode regulators, DC-DC converters and inverters.

The devices, their operating principles and typical circuits are all dealt with in detail. The action of rectifiers and the reservoir capacitor is emphasised, and the subject of stabilisation is covered. The book includes some useful formulae for assessing the likely hum level of a conventional rectifier reservoir supply.

136 pages Order code PC108 £7.95

MODERN OPTO DEVICE PROJECTS

R.A. Penfold

In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these devices have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.

While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.

104 pages Order code BP194 £2.95

DIGITAL LOGIC GATES AND FLIP-FLOPS

Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning. This is not a constructor's book in the sense of presenting circuits to build and use, it is for the user who wants to design and troubleshoot digital circuitry with considerably more understanding of principles.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages Order code PC106 £8.95

HOW TO USE OP-AMPS

E. A. Parr

This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages **Order code BP88 £2.95**

MICRO INTERFACING CIRCUITS–BOOK 1
MICRO INTERFACING CIRCUITS–BOOK 2

R. A. Penfold

Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.

Book 1 is mainly concerned with getting signals in and out of the computer;. Book 2 deals primarily with circuits for practical applications.

Book 1 *112 pages* Order code BP130 £2.25
Book 2 *112 pages* Order code BP131 £2.75

SENSORS AND TRANSDUCERS

Keith Brindley

There are a considerable number of transducers. Look through any electronic components catalogue and you'll find a wide variety of types, and each type has many versions. It's not easy to choose a transducer correctly for a particular function. In many specifications, terms and procedures are referred to which might deter you from using one that is, in fact, the best for the job. Yet, opting to use a transducer merely because it is easier to interface into the measuring system is not the answer. A greater knowledge of all types of transducers capable of doing the task is the ideal, and only then can a totally satisfactory decision be made to use one in particular.

176 pages Order code NE17 £12.95

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS

Robert Penfold

Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.

The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.

92 pages Order code BP179 £2.95

50 SIMPLE LED CIRCUITS

R. N. Soar

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components—the light-emitting diode (LED). Also includes circuits for the 707 common anode display

64 pages **Order Code BP42 £1.95**
BOOK 2 50 more l.e.d. circuits Order code BP87 £1.95

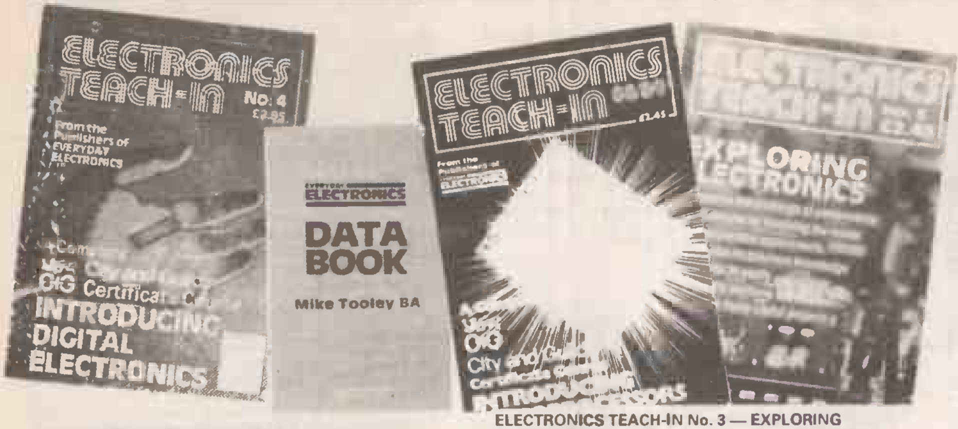
ELECTRONICS SIMPLIFIED —CRYSTAL SET CONSTRUCTION

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.

80 pages **Order Code BP92 £1.75**

TEACH-IN, THEORY, AND REFERENCE



ELECTRONICS TEACH-IN No.4 INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics)*

Michael J. Cockcroft

Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

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

112 pages (A4 size) **Order code TI4** **£2.95**

ELECTRONIC MODULES AND SYSTEMS FOR BEGINNERS

NEW

Owen Bishop

This book describes over 60 modular electronic circuits – how they work, how to build them, and how to use them. The modules may be wired together to make hundreds of different electronic systems, both analogue and digital. To show the reader how to begin building systems from modules, a selection of over 25 electronic systems are described in detail, covering such widely differing applications as timing, home security, measurement, audio (including a simple radio receiver), games and remote control.

200 pages **Order code BP266** **£3.95**

FROM ATOMS TO AMPERES

F. A. Wilson

Explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever.

Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?

Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.

