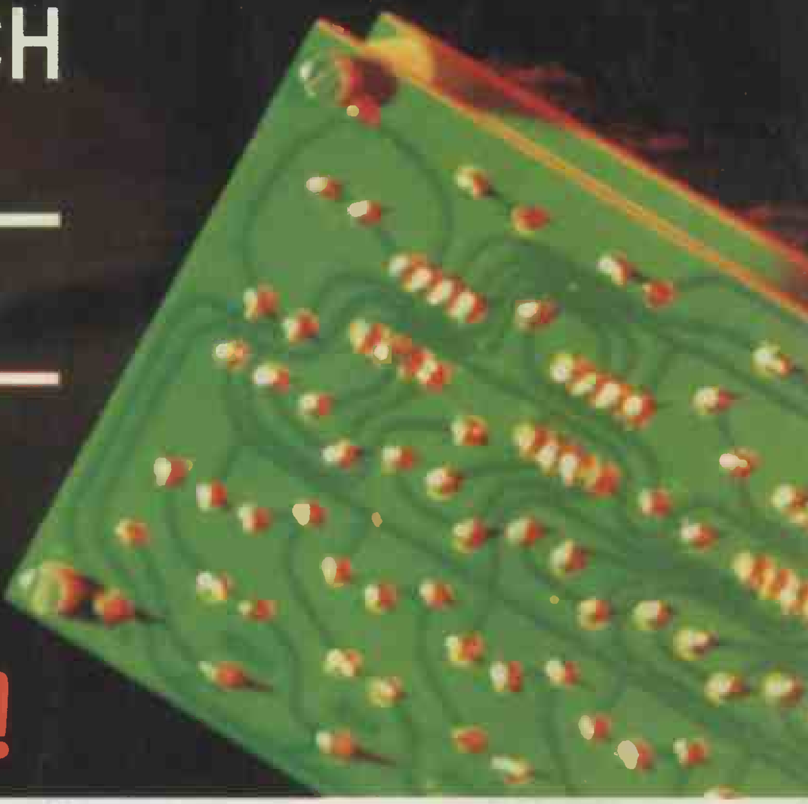
EVERYDAY ELECTRONICS

MAY 1990

INCORPORATING ELECTRONICS MONTHLY £1.40



AMSTRAD SPEECH SYNTHESISER

QUIZMASTER

ELECTRONIC BAROMETER

FREE INSIDE!

SPECIAL AMATEUR RADIO SUPPLEMENT

SHORT WAVE RECEIVER

DIY AERIALS

ISSN 0262-3617

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The Magazine for Electronic & Computer Projects

ONE POUND PACKS

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

BD2	5	13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD9	2	6V 1A mains transformers upright mounting with fixing clamps.
BD11	1	6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
BD13	12	30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
BD22	2	25 watt loudspeaker two unit crossovers.
BD30	2	Nicad constant current chargers adapt to charge almost any nicad battery.
BD32	2	Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42	5	13A rocker switch three tags so on/off, or change over with centre off.
BD45	1	24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
BD49	5	Neon valves, with series resistor, these make good night lights.
BD56	1	Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD67	1	Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A	1	6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120	2	Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD128	10	Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132	2	Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134	10	Motors for model aeroplanes, spin to start so needs no switch.
BD139	6	Microphone inserts—magnetic 400 ohm also act as speakers.
BD148	4	Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149	6	Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
BD180	6	Neon indicators in panel mounting holders with lens.
BD193	6	5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD199	1	Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201	8	Keyboard switches—made for computers but have many other applications.
BD211	1	Electric clock, mains operated, put this in a box and you need never be late.
BD221	5	12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242	2	6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
BD252	1	Panostat, controls output of boiling ring from simmer up boil.
BD259	50	Leads with push-on ¼in tags—a must for hook-ups—mains connections etc.
BD263	2	Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268	1	Mini 1 watt amp for record player. Will also change speed of record player motor.
BD283	3	Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
BD305	1	Tubular dynamic mic with optional table rest.
BD400	4	Books, useful for beginners, describes amplifiers equipment and kit sets.
BD653	2	Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.
BD548	2	3.5V relays each with 2 pairs changeover contacts.
BD667	2	4.7 μf non-polarised block capacitors, pcb mounting.

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

TOASTERS 2 slice toasters — may need slight attention. Only £3.00 each. Ref 3P84.

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

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

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

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

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

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

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

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder – a complete mains operated kit, case included. £12.50. Our ref 12P5/1.

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

REAL POWER CAR SPEAKERS. Stereo pair output 100W each. 4-Ohm impedance and consisting of 6½" woofer, 2" mid range and 1" tweeter. Each set in a compact purpose built shelf mounting unit. Ideal to work with the amplifier described above. Price per pair £30.00. Order ref: 30P7.

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

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

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

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

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

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

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

BUSH RADIO MIDI SPEAKERS Stereo pair. BASS reflex system, using a full range 4in driver of 4ohms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8½in wide, 14in high and 3½in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair. Our ref 5P141.

3½in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £59.50, reference 60P2. Both are brand new.

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

REMOTE CONTROL FOR YOUR COMPUTER With this outfit you can be as much as 20 feet away as you will have a joystick that can transmit and a receiver to plug into and operate your computer and TV. This is also just right if you want to use it with a big screen TV. The joystick has two fire buttons and is of a really superior quality, with four suction cups for additional control and one handed play. Price £15 for the radio controlled pair. Our ref 15P27.

ASTEC PSU. Mains operated switch mode, so very compact. Outputs + 12v 2.5A, +5v 6A, ±5v .5A, ±12v 5A. Size: 7½in long x 4¾in wide x 2¼in high. Cased ready for use. Brand new. Normal price £30+, our price only £13.00. Order ref 13P2.

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

PHILIPS LASER
This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £35. Our ref. 35P1.
Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. As above for 12V battery. Also £15. Our ref 15P22.

PANEL METERS 270 deg movement. New. £3.00 each. Our ref 3P89.

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

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

GEIGER COUNTER KIT Includes PCB, tube, loudspeaker, and all components to build a 9v battery operated geiger counter. Only £39. Our ref 29P1.

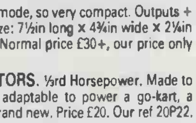
12V TO 220V INVERTER KIT This kit will convert 12v DC to 220v AC It will supply up to 130 watts by using a larger transformer. As supplied it will handle about 15 watts. Price is £12. Our ref 12P17.

FULL RANGE OF COMPONENTS at very keen prices are available from our associate company SCS COMPONENTS. You may already have their catalogue, if not request one and we will send it FOC with your goods.

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

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

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



J & N BULL ELECTRICAL
Dept. EE 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT.

MAIL ORDER TERMS: Cash, PO or cheque with order. Monthly account orders accepted from schools and public companies. Please add £2.50 postage to orders. Access and B/Card orders accepted – minimum £5. Phone (0273) 734648 or 203500. Fax No. (0273) 23077.

POPULAR ITEMS — MANY NEW THIS MONTH

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

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

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

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

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

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

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

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

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

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

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140v 100watt pair made by Hitachi. Ref 2SK413 and its complement 2SJ118. Only £4.00 a pair. Our Ref. 4P42.
Also available in H pack Ref 2SJ99 and 2SK343 £4.00 a pair. Ref. 4P51.

TIME AND TEMPERATURE LCD MODULE A 12 hour clock a Celsius and Fahrenheit thermometer a too hot alarm and a too cold alarm. Approx 50×20mm with 12.7mm digits. Requires 1AA battery and a few switches. Comes with full data and diagram. Price £6.00. Our ref. 6P12.

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

A REAL AIR MOVER Circular axial fan moves 205 cubic foot per min which is about twice as much as our standard 4½" fans. Low noise mains operated 6½" dia, brand new. Regular price over £30.00. Our price only £10.00. Our ref 10P71.

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

EX-EQUIPMENT SWITCHED MODE POWER SUPPLIES Various makes and specs but generally +–5, +–12v ideal bench supply. Only £8.00. Our ref. 8P36.

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

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

NEW PIR SENSORS Infra red movement sensors will switch up to 500w mains, UK made, 12 month manufacturers warranty, 15-20m range with a 0-10min timer, adjustable wall bracket. Only £20.00. Ref. 20P24.

MITSUBISHI 3½" DISC DRIVES Brand new drives, ½ height double sided, double density warranted. Our price £60.00. Ref. 60P5.

NON-MEMORY PUSHBUTTON TELEPHONES. Same condition as 10 Memory with redial £3.00. Our ref. 3P79. BT approved.

SPECTRUM PRINTER INTERFACE Add a centronics interface to your Spectrum complete with printer cable for only £4.00. Our ref. 4P52.

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

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

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

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

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

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

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

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

MAINS SOLDERING IRON Price £3.00. Our ref. 3P65.

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

MAINS SOLDERING IRON Price £3.00. Our ref. 3P65.

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

PIR SENSORS Suitable for alarm systems etc. Nicely boxed. Priced at only £10.00. Our ref. 10P79.

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

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

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

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

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

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

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

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

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

VOL 19 No 5 MAY 1990

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ABC

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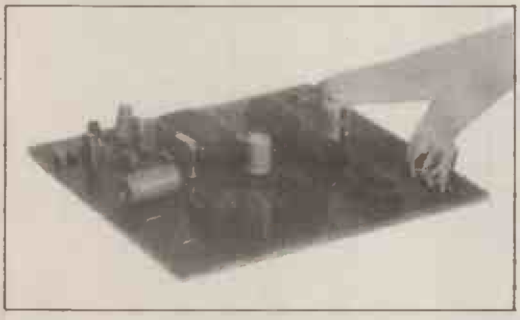
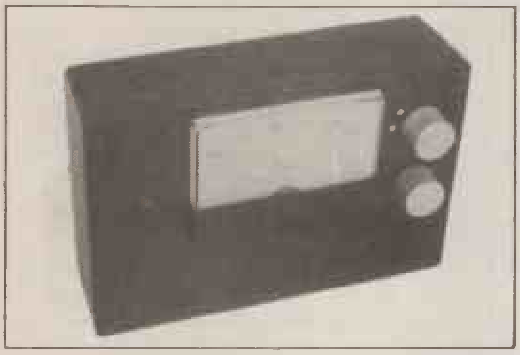
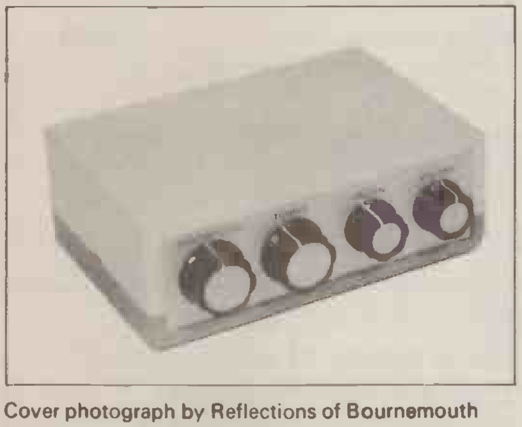
PROJECTS . . . THEORY . . . NEWS . . . COMMENT . . . POPULAR FEATURES . . .







Cover photograph by Reflections of Bournemouth

Projects

Series

Features

Our June '90 Issue will be published on Friday, 4 May 1990. See page 295 for details.

RESISTORS

Carbon Film 0.25W E12 or E24 series 1p each (min quantity 10 per value), 80p per 100, £6.00 per 1000.

**** Special Offer ****
Mixed Pack, of 1000 Carbon Film resistors, 1R to 10M, 100 different values all separately packed and labeled only **£5.90**

Metal Film 0.25/0.5 W E96 series 10R to 1M0 4p each (min quantity 10 per value), £3.00 per 100.

Ceramic/wirewound
4W 0R1-10K 35p each
7W 0R33-12K 37p each
11W 0R68-10K 40p each
17W 1R-10K 44p each
5% discount on 10+, 10% on 25+, 20% on 100+

Skeleton Pre-Sets
E3 series 100R-1M 20% Horizontal or vertical 18p each. 5% discount on 10+, 10% on 25+, 20% on 100+

Enclosed Pre-Sets
100R-10M 20% Horizontal or Vertical 24p each. 5% discount on 10+, 10% on 25+, 20% on 100+

20 Turn 3/4" Cermet Pots
10% tolerance 10R-2M 90p each, 5% discount on 10+, 10% on 25+, 20% on 100+

TRANSISTORS

BC107B	20p
BC108B	20p
BC109C	22p
BC184C	6p
BC212B	6p
BC239C	4p
BC307C	4p
BC548C	4p
BC558C	4p
ZTX300	17p

The above are a few examples from the 1000's of transistor types we have. We cover all ranges and types including JFET, SIPMOS, TMOS, TIP plastic & metal, FET & Darlingtons.

REGULATORS

7805	5V @ 1.5A	30p
7812	12V @ 1.5A	30p
7815	15V @ 1.5A	30p
7905	-5V @ 1.5A	30p
7912	-12V @ 1.5A	30p
7915	-15V @ 1.5A	30p

CAPACITORS

Radial Aluminium Electrolytic 20% tolerance

10/16/25/35 Volt	
4.7,10,22,33,47,100	12p
220,330,470	20p
1000	30p
2200	48p
3300	65p
4700	85p
50/63/ Volt	
0.47,1,2.2,3.3,4.7,10	12p
22,33,47	20p
100,220	30p
470	50p
1000	90p
100 Volt	
0.47,1,2.2,4.7	12p
10,22	20p
47	30p
100	50p

Ultra miniature Aluminum electrolytic radial 20% tolerance

4 V	
220	18p
6.3 Volt	
22,100	18p
16 Volt	
10,22,47	18p
25 Volt	
10,22,33	18p
35 Volt	
4.7,10,22	18p
50 Volt	
0.1,0.22,0.33,0.47, 1,2.2,3.3,4.7,10	18p

CAPACITORS

Disc Ceramic 5% tolerance 150Volt values in pF

15,22,33,47,68,	4p
100,150, 220,330,470	6p

10% tolerance value in pF

220,330,470,680,	6p
1000,1500,2200 3300,4700,6800	8p

+80%-20% tol. value pF

4700,10000	6p
22000,47000	9p

Tant. Bead resin dipped 20% tolerance value in uF

6.3 Volt	
10,22	15p
47	25p
10 Volt	
3.3,4.7,6.8	15p
10,15	25p
22,33,47	35p
16 Volt	
2.2,3.3,4.7,6.8	15p
10,15	25p
22,33	35p
25 Volt	
1,2.2,3.3	15p
4.7,6.8	25p
10,15	35p
35 Volt	
0.1,0.22,0.33,0.47	15p
0.68,1,2.2,3.3	20p
4.7,6.8,10	30p

CMOS

4000	17p	4106	34p
4001	17p	4160	40p
4002	17p	4161	40p
4006	37p	4162	40p
4007	17p	4163	40p
4008	37p	4174	37p
4011	17p	4175	40p
4012	17p	4194	42p
4013	25p	4501	27p
4014	37p	4502	40p
4015	37p	4503	37p
4016	28p	4504	120p
4017	37p	4506	76p
4018	37p	4508	99p
4020	37p	4510	37p
4021	37p	4511	37p
4022	37p	4512	37p
4023	17p	4513	99p
4024	35p	4514	85p
4025	17p	4515	80p
4027	34p	4516	37p
4028	37p	4517	99p
4029	37p	4518	37p
4032	56p	4519	26p
4034	95p	4520	37p
4035	44p	4521	85p
4038	65p	4522	44p
4040	37p	4526	44p
4042	37p	4527	44p
4043	37p	4528	44p
4044	37p	4529	50p
4046	47p	4530	99p
4049	27p	4531	44p
4050	27p	4532	60p
4051	37p	4534	240p
4052	37p	4536	120p
4053	37p	4538	54p
4060	37p	4539	45p
4066	29p	4541	50p
4067	99p	4543	54p
4068	17p	4544	130p
4069	17p	4547	130p
4070	17p	4549	400p
4071	17p	4551	85p
4072	17p	4553	120p
4073	17p	4554	320p
4075	17p	4555	50p
4076	37p	4556	50p
4077	17p	4557	120p
4078	17p	4558	120p
4081	17p	4559	440p
4082	17p	4560	110p
4093	27p	call sales for 4500 series above 4560	
4094	48p		
4097	99p		
4099	46p		

DIODES

1N914	5p
1N4148	4p
1N4001	3p
1N4002/3/4/5/6	4p
1N5401	7p
1N5402/4/6/8	11p

Zener Diodes
500 mW
2.4,2.7,3.3,3.3,3.9,4.7,5.1,5.6,6.2 6.8,8.2,10,11,12,13,15,16,18 20,22,24,27,30,33,39,43,62,68 75,82,91
All above voltages at 5p each

1.3 W
3.3,3.9,4.3,4.7,5.1,5.6,6.2,6.8 7.5,8.2,9.1,10,11,12,13,15,16 18,20,22,24,27,30,33,36,39,43 47,51,56,62,68,75,82,91
All above voltages at 16p each

2.5W,20W & 75W versions available

Bridges

W005		23p
W02		25p
W04		30p
W06/08		35p
2A	200V	65p
2A	400V	72p
2A	600V	90p
6A	200V	78p
6A	400V	84p
6A	600V	99p.

Linear I.C.s
call for price

KITS KITS KITS

ALL KITS ARE SUPPLIED WITH MAINS TRANSFORMER, HIGH QUALITY GLASS FIBRE SILK SCREENED PCB, FULL INSTRUCTIONS, HEATSINK, SOLDER ETC. CASE NOT SUPPLIED BUT AVAILABLE

CONSTANT CURRENT NI-CAD CHARGER Charge your Ni-Cads safely, can be left on indefinitely without damage, batteries fully charged from flat in approx. 18 hours. Charge up to 12 batteries in series (except PP3). **£7.50**

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MAINS APPLIANCE REMOTE CONTROL

The dream of controlling any appliance from your armchair comes much closer with our Mains Appliance Remote Control. It employs an infra-red remote control and the standard house mains wiring to switch most mains appliances or to adjust a digital room thermostat. Its uses are limited by your imagination and ingenuity!

DIRECT CONVERSION RECEIVER

Designed for the 80 metre amateur band this set has a performance that is not far short of a full superhet circuit. The receiver and the chosen frequency band provide an excellent introduction to amateur radio for those with some constructional experience.

MINI BRIDGE AMPLIFIER

This simple audio power amplifier is a general purpose type which could be used in a number of applications. Its design was prompted by a reader's request for a small but reasonably powerful amplifier suitable for use with video equipment. The unit should be equally suitable for operation with a guitar pick-up or as a general purpose test amplifier. It is powered by four HP7 size batteries.

CHOOSING AND USING TEST EQUIPMENT

This is the first part of a short series of self contained articles looking at the various items of test gear available, giving consideration to how useful they are, how to use them and what to look for when buying them.

Unless you own all the test gear you could ever need these articles are for you.

EVERYDAY ELECTRONICS

JUNE ISSUE ON SALE FRIDAY MAY 4 1990

TRANSISTORS

AAY32	9p
AC107	40p
AC125	25p
AC126	25p
AC127	21p
AC128	21p
AC128K	26p
AC141K	30p
AC142K	30p
AC176	22p
AC176K	28p
AC187	21p
AC187K	28p
AC188	21p
ACY18	48p
ACY19	48p
AD149	60p
AF124	50p
AF125	50p
AF126	50p
AF127	50p
AF139	30p
AF239	30p
AF379	45p
BA145	10p
BA148	10p
BA154	6p
BA157	12p
BB105B	18p
BB205B	24p
BC107	8p
BC108	8p
BC109	8p
BC109C	10p
BC115	10p
BC118	11p
BC140	20p
BC141	20p
BC142	20p
BC143	20p
BC147	8p
BC148	8p
BC149	8p
BC157	8p
BC159	8p
BC160	30p
BC171	10p
BC172	10p
BC177	14p
BC178	14p
BC179	14p
BC182	7p
BC182L	7p
BC183	7p
BC183L	7p
BC184	7p
BC184L	7p
BC212	7p
BC212L	7p
BC213	7p
BC213L	7p
BC214	7p
BC214L	7p
BC237	7p
BC238	7p
BC239	7p
BC300	20p
BC301	20p
BC302	20p
BC303	20p
BC304	25p
BC308	10p
BC327	7p
BC328	7p
BC337	7p
BC338	7p
BC441	28p
BC446	8p
BC449	15p
BC461	28p
BC477	18p
BC478	18p
BC479	18p
BC489	20p
BC490	18p
BC516	22p
BC528	22p
BC537	25p
BC546	8p
BC547	8p
BC548	8p
BC549	8p
BC550	8p
BC556	8p
BC557	7p
BC558	8p
BC559	8p
BC560	8p
BC637	20p
BC638	20p
BC639	20p
BC640	20p
BCY32	200p
BCY33	200p
BCY34	200p
BCY70	16p
BCY71	16p
BCY72	16p
BD115	30p
BD124P	50p
BD124	110p
BD131	25p
BD132	25p
BD133	50p
BD135	20p
BD136	20p
BD137	20p
BD138	20p
BD139	20p
BD140	20p
BD142	45p
BD150	30p
BD157	38p
BD158	38p
BD166	30p
BD175	30p
BD177	30p
BD179	32p
BD181	45p
BD182	60p
BD184	60p
BD187	30p
BD201	33p
BD202	38p
BD203	42p
BD204	42p
BD222	31p
BD225	31p
BD232	31p
BD233	32p
BD234	32p
BD235	28p

BD236	30p
BD237	21p
BD238	24p
BD239	30p
BD240	40p
BD241A	40p
BD243A	40p
BD244	50p
BD245	50p
BD246A	50p
BD265	45p
BD267	45p
BD269	45p
BD278	50p
BD311	100p
BD312	100p
BD313	100p
BD314	100p
BD315	150p
BD316	150p
BD317	150p
BD318	150p
BD331	40p
BD332	40p
BD361	60p
BD362	60p
BD370	30p
BD371	30p
BD410	50p
BD433	28p
BD434	30p
BD435	31p
BD436	30p
BD437	28p
BD438	36p
BD439	40p
BD440	40p
BD441	40p
BD442	40p
BD520	60p
BD533	50p
BD534	38p
BD535	38p
BD536	38p
BD537	40p
BD538	40p
BD643	50p
BD645	50p
BD647	50p
BD649	50p
BD651	50p
BD675	40p
BD676	40p
BD677	38p
BD678	40p
BD680	40p
BD679	40p
BD681	45p
BD682	45p
BD705	50p
BD707	50p
BD709	50p
BD711	50p
BD736	50p
BD826	50p
BD828	50p
BD875	50p
BD897	50p
BD899	50p
BD901	50p
BD977	50p
BDX32	100p
BDX33	60p
BDX53	60p
BDX65	80p
BDW23	55p
BDW24	55p
BDW93	50p
BDW94	50p
BDY20	100p
BDY92	100p
BF137	35p
BF154	25p
BF167	30p
BF173	40p
BF178	30p
BF180	16p
BF181	18p
BF183	20p
BF185	20p
BF194	7p
BF195	7p
BF196	8p
BF197	10p
BF198	10p
BF199	8p
BF200	16p
BF225	30p
BF240	16p
BF245	25p
BF254	15p
BF255	12p
BF256	18p
BF257	18p
BF258	18p
BF259	18p
BF262	25p
BF263	25p
BF270	18p
BF273	15p
BF311	21p
BF324	25p
BF336	20p
BF337	20p
BF355	28p
BF362	30p
BF367	13p
BF371	17p
BF392	18p
BF420	16p
BF421	18p
BF422	21p
BF423	25p
BF450	20p
BF455	14p
BF458	19p
BF459	19p
BF461	60p
BF462	52p
BF469	30p
BF470	28p
BF471	28p
BF472	28p
BF479	30p
BF493	18p
BF494	16p
BF495	16p
BF506	25p
BF595	16p
BF596	16p
BF615	30p
BF617	30p
BF757	40p
BF758	41p

BF759	40p
BF760	40p
BF763	40p
BF869	22p
BF870	22p
BF871	22p
BF872	23p
BF960	38p
BF961	35p
BF963	40p
BF964	38p
BF966	40p
BFR40	25p
BFR79	25p
BFR90	52p
BFR91	99p
BFT37	130p
BFT42	30p
BFT43	30p
BFT84	30p
BFW92	35p
BFX29	20p
BFX84	20p
BFX85	20p
BFX87	15p
BFX88	15p
BFX89	60p
BFY17	30p
BFY18	40p
BFY50	14p
BFY51	14p
BFY52	14p
BFY56	25p
BFY64	25p
BFY90	45p
BLY48	85p
BR100	14p
BR101	43p
BR103	37p
BR303	85p
BRY39	55p
BRY49	38p
BRY56	33p
BS574	33p
BSX20	15p
BSX26	18p
BSX29	19p
BT100A	70p
BT106	180p
BT109	90p
BT116	80p
BT119	100p
BT138	60p
BT146	99p
BT151	58p
BTY79	140p
BU100A	110p
BU104	100p
BU105	80p
BU108	100p
BU109	100p
BU110	110p
BU111	140p
BU124	60p
BU126	70p
BU180	150p
BU184	100p
BU204	75p
BU205	70p
BU206	100p
BU208	70p
BU208D	80p
BU209	140p
BU225	190p
BU226	190p
BU312	120p
BU325	55p
BU326	75p
BU406	85p
BU406D	95p
BU407	80p
BU407D	95p
BU408	85p
BU408D	95p
BU409	95p
BU426A	75p
BU500	110p
BU508A	85p
BU508D	90p
BU536	150p
BU526	80p
BU546	140p
BU608	150p
BU626	150p
BU636	150p
BU801	95p
BU806	80p
BU807	75p
BU902	130p
BU903	130p
BU920	130p
BU921	130p
BU922	130p
BU930	130p
BUT11A	90p
BUT56A	250p
BUX80	180p
BUX82	180p
BUX84	50p
BUX85	50p
BUY69A	200p
BUY71	300p
C106D	28p
MEO411	38p
MEO414	125p
ME3001	12p
ME4103	12p
ME6001	12p
ME6002	15p
ME8001	15p
ME9021	12p
MJ802	350p
MJ900	200p
MJ1000	200p
MJ1001	200p
MJ10012	300p
MJ15001	325p
MJ15002	300p
MJ15003	325p
MJ15004	370p
MJ15022	400p
MJ2501	110p
MJ2955	55p
MJ3000	115p
MJ3001	115p
MJE29A	30p
MJE30A	30p
MJE340	25p
MJE350	80p
MJE520	30p
MJE2955K	90p
MP8111	40p
MP8112	45p
MP8113	55p

MP8512	50p
MPS65781	20p
MPS9012	20p
MPS9013	20p
MPS9014	20p
MPS9015	20p
MPSA05	15p
MPSA06	15p
MPSA13	15p
MPSA20	15p
MPSA42	15p
MPSA43	15p
MPSA65	25p
MPSA66	25P
MPSA70	15p
MPSA92	20p
MPSA93	20p
MR510	35p
MR856	36p
OC28	250p
OC29	250p
OC35	250p
OC36	250p
OC45	50p
OC71	30p
OC72	50p
OC200	180p
OT121	120p
R20088	100p
R20108	100p
S2800D	52p
S2800M	72p
T2800D	52p
T2800M	72p
TIP29	15p
TIP29A	22p
TIP29C	25p
TIP30	25p
TIP30C	30p
TIP31A	24p
TIP31C	30p
TIP32	24p
TIP32A	24p
TIP32C	28p
TIP33	50p
TIP33C	60p
TIP34	50p
TIP34C	60p
TIP35C	65p
TIP36C	65p
TIP41A	22p
TIP41C	25p
TIP42A	22p
TIP42C	25p
TIP47	40p
TIP48	40p
TIP49	45p
TIP50	60p
TIP51	120p
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TIP53	120p
TIP54	140p
TIP105	65p
TIP106	65p
TIP107	65p
TIP110	47p
TIP111	50p
TIP112	40p
TIP115	45p
TIP116	45p
TIP117	50p
TIP120	43p
TIP121	47p
TIP122	47p
TIP125	47p
TIP126	56p
TIP127	56p
TIP130	30p
TIP131	30p
TIP132	30p
TIP141	90p
TIP142	90p
TIP145	65p
TIP146	90p
TIP147	100p
TIP150	90p
TIP151	90p
TIP2955	42p
TIP3054	45p
TIP3055	42p
TIS44	40p
TIS61	15p
TIS90	15p
TIS91	18p
VK1010	88p
VN10KM	60p
VN66AF	100p
VN88AF	115p
ZTX107	11p
ZTX108	11p
ZTX109	12p
ZTX212	27p
ZTX300	13p
ZTX301	16p
ZTX302	16p
ZTX303	24p
ZTX304	17p
ZTX320	29p
ZTX500	13p
ZTX501	13p
ZTX502	18p
ZTX503	18p
ZTX504	25p
ZTX550	24p
2N.696	26p
2N.697	22p
2N.698	40p
2N.706	22p
2N.708	22p
2N.914	28p
2N.930	18p
2N.1131	28p
2N.1132	28p
2N.1613	24p
2N.1711	24p
2N.1893	30p
2N.2102	50p
2N.2218A	24p
2N.2219	24p
2N.2221	23p
2N.2222	23p
2N.2369	15p
2N.2484	20p
2N.2646	40p
2N.2904	20p
2N.2905	20p
2N.2906	18p
2N.2907	18p
2N.2926	8p
2N.3019	28p
2N.3053	18p
2N.3054	40p
2N.3056	38p
2N.3055H	50p
2N.3440	58p

2N.3442	85p
2N.3583	90p
2N.3585	120p
2N.3702	9p
2N.3703	9p
2N.3704	9p
2N.3705	9p
2N.3706	9p
2N.3707	9p
2N.3708	9p
2N.3710	12p
2N.3711	12p
2N.3771	85p
2N.3772	90p
2N.3773	110p
2N.3799	18p
2N.3819	29p
2N.3866	68p
2N.3903	11p
2N.3904	11p
2N.3905	11p
2N.3906	11p
2N.4031	25p
2N.4036	25p
2N.4037	25p
2N.4062	12p
2N.4064	100p
2N.4401	12p
2N.4403	12p
2N.4443	76p
2N.5061	20p
2N.5088	20p
2N.5163	45p
2N.5192	50p
2N.5241	500p
2N 5245	45p
2N.5294	30p
2N.5296	30p
2N 5320	90p
2N.5321	60p
2N.5366	25p
2N.5401	12p
2N.5448	12p
2N.5496	80p
2N.6107	40p
2N.6109	40p
2N.6254	110p
2N.6292	40p
2N.6384	120p
2N.6385	120p
2N.6403	160p

DIODES RECTIFIER DIODES

BY100	40p
BY103	32p
BY126	6p
BY127	8p
BY133	8p
BY164	40p
BY179	35p
BY184	32p
BY196	20p
BY206	11p
BY207	11p
BY208	18p
BY210	22p
BY225	120p
BY226	18p
BY227	19p
BY228	32p
BY296	20p
BY298	26p
BY299	28p
BYX10	15p
BYX55/350	30p
BYX55/600	30p
BYX70/500	32p
BYX70/800	36p
OA91	8p
OA200	7p
OA202	7p
IN.914	2p
IN.4001	4p
IN.4002	4p
IN.4003	4p
IN.4004	4p
IN.4005	4p
IN.4006	4p
IN.4007	5p
IN.4148	2p
IN.5400	9p
IN.5401	10p
IN.5402	10p
IN.5403	11p
IN.5404	11p
IN.5405	12p
IN.5406	13p
IN.5407	13p
IN.5408	13p
SKE4F2/06	50p
SKE4F2/08	70p
SKE4F2/10	90p

I.C. SOCKETS

8 PIN	6p
14 PIN	8p
16 PIN	9p
18 PIN	12p
20 PIN	14p
22 PIN	16p
24 PIN	18p
28 PIN	20p
40 PIN	25p

ZENER

400 MV BZY88 RANGE 2V7 TO 39V	6p
1.3W BZX61 RANGE 2V7 TO 39V	12p

VOLTAGE REGULATORS

7805	35p
7806	35p
7808	35p
7812	35p
7815	35p
7818	35p
7824	35p
7905	35p
7906	40p
7908	40p
7912	40p
7915	40p
7918	40p
7924	40p

78L05	28p
78L08	28p
78L12	28p
78L15	28p
78L18	28p
78L24	28p
79L05	40p
79L08	40p
79L12	40p
79L15	40p
7818KC	100p
7824KC	100p
LM309K	100p
LM317K	220p
LM317T	180p
LM323K	420p
LM723	40p
78HGKC	570p
78H05KC	800p
78H12KC	700p
79GU1C	190p
79GU1C	215p
79HGKC	800p

L.E.D.'S

LED 3MM RED	5p
LED 3MM YELLOW	10p
LED 3MM GREEN	10p
LED 5MM RED	5p
LED 5MM YELLOW	10p
LED 5MM GREEN	10p

RECTANGULAR L.E.D.'S

RED	10p
GREEN	15p
YELLOW	15p

LINEAR IC's

LF-347	110p
LF-351	45p
LF-353	48p
LF-355	60p
LF-356	60p
LF-357	70p
LF-398	300p
LM-301	26p
LM-307	42p
LM-308CN	70p
LM-311	35p
LM-318	120p
LM-319	165p
LM-324	35p
LM-334Z	115p
LM-335Z	120p
LM-337	250p
LM-339	37p
LM-348	55p
LM-358	45p
LM-377	220p
LM-380	100p
LM-381	150p
LM-382	130p
LM-384	130p
LM-386	85p
LM-387	100p
LM-392	100p
LM-393	55p
LM-709DIL	30p
LM-710	45p
LM-711	85p
LM-723	40p
LM-733	60p
LM-741DIL	18p
LM741MET	45p
LM-747	58p
LM-748	35p
LM-1458	33p
LM-1889	400p
LM-3900	40p
LM-3909	80p
LM-3911	160p
LM-3914	250p
LM-3915	255p
LM-3916	290p
MB-3515	240p
MB-3614	180p
MB-3712	140p
MB-3713	130p
MB-3714	270p
MB-3715	250p
MB-3722	310p
MB-3730	200p
MB-3731	300p
MB-3756	230p
MB-3759	200p
MB-8719	360p
MC-1310P	130p
MC-1455	45p
MC-1458	33p
MC-1469	290p
MC-1488	65p
MC-1489	65p
MC-1496	65p

MC-3302	70p
MC-3401	45p
MC-3403	60p
MC-3423	75p
NE-531	115p
NE-544	170p
NE-555	20p
NE-556	40p
NE-565	110p
NE-566	130p
NE-567	115p
NE-570	360p
NE-571	290p
NE-592	85p
NE-5532P	140p
NE-5534P	110p

74 SERIES

7400	20p
7401	16p
7402	18p
7403	20p
7404	35p
7405	10p
7406	36p
7407	36p
7408	25p
7409	20p
7413	30p
7414	45p
7416	40p
7417	32p
7420	22p
7421	25p
7425	15p
7430	25p
7437	28p
7438	32p
7442	38p
7447	60p
7450	22p
7451	10p
7454	25p
7470	30p
7473	25p
7474	35p
7475	25p
7481	90p
7482	60p
7485	28p
7486	28p
7489	75p
7490	35p
7492	45p
7493	35p
7495	48p
7497	80p
74107	30p
74111	52p
74116	85p
74119	85p
74122	40p
74123	20p
74125	40p
74126	45p
74132	42p
74141	55p
74145	70p
74153	45p
74155	45p
74157	45p
74160	50p
74164	50p
74167	35p
74173	50p
74174	60p
74175	65p
74176	45p
74180	50p
74182	45p
74192	40p
74196	40p
74197	45p
74393	70p

74LS SERIES LOW POWER SCHOTTKY T.T.L.

74LS00	12p
74LS01	12p
74LS02	12p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS09	14p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	20p
74LS14	24p
74LS15	14p
74LS20	14p
74LS21	14p
74LS22	14p
74LS24	35p
74LS26	14p
74LS27	14p
74LS28	14p

74LS30	14p
74LS32	15p
74LS33	15p
74LS31	15p
74LS38	16p
74LS40	15p
74LS42	25p
74LS47	52p
74LS48	48p
74LS51	13p
74LS54	13P
74LS55	15p
74LS73	24p
74LS74	18p
74LS75	24p
74LS76	24p
74LS78	24p
74LS83	37p
74LS85	37p
74LS86	25p
74LS90	28p
74LS91	55p
74LS92	32p
74LS93	26p
74LS95	41p
74LS96	52p
74LS107	28p
74LS109	28p
74LS112	28p
74LS113	28P
74LS114	28p
74LS122	35p
74LS123	35p
74LS124	85p
74LS125	30p
74LS126	30p
74LS132	30p
74LS133	30p
74LS136	30p
74LS138	28p
74LS139	28p
74LS145	65p
74LS147	90p
74LS148	75p
74LS151	27p
74LS153	31p
74LS154	78p
74LS155	36p
74LS156	36p
74LS157	22p
74LS158	27p
74LS160	38p
74LS161	38p
74LS162	38p
74LS163	36p
74LS164	36p
74LS165	50p
74LS166	55p
74LS168	60p
74LS169	55p
74LS170	68p
74LS174	30p
74LS175	32p
74LS190	47p
74LS191	43p
74LS192	41p
74LS193	41p
74LS194	41p
74LS193	44p
74LS196	45p
74LS197	42p
74LS221	45p
74LS240	45p
74LS241	42p
74LS242	43p
74LS243	50p
74LS244	40p
74LS245	40p
74LS247	45p
74LS248	40p
74LS249	70p
74LS251	24p
74LS253	36p
74LS256	52p
74LS257	32p
74LS258	35p
74LS259	50p
74LS260	30p
74LS266	22p
74LS273	44p
74LS279	33p
74LS280	88p
74LS283	51p
74LS290	26p
74LS293	26p
74LS365	26p
74LS366	31p
74LS367	28p
74LS368	30p
74LS373	45p
74LS374	45p
74LS375	46p
74LS390	42p
74LS393	37p
74LS399	68p
74LS629	95p
74LS641	88p
74LS642	105p
74LS644	105p
74LS645	105p
74LS670	62p
74LS674	310p
74LS687	250p

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2114	200p
2532	330p
2716	200p
2732	280p
2732A	300p
2764	240p
27C64	550p
27128	310p
27256-25	400p
41256-15	240p
4116	75p
4164-15	150p
6116	150p
6264-12	300p
6502	300p
6502A	400p
65C02	930p
6503	570p
6520	170p
6522	330p
6532	460p
6545	880p
6551	530p
6800	210p
6802	220p
6803	800p
6808	500p
6809	600p
6810	150p
6818	380p
6820	140p
6821	140p
6840	310p
6845	620p
6850	110p
8080A	400p
8085A	300p
8086	500p
8088	500p
8155	360p
8156	300p
81LS95	120p
81LS96	130p
81LS97	130p
81LS98	130p
8224	240p
8226	240p
8243	250p
8250	850p
8251	270p
8253	230p
8255	200p
8256	1200p
8257	220p
8259	280p
8271	3400p
8279	270p
8284	440p
8288	650p
8748	1100p
8755	1400p
AY3-1015	290p
SP0256AL2	500p
Z80ACPU	150p
Z80BCPU	400p
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Z80AP10	220p
Z80BP10	340p
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5 speed single phase, ⅙ hp motor drives 13mm chuck belt

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Super-directive sound collecting microphone. High sensitivity super cardioid electret condenser. Tubular element with foam windshield. Built-in amplifier and earphones

Type	Uni-directional. Electret condenser
Impedance	2Kohms
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Sensitivity: Mic	−45dB
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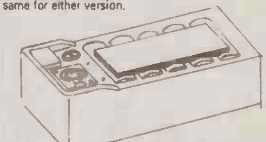
* This unit is supplied, depending on availability. Either in 4-pin version or 6-pin version. The price is the same for either version.



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A 4-way 13A socket, fused and with neon indicator. Fitted with 3 meters of cable terminating in a 13A fused plug. White.

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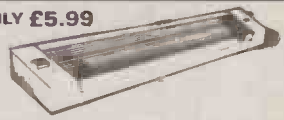

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High power stereo in-car amplifier, 2 × 75W stereo or mono (switchable). Input selector switch permits connections to normal and high power car stereo players. Power will ON/OFF automatically from remote connection to car stereo power lead. Input sensitivity selector.
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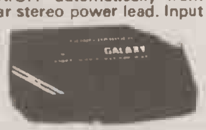

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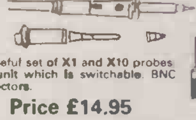
PROBES – X1, X10



Useful set of X1 and X10 probes One unit which is switchable. BNC connectors.
Price £14.95

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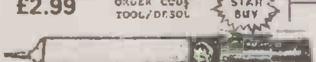

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3-4, 5-6-7, 5-9-12V 300 – A
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2W5 off (365)	£25.00
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FM TRANSMITTER

Very High Quality 'MINI-BUG' – Ideal for Baby Alarm etc.!!
A very good range is obtainable – we have obtained over ½ mile, but it does depend on conditions. Simply remove cover – Insert battery – and you're ready to go. Reception can be obtained on any FM radio.
Frequency: 105-109MHz FM. Power: PP3 9V battery (not included).
Dimensions: 4.25"×2.25"×0.75". Order Code – SO.004. Price: £9.99

22SWG RESIN SOLDER

500gm. REEL	1+	10+	100+
	£4.99	£4.75	£3.99

ALSO 18SWG at £4.95 500gm.
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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

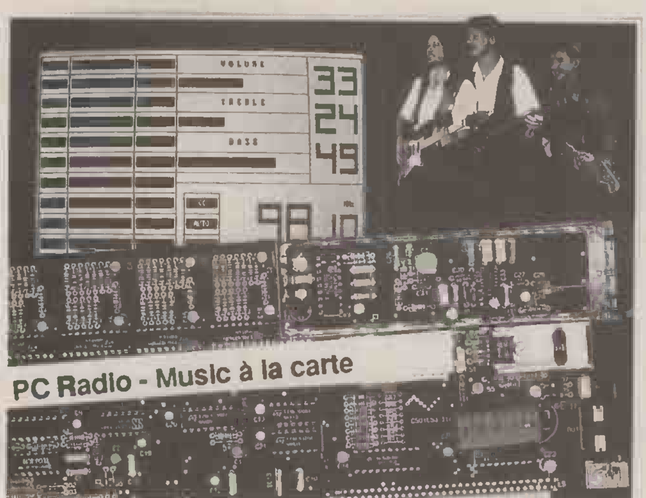
Ready assembled module
44.255F .... £ 134.50

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 carged at cost at heigher weight Air/Surface -
- we deliver worldwide except USA and Canada
- dealer inquiries welcome

RFK 700 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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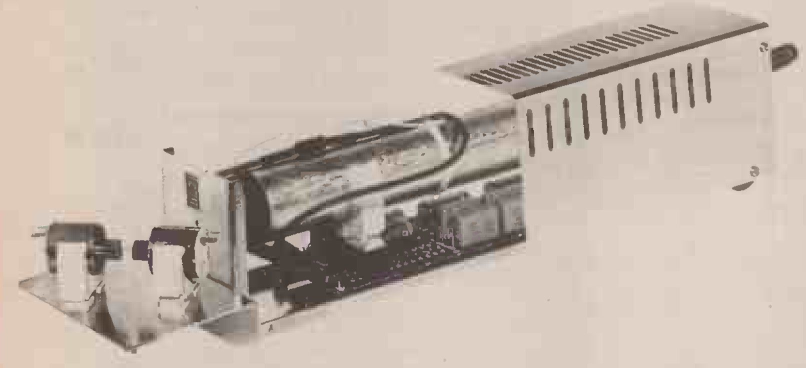
LPS 8000 / LC 7000 Low Cost Show Laser

(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

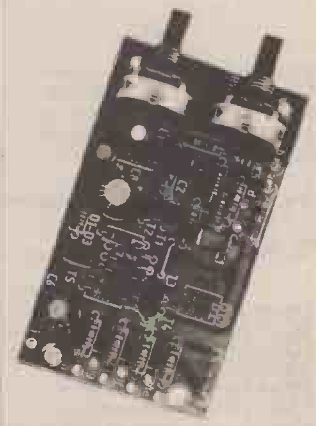
LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F.................... £ 104.30

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.

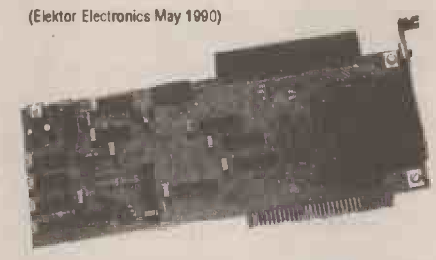


Complete Kit
(including Box, PCB and all parts
44.324BKL .... £ 14.75

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

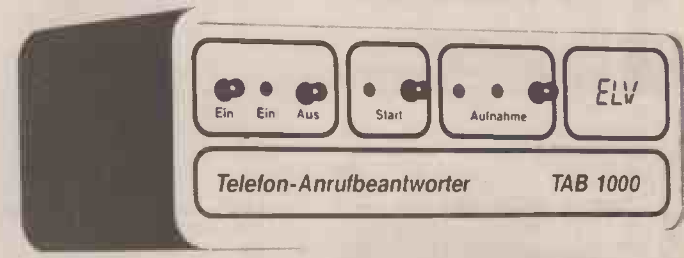
TA 1000 Telephone Answering Unit

(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

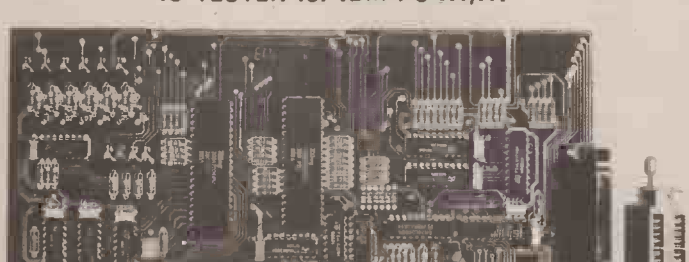
Ready assembled module
44.433F..................... £ 87.25



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

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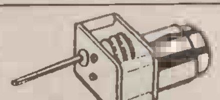

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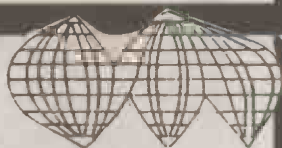

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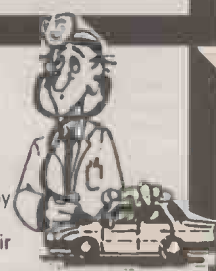

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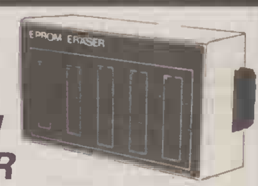

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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

VOL. 19 No. 5 **May '90**

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MISSING MORSE

This issue has been bumped up in size with the inclusion of the *Amateur Radio Supplement*. Amateur radio is a fascinating hobby, closely allied to electronics and of course totally dependent on electronics.

Before I go on about radio I must make an apology – we have been unable to publish the *Morse Tutor* announced last month, due to circumstances beyond our control – will Mr D. Virden (the designer) please contact us with regard to this project! Providing we can re-establish contact and sort out some minor technical points we hope to publish the design in a few months' time – as they say, watch this space.

As far as we can tell this is the first time in the history of EE that we have been unable to publish an "advertised" project. I hope we can put this right in due course.

Getting back to radio I must say that it was listening to short wave transmissions that originally got me interested in electronics. Building and using your own receiver adds that extra something which makes the hobby even more interesting. Please let us know of your experiences and interest in this subject. It is not an area that we cover in any depth but should there be a high level of interest among readers we will consider more amateur radio projects.

B.A.E.C. FOUNDER

It is with regret that we must report the death of Cyril Bogod. Well known to many readers, Cyril was the founder of the British Amateur Electronics Club, an organisation which has helped many hobbyists over the years. Cyril was always interested in helping anyone with their hobby and no doubt there are many readers who have much to thank him for.

His organisational abilities and enthusiasm ensured that the B.A.E.C. survived through many years. His generosity has insured it will continue. A short obituary appears on page 347. The last time I spoke to Cyril he was 'phoning from his hospital bed to see if I could help find someone to assist with the B.A.E.C. in future years, such was his dedication.

Mike Kenward

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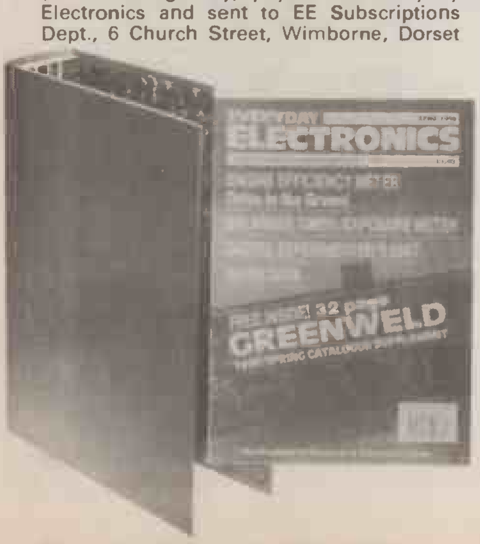

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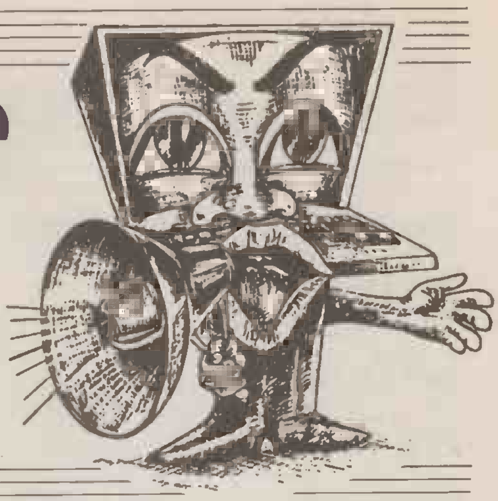
Constructional Project

AMSTRAD CPC SPEECH SYNTHESISER



ROBERT PENFOLD

Low-cost voicing for your Amstrad. Based on the popular SPO256 "speech" chip.

Although they rank as one of the most popular computer ranges, the number of published add-on projects for the Amstrad CPCs seems to be relatively small. Possibly this is due to the fact that Amstrad launched these computers after the main home computer boom, when interest in computer projects had waned somewhat. Anyway, this article describes an add-on speech synthesiser for any computer in the CPC range, and helps to rectify the lack of projects for these machines.

The unit fits onto the CPC expansion port, and provides its speech output via the computer's built-in loudspeaker. The circuit is based on the popular SPO256 speech synthesiser chip. This is a relatively cheap speech chip, but is one which gives an unlimited vocabulary.

Unlike some methods of speech synthesis, the one used by the SPO256 does not require large amounts of the computer's memory in order to store a few words. In fact a dozen long sentences would probably require no more than about 1K of memory. The speech quality is not as good as some systems, but is quite acceptable. Considering the simplicity of the system used in this method of speech synthesis, the speech quality is remarkably good.

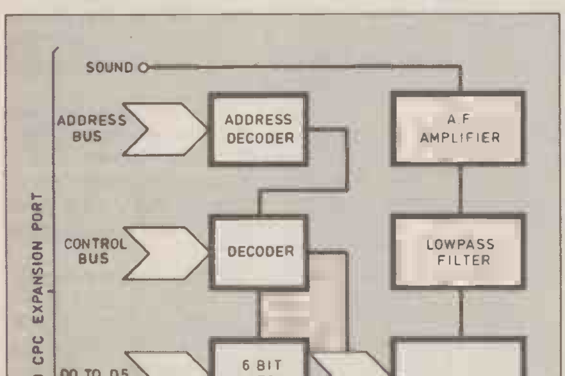
ALLOPHONES

There is a slight drawback in using the SPO256 speech chip, and this is simply that it is relatively difficult to program well. It produces words by stringing together a number of "allophones", which are the basic sounds of speech. For example, "shhhh", "arrr", and "ow" are the sort of simple sounds that can be fitted together to make up the more complex sounds of complete words. These words, separated by pauses where necessary, can then be put together to make complete sentences, or even a number of sentences if required.

For this system to be successful you must have at your disposal all the sounds needed to make up all the words in the language. Apparently the sounds required vary significantly from one language to another, and the sounds for a particular language are called "phonemes". The SPO256 contains sixty four phonemes (including pauses) that permit any English word to be produced.

For this system to work well the allophones need to be chosen very carefully, and the obvious ones are not necessarily the ones that give the best results. However, with a little experience it is possible to put together some intelligible sentences in a reasonably short space of time, perhaps with a little "fine tuning" being needed in order to get things just right.

Fig. 1. The Amstrad CPC Speech Synthesiser block diagram.



SYSTEM OPERATION

The block diagram of Fig.1 shows the basic arrangement used in this speech synthesiser. The speech synthesiser chip is at the heart of the unit, and this includes a 2K by 8 ROM that contains all the allophones. It has provision for operation with up to three external ROMs, giving a maximum capacity of 256 allophones. However, in most circuits (including this one) no external ROMs are used. There are 64 allophones available to the user, and these are selected via six address inputs.

Rather than a true audio output, the SPO256 provides a pulse width modulated output signal. In other words, the output signal is a high frequency pulse signal, with the pulse width being varied to give the required audio output voltage. A high mark-space ratio gives a high average output voltage, a low mark-space ratio gives a low average output potential, and a 1 to 1 ratio gives an intermediate average output level.

By varying the pulse width the average output voltage can therefore be made equal to the required audio output potential. In order to decode this type of signal it is merely necessary to pass it through a lowpass filter. This filters out the pulses and leaves a potential equal to the average voltage of the pulse signal. The output signal from the lowpass filter is too low to drive the audio input of the CPC computers properly, and so the signal is boosted by an amplifier before being fed to the computer.

INTERFACING

Interfacing the SPO256 to the buses of a computer is reasonably straightforward. In order to produce a series of allophones from the chip it must first be fed with a 6-bit allophone address. Then, in order to get the chip to produce the selected allophone, a pulse must be applied to the chip's "ALD" (allophone load) input.

It is important that the next allophone is not sent to the SPO256 until it has completed the current one. Otherwise, each allophone, apart from the final one, is cut short to make way for the subsequent one, giving what is just a brief burst of noise from the loudspeaker.

The SPO256 provides a sort of "handshake" output in the form of its "LRQ" (load request) output. This is normally low, but it goes high when the chip is producing an allophone.

The flow of data can be correctly controlled by using a software routine to send an allophone address to the SPO256, wait until "LRQ" goes low, send another allophone address, monitor "LRQ" again, and so on, until all the allophones have been produced. Timing loops are not really a viable alternative as the allophones have various durations from 10ms to 420ms. An accurately timed flow of data is essential if a good quality output is to be achieved.

In my experience at any rate, feeding the address inputs of the SPO256 direct from one of the computer's buses is not likely to be successful. More reliable results are usually obtained if it is fed from a latching output port. In this case it is driven from a 6-bit latching output derived from data lines D0 to D5.

The "ALD" input of the speech chip is driven from the "write" output of the address/control bus decoder circuit. Consequently, writing an allophone address to the SPO256 results in that allophone being automatically produced by the device.

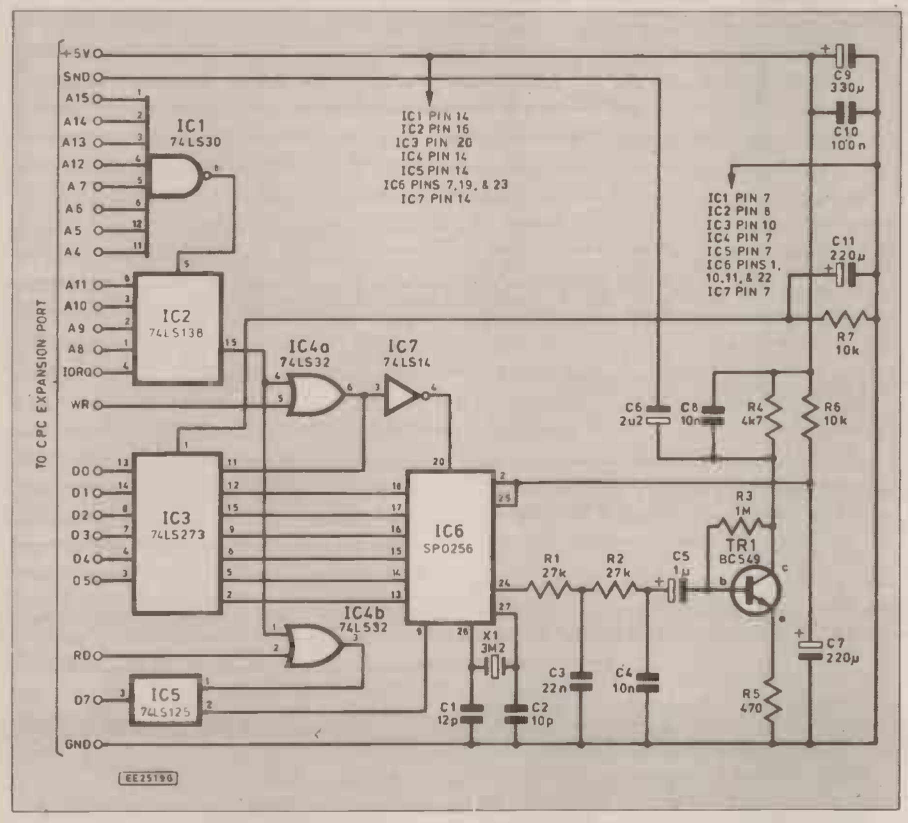


Fig. 2. Complete circuit diagram for the Amstrad CPC Speech Synthesiser.

The "LRQ" output of the SPO256 is fed to D7 of the data bus via a tristate buffer. Note that data line D6 is not required by the speech synthesiser, and that this line of the computer's expansion port is left unconnected.

DECODING

With an unexpanded CPC464 it is possible to utilize a very simple form of address and control bus decoding, which more or less consists of activating the interface when A10, IORQ, and either RD or WR are all low. With expanded or disk based CPCs the situation is a little more tricky, and much more precise decoding is required if interactions between the user add-on and other hardware (particularly the disk drivers) are to be avoided.

In this circuit all the address lines from A4 to A15 are decoded so that the speech synthesiser is placed in the input/output map at address &F8F0. In fact is appears at "echoes" from &F8F0 to &F8FF, and can be accessed by way of any address in this range.

This range of addresses is specified as being free for user add-ons in the Amstrad CPC manuals, and there should be no danger of any conflicts between the speech synthesiser and any official Amstrad add-ons or the computer's internal hardware. However, other add-ons might use the same address range, and might not be compatible with this unit.

The address/control bus decoder provides separate "read" and "write" outputs. Address &F8F0 is therefore used for sending allophone addresses to the SPO256, and for monitoring its "LRQ" output.

CIRCUIT OPERATION

Refer to Fig.2 for the full circuit diagram of the Amstrad CPC Speech Synthesiser. IC6 is the SPO256 speech chip, and this has a built-in clock oscillator. It requires a discrete crystal and two capacitors (X1, C1, and C2), and the clock frequency recommended by the speech chip manufacturer is 3.12MHz.