244 pages **Order code BP254** **£3.50**

ELECTRONICS TEACH-IN No. 3 — EXPLORING ELECTRONICS (published by *Everyday Electronics)*

Owen Bishop

Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.

88 pages (A4 size) **Order code TI3** **£2.45**

ELECTRONICS TEACH-IN 88/89— INTRODUCING MICROPROCESSORS

Mike Tooley BA (published by *Everyday Electronics)*

A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject.

80 pages (A4 size) **Order code TI-88/89** **£2.45**

NEWNES ELECTRONICS POCKET BOOK

E. A. Parr

Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op.amp. applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.

315 pages (hard cover) **Order Code NE02** **£9.95**

ELECTRONICS – A "MADE SIMPLE" BOOK

G. H. Olsen

This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.

330 pages **Order code NE10** **£4.95**

EVERYDAY ELECTRONICS DATA BOOK

Mike Tooley BA

(published by EE in association with PC Publishing)

This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!

256 pages **Order code DATA** **£8.95**

ELECTRONIC HOBBYISTS HANDBOOK

R.A. Penfold

Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.

88 pages **Order code BP233** **£4.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST

G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.

The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics.

128 pages **Order Code 228** **£2.50**

PRACTICAL DIGITAL ELECTRONICS HANDBOOK

Mike Tooley (Published in association with *Everyday Electronics*)

The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.

208 pages **Order code PC100** **£6.95**

COMPUTING

NEWNES COMPUTER ENGINEER'S POCKETBOOK (Second Edition)

Michael Tooley

An invaluable compendium of facts, figures, circuits and data, indispensable to the designer, student, service engineer and all those interested in computer and microcomputer systems. It will appeal equally to the hardware or software specialist and to the new band of "software engineers". This first edition covers a vast range of subjects at a practical level, with the necessary explanatory text. The data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit.

205 pages (hard cover) **Order code NE01** **£9.95**

AN INTRODUCTION TO Z80 MACHINE CODE

R. A. & J. W. Penfold

Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The Z80 is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128.

144 pages **Order code BP152** **£2.75**

A Z80 WORKSHOP MANUAL

E. A. Parr, B.Sc., C.Eng., M.I.E.E.

This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.

192 pages **Order Code BP112** **£3.50**

COMPUTERS AND MUSIC — AN INTRODUCTION

R.A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone. Computer-based music systems in the past have tended to be either horrendously expensive, very crude, or both! These days, prices are much more modest and the potential of the equipment is much greater. Consequently a lot of musicians are being tempted into the unfamiliar territory of computer music systems.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.

174 pages **Order code PC107** **£7.95**

GETTING THE MOST FROM YOUR PRINTER

J. W. Penfold

Details how to use all the features provided on most dot-matrix printers from programs and popular word processor packages like Wordwise, Visawrite and Quill, etc. Shows exactly what must be typed in to achieve a given effect.

96 pages **Order Code BP181** **£2.95**

A CONCISE INTRODUCTION TO MS-DOS

N. Kantaris

This guide is writen with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.

The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.

64 pages **Order code BP232** **£2.95**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE

R. A. & J. W. Penfold

Obtain a vast increase in running speed by writing programs for 68000 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.

112 pages **Order code BP184** **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM

M. James, B.Sc., M.B.C.S.

It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.

144 pages **Order code BP119** **£2.50**

AUDIO & MUSIC

BEGINNER'S GUIDE TO HI-FI
Ian Sinclair
The *Beginner's Guide to Hi-Fi* will appeal to the audio enthusiast, whether newly won over by advances in technology or well established and wondering whether to update equipment. The book deals with the sound from its sources in the studio to its ultimate end in your ears, and shows what sound is, how it is recorded and how it is reproduced.
Every aspect of Hi-Fi, from pickup cartridges to loudspeakers, has been covered, and the emphasis has been on explaining design aims. Cassette systems have been given considerable prominence, including the more modern Dolby C and dbx noise reduction systems. The CD record has been covered in detail so that you can find out just why this system of sound reproduction is so superior.
194 pages Temporarily out of print.