Crystals having this operating frequency do not seem to be very easily obtained, and I opted for a 3.2768MHz component. This is a readily available and inexpensive type intended for use in "quartz" clocks.

The increased clock frequency merely results in a slight increase in the pitch of the audio output, and a marginal increase in the speed with which words are "spoken" by the unit. Perfectly satisfactory results should be obtained using any crystal frequency from about 3MHz to 3.3MHz.

The SPO256 reqires a negative reset pulse at switch-on, and this is provided by R6 and C7. The pulse code modulated output is filtered by R1/C3 and R2/C4 to leave the decoded audio frequency signal which is fed to a common emitter amplifier based on TR1. This has a large amount of local negative feedback provided by R5, and this reduces its voltage gain to about 20dB (10 times). This gives an audio output of more than adequate strength to drive the CPC's audio input. C8 provides some additional lowpass filtering which helps to give a low ripple output signal.

ADDRESS DECODING

Address decoding is provided by IC1 and IC2. IC1 is an eight input NAND gate, and it decodes A4 to A7 and A12 to A15. The output of IC1 only goes low when all eight of these address lines are high, which is when an address which has "F" (hex) as the first and third digits is accessed.

IC2 decodes address lines A8 to A11. IC2 is a three-to-eight line decoder, but in this case only output "0" of the device is utilized. A8 is connected to its positive enable input, while A9 to A11 are coupled to its three address inputs.

Output 0 to IC2 goes low when an address having "8" (hex) as its second digit is accessed. However, the output of IC1 couples to one of the negative enable inputs of IC2, so that output 0 of IC2 only goes low when an address in the range &F8F0 to &F8FF is accessed.

This almost gives all the required decoding, but there are a couple of mild complications. One is simply that the Z80A microprocessor used in the CPC machines has separate input/output and memory maps.

The microprocessor indicates to the rest of the system that it is undertaking an input/output instruction by taking the IORQ line low. Thus, the speech synthesiser must ignore addresses in the relevant range unless IORQ is low. This is achieved by connecting IORQ to a second negative enable input of IC2.

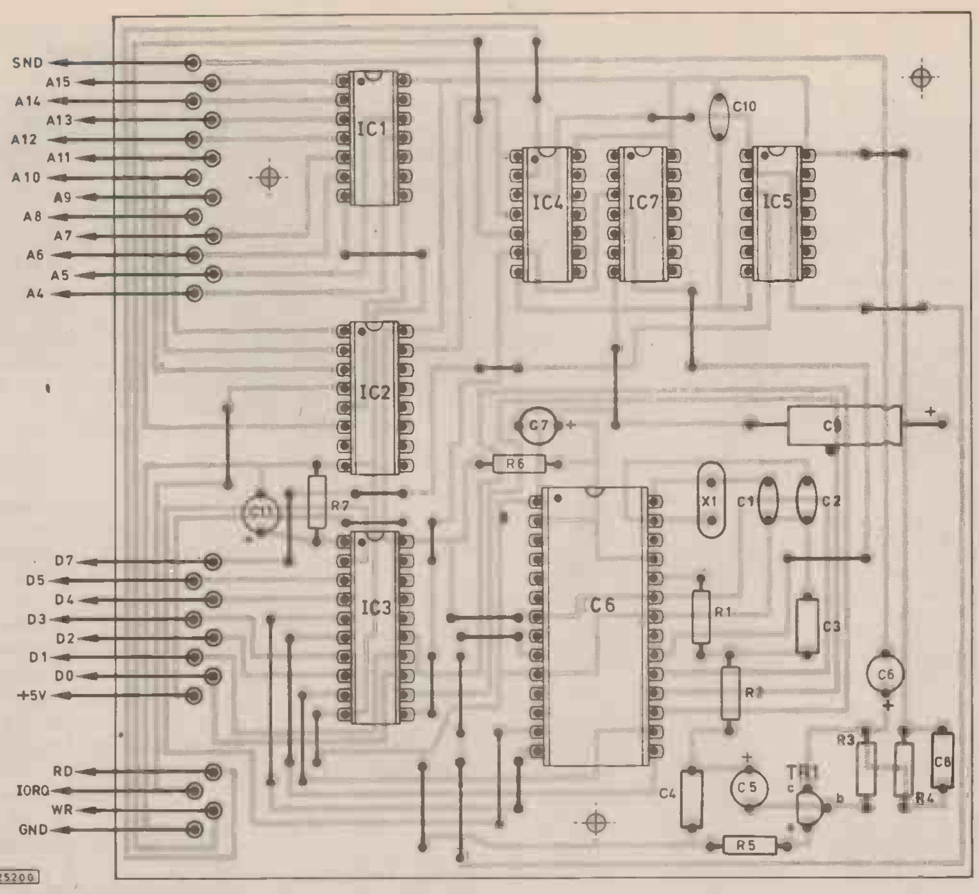


Fig. 3. (above) Printed circuit board component layout and wiring details. (below) Full size printed circuit copper foil master pattern.

The second complication is that we require separate outputs for read and write operations. This is achieved by gating the output of IC2 with the RD (read) and WR (write) lines of the CPC expansion bus, using a separate OR gate for each of these two lines. This gives a negative read pulse from IC4b, and a negative write pulse from IC4a.

A positive pulse is needed for the ALD input of the speech chip, and this is derived from the write output via inverter IC7. The six bit latching output for IC6 is provided by IC3, which is actually an octal D type flip/flop. In this case only six of the flip/flops are used, with the two "spares" just being ignored. IC4a provides a negative pulse to the "clock pulse" input of IC3 during write operations to the interface, and this latches the outputs of the flip/flops.

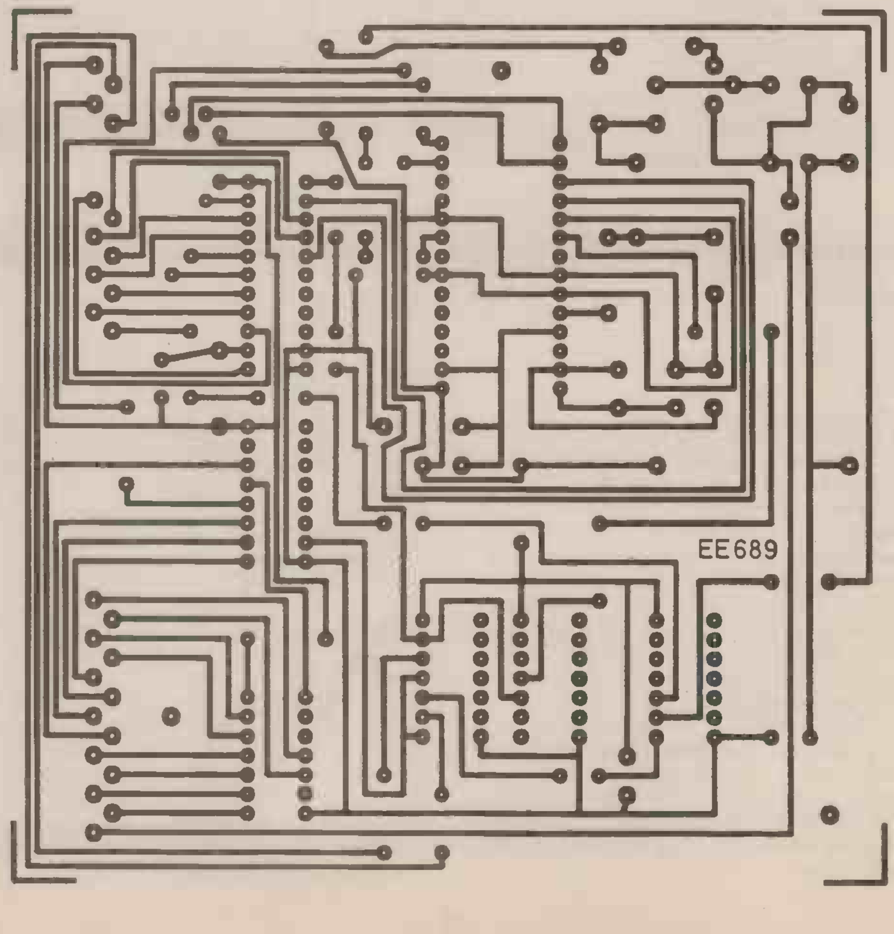
At switch-on a negative reset pulse is supplied to IC3 by C11. This ensures that IC3 commences with all its outputs low, and that the speech chip does not produce any output until the user activates it. R7 ensures that C11 is rapidly discharged when the computer is switched off, so that a fresh reset pulse is produced when it is switched on again.

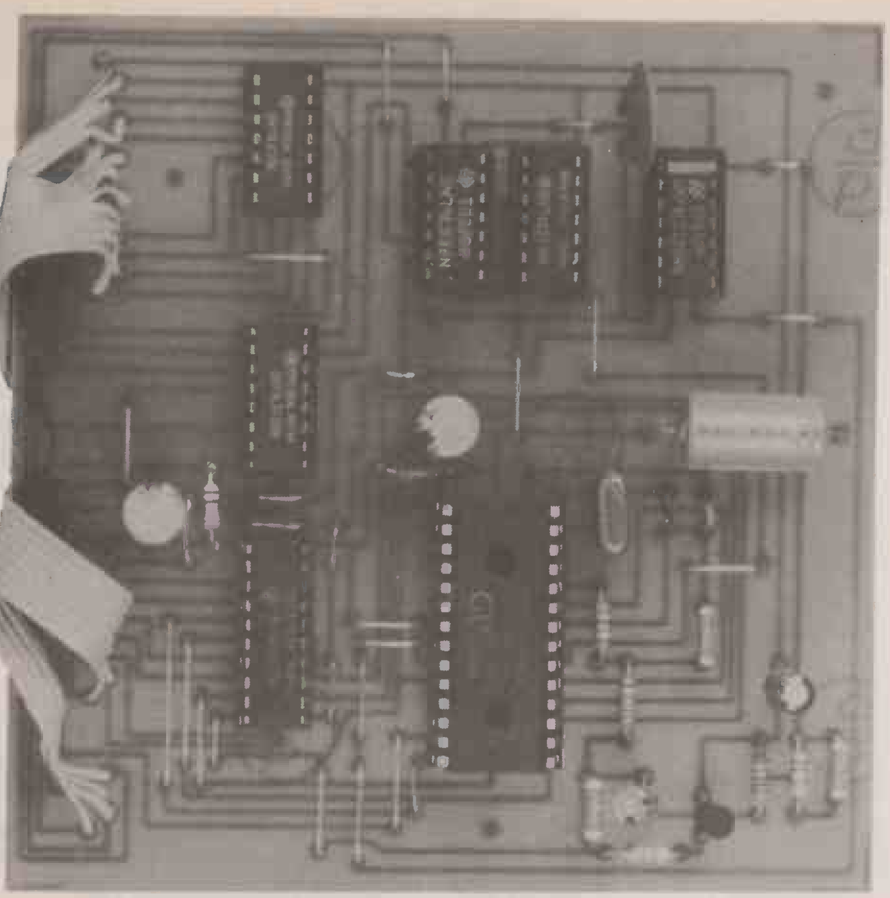
IC5 is a quad tri-state buffer, but in this circuit only one buffer is used and no connections are made to the other three. It interfaces the LRQ output of IC6 to D7 of the CPC expansion bus, and it is set to the active state by the output pulses from IC4b during read operations to the speech synthesiser.

Power for the speech synthesiser is obtained from the +5 volt supply output of the CPC expansion port. C9 provides smoothing which helps to give a low noise level on the audio output of the unit.

CONSTRUCTION

Details of the printed circuit board are provided in Fig.3. Crystal X1 must be a miniature wire-ended type with 0.2 inch lead spacing if it is to fit easily onto the board. Try to complete the soldered joints reasonably rapidy when fitting this component as some crystals are relatively easily





Completed circuit board showing all the i.c.s. mounted in i.c. holders.

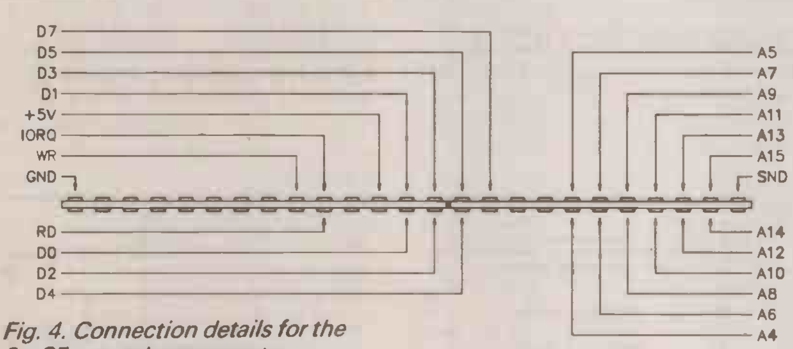


Fig. 4. Connection details for the 2 x 25 way edge connector.

damaged by heat. IC6 is a MOS integrated circuit, and as such it is vulnerable to damage by static charges.

Leave this component in its anti-static packaging until, in all other respects, the unit is finished. Then fit this component onto the board, handling it as little as possible, avoiding touching the pins and fitting it into a holder already fitted to the board so that there is no need to make any direct soldered connections to this chip.

With a fairly large integrated circuit of this type, IC6 can be a bit difficult to fit a into its socket. Usually the pins have to be carefully bent inwards slightly. Be careful not to buckle any of its pins when fitting IC6 into its socket. Although none of the other integrated circuits are static sensitive types, it is recommended that they should be fitted in holders.

There should be no difficulties in fitting the other components onto the board provided the correct types of capacitor are used. In particular, the polyester types should have a lead spacing of 7.5 millimetres (0.3 inches). Be careful to fit the electrolytic capacitors with the correct polarity. A number of link wires are required, and these can be made from 22s.w.g. tinned copper wire, or the leads trimmed from the resistors and capacitors might be sufficient.

CONNECTIONS

The board is connected to the computer via a 25-way ribbon cable which is fitted with a 2 by 25-way 0.1 inch pitch edge connector at the computer end. At the other end it is either connected directly to the board, or via pins if preferred.

Both ends of the cable should be prepared by separating all the wires, stripping a few millimetres of insulation from each one, and tinning them all with solder. The terminals of the edge connector (or the twenty five that are used anyway) should be tinned with solder, as should the pins on the board if this method of connection is adopted.

In my experience the CPC computers are not tolerant of long connecting leads on their expansion bus. It is therefore recommended that the connecting cable should be no more than about 0.6 metres long.

The edge connector connection details are given in Fig.4. The board has been designed so that the order of the connections on the board matches up well with that of those on the edge connector. There is no need for any crossing over of wires, but you still need to be very careful to get each lead connected to the right terminal of the edge connector.

The multi-coloured "rainbow" ribbon cable is better for this sort of thing, but grey ribbon cable is usable if you take extra care. If you are using a connector fitted with the appropriate polarising key, make quite sure that you have the connector the right way up before making the connectio ns to it.

If the connector is not fitted with a polarising key, clearly mark the top and bottom edges such as to minimise the risk of fitting it to the expansion port up-side-down. Once this wiring has been completed, check it very thoroughly at least once before connecting the unit to the computer and trying it out.

Projects of this type are often left as uncased boards, as was the prototype. However, it should not be difficult to fit the unit into a small plastic case if preferred. This does have the advantages of being a bit neater, and keeping dust etc. off the circuit board.

COMPONENTS

Shop Talk
See page 319

Resistors

R1, R2	27k (2 off)
R3	1M
R4	4k7
R5	470
R6, R7	10k (2 off)

All 0.25W 5% carbon

Capacitors

C1	12p ceramic plate
C2	10p ceramic plate
C3	22n polyester (7.5mm pitch)
C4, C8	10n polyester (7.5mm pitch) (2 off)
C5	1µ radial elect. 63V
C6	2µ2 radial elect. 63V
C7, C11	220µ radial elect. 10V (2 off)
C9	330µ axial elect. 10V
C10	100n disc ceramic

Semiconductors

IC1	74LS30 8-input NAND gate
IC2	74LS138 3-to-8 line decoder
IC3	74LS273 octal flip/flop
IC4	74LS32 quad 2-input OR gate
IC5	74LS125 quad tristate buffer
IC6	SP0256 speech synthesiser
IC7	74LS14 hex inverting trigger
TR1	BC549 silicon *npn*

Miscellaneous

X1	3.2768MHz miniature wire-ended crystal (see text)

Printed circuit board available from the *EE PCB Service*, order code EE689; case (see text); 2 x 25 way 0.1 inch pitch edge connector; 25 way ribbon cable; 14 pin d.i.l. i.c. holder (4 off); 16 pin d.i.l. i.c. holder; 20 pin d.i.l. i.c. holder; 28 pin d.i.l. i.c. holder; connecting wire; etc.

Approx cost. Guidance only **£20**

IN USE

With any add-on project that connects to a computer's buses it is essential to connect it to the computer *prior* to switch-on. Otherwise the computer is likely to crash when the add-on is connected, and the computer and (or) add-on could be damaged. Once switched on, the computer should go through its start-up routine in the normal way. Switch off at once and recheck all the wiring if there is any hint of anything out of the ordinary at switch-on.

To test the unit you can try this example program, which should result in the speech unit saying a couple of words that will be familiar to all readers!

```
5 REM SPEECH ROUTINE
10 READ a
20 OUT &F8F0,a
30 IF a = 64 THEN END
40 WHILE INP(&F8F0) > 127
50 WEND
60 GOTO 10
70 DATA 7, 7, 35, 52, 19, 0, 33, 20, 3, 19,
   45, 7, 42, 17, 39, 24, 11, 12, 41, 55, 64
```

Line 10 reads data from line 70, and at line 20 each read value is sent to the speech synthesiser. Line 30 is used to detect the end of the speech data, and terminate the routine.

This is achieved by using a number of 64 as the last allophone value. This value is sent to the speech unit, but as it does not respond to the two most significant bits, the value it is sent is effectively zero. This is important, because most of the allophones do not cut off after the appropriate length of time, but will continue indefinitely if allowed to do so. Using 0 as the last allophone address finishes the sequence of allophones with a short pause, and ensures that there is then silence from the speech unit until it is activated again.

A WHILE...WEND loop at lines 40 and 50 halts the progress of the program until the current allophone has been completed. The test used is whether or not the value returned from the speech unit is greater than 127. It must be more than 127 while an allophone is being produced, since D7 will be taken high by the status output of the SPO256, giving a returned value of at least 128. However, once an allophone has been completed, and D7 is taken low, the returned value can be no more than 127. Logic ANDing could be used to mask D0 to D6, but the method used in the demonstration program is probably faster and easier.

The allophone values used in the example program are the obvious ones, and they give reasonable results. In some cases the obvious allophones give something far removed from the desired result, but a little experimentation will often resolve matters.

Sometimes what may seem like a sound that requires just one allophone needs to be put together from two or even three allophones. The accompanying list of allophones, addresses (in hex and decimal), plus example words to clarify the sounds they produce, should aid the selection of likely allophones for your own phrases.

TABLE. 1: List of Allophones, their addresses and sample words

Dec Address	Hex Address	Allo-phone	Example Word	Dec Address	Hex Address	Allo-phone	Example Word
0	0	PA1*	10ms pause	32	20	AW	OUr
1	1	PA2*	30ms pause	33	21	DD2	Down
2	2	PA3*	50ms pause	34	22	GG3	fIG
3	3	PA4*	100ms pause	35	23	VV	Vertical
4	4	PA5*	200ms pause	36	24	EG1	GUest
5	5	OY	bOY	37	25	SH	SHone
6	6	AY	frY	38	26	ZH	aZure
7	7	EH*	End	39	27	RR2	tRain
8	8	KK3	Come	40	28	FF*	Find
9	9	PP	Poster	41	29	KK2	sKy
10	A	JH	dodGe	42	2A	KK1	Can
11	B	NN1	tiN	43	2B	ZZ	Zoo
12	C	IH*	pIt	44	2C	NG	bANk
13	D	TT2	Top	45	2D	LL	Love
14	E	RR1	Rattle	46	2E	WW	Wood
15	F	AX*	sUcceed	47	2F	XR	Rain
16	10	MM	Mint	48	30	WH	WHere
17	11	TT1	porT	49	31	YY1	Yell
18	12	DH1	THem	50	32	CH	CHoose
19	13	IY	sEA	51	33	ER1	fIR
20	14	EY	cAge	52	34	ER2	buRR
21	15	DD1	shoulD	53	35	OW	bOW
22	16	UW1	tO	54	36	DH2	THey
23	17	AO*	tAUght	55	37	SS*	veSt
24	18	AA*	lOt	56	38	NN2	Now
25	19	YY2	YEs	57	39	HH2	How
26	1A	AE*	tAp	58	3A	OR	sORe
27	1B	HH1	Hat	59	3B	AR	alARm
28	1C	BB	BUsy	60	3C	YR	reaR
29	1D	TH*	THen	61	3D	EG2	Got
30	1E	UH*	bOOk	62	3E	EL	saddLE
31	1F	UW2	bOOt	63	3F	BB2	Bottle

Where allophones are marked with a "*" it is possible to use the same one two or more times in a row in order to give an elongated version of the sound.

ALLOPHONE ALTERATION AND USE

Note that in most cases you cannot produce elongated versions of allophones simply by using the same one two or three times in succession. In most cases this just gives a sort of echo effect. It is possible with some though, as indicated in the list.

With a few of these it is acceptable to duplicate them at the beginning of a word, but not if they are used at the end or in the middle. However, I am only giving guidelines rather than rigid rules here. It does no harm to experiment a little, and the invalid use of allophones sometimes gives the best results.

In a number of instances there are what seems to be duplications of allophones. This is where the lengths of the sounds and the emphasis is different. In general, it is the longer and "harder" versions of sounds that are used at the beginnings of words, with shorter and "milder" versions being used at the end or in the middle.

The example words indicate the normal position in a word that each allophone should occupy, although I must again emphasise that there are no hard and fast rules here. Where there are alternative sounds, it is worthwhile trying them all to determine which one sounds best.

Some of the shorter and "sharper" sounds work best if they are preceded by silence. As many of these are often used at the beginnings of words, this preceding silence will be provided anyway. However, where necessary a strategically placed brief pause (allophone 0 or 1) will improve results. The sounds which benefit from this are the B, D, and G ones (which only need short pauses), and the P, T, and K ones (which require longer pauses, possibly even allophone 2 instead of 1).

Pauses in general tend to be problematical. There is a natural tendency to assume that there are short pauses between words, longer ones between sentences, and no pauses anywhere else. In fact there are often few pauses between words, and some in between syllables of the words that do not easily trip of the tongue. When selecting pauses, or any allophones come to that, you should think in terms of what the phrase sounds like, rather than how it appears in written form. □

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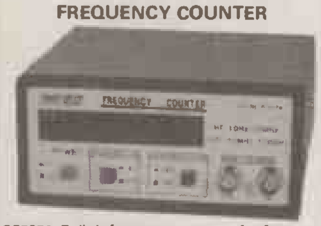
AC current 0-2m-200m-20Aac ±1.0%
DC current 0-200µ-2m-200m-20Adc ±0.5%
Resist 0-200-2k-20k-200k-2M-20MΩ ±0.15%
Capacitance 0-20p-200n-20µF ±2.0%
Frequency 0-20k-200kHz ±2.0%
Transistor hFE 0-1000 NPN/PNP
Dims 176 × 90 × 36mm

FREQUENCY COUNTER



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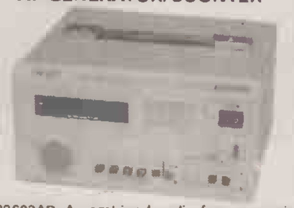

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Output impedance.......... 600Ω unbalanced
Output control.......... 0-20-40dB and fine adjuster
Output control:
Sine.......... 8V rms max
square.......... 10V p-p max

FREQUENCY COUNTER
Frequency range.......... 10Hz to 150MHz
Input voltage.......... Less than 50mV
Max input voltage.......... 3V
Input impedance:
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VHF.......... 50Ω
Power.......... 240Vac 50Hz
Dims.......... 215 × 150 × 200mm
Price.......... £175.00

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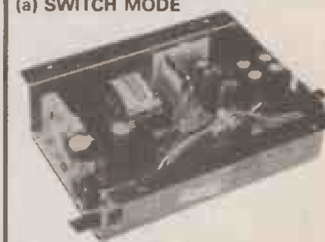

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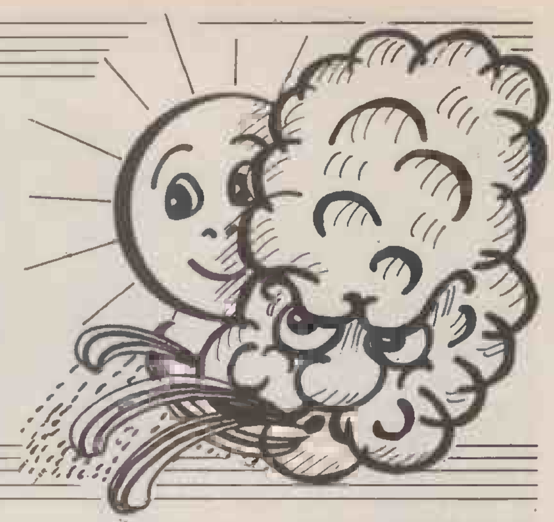
Constructional Project

ELECTRONIC BAROMETER



OWEN N. BISHOP

How to become your local Ian McCaskill and confound the experts.

THIS article describes how to build an instrument for measuring atmospheric pressure and how to use it for making forecasts of local weather conditions. It is based on the cheapest of the electronic pressure sensors currently available.

Readings are in millibars, over the range 950mb to 1050mb; with a precision of 2-3mb. This covers the whole normal range of atmospheric pressure. The Electronic Barometer has a memory circuit to retain the value of the previous pressure reading.

MEASURING PRESSURE

There are several units that are used for expressing atmospheric pressure. The oldest reliable technique for determining atmospheric pressure is to measure the height of the column of mercury in a mercury barometer. The height is usually expressed in inches, centimetres or millimetres. On these scales, atmospheric pressure is in the region of 30 inches or 76cm of mercury. Barometers of the aneroid pattern are often graduated on these scales, even though they work on entirely different principles and they have no mercury column.

Pressure may also be measured in pounds per square inch. This unit was more often used in engineering than in everyday life, though you may occasionally find a pressure-cooker with a gauge graduated in this unit. Average atmospheric pressure is about 14.7lb/in^2.

Nowdays all these units have been largely replaced by the scientific unit of pressure, the Pascal (Pa). A Pascal is a pressure of one Newton per square metre. On this scale, average atmospheric pressure is about 100000Pa, or 100kPa.

However, in meterology, the Pascal has not replaced an earlier pressure unit, the Bar. A pressure of one bar is equivalent to a pressure of 100kPa. Average atmospheric pressure is thus about one bar.

For convenience, atmospheric pressure is usually expressed in thousandths of a bar, or millibars. This is the unit used on the daily weather maps in the newspapers and on TV. This is the unit shown on the display of the Electronic Barometer.

Atmospheric pressure at a given location varies continuously, and this variation is usually associated with changes in the weather. At sea level, the pressure is unlikely to fall below 950mb. Pressure *can* fall lower than this during severe hurricanes but, with buildings collapsing around them, nobody is likely to be interested in reading barometers at such a time. Similarly, there is an upper limit of pressure at sea level which is about 1050mb.

If you live on a hill or a mountain, pressures are lower than those at sea level. This is because, as we go higher, there is less atmosphere above us. In addition, the density of the atmosphere decreases with altitude.

The reduction of pressure with altitude is therefore a complicated relationship. At lower altitudes, pressure falls by approximately 0.12mb for every metre above sea level. Thus pressures are 30mb lower at 250m above sea level.

You may need to take this into account when comparing readings taken with the barometer against pressures shown on weather maps, since the latter are usually corrected to what they would be at sea level. If you need to, it is easy to set the barometer to operate over a slightly lower range of pressures to allow it to be used at altitudes above sea level.

For weather-forecasting, the most important information a barometer provides is whether the pressure is relatively high or low, whether it is rising or falling, and whether it is changing rapidly or slowly. The exact level is not so important. If you intend to use the Electronic Barometer for local forecasting, it is unnecessary to calibrate it precisely or to allow for your height above sea level.

PRESSURE SENSOR

The pressure sensor used in this instrument is the Motorola MPX100A. Its action depends on a piezo-electric transducer, with a reference vacuum on one side of it and atmospheric (or other) pressure on the opposite side. Differences of pressure on either side of the transducer cause strain, resulting in a difference of potential across the transducer.

This potential *difference* appears across the two output terminals of the device ($V+$ and $V-$) and is referred to as the output(V_{out}) of the transducer. The difference of potential (or output) is linearly related to the difference in pressure. Typically, a pressure difference of 1000mb gives an output of 60mV.

Unfortunately there are some complications that must be overcome before this output can be used as an indicator of pressure. When the pressure difference is zero (0mb on both sides of the transducer) the output is about 10mV. This *offset voltage*, has to be subtracted from the output voltage before the pressure can be calculated.

Another complication is that the output voltage is dependent not only on pressure but on temperature. Typically the output drops by 0.19 per cent for every degree Celsius rise in temperature.

This may not sound much but it must be remembered that, when measuring atmospheric pressure, we are concerned only with relatively small variations of pressure. A temperature rise of, say, 10°C causes a drop of output of 1.9 per cent. In terms of pressure, this is equivalent to an error of 19mb in 1000mb.

As we are concerned with measuring pressure over a range of 950mb to 1050mb, a range of 100mb. Over this relatively small range an error of 19mb is very serious. A change of temperature due to a change of weather conditions could easily swamp any corresponding change in pressure rendering the readings of the instrument useless.

Temperature-compensated sensors are available but these are far more expensive than the MPX100A. One method of compensating for temperature with the MPX100A is by using suitable circuits incorporating a temperature sensor. This is not as easy to do, since the offset voltage is also temperature-dependent. Adjusting the circuit using this method becomes complicated.

The output from the sensor (V_{out}) is passed to a chain of three operational amplifiers which perform the calculations necessary to convert it into a voltage (V_c) suitable to drive the meter. The prototype uses a 50μA f.s.d. meter, with a series resistor to convert it to a 1V f.s.d. (approx.) voltmeter. The calculation performed by the circuit must therefore have three stages:

1) Find V_{out}, using an amplifier as a subtractor, to subtract $V-$ from $V+$. The result is V_A, which is very close to V_{out}, but may include small errors due to tolerances in components and the input offset voltage of the amplifier. The circuit compensates for these error at the next stage.

2) Add an offset voltage to compensate for the offset output of the pressure sensor at zero pressure (about 10mV), and for any small offset errors in the operational amplifiers. We also need a large offset voltage to allow for the fact that, when the pressure is 950mb, the output to the meter is to be zero. The total offset required is in the region of −67mV,

The following table shows the voltages at the two ends of the pressure range:

	Low end	High end	Difference
Pressure (mb)	950	1050	100
V_A (typical, mV)	67	73	6
V_B (mV)	0	−6	−6
V_C (mV)	0	1000	1000

To sum up, the equation that these amplifiers have to solve is:

$V_C = 167\,(V_A - 0.067)$ volts

Individual sensors vary to the extent that V_A may increase only 4.5mV or as much as 9mV for pressure increase of 100mb, so it must be possible to adjust the gain anywhere between 111 and 222.

MEMORY

As already mentioned, it is important to know whether and how fast the pressure is rising or falling. The old-fashioned aneroid barometer usually has a pointer mounted on its front glass, that can be turned

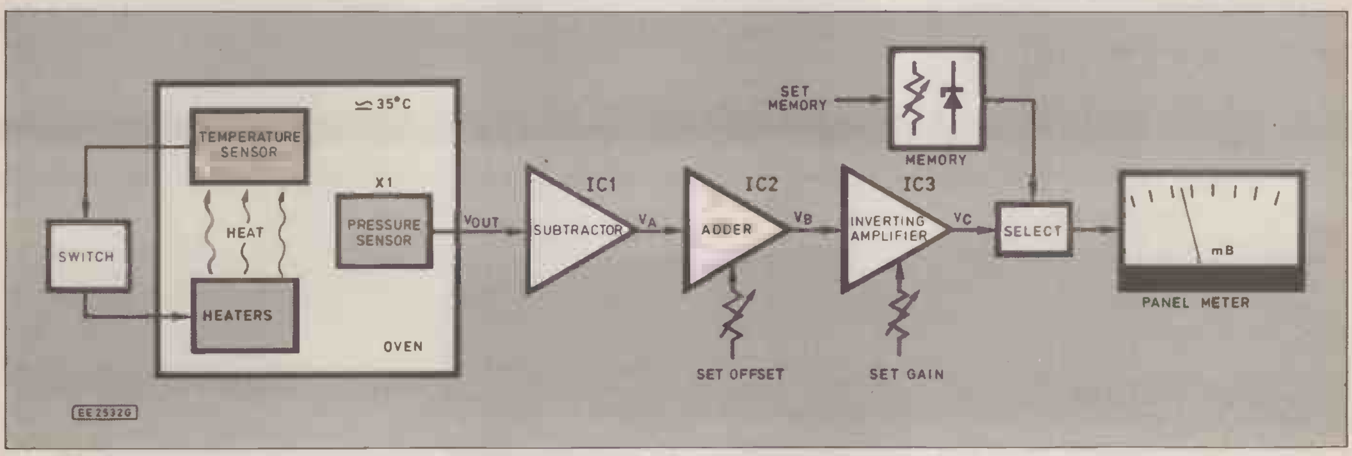


Fig. 1. System block diagram for the Electronic Barometer

In our instrument we adopt a much simpler technique. The sensor is enclosed in a "oven" in which it is held at constant temperature by a simple thermostat circuit. This eliminates the need for temperature compensation.

A third source of error is hysteresis. The effect of this is that, if pressure is increasing, the output for a given pressure is higher than it would be if pressure was decreasing.

Fortunately, this effect is manifest only for relatively large changes of pressure. When measuring atmospheric pressure we are dealing with only small pressure changes and hysteresis can be ignored.

Another factor that must be taken into account is that the magnitude of the output depends on supply voltage. In this circuit we regulate the supply voltage at +5V.

HOW IT WORKS

The system block diagram, Fig.1, shows the pressure sensor enclosed in its oven. There it is held at a constant temperature of about 35°C. The exact temperature does not matter provided that it is constant and that it is slightly higher than any temperature that the instrument may become exposed to during normal operation.

Owing to the heat generated by the transformer and circuit components, the temperature inside the instrument case will be a few degrees above room temperature. The temperature in the oven must be a few degrees above that.

though we must be able to allow for manufacturing tolerances when setting up the circuit.

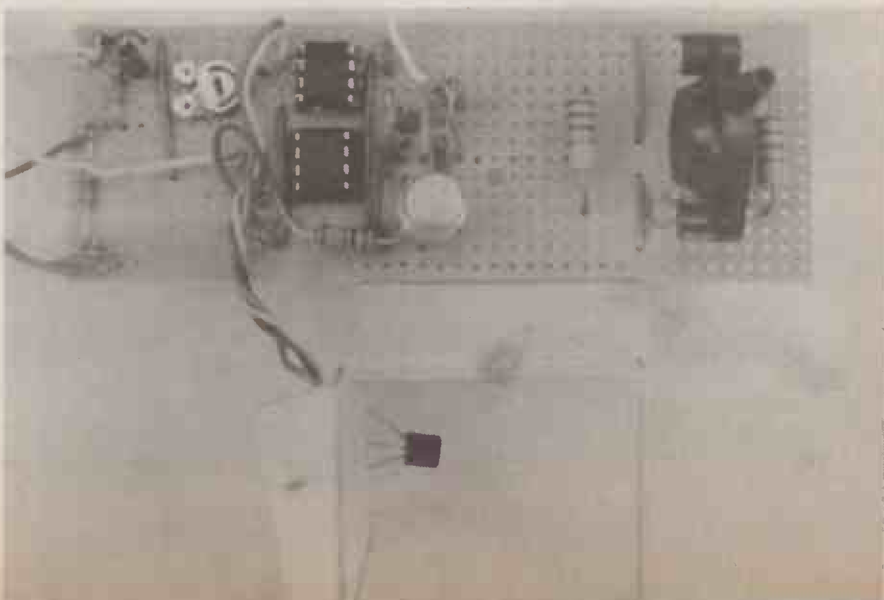
Addition is performed using an operational amplifier connected as an adder, with output V_B. Since the adder also *inverts* the sum, the output of the second amplifier is a negative voltage.

3) Amplify V_B so that while V_B changes from OV to −6mV, the input to the panel meter increases from 0 to 1V. For this we need a operational amplifier connected as an inverting amplifier with a gain of 167. The output of this amplifier is referred to as V_C.

manually to set it to the present pressure. On returning a few hours later, it can be seen what pressure change has occurred since the pointer was last set.

We have a similar facility in the Electronic Barometer. A variable potential divider is connected to the panel meter in place of the operational amplifier chain. The potential divider receives a stabilised voltage of 1.26V from a band-gap voltage reference.

The potential divider is adjusted manually until the meter shows the same reading as is currently being obtained from the amplifiers. The potential divider thus acts as a memory. When the barometer is



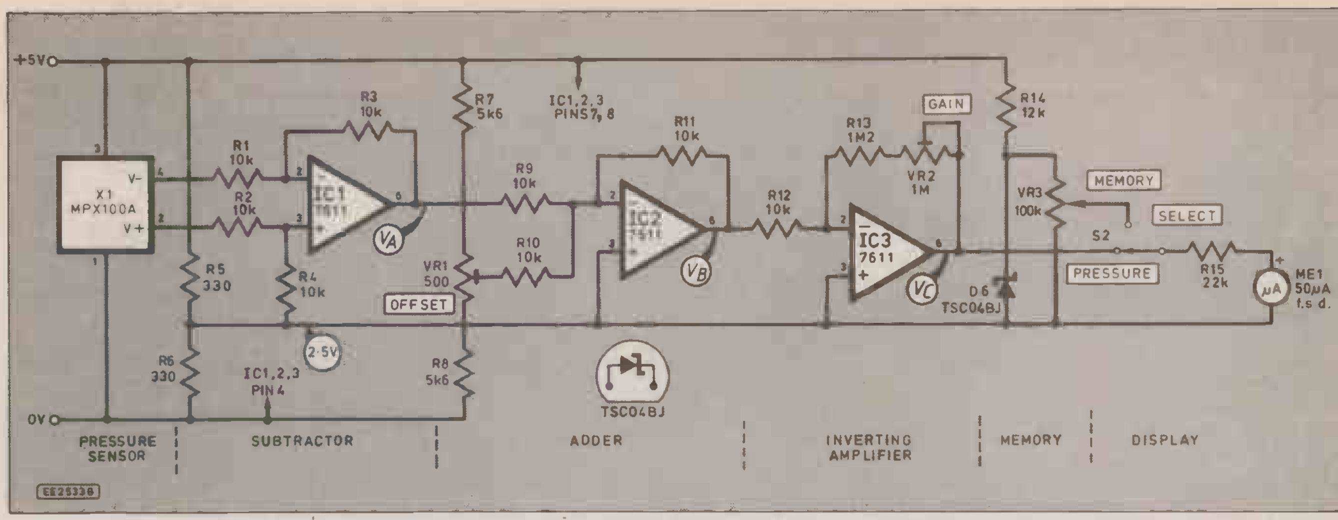


Fig. 2. Pressure-sensing and amplifying circuit diagram for the Electronic Barometer

next used, the reading from the potential divider will not have altered and may be compared with the new reading obtained from the amplifiers.

CIRCUIT DETAILS

The pressure-sensing and amplifying circuit for the Electronic Barometer is shown in Fig.2. IC1 calculates V_A. IC2 adds this to the voltage at the wiper of potentiometer VR1. This preset resistor is adjusted so that the voltage at its wiper is −67mV, or whatever value is needed to produce the required offset. A multiturn present potentiometer is used for VR1, so as to allow this voltage to be set precisely.

The output V_B from IC2 is the invert of the sum, $-(V_A - 0.067)$. IC3 amplifies and inverts V_A. For a "typical" sensor, VR2 is set so as to make the total of VR2 and resistor R13 equal to 1.67M, giving a gain of 167. Thus the output V_C is $167(V_A - 0.067)$.

The output from IC3 passes through switch S1, and resistor R15 to the positive terminal of the panel meter. Since all voltages are referenced to the 2.5V line (Fig.2) the negative terminal of the meter is connected to this line.

The meter used in the prototype was a microammeter with 50μA full scale deflection (f.s.d.). Resistor R15 converts it to a voltmeter with a f.s.d. of approximately 1V.

When 1V is applied, the current through the combined resistance of R15 and the meter coil (1.5k) is 42μA. Thus the voltage required for f.s.d. is a little more than 1V in practice. This discrepancy is taken care of by slightly increasing the gain of the inverting amplifier (IC3). Thus there is no need to use an expensive precision resistor for R15.

If you have a ready-made 1V f.s.d. voltmeter, use this instead and omit R15. If you have a microammeter with a different f.s.d., calculate the value of R15 from:

R = 1/(f.s.d.) − resistance of meter coil.

ANCILLARY CIRCUITS

The thermostat circuit for the oven appears in Fig. 3. The sensor gives an output voltage of 0.01V for each degree Celsius, above 0°C. IC5 compares this with a standard voltage set by preset VR4.

For a temperature of 35°C, the voltage at the sensor output is 0.35V. If the wiper of VR4 is set to produce the same voltage, the output of IC5 rises every time the temperature falls below 35°C. This turns on transistor TR1 and current flows through R18 and R19.

These resistors are rated at 0.5W and act as the heater elements. Note that the resistor current comes from a 12V source, so increasing the heating effect. This circuit maintains the temperature of the oven constant to less than half a degree Celsius.

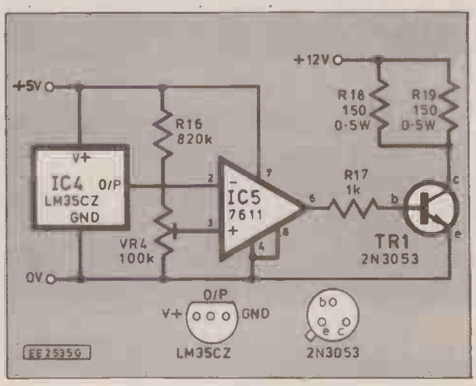


Fig. 3. Thermostat circuit diagram for the "oven".

The suggested power supply circuit is a conventional 5V regulated supply and is shown in Fig.4. It also supplies an unregulated 12V to the heater resistors.

The main circuit and display take about 50mA and the heaters take about 170mA. Other supply circuits giving similar output may be used instead. A heatsink is needed for the 5V regulator, IC6.

CONSTRUCTION

If you do not have a suitable bench power pack, begin by building the power supply circuit. Fig. 5 shows a suitable stripboard component layout and details of underside breaks in the copper strips. Alternatively, purchase a ready-made p.c.b. and the necessary components. The completed power supply must be safely enclosed to prevent the danger of accidentally touching parts at mains potential while building and testing the remainder of the circuit.

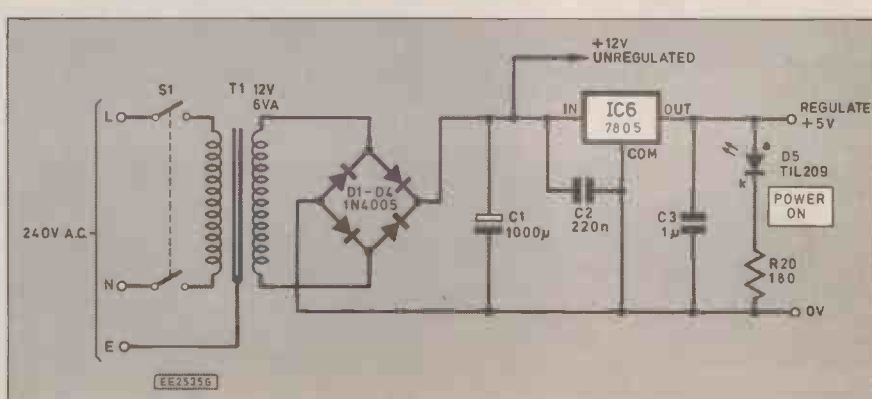
Begin the main circuit construction by building the sensor board, Fig. 6. This holds the thermostat circuit, the pressure sensor and the first of the op amps, IC1.

The oven consists of a cubical box made from stiff cardboard, Fig. 7. It has no bottom as it rests on the stripboard. *Note that the oven must NOT be made air-tight!* A flap along the bottom of the left side of the box has a hole in it so that the box can be secured by a bolt passing through the hole at *I*24.

Three pinholes are made in the left side near the top of the box. The three terminal wires of IC4 are threaded through these and bent as shown, so as to hold the body of the i.c. just above the heater resistor R18. Using a heatshunt, flexible leads are soldered to the three terminal wires of IC4 to connect it to the board at the points shown in Fig.6.

Test the heater circuit by switching on both the +5V and +12V supplies. The oven and temperature sensor should be in place over the pressure sensor and heater resistors. Adjust VR4 so that the voltage at its wiper is 0.35V.

Fig. 4. Suggested power supply circuit using a 5V regulator i.c.



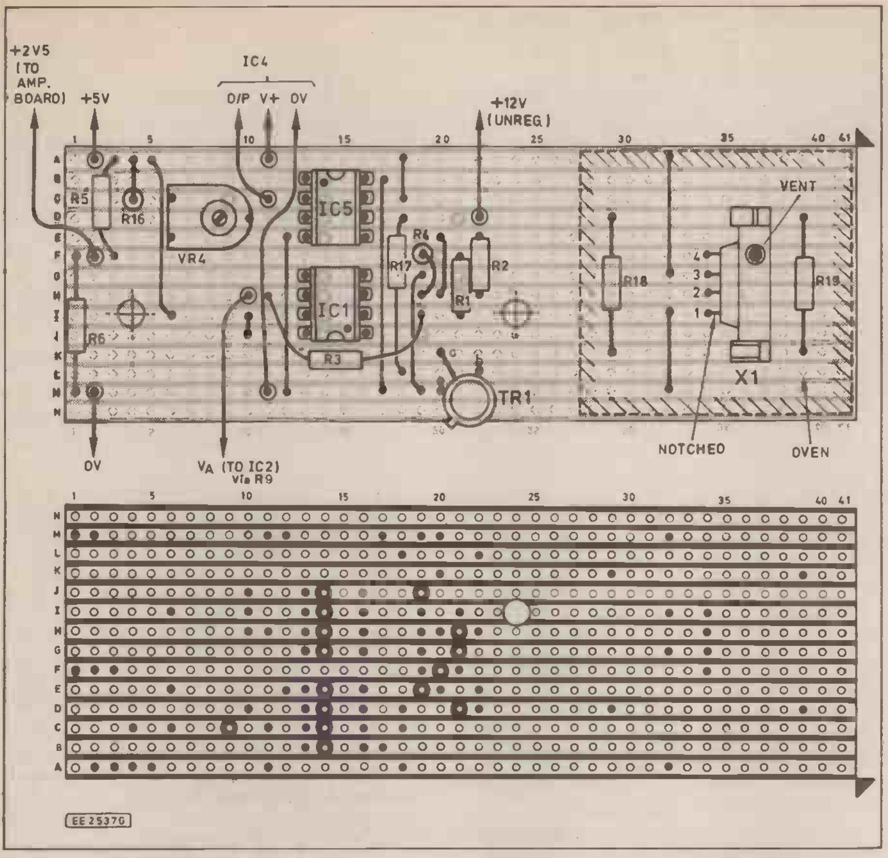


Fig. 6. Component layout and breaks in the underside copper tracks of the pressure sensing/amplifier board.

Use a voltmeter to monitor the output of IC4 (at pin *C*11 on the sensor board). This rises steadily until it reaches about 0.35V and then remains virtually constant. It may take five minutes or more to reach this state.

The functioning of the heaters can be checked by measuring the p.d. across them. Connect a voltmeter between the 12V supply and the collector of TR1. When the circuit is first switched on, the p.d. should be about 11V, indicating a current of just over 150mA. When the required temperature is reached, the p.d. falls and, from then on, ranges *slowly* between 0V and 11V.

The output from the pressure sensor X1 may now be checked. There was little point in checking it before because, even under constant temperature, it takes about five minutes after power is applied to reach a steady output state.

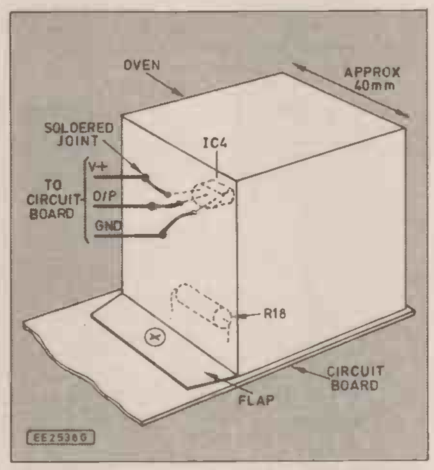
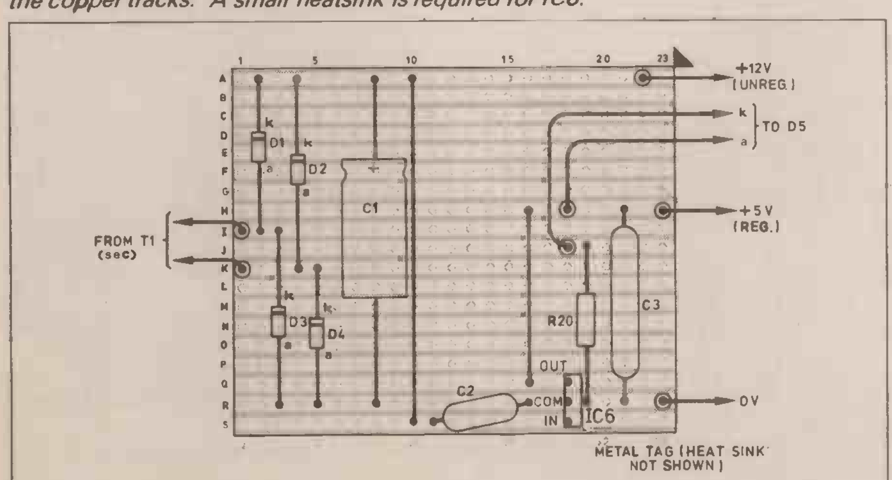


Fig. 7. Mounting the temperature sensor in the "oven".

Fig. 5. Stripboard component layout for the power supply. There are no breaks in the copper tracks. A small heatsink is required for IC6.



A voltmeter connected between the resistor lead at *H*22 (positive) and the resistor lead at *F*21 shows a voltage *difference* of about 50mV to 120mV, depending upon the characteristics of the individual sensor. A voltage equal to this voltage difference appears at the output (pin 6) of IC1, measured relative to the +2.5V line (pin *F*2).

COMPONENTS

Resistors

R1-R4, R9-R12	10k 0.6W metal film 1% (8 off)
R5, R6	330 0.6W metal film (2 off)
R7, R8	5k6 (2 off)
R13	1M2
R14	12k
R15	22k
R16	820k
R17	1k
R18, R19	150 0.5W carbon 5% (2 off)
R20	180

All 0.25W 5% carbon, except where stated

Shop Talk
See page 319

Potentiometers

VR1	500 multiturn cermet preset
VR2	1M sub-min. skeleton preset, horiz.
VR3	100k rotary
VR4	100k sub-min. skeleton preset, horiz.

Capacitors

C1	1000µ elec. 16V
C2	220n polyester
C3	1µ polyester

Semiconductors

D1-D4	1N4005 rect diode (4off)
D5	TIL209 l.e.d. (or similar)
D6	TSC04BJ 1.2V band-gap voltage reference
TR1	2N3053 *n.p.n.* silicon
IC1-IC3, IC5	7611 CMOS op. amp (4 off)
IC4	LM35CZ temp. sensor
IC6	µA7805UC +5V 1A voltage regulator
X1	MPX100A pressure sensor

Miscellaneous

T1	12V 6VA mains transformer
ME1	50µA f.s.d. moving coil panel meter
S1	DPDT mains toggle switch
S2	2-pole 6-way rotary or s.p.d.t. toggle switch

Stripboard, 0.1 in. matrix 41 holes x 14 strips, 25 holes x 17 strips and 23 holes x 19 strips; 8-pin d.i.l. sockets (4 off); 1mm solder pins (20 off); metal diecast case, size 220mm x 150mm x 65mm; stick-on feet (4 off) knobs (2 off); card for making oven; nuts and bolts for mounting T1 and circuit boards; connecting wire; mains lead and plug; heatsink; solder etc.

Approx cost. Guidance only **£52**

ADDER/ INVERTING BOARD

The other two amplifiers are built on a separate board (Fig.8) which is later mounted on the back panel of the instrument case. Holes bored in the back panel allow screwdriver access to VR1 and VR2 so that the circuit may be adjusted while the case is closed.

After mounting the components on this board, make the necessary inter-board connections. (+5V supply, 0V line, +2.5V line, V_A). Switch on the power and wait five minutes for the sensor to stabilise. Check the value of V_A at pin *B*3 (on the amplifier board), relative to the +2.5V line. Adjust VR1 until the voltage at its wiper is −0.067V (relative to the +2.5V line). The output of IC2 now shows the value of V_B, which is between 0mV and −6mV.

TESTING

To convince yourself that the circuit is working, remove the oven temporarily and attach a length of plastic tubing (e.g. aquarium air-tubing) to the vent of the pressure sensor. Connect a voltmeter to measure V_A and then blow gently into the tube.

A small but appreciable increase of voltage should be indicated. Conversely, sucking gently on the tube causes a decrease in V_A. Repeat this, measuring V_B, which should show a decrease with increased pressure and an increase with decreased pressure.

Now connect the voltmeter to measure V_C (pin *G*25). Adjust VR2 so that the output is about 0.5V, to give a mid-scale reading. Blowing and sucking now causes the needle to swing rapidly across the voltmeter scale.

CASE

Bore holes in the rear of the case for the bolts supporting the amplifier board and to allow access to VR1 and VR2. For the type of panel meter specified, cut a circular aperture in the front panel for the body of the meter and four holes for the fixing bolts.

Drill holes in the front panel for the switch S2, the potentiometer VR3, and l.e.d. D5. Mount S2, VR3 and D5 on the front panel. Mount the panel meter and complete the off-board wiring connections as shown in Fig. 9.

Remove the graduated scale from the meter and paint out the numerals and the legend "microamperers", using Tippex typewriter fluid or other "liquid paper". Re-number the scale from 950 to 1050, using rub-down lettering. Add the legend "Millibars". Replace the scale in the meter.

BENCH TEST

Switch on, select "Pressure", and allow at least 20 minutes for the heaters to warm the oven and for the pressure sensor to stabilize. Set VR2 to the centre of its track. If you have access to a reliable Barometer, read the pressure in millibars. Calculate what V_A should be:

1013mb = 760mm of mercury = 29.9in of mercury

V_C = (pressure − 950)/100 volts

Adjust VR1 until V_C (relative to the =2.5V line) equals this value.

If you do not have access to a barometer, estimate your local pressure from a weather map (on TV). The display shows the pressure you have just set in millibars.

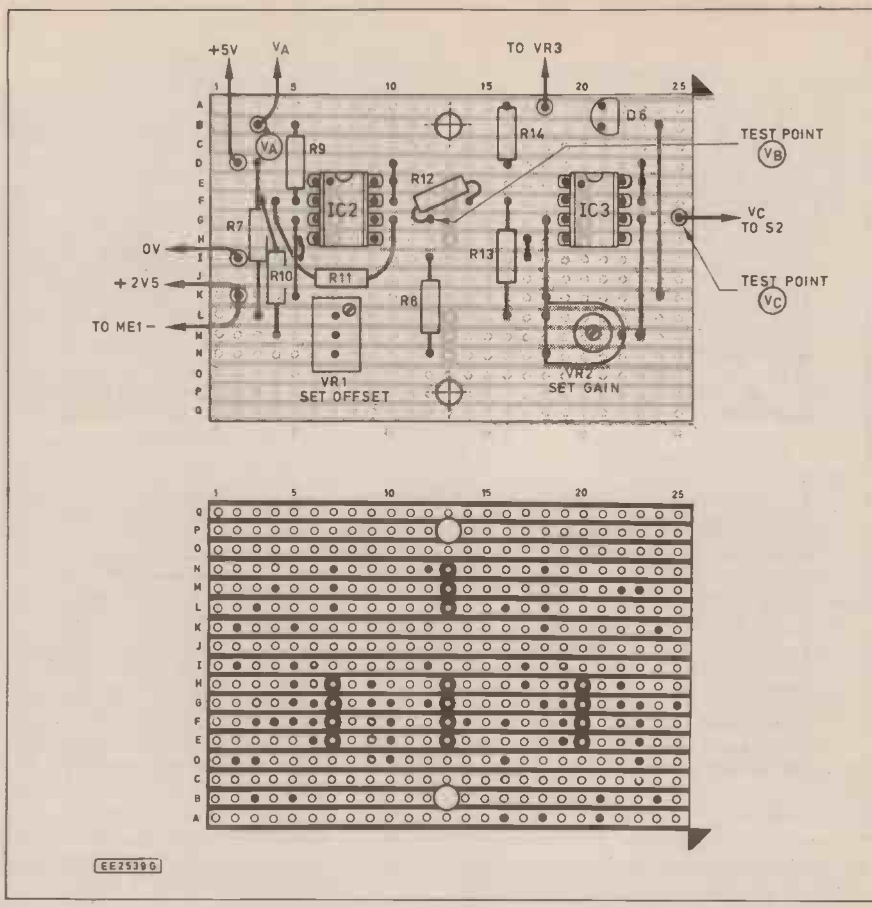
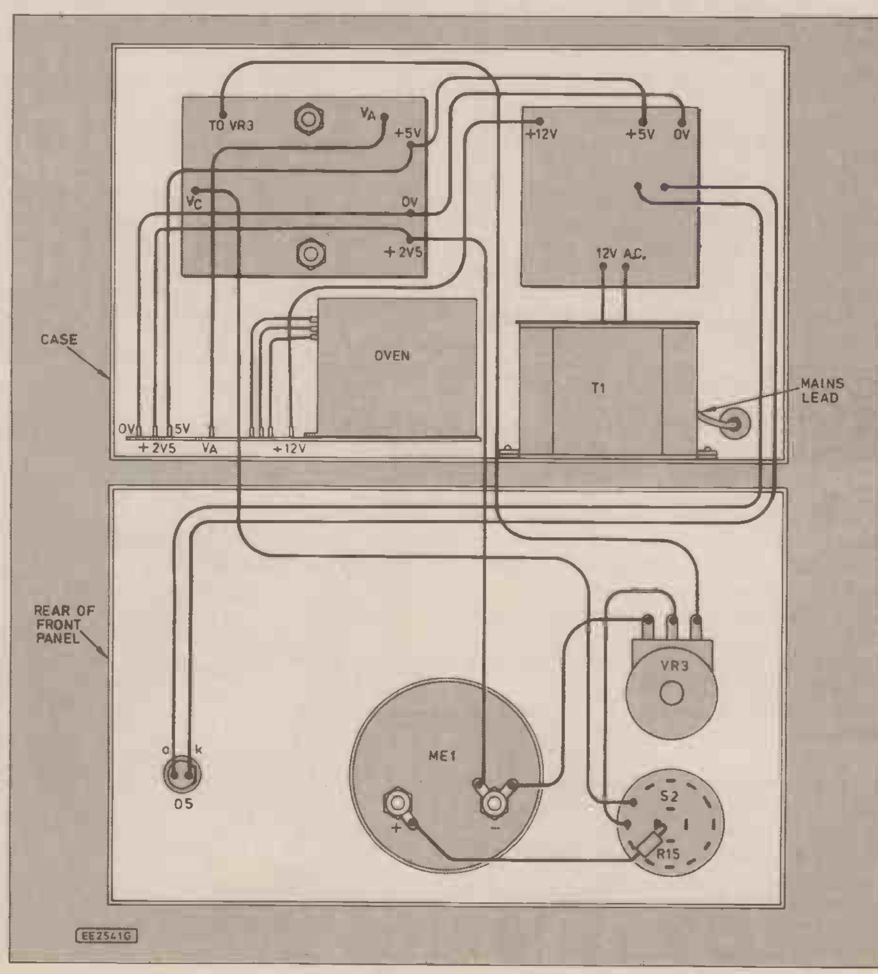


Fig. 8. Component layout and details of breaks in the underside copper tracks of the adder/inverter board.