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel
This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.
148 pages **Order Code BP256** **£2.95**

MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold
The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.
A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.
90 pages **Order code BP246** **£5.95**

PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
128 pages **Order code PC101** **£6.95**

COMPUTERS AND MUSIC
— see computer section

DATA & COMPONENT IDENTIFICATION

HOW TO IDENTIFY UNMARKED ICs
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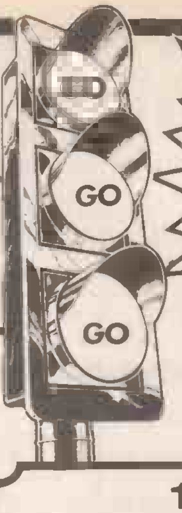

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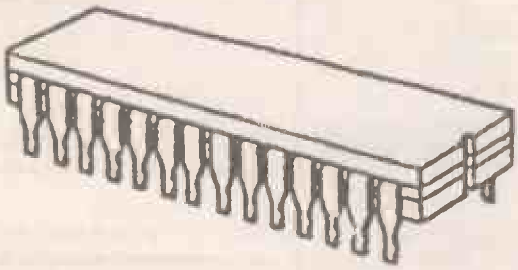


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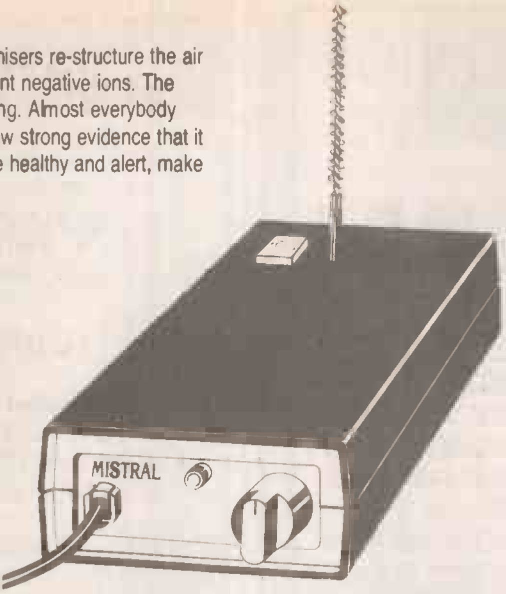

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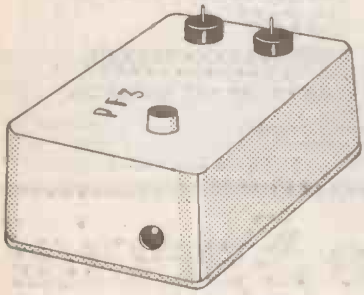

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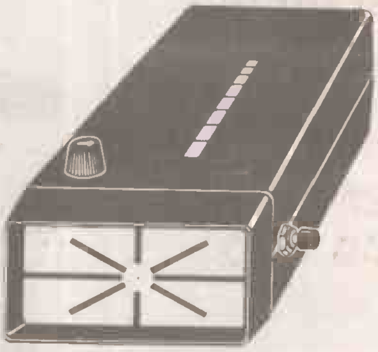

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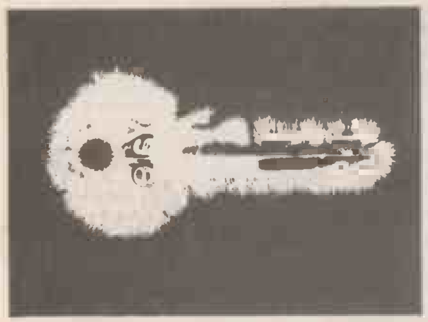
* Triffids

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

* The Electric Handshake

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



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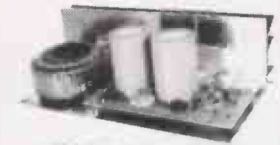

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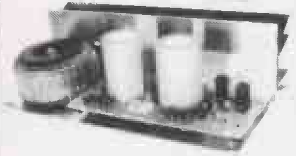

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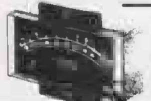

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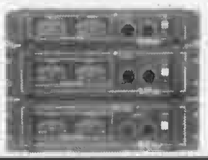

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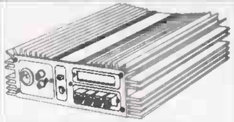


TWO SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

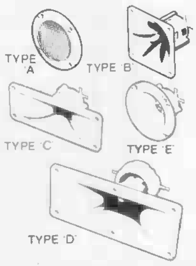
150 WATTS (75+75) INTO 4 OHMS
300 WATTS (150+150) INTO 4 OHMS
FEATURES:—
★ HIGH & LOW INPUT IMPEDANCES
★ HIGH & LOW INPUT SENSITIVITIES
★ VARIABLE INPUT GAIN CONTROL
★ SHORT CIRCUIT OUTPUT PROTECTION
★ POWER REQUIREMENT 12V. D.C.

PRICES: 150 WATT £43.00
300 WATT £95.00 + £3.00 P&P EACH

PIEZO ELECTRIC TWEETERS-MOTOROLA

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 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each +** 50p **P&P.**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each +** 50p P&P.
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STEREO DISCO MIXER with 2 × 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:—
3 Turntables (Mag). 3 Mics. 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360×280×90mm. Supply 220-240v.

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