Fig. 9. Interwiring to the three boards and off-board components.



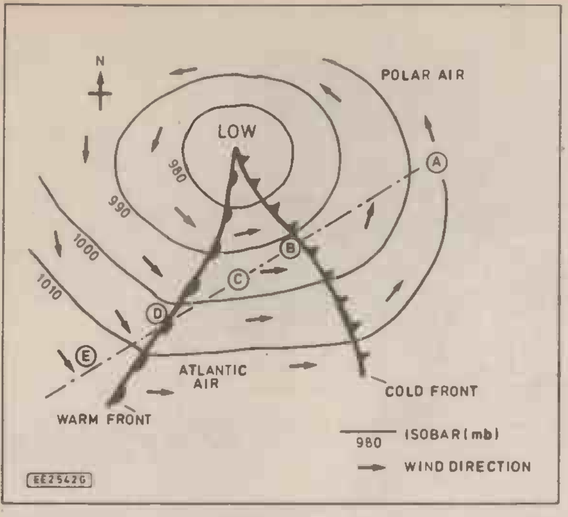


Fig. 10 (left). Example "weather map" showing low pressure or depression region.

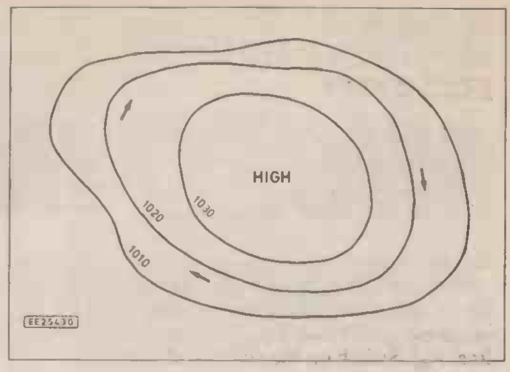


Fig. 11 (right). Example of high pressure or anticyclone region.

Turn switch S2 to "Memory". As you turn preset VR4 it is possible to make the display change over the full scale from 950mb to 1050mb.

Keep the barometer switched on permanently for the next few days. Make records of its readings at given times and compare these with those you obtain from another barometer or from weather maps.

You will probably find that the gain setting is too high or too low. The effect of this is that, for example, pressure increases by 20mb, as shown by the other barometer, but the readings of the Electronic Barometer increase by only 16mb. The gain is too low: adjust VR2 accordingly, turning it slightly clockwise. Or maybe the barometer shows an increase of 27mb; in this case the gain is too high and VR2 must be turned anti-clockwise.

At this point you may find that, with VR2 turned fully one way or the other, it is not possible to set the gain to the required amount. This is due to manufacturing variations between individual sensors. If so, remove resistor R13 and replace it with a resistor of higher or lower value.

After these adjustments, the barometer may now be showing the right amount of *change*, but its readings may be overall too high or too low. Adjust VR1 to offset the readings by the right amount. you may need to adjust VR2 and possibly VR1 again slightly over the next few days but, after that, the barometer will have been calibrated sufficiently closely for normal use.

LOCAL WEATHER FORECASTING

Although one can not hope to compete with the vast technological resources of the official meterologists, a barometer can provide a remarkably reliable forecast of local weather in the short term. As mentioned before, it is the *changes* in pressure that count most.

First of all, here are some simple forecasts:

***Pressure falling** — expect cloud, rain (snow or sleet in winter).*

***Pressure rising** — expect fine weather (possibly clear weather with frosty nights in winter)*

***Slowly changing pressure (or no change)** — weather continuing as at present, light winds or calm.*

***Rapid change in pressure (rise or fall)** —forecasts strong winds and rapid changes from the existing weather.*

The rules above do not apply in all circumstances and, for a more reliable forecast, we need to take wind direction into account. There are two types of weather system in the region of the British Isles, the *depression* and the *anticyclone.*

DEPRESSION

A depression is a region of low pressure and is associated with a region of warm moist Atlantic air being partly surrounded by cold dry Polar air (Fig 10). The borders between the two air masses are referred to as a warm front and a cold front. Depressions vary in size — a large one is more-or-less the same size as the British Isles. Normally they move across the country from south-west to north-east. On occasions, though, they may change direction, halt, or even move in the opposite direction, which unpredictability may result in somewhat red faces among the weather-people.

Assuming normal behaviour, if you are at a point A (Fig 11) you may expect the following weather sequence over the next several hours as the depression passes by (the diagram shows you travelling SW through the depression - which gives the same sequence):

A Pressure falling, becoming cloudier, clouds becoming lower, wind becoming stronger and veering (i.e. changing direction clockwise) from SE or SW to westerly.

B The warm front arrives, warmer but "muggy", pressure still falling, winds veer abruptly, rain (snow or sleet in winter).

C Pressure reaches a minimum and starts to rise again. Clouds may clear but then reappear.

D The cold front arrives, cooler but less "muggy", winds stronger and veering again, to NW or N, rain, though possibly less than before.

E Pressure rising, clouds clearing, dry fine weather.

With a little guidance from recent weather maps, you should be able to work out where you are in relation to the next depression and to forecast what weather to expect next. One of the big problems of the weather forecasters is that depressions behave erratically and do not always reach the predicted location at the expected time.

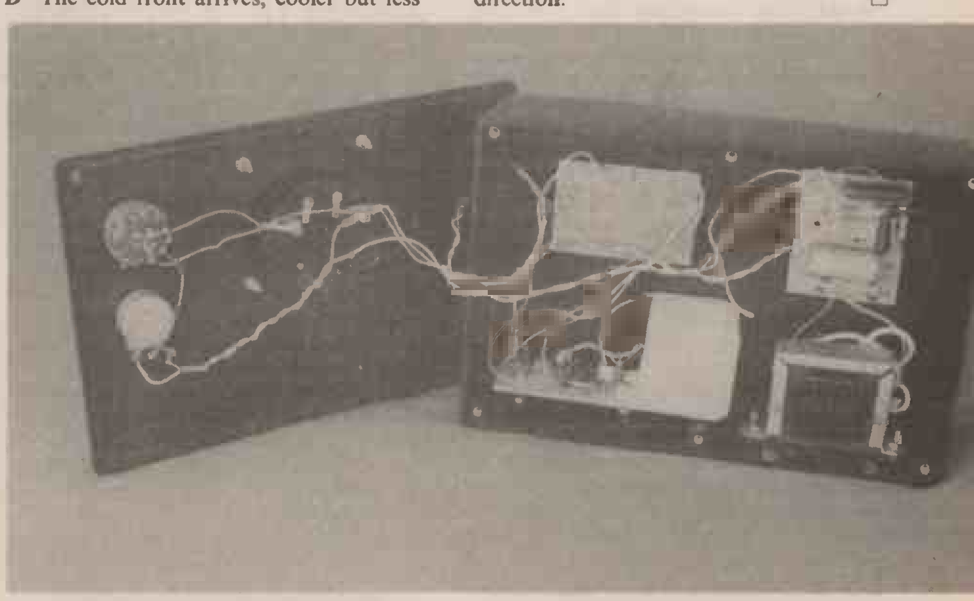
This is why rain often comes before or after it is officially forecast. Using your barometer you are able to watch the actual progress of the depression and to know more exactly when the predicted weather changes will occur, if at all.

ANTICYCLONE

An anticyclone is a region of high pressure (Fig 11). Weather is usually good in such conditions. Clear skies, and bright sunny days in summer — with cold frosty nights in winter. Winds are usually none or light.

Anticyclones often stay around for several days at a time before they finally move away and the weather changes. The winds circulate in a clockwise direction so, by observing your local wind direction and the changes in pressure, you will be able to work out your position within the system and which way the anticyclone is moving. This will tell you if the good weather is likely to continue and for how long.

The description above is over-simplified but it will help you to get started with the fascinating hobby of predicting your local weather. There are several popular books available that will take you further in this direction. □



Special Series

MICRO IN CONTROL

JOHN HUGHES

Part Six

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

Now we are starting to get close to the real microprocessor area – let's look at counting circuits and control logic.

EXERCISE 13

Dividers and Counters

T Look carefully at the relationship between INPUT and OUTPUT pulses for the 7476 flip-flop. Each input pulse only causes HALF an output pulse, in our case DOWN, then UP. Because of this, a flip-flop like this is sometimes called a BINARY DIVIDER circuit, because it takes two input pulses to produce each output pulse (Fig. 6.1).

S *That's why we need binary arithmetic.*

T Right again. We work in steps of two because the chips do so. Most of you are probably familiar with binary numbers, but just in case, we'll write them down as we go along. We've already seen that there are only the two DIGITS 0 and 1 that we can use. They can represent 0 volts and 5 volts respectively, also OFF and ON. They could be made to represent any TWO-STATE system, couldn't they?

Let's get on with our exercise, and bring the second 7476 flip-flop into use. We'll just take the output of the first one to the clock input of the second (leave the indicator connected and add an extra indicator to the new output. Let's label the outputs QA and QB. OK?

S *And ignore "NOT QA" and "NOT QB"?*

T For now, yes. Now wire it up and send it some pulses as before from the de-bouncer (Fig. 6.2).

S *It's dividing by two again / by four now.*

T That's right. Our two indicators (remove the one from the 7400 now) are counting "nought . . one . . two . .three . . nought" if you watch them, thus (writes table):

Counting Pulses

ordinary (denary numbers	BINARY numbers QB	QA
0	0	0
1	0	1
2	1	0
3	1	1
4 (same as 0)	0	0

T It makes sense now to start with column A on the RIGHT as this is how we normally deal with numbers. Then the right-hand column is UNITS, the next (B) is TWOs, and so on.

S *They keep going round and round.*

T Yes. Could we go beyond 3?

S *Only with more flip-flops.*

T Right. If you wish you could add another 7476 and link it in to count up to . . .?

S *(eventually) 16. No, 15.*

T Right again. However, guess what? The chip makers got there before us and made chips with four or more stages in them. We'll now look at a "four bit counter" the 7493.

S *This will give Fours and Eights / C and D columns.*

T Exactly. Let's see the pin-out for the 7493 (Fig. 6.3). Having spotted the power pins 5 and 10, notice that there are four output pins, as expected, but only two in-

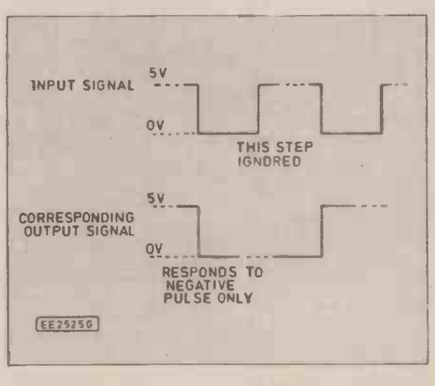


Fig. 6.1. Behaviour of binary divider

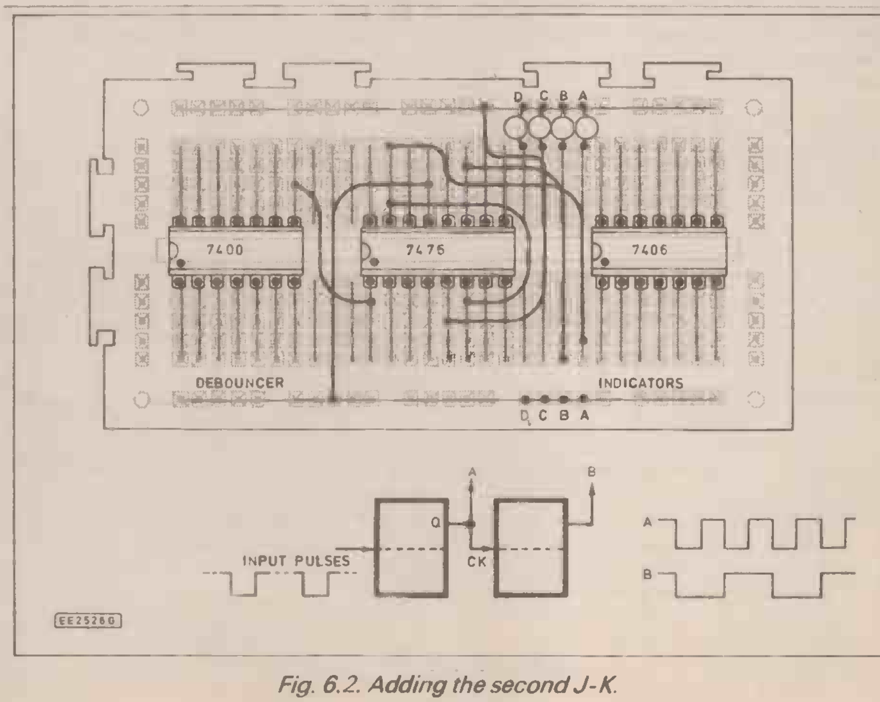


Fig. 6.2. Adding the second J-K.

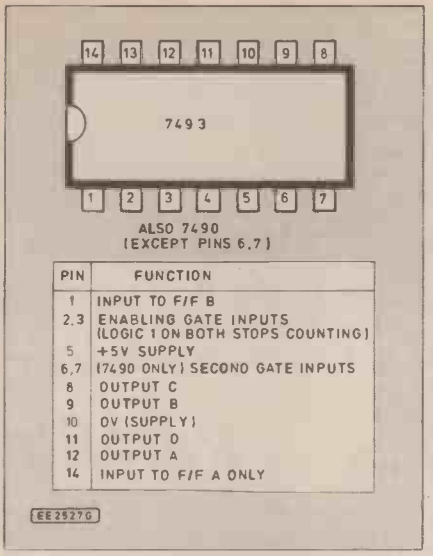


Fig. 6.3. The 4-bit binary counter.

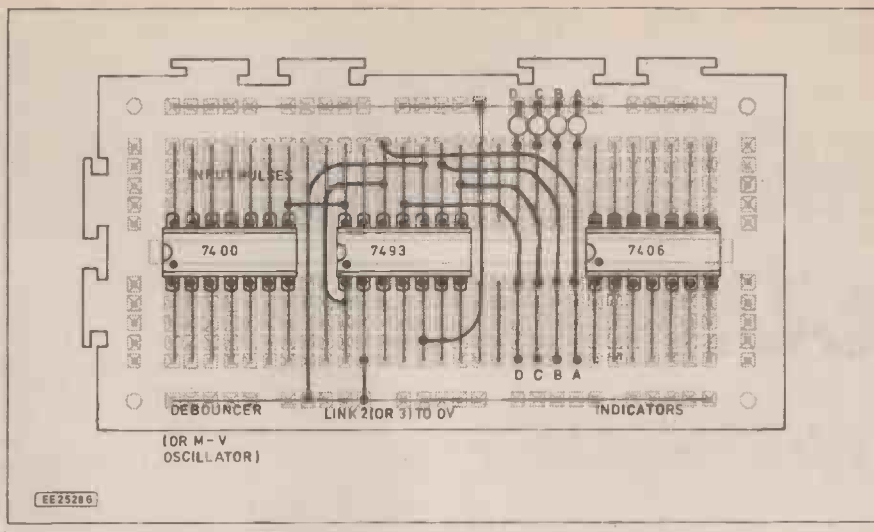


Fig. 6.4. Checking the binary counter.

put pins. There are also a couple of "gate" pins (2 and 3).

The chip is labelled as "divide-by-two and divide-by- eight", which means that, to increase its usefulness, the makers have put into it a single binary divider (input pin 14, output 12), and three more dividers linked internally together, so that only the first input, B, is needed (pin 1). The outputs B, C and D are marked as pins 9, 8 and 11 respectively.

S *Does "NC" stand for "no connection"?*

T Yes, there are some unused pins.

Now insert the chip carefully as usual in the space I hope you left in the middle of your board (Fig. 6.4) and add the links as shown. Thus we take our pulse input from our debounced switch to pin 14. (A "biased" switch, one which springs back when released, or a push-button, is easier to use here).

S *What about input B? Does this go to the output of A?*

T Yes. It can also be taken to indicator A, and you can link outputs B, C and D to their indicators.

S *Inputs C and D are presumably connected already, inside the chip.*

T Right. Don't forget power links, by the way.

S *Do we need to connect the "gates" you mentioned?*

T They are alternatives, so we'll need to connect either one of them in order to "enable" the chip. They provide a valuable facility in that we can stop the chip by means of these gates if we need to. For now, link one of them to logic 0 (the 0V line, as shown).

Now we're ready to switch on and go. Try a few pulses to see what happens. Is it as you'd expect?

S *(mostly) Yes, it seems to be counting in binary.*

T We'd better write down the patterns to make sure:

Number of input pulses	Output pattern D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
16 (same as 0)	0	0	0	0 ...and so on

S *It goes round as before. We could add more stages to count further, I suppose.*

T Quite. Practical circuits would clearly need to do this, wouldn't they? However, there are a few points worth noting at this stage.

The first is that, in order to represent ALL the common digits (0 to 9) of our familiar denary system, we MUST have all four columns A, B, C and D. Three columns would only get us up to . . .?

S *Seven (I nearly said eight).*

T Yes. Of course, nought to seven is eight numbers, if we count zero, as we must.

Now, if we were designing a pocket calculator, for example, we would need counters for each digit which stop at nine, wouldn't we?

S *Yes. Could we use the gates to stop it at that point?*

T Exactly. In fact, let's try. Add the links shown in Fig. 6.5. Can you see what they do (we hope)?

S *(after some thought) They remove the logic 0 on both gates when the counter reaches ten, and stop it moving on beyond nine.*

S *(another), Because of the logic 1 on pins B and D.*

T Spot on. I see some of you have it working now. This kind of counter is called a BCD counter. It stands for "binary-coded-denary" (or decimal) and is widely used.

S *I suppose there's a chip for this, too.*

S *(another) I've found one in the data sheet, 7490. They call it a decade counter.*

T OK. There's also a divide by twelve counter. But let's proceed. In computers, there's no need to limit the chip in this way (at least, not until it needs to talk to us humans) and the full counter is quicker for long calculations. This brings us to HEX notation.

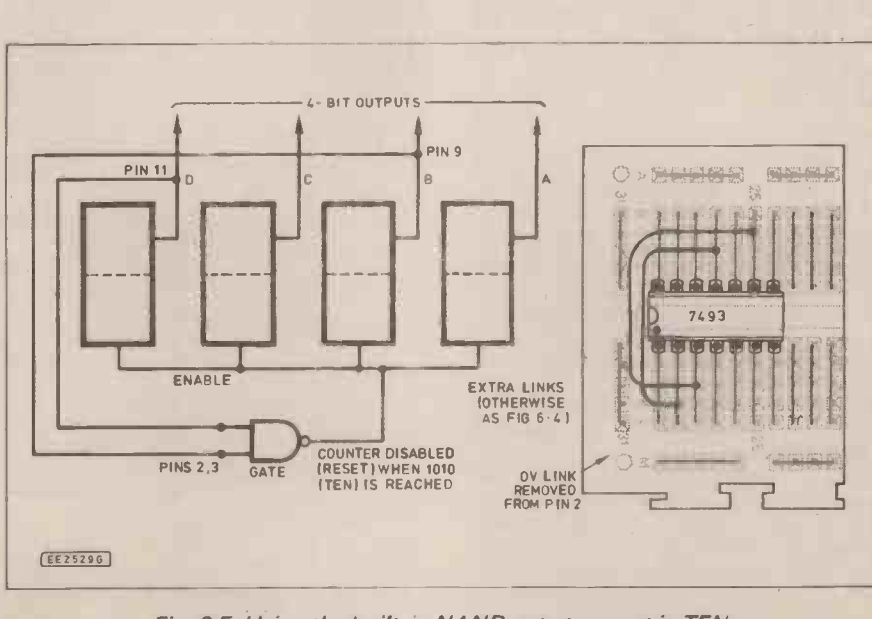


Fig. 6.5. Using the built-in NAND gate to count in TENs.

S *Sounds like witchcraft.*
T Behaves like it, too, at times! The point is, we have a four bit chip available, and the idea of this new and useful notation is to keep all its possible output values in a single "column", by introducing extra symbols for the last six values (the ten, eleven, etc., which get two columns in ordinary notation).
S *I could suggest some smashing new symbols.*
T I bet. Unfortunately, the mathematicians who work in this area got there first, and just used the first six letters of the alphabet. Thus A represents ten, B eleven, and so on.
S *Up to F for fifteen, then?*
T You might like to write them down. You could fill in an extra column in the earlier table, reading "1,2,3,4,5,6,7,8,9 . . . then?
S *"ten, el . . , NO. A,B,C,D,E,F"*
T Good. We may find HEXADECIMAL (hex for short) arithmetic useful from time to time. Don't forget it.
S *Are there any more special counter chips?*
T Many. It's easy to make a counter count backwards. By linking the NOT Q outputs instead of the Q outputs to the next stages, for example. A "down counter" has many uses in calculating circuits. Switching by gates between up and down counting is also useful. And they can have more than four bits, of course.
S *Some computers use 16 or 32 bits nowadays.*
T Sure. For control purposes we won't need so many. In fact we'll probably find an eight-bit micro is plenty to cope with.
S *Can we connect our clock to the counter?*
T Why not, indeed. You could spend some time now re-checking some of the circuits we've just discussed, and perhaps trying some of the other counter chips we mentioned.

EXERCISE 14

Logic Control Examples

T It's time we tried to apply our grasp of logic to a control system example. Let's start with an easy one. Do you still have the small motor and battery that we used to test the relay circuit?
S *Yes, and mine still works. Look.*
T Good. Now what I'd like you to consider is this: Can you make the motor run only after a number of buttons or switches have been pressed in the right order?
S *I could do the first part (without the "right order") by using AND gates. / or NANDs*
S *(another) With a bistable, to keep it ON when the buttons have been released.*
T That sounds OK to me. I assume you could draw a diagram of your system.
S *Yes, but I'd need to have more details, such as:*
- *How many buttons, and in what order?*
- *Does the motor run on logic 0 or logic 1?*

S *(another) That second one doesn't matter. It's up to you, isn't it. You choose in your design.*
T Well. you both seem to be clear about starting. Perhaps we should set ourselves a specific task as a starter. Let's say THREE buttons or switches (and don't forget you can "dab" a wire to logic 0 for testing), and let's say A has to be pressed first, then B and C TOGETHER, to start the motor.

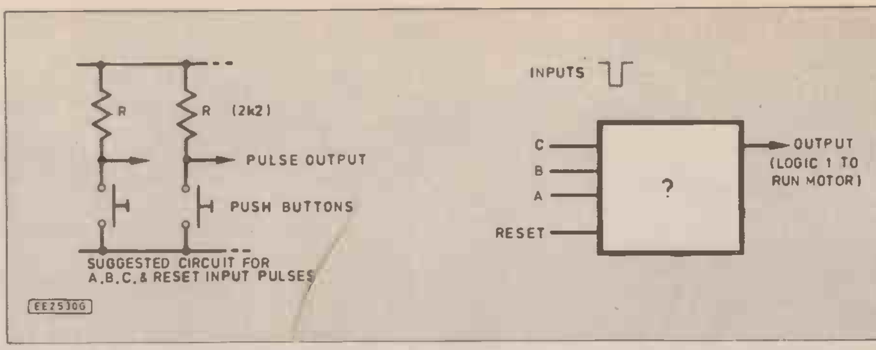


Fig. 6.6. Motor control example. To start the motor, A must be pressed first, then B and C together.

S *The letters don't matter. We could relabel them.*
T Quite, though in a real system, the same buttons might be used for many functions.
S *Like a telphone dialling pad.*
T Just so. Let's suppose, too, that our motor drive circuit (the one with the relay in it, OK?) switches the motor ON when it receives an input at logic 1 (at 5V).
Then we could start as we did with the electronic lock, by drawing a box and seeking to work out what to put in it (Fig. 6.6).
S *Will the inputs be normally at 0 or 1?*
T As one of you said, it's up to us. I suggest we adopt a widely-used method of having them all at logic 1, with a button to pulse each to logic 0 when pressed (momentarily, that is).
S *We'll need debouncers, then.*
T It's possible, though a simple bistable, as we've seen, does its own debouncing. It's only when actually counting (using the clock pin) that we need "clean" pulses. I'll leave it to you for now.
S *We'll need an AND (or NAND) for B and C.*
S *(another) and a flip-flop to hold the output ON.*
S *(another) What about a "reset" button to stop it?*
T That sounds like something we should add to our specification, doesn't it? Right, we'll have a fourth one. Can you try filling in the box, now? I'll add my version, and we can compare them (Fig. 6.7).
Now I think we could try it out.
S *We don't really have to use the motor. One of the l.e.d. indicators would do.*
S *(others) A motor's more fun / lazy so-and-so / etc.*
T You're probably right, and most systems are tried out using bread-board techniques at first. But there does come a time when the system has to work in the real world. Then we MAY find extra difficulties, such as unexpected pulses from interference sources, mechanical time delays, and other snags.
I agree with those who think it's fun to use a real motor if you have one handy, but most of the time we may be stuck with indicators only. Either way, carry on and check it now.
S *(later) Can we discuss how it works?*
T I agree, we should. Anyone start us off?
S *I started by realising that a bistable is needed to keep the motor on . . . and off.*
S *(another) Yes, and it has to be SET by a logic 0 pulse, and this has to be controlled by a gate. It took me some time to see which kind, though.*
T Yes. You will have realised that, in a sense, an OR gate behaves like an AND for logic 0, doesn't it? You ONLY get logic 0 out when both A AND B inputs are also 0. Some designers use such "inverse logic" a great deal.
S *(others) Then we need a second bistable to make it necessary to follow the correct sequence. / and another OR gate. / the RESET button puts the motor flip-flop OFF.*
S *And the second flip-flop needs resetting, using the pulse from buttons B and C / the one that starts the motor.*
T You seem to have it well sorted out. Bear in mind that all the pulses are to logic 0, and notice that the Q output gives logic 1, so we use the complementary output of the second bistable.
S *I used the other output, but swopped the SET and RESET signals.*
T Again, there are more ways . . . Well done.

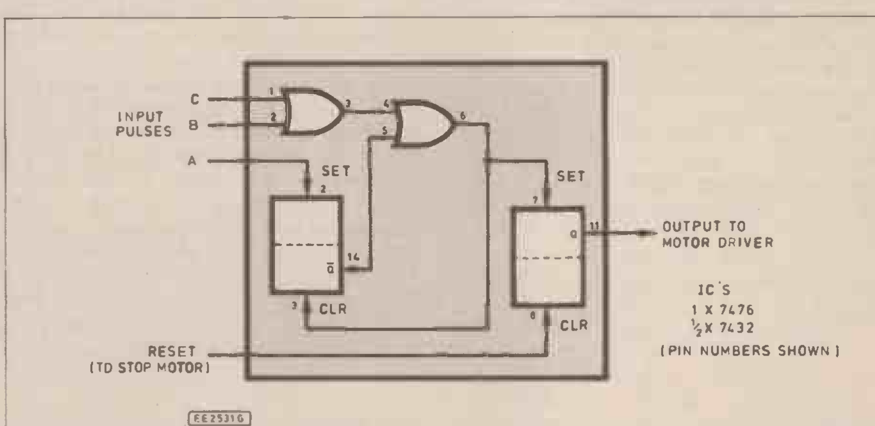


Fig. 6.7. Suggested logic system for motor exercise. It may be preferable to use reset signal to clear both bistables. (Remember power supply links to i.c.s.).

EXERCISE 15

Going up? (or down?)

T The control of a lift provides an excellent example for us. It can be more complex than might at first appear, and we may wish to go back to the days of the lift operator! However, let's see how far we can get.

As before, we need an exact specification, then we must agree on details of input and output signals. Both these, in practice, would naturally reflect the "state-of-the-art" in both electronic and mechanical design, including the vital considerations of safety and of cost.

S *And appearance, noise, and so on.*

T Yes, and even whether the stairs would be better for our physical well-being! Fortunately, we can limit our design features to keep life fairly simple today. Let's start with the lift spec.

Specification: It should work between two floors to start with, but provide for a third (or more) afterwards. Each floor will have a CALL BUTTON, and, of course, the lift must not move unless all doors are closed.

S *Do we need buttons inside the lift?*

S *(another, after thought) No, because they only do what the external buttons do and could have the same circuits.*

T I agree. Perhaps, on our model, we can also do without internal doors. In fact, the model lifts we have knocked up to give you something to work on are virtually "two-dimensional" as you'll see.

S *Because we don't need to carry a real load?*

T Quite. But we shall need call buttons. Anything else?

S *We'll need some sort of sensors to detect when the lift reaches each floor. / and if the doors are closed / and if the lift goes too high or too low / or too quickly for safety / signal lights / etc.*

T Good points, all of them. Duly noted. Our next task (**next month**) will be to list the INPUT and OUTPUT SIGNALS required. And, if some of you wish to build you own lift model (a challenging and worthwhile project), I'll describe some of the features of our version (and how it might be improved).

SHOP TALK

with David Barrington

Amstrad CPC Speech Synthesiser

No matter what permutation we tried when pricing up the parts for the *Amstrad CPC Speech Synthesiser* we were unable to come anywhere near the price being offered by **Greenweld** (☎ *0703 772501*) for a *complete* kit (including p.c.b. but excluding case). We think that at £10.95 (plus £2 p&p) it's got to be a bargain. This price includes an extra Free speech chip!

A suitable case will only cost £3 and the SP0256-AL speech chip £2.50 when purchased separately. (The nearest price for the speech i.c. we found was £5). **Greenweld Electronics, Dept EE, 443D Millbrook Road, Southampton, SO1 0HX.**

The 3.2768MHz crystal is to be found in most catalogues under the "Timing" Crystals" section for timekeeping or use in quartz clocks. Satisfactory results should be obtainable from crystals using a frequency from 3MHz to 3.3MHz.

The printed circuit board for the Amstrad CPC Speech Synthesiser is available through the *EE PCB Service*, code EE689 (see page 356).

Electronic Barometer

Quite a few of the components used in the *Electronic Barometer* can be classed as special items, and therefore most likely to cause purchasing problems locally.

The only source to date that we have been able to find for the TC04JB band-gap voltage reference is from **Electromail** (☎ *0536 204555*), code 283-564. If constructors experience any difficulty in locating the ICL7611 CMOS i.c.s, the same company carry stocks. Also **Grandata** are able to supply this CMOS op. amp.

The heart of the barometer circuit is the "pressure sensor" and this device was purchased from Maplin, code UH37S (MPX100AP). The MPX100AP sensor cost £13.95 so care should be exercised when handling and soldering this device on the stripboard. Double check that it is the correct way round before finally soldering it in position.

When ordering the LM35CZ temperature sensor i.c. it is important to ask for the Centigrade version, designated with the letters **CZ**. The one in the prototype was obtained from Maplin, code UF51 (LM35CZ) £5.25.

Provided the meter movement is rated at 50μA full scale deflection (f.s.d.), practically any moving coil meter will do here. It is, of course, better to use as large a meter as possible for ease of reading and the 4in. movement, code RX54J (50μA Lrge Pan Meter) £8.25 from Maplin was used in our model.

TRF Receiver

The main items that push up the cost of the *TRF Receiver (Amateur Radio Supplement)* are the variable capacitors. However, although a value of 300p is quoted for the capacitor VC1, in practice you can, if you wish, choose any value between 250p and 500p and it should work satisfactory.

But try to avoid inexpensive tuning capacitors which have miniature spindles. It could prove difficult to locate a suitable control knob for these types.

The Jackson series "0" quality tuning capacitors are currently stocked by **Cirkit** (☎ *0992 444111*). They are also the main distributor for Toko coils and stock a good range of r.f. chokes.

For maximum output, loudspeaker LS1 should have an impedance of 8 ohms, however speakers having an impedance up to about 80 ohms should give a reasonable performance in this circuit. When purchasing potentiometer VR2 be sure to ask for a "log" law type.

If constructing the simple "crystal set", keep in mind that germanium diodes are more susceptible to heat damage than silicon types. So take extra care when soldering this device in circuit.

Quizmaster

Looking down the list of components for the *Quizmaster* project, we cannot foresee any component purchasing difficulties.

For those readers who do experience troubles, **Robinswood Electronics** are selling a complete kit, including case, for the sum of £25.95 plus £1 post and packing.

They also claim that if any constructor runs into troubles and cannot get their kit to work they will repair it Free of charge.

The offer only applies provided the kit is returned within 30 days of purchase. They will, of course, charge for return postage and replacement parts. **Robinswood Electronics, Dept EE, 33 Cotteswood Road, Glouscestershire, GL4 9RQ.** ***(Mail Order Only).***

The printed circuit board is available from the *EE PCB Service*, code EE690 (see page 356).

Auto Memo

All the components called up in the *Auto Memo* parts list appear to be off-the-shelf items and should not cause local sourcing problems.

The p.c.b. type warning device (**Electromail** (No. 249-794) ☎ *0536 204555*) used in the model seems fairly expensive for this simple circuit and one of the many cheaper piezo transducers on the market should work here. Most are rated at about 4V to 12V plus and range in price from approximately 70p to £2.

The "click switch" or a suitable alternative, such as a microswitch, should be available from most component advertisers. The one used in the prototype is the **Maplin** non-locking click-effect switch, code FF87K (Click Switch).

Azimuth Adjustment Aid

We do not expect any component buying problems for readers undertaking the *Azimuth Adjustment Aid*. The dual, p.c.b. mounting potentiometer is a standard line and should be stocked by most component suppliers.

If you do find that you require a new tape head for your machine, we can recommend the excellent range stocked by **Hart Electronic Kits** (☎ *0691 652894*). They will be only too pleased to advise you on your requirements.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Lap-top Rambo

Recently the Dell Computer Corp. of Texas launched a new computer, a high specification lap-top with a 386 processor, hard disk and back lit l.c.d. screen. It's a nice piece of kit at a good price (under £3,000). They boast its weight as "under fifteen pounds".

Whatever that looks like on paper, I can tell you it's darned heavy when you actually lift it. What's more, the big and heavy re-chargeable nickel-cadmium battery only runs for two hours. "Computing time for the Dell portable is limited only by the number of spare battery packs the user can carry", says Dell. To work on the move you need to carry several spare batteries, and end up looking like Rambo with a bandelier of heavy hardware.

"Why call it a lap-top?", I asked the Dell people. "Have any of you ever actually tried using it on a long plane journey?".

Their answer is that computers like this are not intended to be used for steady work on long plane journeys. They are intended to be dumped in the back of a car and moved between home, office and hotel room.

"Why not call it transportable then?".

Because, says Dell, people think that a "transportable" needs to be plugged into the mains. The trade term for a computer that works on batteries as well as mains is "lap-top". Toshiba started it, says Dell.

The common sense fact that people don't use heavy computers on their laps does not, it seems, count for anything.

Back-up

What for many people will be a real benefit of a "lap- top" isn't even mentioned in the publicity material.

Anyone who has suffered a power cut while working with a desk top PC, and either lost data from memory or had disks corrupted, ends up wanting a UIPS, or UnInterruptible Power Supply. A UIPS has low voltage batteries which are continually charged by the mains. At the same time the battery voltage is stepped up to mains voltage to run the computer.

The power supply for the computer thus floats independently of the mains. If there is a short failure, the batteries just bridge the gap; if the failure is long term the batteries keep the computer running for a few minutes, which is long enough to save all data from memory onto disk.

But add-on UIPS units cost several hundred pounds.

A lap-top that can run on either mains or battery power has the equivalent of a "free" UIPS built-in. In most designs, if the mains supply fails the computer just goes on running off its batteries.

But even the normally smart Dell people haven't spelled this obvious benefit out in their publicity material. Instead they make much of a long-life lithium battery buried inside the lap top which keeps the memory powered up for two minutes while the roving user changes batteries.

How long, I wonder, before a computer firm cottons on to the value of free UIPS as a selling feature for lap tops? And how long, I wonder, before firms making portable computers, and video camcorders, start selling what many users would welcome — a battery pack that takes expendible cells.

Camcorders, like portable computers, rely on rechargeable NiCads. If one thing in life is certain, it is that a NiCad will always go flat when you most need power. Working on a long journey, or shooting video in deep country, you cannot charge flat batteries. The simple answer is a battery pack, the same size as the NiCad pack, but with slots inside to take standard alkaline batteries. Alkaline cells can be bought virtually anywhere in the world.

Of course, it's far more expensive to use alkaline cells than rechargeable batteries, but if you are stuck with no mains supply, wanting either to work on a computer or shoot video, £10 on alkaline cells for a couple of hours power will seem cheap at the price. In any case business people who work on the move, can claim back the price of batteries. But so far I know of no dummy NiCad packs, which take alkaline cells.

Hot Tip

This may save a lot of people a lot of wasted time.

Over the years, I've many times cursed battery-powered soldering irons, which always seem to run down just before you have finished the last joint. And they are next to useless in cold weather, for instance working outside on a car.

So I jumped at the chance of buying one of the Flame Master hot gas soldering tools widely advertised in the electronics press by *Maplin Electronics.* After a few muddles over the order I got the iron — but couldn't use it because it comes empty, and without a source of gas to fill it. The instruction manual simply says "powered by butane gas", with no identification of what kind of butane can or cylinder to use, and where to buy them.

The butane cylinders sold in hardware stores have a wide range of proprietory nozzle fittings. So I carried the Maplin tool round several shops and finally found a cylinder, made by Braun, which seemed to fit. But I had great difficulty getting enough gas from the cylinder into the tool to keep it running for anything like the claimed "up to two hours continuous use".

So I wrote to Maplin asking what make of gas cylinder they recommended. Maplin replied that their service department tested the tools with "Newport purified butane gas". This, said Maplin, is available from branches of *Woolworths* or direct from the suppliers, *Keen World Marketing,* of Ridgeway, Iver Bucks.

I then tramped round every Woolworths I could find. But not one stocked, or had even heard of, Newport cylinders. So I wrote to Keen, who said that Maplin were wrong, and they do not offer a mail order service.

But at last the trail was getting as warm as the soldering tool should be. Keen say that Newport is "available from most independent retail confectioner, tobacconist and newsagents in the UK".

The key point is that the Newport cylinder is intended to refill *cigarette lighters,* and it comes with a cap which has eight different nozzle fittings loosely mounted as a push fit. This, says Keen, provides a safe fit with any of the 2,000 or more different brands of re-fillable gas lighters available worldwide. You need a good fit to get the gas into the tool, without spillage — which is an obvious fire risk.

By trial and error I found that several nozzles, e.g. the white one, would do the trick of filling the Maplin iron.

Hopefully this piece of information will help any readers who have bought what is actually a very neat little tool. But surely it would make sense for Maplin now to add a note to the instructions that go with the soldering iron, naming the Newport cylinder, explaining where it can be bought and saying which of the eight coloured nozzles Maplin's service department have found best able to load gas without risk of leaks around the nozzle.

Maplin tell us that a variety of different types of butane refill can be used with the iron. They are generally available from tobacconist and many other retailers who sell cigarettes.

Maplin do not sell the gas due to the problems of supplying it by mail order. (Ed).

DATs Music

A music journalist told recently how he often gets music from new bands sent to him on DAT cassette. Small independent record companies find it far cheaper to produce small runs of DAT real-time copies, than to press CDs.

Apart from producing a CD master tape (at around £350 a time), a master disc for pressing (another £350) and then paying between £1 and £2 each for pressed discs (depending on volume), most pressing plants won't press less than 500 CDs. So it's far easier and cheaper for a record company to send out DAT cassettes of new bands to the press.

There is only one snag. Many of the magazines receiving these cassettes, do not have DAT players.

THE RTC MONITOR II

100 WATT SPEAKER KIT £60.00 +£3.50 P&P (pair)

RESPONSE: 55Hz–20kHz

BASS POLYMER CONE D: 22cm

DOME TWEETER: 14mm

OVERALL SIZE (HWD): 382,252,204mm

RECOMMENDED AMP POWER: 10-100 watts per channel

The performance standard achieved in this compact design is distinctively superior to anything else available at the price. The drive units used are of sophisticated design and have been carefully integrated with a Complex Crossover. Stereo performance is exceptionally good with a well focussed sound stage and sharp resolution of detail. Distortion throughout the frequency range is low even at quite high power input and this gives a great sense of dynamic range and openness especially when used in bi-wired mode.

Supplied with:— 2 READY CUT BAFFLES, ALL CROSSOVER COMPONENTS, 2 BASS MID-RANGE, 2 DOME TWEETERS, HOOK UP WIRE, GRILLE CLOTH, SCREW TERMINALS AND SCREWS.

GOODMANS 60W CAR GRAPHIC

As new condition but have been returned by customers or shops, so they may need some attention. Hence the price of only £8.00 each. Order six of these units and you get the seventh one free. Postage £2.90

LCD DIGITAL MULTI TEST METER AC DC

Volts resistance and DC Amps. Most of these units are new but have been returned or rejected by the store and sold with all faults at £11.00 each. Postage £1.00. (Made by Ross Electronics).

ROSS PUSH BUTTON RADIO

Mains and battery operated. High quality VHF/FM, Medium and Long Wave reception.
6 pushbutton selected preset stations.
Fully retractable telescopic aerial.
Headphone/earphone jack socket.

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Ref RE-5500.
Brand new.
Listed price over £30.00.

Price £14.95
+ £2.80 P&P

SHURE HIFI STEREO MAGNETIC CARTRIDGE

Fitted with an elliptical diamond stylus supplied with fitting kit and instructions. A good quality unit made to sell for well over twenty pounds due to scoop purchase, we are able to offer these at a fraction of the manufacturers price. All units are brand new and boxed. £7.20 each. If you order in multiples of five you get one free. Postage £1.30 (Made in U.S.A.)

KOSS STEREO HEADPHONES

High quality light weight stereo headphones fitted 3.5mm jack with adaptor to 6.4mm jack. Ideal use Hifi or personal stereos made to sell for nine pounds. Our price for this unit £4.25. Postage 60p.

TV SOUND TUNER KIT

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are quite common and that really is quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact independent TV tuner that connect direct to your Hi-Fi is a must for quality reproduction. The unit is mains operated. This TV SOUND TUNER offers full UHF coverage with 4 preselected tuning controls. All parts including Varicap tuner, mains transformer, PCB with IC's, capacitors and coils etc., to build the unit illustrated above; without case and scale.

£11.50 + £2.30 P&P

Case as illustrated £6.90 + £2.00 P&P

MAIL ORDER £1 BARGAIN PACKS BUY 20 GET 1 FREE

Please state pack(s) required

No.	Qty. per pack	
BP015B	1	30W dome tweeter. Size 90×66mil *JAPAN made*
BP016	6	2200µf can type Electrolytic 25V d.c. computer grade *made in UK by PHILIPS*
BP017	3	33000µf 16V d.c. electrolytic high quality computer grade *UK made*
BP019	20	20 ceramic trimmers
BP020	4	Tuning capacitors, 2 gang dielectric a.m. type
BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made in USA*
BP022	5	Push-button switches, push on push off, 2 pole change over. PC mount *JAPAN made*
BP023	6	2 pole 2 way rotary switch
BP024	2	Right angle, PCB mounting rotary switch, 4 pole, 3 way rotary switch *UK made by LORLIN*
BP025	4	3 pole, 3 way miniature rotary switch with one extra position off (open frame YAXLEY type)
BP026	4	4 pole, 2 way rotary switch *UK made by LORLIN*
BP027	30	Mixed control knobs
BP029	6	Stereo rotary potentiometers
BP030	2	10k wire wound double precision potentiometers *UK made*
BP031	6	Single 100k multitune pots, ideal for varicap tuners *UK made by PHILIPS*
BP032	4	UHF varicap tuner heads, unboxed and untested *UK made by PHILIPS*
BP033	2	FM stereo decoder modules with diagram *UK made by PHILIPS*
BP033A	4	6"×3/8" High grade Ferrite rod. *UK made*
BP034	3	AM IF modules with diagram *PHILIPS UK made*
BP034A	2	AM-FM tuner head modules. *UK made by Mullard*
BP034B	1	Hi-Fi stereo pre-amp module inputs for CD, tuner tape, magnetic cartridge with diagram. *UK made by MULLARD*
BP035	6	All metal co-axial aerial plugs
BP036	6	Fuse holders, panel mounting 20mm type
BP037	6	In line fuse holders 20mm type *UK made by BULGIN*
BP038	20	5 pin din, 180° chassis socket
BP039	6	Double phono sockets, Paxolin mounted
BP041	3	2.8m lengths of 3 core 5 amp mains flex
BP042	2	Large VU meters *JAPAN made*
BP043	30	4V miniature bulbs, wire ended, new untested
BP044	2	Sonotone stereo crystal cartridge with 78 and LP styli *JAPAN made*
BP045A	2	Mono Cassette Record and play heads
BP046	4	6-0-6 4VA mains transformers, PC mount *UK made*
BP047	1	24V 0.3VA mains power supply. Brand new boxed *UK made by MULLARD*
BP049	10	OC44 transistors. Remove paint from top and it becomes a photo-electric cell (ORP 12) *UK made by MULLARD*
BP050	30	Low signal transistors n.p.n., p.n.p. types
BP051	6	14 watt output transistors. 3 complimentary pairs in T066 case *(Ideal replacement for AD161 and 162s)*
BP052A	1	Tape deck pre-amp IC with record/replay switching No LM181B with diagram
BP053	5	5 watt audio ICs. No TBA800 *(ATEZ)*
BP054	10	Motor speed control ICs, as used with most cassette and record player motors
BP055	1	Digital DVM meter I.C. *made by PLESSEY* as used by *THANDAR* with diagram
BP056	4	7 segment 0.3 LED display (red)
BP057	8	Bridge rectifiers, 1 amp, 24V
BP058	200	Assorted carbon resistors
BP059	1	Power supply PCB with 30V 4V/A transformer. MC7818CT IC & bridge rectifier: Size 4"×2¾"
BP061	5	6.35mm Mono jack plugs
BP063	5	6.35mm stereo switched jack sockets
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BP065	1	3mtr Euro-mains lead with chassis socket

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Kit enclosed: case, P.C.B., all components, scale and knobs **£36.80.** post £3.50

(Featured project in *Everyday Electronics* April 1989 issue). Reprint Free with kit.

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125 watt per channel stereo power amplifier with independent volume controls, professional 19" rack mount and silent running cooling fan for extra reliability.

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Output impedance .... 4 to 16 ohms (max. power into 4 ohms)
Sensitivity ....450V at 22K ohms
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4-channel stereo disco mixer with built-in 5-band graphic equalizer capable of mixing a total of 8 line, phono or mic inputs, switchable on the front panel. Controls include cross fade between channels 1 and 2, headphone cue, DJ mic talkover, channel level markers and stereo/mono switch. Twin 12 LED bargraph display. Output to amp, tape and headphones.

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Input impedance........Mic. 600Ω, Phono 47kΩ, Line 47kΩ
Max. input level.........Mic. 30mV, Phono 140mV, Line 5V
Output impedance...600Ω
Rated output......................................Amp 800mV
Hum and noise...>3mV
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Constructional Project

AZIMUTH ADJUSTMENT AID

T.R. de VAUX-BALBIRNIE

"As new" performance from ageing cassette players.

MOST HOMES have at least one cassette player. As well as the family stereo unit, there may be others in children's bedrooms, cars, and perhaps for computer data storage. Personal stereos of the "Walkman" variety and cassette players combined with portable radios and televisions add to the list.

It is wrong to assume that these will continue to work at peak performance without servicing. Regular cleaning of the heads and tape transport mechanism is essential. This can be done using a cleaning cassette in accordance with the manufacturer's instructions.

If this is not done, deposits of oxide rubbed from the tape surface will build up on the record/playback head and spoil high-frequency performance. The sound will then be muffled and there may be incomplete "wiping off" when the erase head is involved.

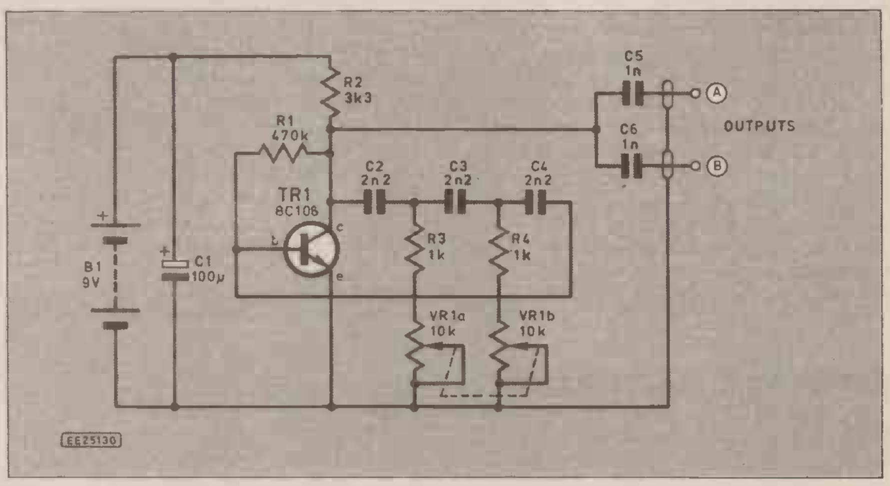
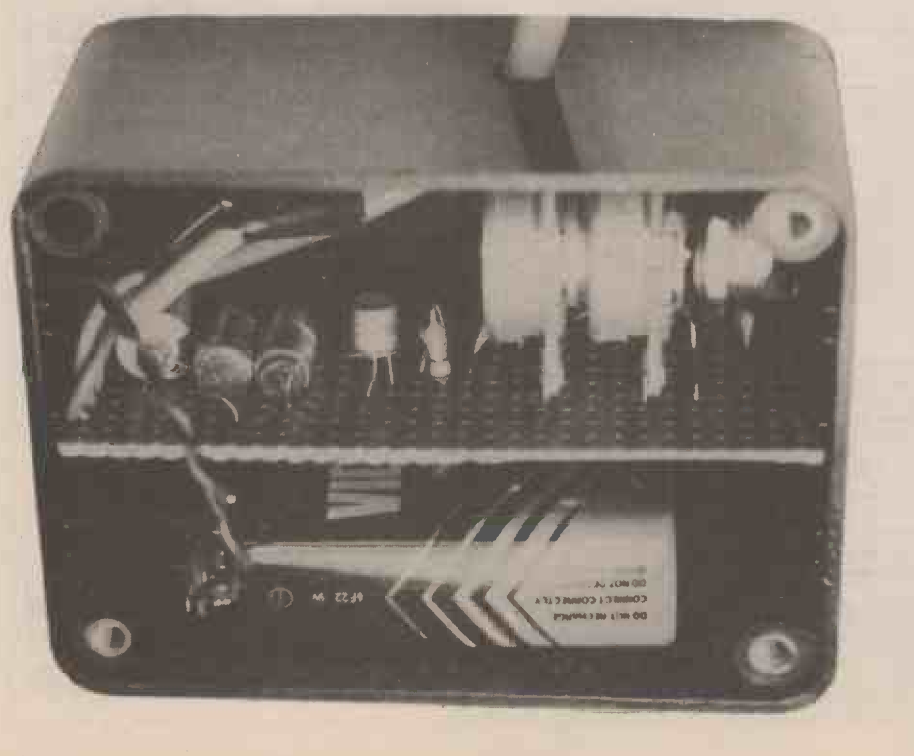


Fig. 1. Complete circuit diagram for the Azimuth Adjustment Aid.

In severe cases, ordinary cleaning will be inadequate and more extensive manual cleaning required. Further servicing requires head demagnetising and the most convenient way of doing this to to use an electronic demagnetising cassette. This is necessary since, over a period of time, the record/playback head can become magnetised – again, resulting in poor high-frequency response.



REPLACEMENT

Unfortunately, even with regular servicing, there will come a time when the heads become excessively worn and reach the end of their useful life. The above measures will then fail to restore sound quality.

Many a cassette player is discarded for this reason when there are still years of life left in it. It is a relatively inexpensive job to replace worn out heads and restore "as new" performance. Advertisers in this magazine supply replacement heads which will fit virtually all machines.

However, the new record/playback head will need to be adjusted so that the gap, over which the tape passes, is accurately aligned to be at right angles to the direction of tape travel –this is called "*azimuth adjustment*".

Adjustment is simply a matter of turning one small screw. However, if this is not done properly, high-frequency response will, once again, suffer.

Accurate adjustment needs a tape on which is recorded a high frequency tone. This is listened to as the azimuth adjustment is made. When playback reaches maximum volume, the adjustment is cor-

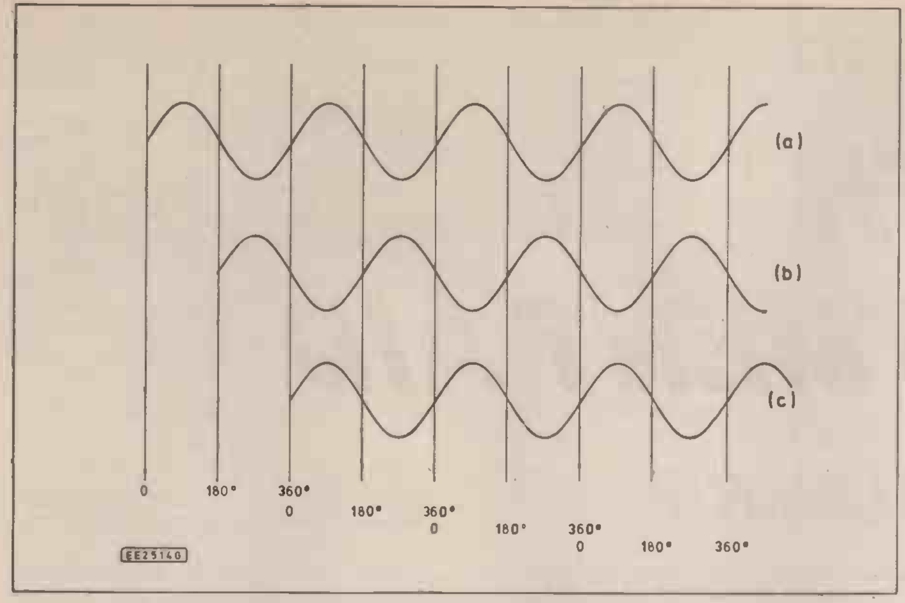


Fig. 2. Waveforms showing phase-shift differences in the circuit.

rect. It often happens that azimuth adjustment will give a new lease of life to the machine even when the record/replay head is slightly worn.

The present project is a sine-wave oscillator which produces a tone of approximately 8kHz which is a very high pitched whistle. The unit is plugged into the input socket of a tape recorder known to be in good condition and a recording made. The recording is then preserved and used as a master tape in making the azimuth adjustment on other machines.

CIRCUIT DESCRIPTION

The complete circuit for the Azimuth Adjustment Aid is shown in Fig. 1. This is a phase-shift oscillator and works in the following way.

Consider for a moment an a.c. signal at transistor TR1 collector (c). Furthermore, imagine that a complete wave occupies 360 degrees (see Fig. 2a). Each of circuit elements C2 and R3/VR1a, C3 and R4/VR1b together with capacitor C4 introduce a change of phase to this signal.

This means that the wave falls out of step with the original. The amount by which it is out of phase is specified as a number of degrees (remembering that a complete wave occupies 360 degrees). Thus, the wave would be totally out of step if the phase difference were 180 degrees – that is, one half of a wave (see Fig. 2b).

With any particular component values in the circuit elements above, there will be one particular frequency where the phase change is exactly 60 degrees per stage. The effect of the three circuit elements in cascade, is therefore to produce a phase difference of 180 degrees.

The output from capacitor C4 is directly coupled to TR1 base (b) which amplifies it and introduces a further phase change of 180 degrees due to its own action. The overall effect is that the new signal arrives at the collector with a phase diference of 360 degrees compared with the original – that is, the waves are in step with one another (see Fig. 2c).

The new signal now matches the original and re-inforces it. Each circuit element introduces quite a lot of signal loss so TR1 needs to be a high-gain transistor to give sufficient "boost" and maintain oscillation.

The output appears as a sine wave between TR1 collector and emitter (e). At first sight, there seems no reason why the circuit should begin oscillating in the absence of an initial signal on which the transistor can operate. However, in practice, stray noise and pick-up provide sufficient input for the process to begin. The circuit then works selectively on the frequency which gives the necessary 360 degree phase change. By altering the setting of potentiometer VR1, the required frequency may be selected. VR1a and VR1b comprise both sections of a dual potentiometer so adjustment of one automatically adjusts the other. In the prototype unit, this provides adjustment between limits of 3 kHz and 14 kHz approximately. At the end of contruction it will be set to deliver a frequency of 8kHz approximately. Resistor R1 applies base bias and R2 acts as a load resistor for TR1. Capacitors C5 and C6 allow the a.c. signal from TR1 collector to pass to each channel of the stereo output.

CONSTRUCTION

Construction is based on a circuit panel made from a piece of 0.1 in. matrix stripboard size 11 strips x 29 holes (see Fig. 3). Cut this to size and file it carefully to fit the slots of the specified plastic box.

Make the inter-strip link and track breaks as indicated then solder the onboard components into position as shown in Fig. 3, except for VR1. Before fitting the dual-ganged potentiometer VR1, cut the spindle to a length of 3mm and make a cross cut using a hacksaw – this will enable it to be adjusted with a screwdriver at the end of construction.

Note that VR1 fits the stripboard matrix but the holes occupied by the tags will need to be drilled slightly larger. When doing

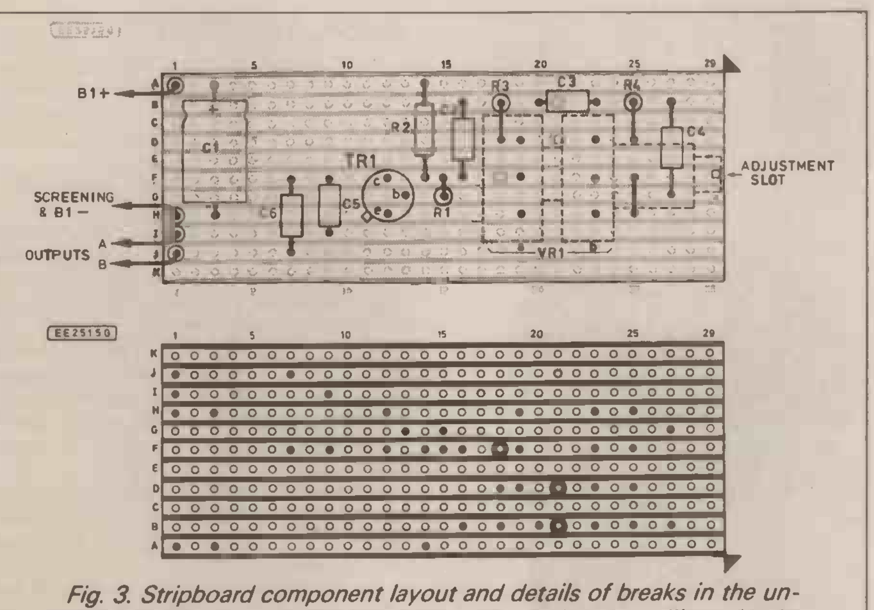


Fig. 3. Stripboard component layout and details of breaks in the underside copper tracks. The holes for the potentiometer will need to be enlarged to take this component.

COMPONENTS

Shop Talk
See page 319

Resistors

R1	470k
R2	3k3
R3, R4	1k (2 off)

All 0.25W 5% carbon

Potentiometer

VR1	10k dual-track p.c.b. mounting, lin.

Capacitors

C1	100μ axial elec. 16V
C2, C3, C4	2n2 ceramic (3 off)
C5, C6	1n polystyrene (2 off)

Semiconductor

TR1	BC108 *npn* silicon

Miscellaneous

Stripboard 0.1in. matrix, size 11 strips x 29 holes; plastic case, size 76mm x 58mm x 38.5mm internal; B1 PP3 battery and connector to suit; miniature twin screened wire, approx. 50cm; connectors to suit tape recorder input; adhesive fixing pad; connecting wire; solder etc.

Approx cost. Guidance only **£8**

this, take care to avoid breaking any tracks – if you do, solder a short bridging wire across any gap. Solder a 10cm piece of light-duty stranded connecting wire to copper strip *A* and a 2cm piece of similar wire to Strip *H*.

Drill a hole in the rear of the box for the output lead to pass through. With the circuit panel in place, measure the position of VR1 spindle and mark this on the inside of the box. Remove the circuit panel and drill the marked position with a hole 4mm in diameter through which VR1 may be adjusted with a small screwdriver.

Mount remaining components and, referring to Fig. 4, complete the internal wiring. Use a piece of light-duty twin screened wire for the output lead – 50 cm. will probably be found sufficient. Solder the inner conductors to copper strips *I* and *J*. Twist the screening, sleeve 2cm of it and trim off any excess. Solder this and the negative battery connector wire to the "free" end of the wire already soldered to strip *H*. Insulate the bare ends with p.v.c. tape (see photograph).

Pass the signal wire through the hole in the case already drilled for the purpose and tie a a piece of string tightly around it on the inside so that it cannot pull free in use. Adjust VR1 to approximately mid-track position and replace the circuit panel. Connect the battery and secure it to the side of the box using a double-sided adhesive fixing pad.

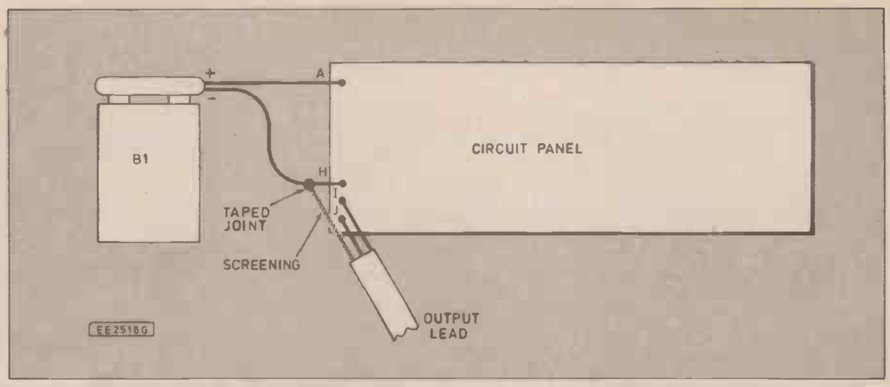


Fig. 4. Interwiring from the circuit battery board to the screened output lead and battery.

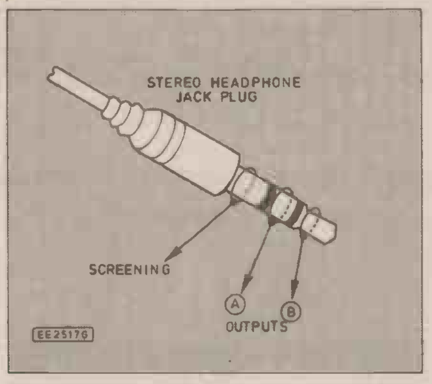


Fig. 5. Test set-up using a pair of stereo headphones.

TESTING

Make a basic test by connecting a pair of stereo headphones to the output lead as shown in Fig.5. Twisted connections are in order here since short circuits will cause no harm.

When the unit is switched on, a whistle should be heard whose pitch depends on VR1 adjustment – clockwise rotation increases the frequency. Adjust VR1 so that the whistle is very high-pitched – about 1/16th turn of VR1 anticlockwise from the highest pitch which can be heard.

The exact frequency is unimportant but should lie in the range 7kHz to 10kHz. Readers having access to an oscilloscope can use this to adjust frequency.

The master tape is made on a tape machine known to be in good condition. A high-quality recorder will give best results. Attach connector(s) to the ends of the output wires to suit the recorder input. The microphone input will be found most convenient to use because this is easily accessible.

If there are manual recording level controls set them to zero. Before switching the amplifier on, turn the volume control to zero – *this is very important*. Switch off any noise reduction system.

Start recording and advance the level controls until the VU meters show the correct signal strength. This will be found with the controls only slightly advanced.

With automatic machines, try a test recording. Turn the amplifier volume control up gently to listen to the test signal. If the recording level is too high, use a less sensitive input– the phono input, for example.

On playback the high pitched whistle should be clearly heard although quite a lot of background noise (tape hiss) is to be expected. If no signal is heard, perhaps the frequency has been set too high for the recorder to handle. Try reducing it a little by anti-clockwise adjustment to VR1.

AZIMUTH ADJUSTMENT

With all adjustments made, make a recording lasting for at least two minutes. Now, working on the suspect machine, locate the azimuth adjustment screw on the record/playback head (the one with the spring under it). In many machines this screw is easily accessible – sometimes through a small hole. A mirror may be needed and in some case limited dismantling is necessary.

Clean the tape heads before proceeding. If there are any stubborn deposits on the heads and transport mechanism, clean them off gently using a cotton bud and proprietary cleaning fluid. If a demagnetising cassette is available, use this too.

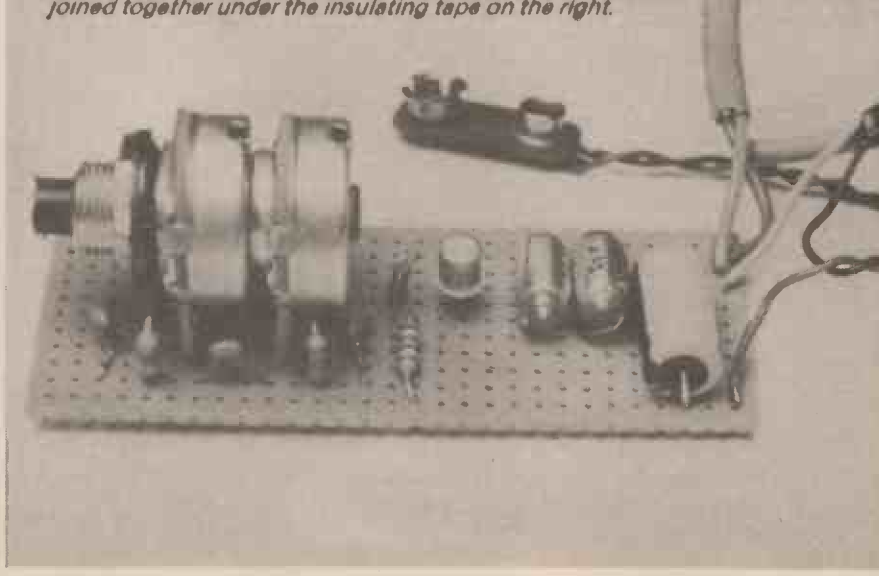
Now play the test tape and listen carefully. Adjust the azimuth adjustment screw very slowly one way and the other until the whistle is as loud as possible. Even in severe cases, only very small adjustments are needed. With luck, performance will now be restored.

If results are poor and further cleaning does not improve the sound, the fault is likely to be a worn record-playback head. Usually replacement is simply a matter of fitting a new one after any necessary dismantling. Obviously, this is a job which needs patience and care. Be sure to use a head of at least as good a quality as the one being replaced or results will be disappointing.

Solder the wires to the new head cautiously, avoiding excessive heat. Make sure the connections do not touch one another or the surrounding metalwork. The head must then be aligned as previously described. After re-assembling, the tape recorder should sound brand new again!

Note that no on-off switch has been included. It is therefore necessary to disconnect the battery after use. A switch could be placed in the battery positive wire but this was not thought worthwhile in the prototype. □

The completed circuit board. The battery negative lead, signal lead screen and negative board lead are joined together under the insulating tape on the right.



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Robot Roundup

NIGEL CLARK

ROBOT OLYMPICS

Wednesday and Thursday, September 26 and 27 should be kept free in the diaries of all robotophiles. The Turing Institute in Glasgow is holding a Robot Olympics which it is hoped will attract all the latest creations of schools, colleges, companies and individuals throughout the world.

Dr Peter Mowforth, who is organising the event, said the idea behind it was to provide a physical forum for the latest robot developments.

At the moment the only way for researchers to find out what other roboticists are doing is to read the journals or speak to each other at conferences. They exchange notes and plans and if they are lucky they might be able to see a video.

But as Mowforth said the video might have taken weeks to prepare and what the researchers want is to see the mistakes as well as the successes. He added that at a recent conference in Japan one of the most popular events had been a collection of video "out-takes" of robot mistakes.

The best way of assessing a robot was to see it operating. Mowforth said that robotics was going through a very interesting phase at the moment. In the last five years, and particularly the last two, there had been a change in thinking about what makes a robot.

Before that most developments concerned the expansion of uses of industrial arms, such as adding sensors and improving software. But now there was a greater concern about the behaviour of robots with a search for intelligent connections between perceptions and actions or inputs and outputs.

There had also been a fall in the cost of components which meant that much worthwhile work was being done outside the traditional academic areas.

Mowforth hoped the event would attract more worldwide interest in the work being done in this country, which 20 years ago led the world in robotics, and in particular the work at the Turing. Finally he wanted it to be fun.

COMPETITION

There will be a competitive element with a prize for the best robot overall. The judging will be based on the quality and precision of the building of the device, the sophistication of its behaviour and its novelty.

If there are a number of similar robots, hexapods for example, it is intended to have a competition between them.

Anyone is welcome to enter provided their machines conform to the definition of being an autonomous device showing an intelligent link between perception and action. They also had to agree with most people's general prejudices about what constitutes a robot. Automatic washing machines do not qualify.

The interest which had already been generated can be judged from the fact that the event has had to be put back. Originally it was intended to be held in April for only one day but many potential entrants said that they would be unable to have their projects ready by then.

Anyone interested in participating can contact Dr. Peter Mowforth at: *Turing Institute, 36 North Hanover Street, Glasgow G1 2AD. (Fax: 041 552 6400)*

TREKKER

An attempt to gauge the value of *Clwyd Technics'* move into the primary school market with an extension pack for its Trekker mobile resulted in more questions than answers. I asked teachers at my local infants and junior schools in St. Albans to assess how useful the two-wheeled vehicle would be in trying to meet the criteria laid down in the craft and technology section of the National Curriculum.

It was quickly apparent that the infants, aged between five and seven, would not benefit from Trekker. It was too complex and sophisticated. Young small hands need something that is simple and robust.

Lights, sensors and fancy dancing are not needed. An ability to show off what the computer is capable of without having components broken off the control board are.

The teachers said that the children found Trekker exciting while running through its demonstration programs and many made suggestions for ways in which the various sensors could be used. It was thought that the use of heat sensors and the magnet might be possible with the infants.

However, there were a number of drawbacks which severely limited its use by children of that age. The switches were too small for their fingers, they could not see the end of the pen, which on the Trekker is held in a holder in the centre of the mobile, so that they had difficulty estimating line length and angle size. It was also thought to be too fragile.

Perhaps it was a little unfair to test Trekker on infants as the extension pack was not intended for children so young. However, it did point to areas which needed to be kept in mind when providing equipment for infants particularly in relation to its ability to withstand a large amount of less-than-careful use.

Shirley Harwood at the junior school was more positive about its possible assistance in the teaching of technology to the older children. She was able to see areas in which Trekker could be used in developing projects to increase the children's understanding of various technical problems.

However, she did not feel she had been able to give it a thorough testing, not because of any difficulties with the equipment or its acompanying documentation, but because of organisational arrangements which had already been made.

Preparing projects for the children to undertake takes time and must be based around the facilities and equipment available at the time. It is difficult to incorporate new unexpected pieces of equipment, particularly ones which need to be worked on without the children so that the teacher can assess how they can be incorporated into the classroom work.

Time is the great enemy in achieving an understanding of a new piece of equipment. Harwood felt that she would need to be able to work with Trekker through the summer holidays to be able to assess how best to use it.

TEACHER SUPPORT

This raises a number of questions about how to ensure that children have the best resources available to help them in their learning about and understanding of the subject. For once money is not the problem, directly anyway.

If teachers do not have time to assess all the equipment available and how it can best be used, all the money in the council's budget would not make any difference.

It is here that the teacher support, provided by the local authority, is important in providing the necessary advice and training. But even this cannot guarantee success if teachers do not have time to go on courses or properly assimilate the information given. We are now back to money and staffing.

It will be some time before the craft and technology section of the National Curriculum is functioning properly. Today's schoolchildren will be the guinea pigs.

AMATEUR RADIO SUPPLEMENT

In this supplement we will consider some of the basic principles of short wave radio, together with two practical projects for you to build. The projects range from the most basic of sets suitable for the absolute beginner, through to a Direct Conversion Receiver (to be published next month) more appropriate for constructors with a reasonable amount of experience at electronics construction. We start with the most basic possible receiver, the crystal set.

Short Wave Reception

by Robert Penfold

Radio Signals

In order to understand the principles of radio you need to know what is meant by a radio signal. A radio signal is just an ordinary a.c. (alternating current) type, very much like the mains supply or an audio signal. The voltage rises from zero in a positive direction, reaches a peak and then falls back to zero again. The voltage then rises and falls again, but is negative in value.

Each pair of positive and negative excursions constitutes one complete cycle. A repetitive a.c. signal has a frequency, which was once expressed as so many cycles per second. These days the term "Hertz" (often just abbreviated to "Hz") is used instead. One cycle per second is the same as one Hertz (1Hz).

The mains frequency is 50 Hertz, which is quite low, at something approaching the lower limit of the audio range (20Hz to 20kHz). High audio frequencies are often expressed in kilohertz (kHz) incidentally, and one kilohertz equals one thousand Hertz. Radio signals are at frequencies above the audio range, and more or less carry on where the audio spectrum leaves off. The short wave bands lie within the range 1.6MHz to 30MHz. A megahertz (MHz) is equal to one million Hertz, or one thousand kilohertz, and so we are talking here about frequencies that are well beyond the audio range.

Exactly why a high frequency signal fed into a length of wire acting as an aerial results in a radio signal being radiated is one of those things for which there is no easy answer. At this stage it is best just to accept it as a fact. Radio signals are a form of electromagnetic radiation, and they will induce corresponding voltages into any aerial wires that they reach. The strength of these voltages is not likely to be very great in practice.

As the radio signals move outwards from the transmitting aerial they cover an ever wider area, but become weaker. This is just like the light from a bulb or candle becoming weaker further from the light source. Each doubling of distance reduces the signal by a factor of four.

Aerials

It is possible to focus the radio signals into a beam to limit the spreading effect, and enable the energy to be concentrated in one particular direction, like a torch focuses the light from its bulb into a narrow beam. Aerials of this type can be very effective for reception as well. Interference from unwanted stations is reduced as they are mostly out of the aerials field of "view".

Directional aerials almost invariably provide so-called gain, giving stronger signals. Rather than true gain, what they are actually doing is gathering up signals over a relatively large area and concentrating them onto the main receiving element. This gives greater pick-up than the unaided main element can provide.

With short wave signals, especially on the lower frequency bands, it requires some pretty massive aerial arrays in order to achieve even a moderate amount of directivity and gain. Unless you get deeply into short wave radio a simple wire antenna is the order of the day, and the receivers described in this series will

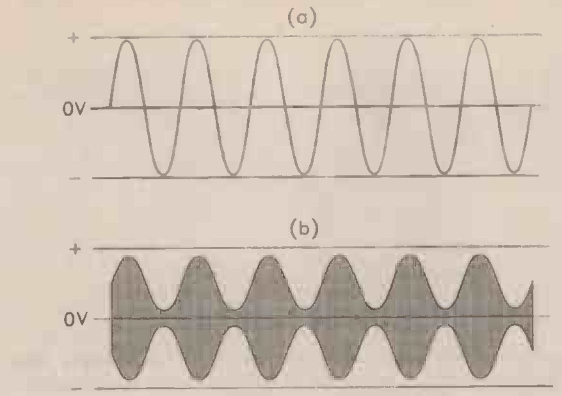


Fig 1. (a) Audio input signal, (b) r.f. signal varied in amplitude by the audio signal.

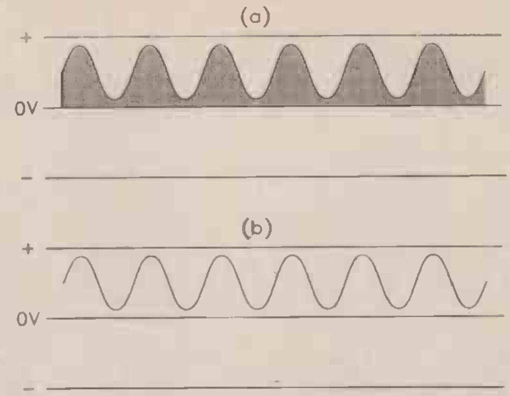


Fig. 2. The rectified r.f signal (a), after lowpass filtering, gives the demodulated audio signal (b).

give good results when used with simple aerials.

Modulation

Transmitting a signal from point A to point B is one thing — getting the signal to convey some useful information is another. The most simple method of putting useful information onto a radio signal is simple on/off switching, which is the system used to send messages using Morse code. For communications on the short wave bands the other forms of modulation used are mostly forms of amplitude modulation (a.m.). Frequency modulation of various types is used to a significant extent, but mainly for specialised types of communications such as FAX and teletype.

In this article we will only be concerned with ordinary a.m. signals, which are the only type used to a significant extent by short wave broadcast stations. It is in fact the same form of modulation that is used by medium and long wave broadcast stations.

I suppose that Morse code sent via radio could be regarded as a very basic form of amplitude modulation. In order to send audio frequency signals a considerably refined form of amplitude modulation is needed. Instead of just on and off switching, proper amplitude modulation has the ability to vary the strength of the signal to any level between these two extremes. The strength of the radio signal is varied in sympathy with the audio input signal. The waveform diagrams of Fig.1 explain this process far better than any words from me. The modulated radio signal is usually termed the "carrier wave" (or just "carrier") incidentally.

Demodulation

With the transmitter having placed the audio signal onto the carrier wave as variations in strength, the receiver must demodulate the signal to recover the original audio signal. A simple filtering process to produce a signal equal to the average signal level might seem like a viable method of demodulation, but matters are not quite as simple as this. The signal is an a.c. type, and the negative half cycles exactly match the positive ones, giving an average signal level of zero regardless of the modulation level.

In order to recover the audio modulation the radio frequency signal must be rectified (Fig.2(a)) and then filtered using a simple C — R lowpass filter. The effect of rectification is to give a signal that is always of the same polarity. It does not matter whether it is the positive or negative half cycles that are removed. In either case, the two sets of half cycles will no longer be there to cancel each other out, and the average signal strength will vary in sympathy with the amplitude of the carrier wave.

The lowpass filter has the effect of smoothing out the rectified carrier signal to give an output signal equal to the average carrier level. This is the required audio signal (Fig.2(b)).

Crystal Set

A crystal set is the most simple of radio receivers, and is actually devoid of any active devices. It does not need a battery — it is the received signal that directly drives the earphone. Obviously this approach does not give very good performance, and I would not suggest that a crystal set is suitable for those wishing to seek out rare and difficult radio stations (or "DXing" as it is known in short wave radio terminology).

On the other hand, a short wave crystal set represents a very simple, inexpensive, but interesting constructional project for beginners and more advanced constructors. It is one of those things that every electronics enthusiast should give a try some time.

It is a real achievement if you manage to pick up a few distant stations from time to time, and it reveals to you just how strong some signals can get. This is an important point, as with any short wave receiver the problem is often not so much one of achieving high enough sensitivity, but one of sorting out the very weak signals from amongst a plethora of strong ones. This is another respect in which a crystal set is not very good. If there are two strong transmissions only a few kilohertz apart, a crystal set will receive them simultaneously. It is up to your hearing mechanisms to sort out one from the other!

Crystal Set Circuit

This crystal set design is entirely conventional, and has the circuit shown in Fig.3. The first task the circuit must perform is to sort out the required signal from the mass of signals at various frequencies that will be picked up by the aerial. This is achieved using a parallel tuned circuit which is comprised of VC1 and L1. These provide a low impedance at most frequencies, and effectively short circuit input signals to earth. However, at and around a certain frequency the tuned circuit is at resonance, and will have an extremely high impedance.

Signals at or close to the resonant frequency can pass through to the next stage, while signals at other frequencies are filtered out. VC1 enables the resonant frequency of the tuned circuit to be varied, and it is an ordinary tuning control.

A single tuned circuit does not provide particularly sharp filtering, and this gives a crystal set the poor selectivity mentioned earlier. The Q of an inductor is a measure of its efficiency, and in theory using a high Q coil for L1 will give improved selectivity. In practice matters are not as simple as this.

In order to make optimum use of the limited signal level from the aerial it must be directly coupled to the tuned circuit. Similarly, the detector stage must take the signal direct from the tuned circuit if it is to give a usable output level. Both these factors result in damping of the tuned circuit and an effective lessening of L1's Q value. A high Q coil will optimise results, but in practice, is not likely to provide a degree of selectivity that is noticeably higher than a component having a more modest Q value.

Diode D1 is the demodulator rectifier which in this case passes the positive half cycles and blocks the negative ones. Connecting D1 round the other way so that it is the negative half cycles that are passed will result in the unit still work-

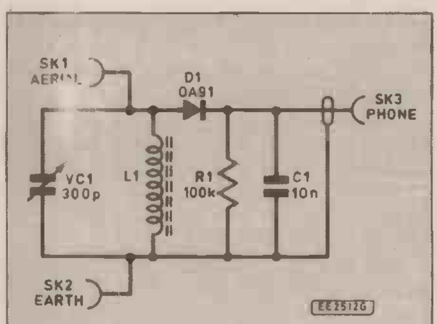


Fig. 3. The circuit diagram of the crystal set. It is purely passive — no battery is needed.

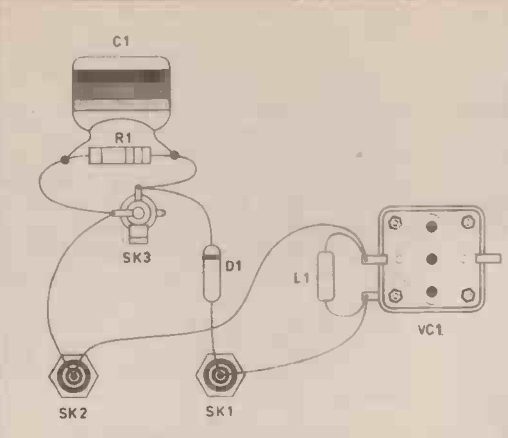


Fig. 4. The crystal set wiring.

Table 1

BAND	FREQUENCY RANGE (MHz)
120 Metres	2.3 - 2.498
90 Metres	3.2 - 3.4
75 Metres	3.95 - 4.0
60 Metres	4.75 - 5.06
49 Metres	5.95 - 6.2
41 Metres	7.1 - 7.3
31 Metres	9.5 - 9.9
25 Metres	11.65 - 12.05
22 Metres	13.6 - 13.8
19 Metres	15.1 - 15.6
16 Metres	17.55 - 17.9
13 Metres	21.45 - 21.85
11 Metres	25.67 - 26.1

ing exactly the same. D1 is a germanium diode and not a modern silicon type.

The problem with a silicon diode is that it does not begin to conduct until the forward voltage reaches about 0.5 volts or so. In many cases the input voltage to the detector will not reach this level, and a silicon diode would give no output at all in such cases. Germanium diodes are well suited to this application as they operate reasonably efficiently at low input voltages. C1 is the filter capacitor which smooths out the rectified radio frequency signal to leave the audio modulation.

Headphones

Traditionally a crystal set is used with a pair of high impedance (about 4k) magnetic headphones of good sensitivity. Headphones of this type are little used these days, and you would probably find it difficult to obtain a pair. Those that are available tend to be rather expensive. Such headphones represent the best option as far as performance considerations are concerned, but a crystal earphone is much cheaper, readily available, and will provide good results.

COMPONENTS

Resistor
R1 100k 5% carbon film

Capacitors
C1 10n polyester
VC1 300p variable (see text)

Semiconductors
D1 0A91 germanium diode

Miscellaneous
L1 2µ2 r.f. choke (see text)
SK1 red 4mm socket
SK2 black 4mm socket
SK3 3.5mm jack socket

Control knob; crystal or high impedance earphone; case approx 130 x 68 x 40mm; plugs and wire for aerial and earth connections — see text; connecting wire; 100p capacitor — optional, see text.

Approx cost. Guidance only **£6**

Electrically, a crystal earphone appears to be a capacitor of a few nanofarads in value. There is no discharge path for C1 through the earphone, and as a result of this C1 tends to charge up to the peak input voltage and hold that charge. Resistor R1 provides a discharge path for C1 so that the required demodulator action is obtained. R1 is not required if the output of the unit will only be fed to high impedance magnetic headphones. These do have a fairly low resistance that will provide the necessary discharge path for C1. The set is unlikely to work at all using any low or medium impedance earphone or headphone.

Construction

With a unit as simple as this there is little point in bothering with a circuit board. It is an easy matter to hard-wire the project. Virtually any small metal or plastic case should suffice for this unit. I used a plastic type having an aluminium front panel and approximate outside dimensions of 130 by 68 by 40 millimetres. The layout of the front panel is not too important, but try to choose one that will avoid any long wires.

Variable capacitor VC1 can be an air spaced component, but I found that using an inexpensive plastic dielectric type gave results that were not noticeably different to those obtained using a high quality component. A Jackson "Type O" 365p air spaced component requires three short 4BA countersunk mounting screws which fit into the threaded holes in the front plate of the component. These screws must be quite short (no more than about 6 millimetres in length) or they might protrude too far into the capacitor and damage its plates.

If you use an inexpensive plastic dielectric component it might be supplied with suitable fixing screws. Often the easiest way of mounting these components is to glue them in place using a good quality adhesive such as an epoxy type. Although a value of 300p is quoted for VC1 in the components list, in practice any value of between about 250 and 500p should be suitable. Try to avoid inexpensive variable capacitors which have miniature spindles. It could prove difficult to locate a control knob to fit one of these!

Coverage

For L1 the prototype has an ordinary r.f. choke having a value of 2.2 microhenries. This gives coverage from about 5.5Mhz to 16MHz, which includes several of the popular short wave broadcast bands (see Table 1). Using a component of suitable value for L1 the unit can be made to cover any band from the long wave band through to the upper end of the short wave spectrum.

The bands covered with the specified value are those which are most likely to furnish some interesting stations. Although the receiver can be made to cover other bands it might not receive any signals at a strength which will provide an audible output. You might like to experiment with other values though.

You can try winding your own inductors. Half a dozen turns of 22 s.w.g. enamelled copper wire on a piece of 10 millimetre diameter ferrite rod will provide good results. Use fewer turns to move the coverage higher in frequency, or more turns in order to shift the coverage in the low frequency direction. Even coils wound on wooden or plastic formers with no ferrite core seem to give quite good results.

Wiring

Details of the crystal set wiring are shown in Fig.4. This is mostly straightforward, but there are a couple of points to bear in mind. D1 is a germanium diode, and as such it is more vulnerable to heat damage than the more familiar silicon devices. The risk of damaging this device when soldering it in place is not severe since its leadout wires will probably be left quite long. However, try to complete the soldered joints to this component reasonably quickly.

Probably the best way of fitting R1 and C1 is to first twist the leads of C1 around those of R1, then solder C1 onto R1, and finally fit this little assembly onto SK3. Making connections to VC1 and the sockets should be easy provided you tin all the tags and the ends of wires prior to attempting to complete any joints.

A Suitable Aerial

At one extreme, the aerial can simply consist of some ordinary p.v.c. connecting wire dangled out of an upstairs window, strung around a picture rail or loft, or something of this type. At the opposite extreme, it can be made from proper aerial wire, strung outside between two trees, aerial masts, or whatever, with an overall length of 40 metres or more. About 5 metres or so of wire mounted as high as possible indoors will provide better results than you might expect. When initially testing the prototype I received the English service of Helsinki Radio using an aerial of this type. Obviously an outdoor aerial will give better results, especially when propagation conditions are poor.

The main point to note if you are using an outdoor aerial are that the antenna is installed as high as possible, and as far away from buildings as possible. The wire needs to be insulated from any earthed objects, which means any building, tree, mast, etc. For a receiving aerial there is no real need to resort to anything particularly elaborate though. Use some plastic twine to connect the far end of the aerial to its support for instance. Protect the insulation on the aerial wire with some added sleeving at any points where there is a risk of it chafing and wearing through.

When using a long aerial with any very simple receiver there is a risk that loading effects will reduce selectivity to an unusable level, with a jumble of stations being received simultaneously. If you use a long aerial with this receiver, you might find that under most conditions results are better if the aerial is connected to SK1 by way of a capacitor of around 100p in value. This will give reduced signal strengths, but the volume should still be quite good, and selectivity will be much improved.

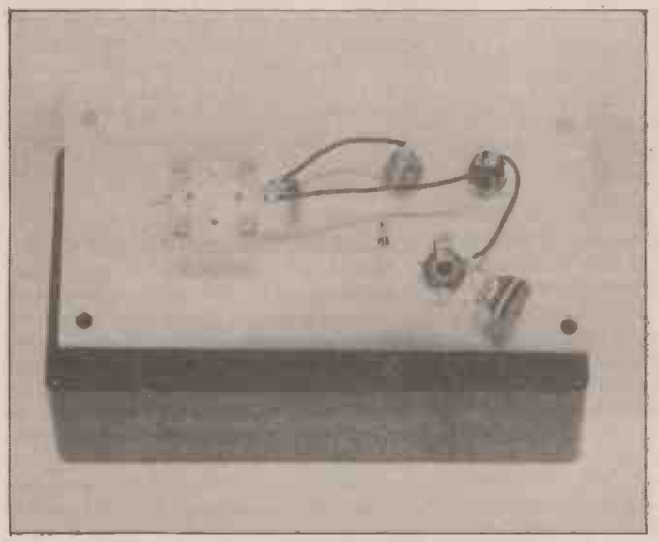
Earth

An earth connection merely consists of a piece of metal which is buried in the ground and connected to the receiver via a piece of wire that should be kept as short as possible. The most popular form of earth connection is a piece of metal pipe pushed into the ground.

The benefit of an earth connection depends to a large extent on the frequency in use. On the lower frequency bands it can substantially boost signal strengths, whereas it is likely to make no noticeable difference at all on the high frequency bands.

Using the set is very easy, since there is only the tuning control to contend with. The bandwidth of the receiver is wide enough to make slow motion tuning drives unnecessary. The main requirement is patience on the part of the user. Interesting stations will appear, often to fade out again soon after, then reappear, and so on.

If you have the patience you can usually identify a station, since most short wave broadcast stations put out frequent station identification messages. This station fading is not due to deficiencies in the receiver, but is caused by the vagaries of the atmosphere and the propagation of radio signals. Even if you have the best short wave radio in the world, fading will still be a problem, and you will still need to exercise patience in order to find and identify weak DX stations. □



DIY Aerials

by George Hylton

THE sunspot cycle is now near its maximum. Short-wave broadcasts from distant lands can be picked up. Ideally, a nice long outdoor aerial should be used, but if like me you live in a flat with no garden this may not be possible. Here are some hints and tips which can often help to improve reception at little cost.

Because receivers differ in design, and no two receiving locations are identical it will pay to experiment. Remember too, that even in the best conditions short-wave reception is usually worse than reception on long and medium waves, and much worse than v.h.f./f.m. But you may still find the effort rewarding, because short waves provide a window on a range of human activities which runs from political propaganda and religious exhortation, to exotic music, information about little known places, and even special programmes for listeners with some knowledge of electronics.

Interference

There are two sorts of interference; local electrical noise from the mains and from appliances inside the house, and interference from more distant sources that arrives through the air along with the radio broadcasts. Inside-the-house interference can obviously be reduced by fitting an outside aerial, that is, by removing the aerial, or at least part of it, from the interference.

For the flat-dweller or similarly restricted listener probably the most that can be done in the way of an external aerial is to mount a whip aerial (Fig.1a) on the wall by a window, or on the window sill, or simply to hang a wire from the window. The lead-in ("downlead") can pass through a (slightly open) window, or through a hole in the window frame or in some cases the wall.

If drilling holes is forbidden and the window must be firmly closed it is possible to couple the aerial through the glass by sticking one metal pad to the outside and another to the inside. The glass pane in between forms the dielectric of a capacitor and the metal pads the plates. A cheap and easy metal pad is a piece of aluminium cooking foil. For a single-glazed window it can be quite small (say the size of a small saucer or the top of a teacup). Wires can't be soldered to aluminium (at least not with ordinary solder) but a line-contact connection formed by laying a few centimetres of bared wire across the foil and sticking it down with tape will serve.

A wall-mounting bracket for a whip can be made by bending a piece of metal pipe, or stout plastic pipe, and fixing it with nails or screws (Fig.1b). (Masonary nails if it must be fixed to the wall). If the whip is a push-fit into the pipe the bared end of the downlead can be wedged in as shown to form a connection.

If you have a TV aerial on the roof you might try using its downlead as a short-wave aerial. With the usual co-axial cable a connection to the "outer" only should suffice, so that the normal use of the aerial for TV is not affected. It must be remembered, however, that TVs themselves create interference in the form of line-timebase harmonics. You may only

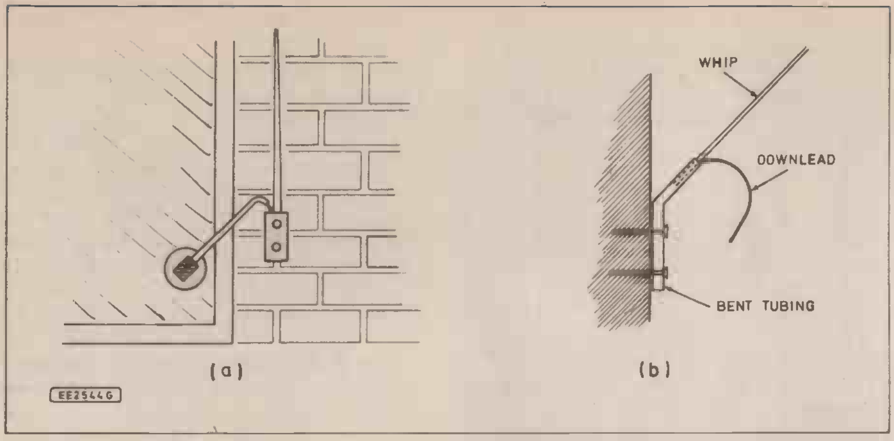


Fig. 1(a). External whip aerial with capacitive coupling through the window glass. (b) Simple mounting bracket.

be able to use the download when the TV is off.

Aerial-to-Receiver Connections

The more expensive types of commercial receiver have special aerial (antenna) terminals. The cheaper ones usually don't. They have a pull-out whip for a SW aerial, and no earth terminal. Don't despair! Connections are easily improvised, without doing any modifications to the receiver circuitry.

The SW performance can often be improved significantly simply by standing the receiver on a metal surface. This increases the efficiency of the whip aerial. If you have no ready-made metal surfaces, use a metal tray, or a large piece of aluminium foil. It may work better if the receiver is laid on its back on the foil.

The foil acts as a sort of r.f. earth, even though it isn't physically earthed. For an aerial connection, the simplest arrangement is to wrap the insulated downlead a few times round the base of the built-in whip (Fig.2). Note that the insulation **is not** removed. The connection is a capacitive one, using the insulation as a dielectric. The capacitance so formed is small, and this is important.

In the cheaper sort of receiver the whip is connected directly (Fig.3) to the aerial tuned circuit L1/C1. Here C1 is the tuning capacitor and the capacitance to "earth" of the whip adds to it. Making a direct connection to an external whip can easily throw enough extra capacitance across C1 to upset the tuning. This is likely to wipe out any advantage gained from increased signal strength.

Indoor Aerials

The trouble with indoor aerials is that they are guaranteed to pick up the maximum amount of mains-borne interference. Also, since most buildings attenuate the incoming radio signals to some extent (steel-framed blocks of flats worst of all) the signal-to-noise ratio is degraded. Nevertheless, indoor aerials can work.

It nearly always pays to experiment to find the best position for the aerial, but near an outside wall is a good bet, and so is in front of a window. If you know where electrical wiring runs in the walls, keep your aerial well clear.

For a receiver with no special aerial terminals practically the only simple indoor aerial worth trying is just a few metres of insulated wire, coupled capacitively to the built-in whip as already described (Fig.2).

The trouble with this type of aerial, however, is that it has a relatively high impedance. This makes it rather good at picking up local interference by capacitive coupling to the mains wiring of the house. If you are greatly troubled by this sort of interference (usually generated by anything that arcs or sparks, such as the brushes of motors in domestic appliances, also fluorescent lamps) you may find it worthwhile to use a low-impedance loop aerial.

Mains Leads

Before describing the loop aerial a point about battery versus mains operation is worthwhile. The mains circuits are apt to be full of interference of the type just described. The mains connecting lead brings this to the receiver. Purpose-built short-wave receivers may have mains filters to reduce this. Ordinary receivers don't. Their mains leads are a pathway which brings interference straight into the heart of the receiver.

Mains leads also act as aerials, bringing to the receiver signals picked up by the house wiring. For this reason they have occasionally been deliberately used (taking precautions against shock) as aerials. The results, in general, are poor, and the practice has died a natural death.

It will be clear that interference may be reduced by dispensing with the mains lead and operating the receiver from internal batteries.

Short-Wave Loops

The ferrite rod aerials now almost universally used for medium and long wave reception are a special form of loop aerial. The "loop" in this case is the little coil of wire wound round the ferrite rod. The function of the rod is to concentrate the magnetic field of the incoming radio wave so that the amount of signal voltage induced in the loop is increased.

There is no reason, in principle, why ferrite rod aerials should not be used for short-wave reception. Unfortunately, practical considerations get in the way. The amount of voltage induced in a loop depends on the number of turns: a short-wave coil needs to have a low inductance, so it has few turns. Ferrite material has losses (i.e. it dissipates energy) which increase with frequency. Special high-frequency ferrite can be made, but it is less good at concentrating the field than the lower-frequency kind. The result is that in practice ferrite short-wave loop aerials are less efficient than another sort of loop.

One-Turn Loops

The single-turn tuned loop (Fig.4) is the better alternative. As mentioned previously the amount of signal voltage increases with the number of turns. On this

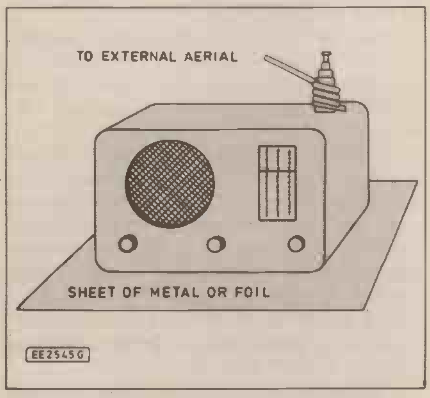


Fig. 2. Where no aerial terminals exist an external aerial can be coupled by wrapping its insulated downlead round the built-in whip aerial. Note that no direct connection is made. Placing the receiver on a sheet of metal often improves reception.

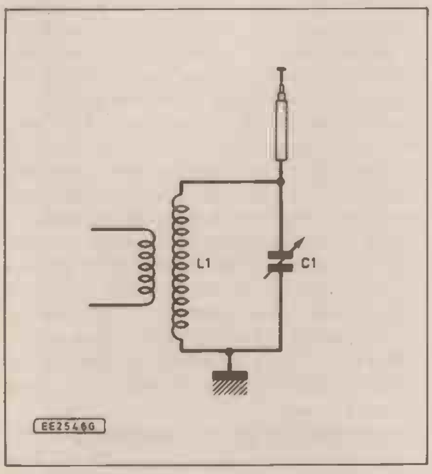


Fig. 3. In many receivers the built-in whip is connected directly to the live side of the signal-frequency tuned circuit L1/C1.

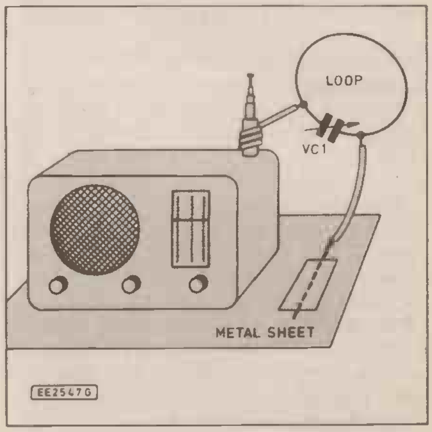


Fig. 4. Coupling arrangements for a tuned loop aerial.

basis a one-turn loop seems a poor bet. Fortunately, pickup is also proportional to the area of the loop, and this compensates for the reduction in turns.

Practical indoor loops can have diameters up to about a metre, which gives about 10,000 times the area of one turn on a ferrite rod. Loops of any shape (e.g. square) may be used, but long thin shapes are inefficient.

If you have a receiver with built-in terminals for an external aerial connection you can try an untuned one-turn loop as an indoor aerial. For ordinary receivers (and often for special SW receivers too), a tuned loop gives better results. Fig.4 shows one method of coupling to an ordinary receiver, using the capacitive wrap-around coupling to the whip for one leg and a taped-down direct connection to the metal or foil base sheet as the other. Variable capacitor VC1 (which can be a "medium-wave" type salvaged from an old receiver) is used for tuning. Tuning is fairly broad and should hold good over any one SW broadcast band.

A circular loop of one metre diameter made from any sort of wire (hookup wire, mains flex, etc.) has an inductance in the region of 4µH. A tuning capacitor of 250pF maximum (typical for a miniature foil-dielectric type as used in MW receivers) gives a lowest tuned frequency of about 5MHz.

The highest tunable frequency depends on the minimum value of the tuning capacitance. This depends on the setting of the trimming capacitor (which is normally part of the tuning capacitor assembly), plus the input capacitance of the receiver (which depends on the number of turns wrapped round the whip) plus the stray capacitance between the two downleads (which can be minimised by keeping them short and well apart). In practice it is generally possible to achieve a 2:1 tuning ratio (e.g. 5 to 10MHz) and by minimising the strays, setting the trimmer to minimum, and using fewer coupling turns you might get a 3:1 ratio (e.g. 5 to 15MHz).

Tuning capacitors from radios are normally two-gang capacitors, so the capacitance can be increased by connecting the two sections in parallel. Air-spaced tuning capacitors from old valve radios usually have higher capacitance, such as 365 + 365pF or 450 + 450pF. these high values give a greater tuning ratio, but may need a smaller loop, which is less efficient as an aerial. They are, however, good for use with our next kind of aerial.

Low-Impedance Loops

Although wire loops often work well indoors they do have fairly high impedance. This can be reduced by reducing the inductance and increasing the capacitance. With wire as a constructional material the only simple way of reducing the inductance is to reduce the loop area, but this reduces sensitivity. The answer is to abandon wire in favour of broad strips of metal. these act in effect as if they were several wires in parallel and the inductance falls even though the loop diameter is unchanged or even increased, within reason.

Metal strip is expensive, but for loop materials use can be made of the fact that at high frequencies the currents flow only on the outer skin of a conductor. So very thin strip can be used, and this is available in handy rolls in the form of aluminium kitchen foil. (At the time of writing this article I bought a roll, 330mm wide and 50m long for £1.80.)

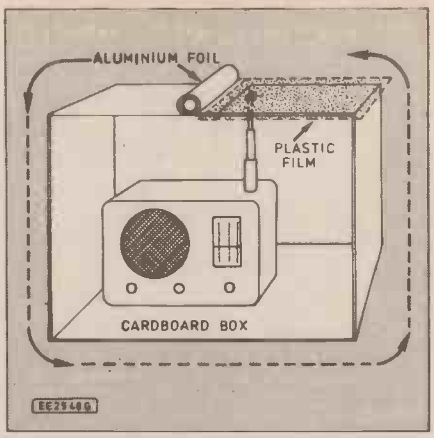


Fig. 5. Box loop. This is tuned by rolling the loose end of the foil over the plastic film.

Box Loop

The simplest and cheapest broad-strip loop aerial doesn't even require a tuning capacitor. It's made (Fig.5) by taping the end of a roll of foil to the top of a large cardboard box, and unrolling the foil round the box and back to where it started. To prevent the loose end from shorting to the taped-down end a sheet of thin plastic film (e.g. from a shopping bag) is placed over the foil as shown. When the loose end is rolled over this foil the resulting sandwich forms a capacitor. Tuning is carried out by rolling or unrolling the foil to vary the overlap.

The receiver can be coupled by standing it inside the box and extending the whip to touch the underside near the gap in the top foil. Coupling capacitance can if necessary be increased by giving the top of the whip a "hat" of foil to increase its area.

Tuning is sharp, but unstable. Stability can be increased, once the approximate tuning point is found, by placing a book on either side of the roll. The roll can be inched along by sliding the books.

The box loop is very effective in reducing breakthrough by powerful local signals (e.g. the local TV transmitter) as well as giving good sensitivity to the wanted signals. Clearly, a large box is desirable, and indeed necessary if the lowest short-wave bands are to be tunable. The box can be of any non-conducting material (wood, plastic) and structures such as wooden cupboards and bookshelves can be used. Avoid having large areas or loops of metal (saucepans etc) in the field of the loop; these reduce sensitivity.

Foil of almost any width can be used with roller tuning, because the reduction in inductance caused by using a wider foil is offset by the increased capacitance due to the greater overlap area.

Loop Orientation

So far nothing has been said about the positioning of a loop, though it will be obvious that the best position should be found by trial and error. It is well known that loops are directional. They give maximum response to signals arriving edge-on and minimum to signals arriving broadside on. This directional property can be used to reduce interference from strong local transmitters. But when a distant transmission is tuned in it is found that rotating the loop often makes little difference to signal strength. The reason is that the same signal often arrives simultaneously from several slightly different directions, having been reflected from different parts of the ionosphere.

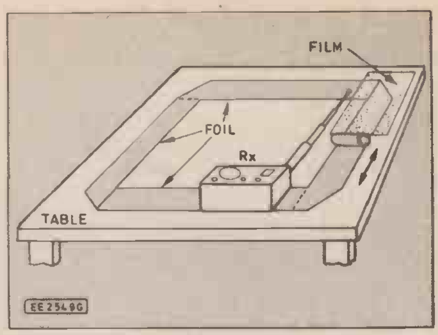


Fig. 6. Horizontal foil loop. The whip aerial must not make contact with the foil but should be extended over it as shown.

For the same reason, the original polarization of the waves is blurred. A vertical aerial radiates a vertically polarized signal and this calls for a vertically orientated receiving aerial. However, reflection by the ionosphere usually results in some of the signal arriving with horizontal polarization.

Table-Top Loop

The table-top loop is useful to the short-wave listener because it enables a flat, horizontal loop to be used if this is more convenient. This leads to the arrangement shown in Fig.6. The table must be of a non-conducting material and must embody no large loops of metal such as an all-round-the-edge metal trim or a metal frame.

Unobtrusive Loops

Loops in general are not compatible with domestic elegance. Having convinced yourself by experiment that a loop aerial is worth having you may well want to hide it from view. It is often quite easy to hide the loop itself.

For example, a wire loop might be run round (or behind) a picture frame. It still has to be coupled to the receiver, however, and this can make its presence obvious.

One trick which can help makes use of the fact that if a second, smaller loop is placed in the field of the loop aerial signal from the aerial is coupled to the smaller loop. A small loop (Fig. 7) can take the form of one or two turns of insulated wire run round the cabinet of the receiver or taped to the back. A wrap-around coupling to a whip aerial can be made as before.

In the absence of a metal-plate base the "earth" connection can be made to a sheet of foil taped to the base of the cabinet or to battery negative. This gives a completely indirect form of coupling, enabling the receiver, when not being used with a loop, to be picked up and carried about the house. The presence of the coupling loop does not interfere with

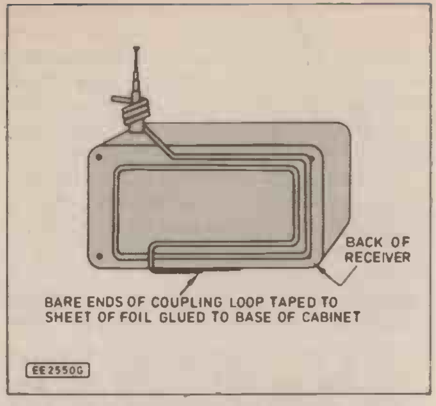


Fig. 7. How to attach a coupling loop to the receiver.

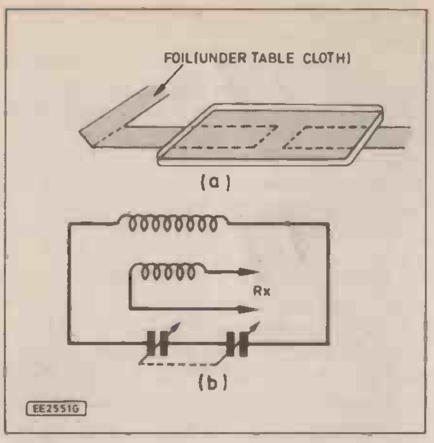


Fig. 8(a). Concealed table-top loop. A thin table cloth (not shown) conceals the foil, and provides a dielectric. A metal tray moved over the gap in the foil tunes the loop. (b) Equivalent loop circuit plus receiver coupling coil.

normal reception of medium and long wave and V.H.F. transmissions.

The tuning capacitor (or roll) of the main loop can be hard to hide. One possibility is to run a horizontal loop round the underside of a table top. A conventional tuning capacitor may be fixed where it is accessible but hidden by the table-top.

This is difficult when a rolling-foil tuner is used. One possible way out (Fig.8a) is to lay a gapped foil loop on the table then cover it with a thin tablecloth, not shown, (preferably of a low-loss material such as nylon). A metal tray (or wooden tray with foil stuck to its bottom) is placed on the cloth so as to straddle the hidden gap. there are now two capacitances from foil to tray, in series across the gap (Fig.8b). Moving the tray changes the overlaps and so tunes the loop.

The receiver is fitted with a coupling coil round its base, capacitively coupled to the whip in the usual way. the "earth" connection can be either to a foil pad on the back of the set or a direct connection to battery negative (or, in some cases, to the loudspeaker grille if this is metal). With this arrangement you can amaze your friends by boosting short wave signals by moving the tea-tray about!

Setting Up

When experimenting with aerials you need some way of find out whether signals are really being boosted by your aerial as opposed to being just picked up directly by the receiver itself. It is essential to use battery operation so as to eliminate pickup by the mains lead. The built-in whip aerial should be retracted into the set as far as possible. When your aerial is working efficiently it should make no difference to the received signal strength when you touch the top of the whip with your finger. Use weak signals when making tests.

It is quite likely, when a tuned loop is being set up, that you will find a perceptible lift in signal as the loop is tuned in but that you still get a louder signal when you touch the whip. This indicates that the coupling between the loop and the receiver is incorrect: probably too weak. Try increasing it by wrapping more turns of insulated wire round the whip or putting more turns on the coupling coil. You can also increase coupling by using a larger coupling coil.

With some receivers, tuning the loop may affect the tuning of the receiver itself. This can happen in two ways. First, the coupling of the loop may be strong enough to pull the receiver off tune in some way. You may still be able to find a loop tuning setting which boosts the signal without too much pulling. If not, the only way out is to slacken off the coupling.

The other tuning effect has quite a different cause. You may well find that some weak signals, often associated with whistles which change pitch as the tuning is adjusted, disappear when the loop is tuned in. These are in fact spurious signals which occur at "image" frequencies.

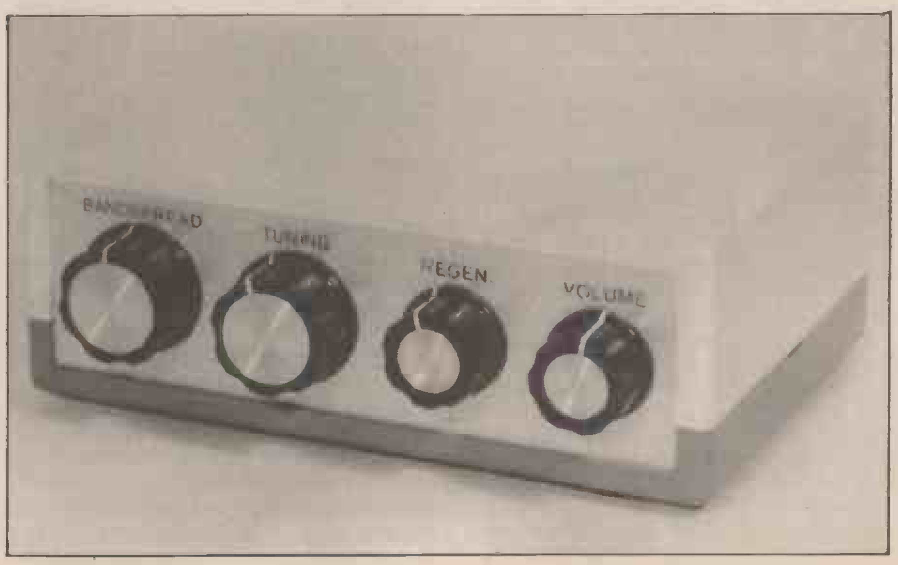
An image frequency differs from the true tuned frequency by twice the intermediate frequency of a superhet receiver. A strong signal on an image frequency may get through the receiver's own built-in aerial tuning, which is not very selective on short waves. A tuned aerial provides some extra selectivity and so attentuates image frequencies. □

TRF Receiver

by Robert Penfold

THESE days t.r.f. (tuned radio frequency) receivers seem to be out of fashion, and few designs for them appear in the electronics press. This contrasts with the situation ten or twenty years ago when simple t.r.f. designs for the home constructor appeared quite frequently.

Technology may have moved on, but sets of this type surely remain as much fun to build and use as they ever were. Their performance may not equal that of a good superheterodyne (superhet) receiver, but they can still provide some good results. They have the advantage of being simple, relatively inexpensive, and once constructed require no alignment (and hence require no test gear to aid with their alignment). Their main disadvantage is that they are relatively difficult to use, and require a lot of careful adjustment of the feedback control if they are to provide good results.



Regeneration

A t.r.f. or "straight" receiver as it is also known, amplifies the incoming radio signal and then demodulates it without any conversion to an intermediate frequency (as used in a superhet receiver). The problem with this approach is that it is difficult to obtain high gain and selectivity at the high frequencies involved in short wave reception. In order to combat this virtually all t.r.f. receivers use a process called "regeneration", usually in the form of a regenerative detector.

Regeneration is a form of feedback, and is in fact just ordinary positive feedback. In other words, some of the output signal of an r.f. amplifier is fed back to the input, and the circuit is arranged so that the feedback signal is in-phase with the input signal. It therefore tends to reinforce it, and give increased gain.

There is a limit to the amount of feedback that can be used successfully. If this threshold is exceeded, the result is a signal being continuously fed around the amplifier, giving oscillation at the frequency where the amplifier has peak gain. The boost in gain just below this threshold level is quite substantial, and in order to obtain good results the feedback level must be set quite accurately just below the oscillation point.

Unfortunately, even fairly small changes to the setting of the tuning control can necessitate minor adjustments to the regeneration level in order to maintain optimum results. This can be a bit irksome when you first start using a t.r.f. receiver, but you soon get used to this way of doing things.

Selectivity

A more than slightly useful side effect of regeneration is that it vastly improves selectivity. The reason this occurs is that there is relatively little feedback away from the frequency where the amplifier has its peak response. The more feedback that is applied to the circuit, the greater the disparity between the feedback level at the centre of the passband and just a little offset from it.

Compared to a superhet receiver having an expensive crystal or mechanical filter the selectivity of a t.r.f. receiver is still relatively poor, but it is vastly better than a crystal set (such as the one described earlier). The improvement in selectivity obtained by using optimum feedback is much greater than one might expect.

Many receivers which utilize positive feedback do not have a diode demodulator. Instead they use some form of regenerative detector. These mostly make use of what is normally an undesirable characteristic of transistors. This is their variations in gain with changes in collector current (or drain current in the case of field effect devices). In general, the gain of a transistor increases with rises in collector current, and decreases with reductions in collector current. This gives what is a rather crude and ineffective form of rectification.

Using regeneration over an amplifier tends to heighten the difference in the amount of amplification on positive and negative half cycles. With the regeneration level optimised, the difference between the peak negative and positive levels is very large, giving very effective rectification of the signal. Simply applying lowpass filtering to the output of the amplifier therefore gives a demodulated signal of good strength. The audio quality is likely to be something less than hi-fi, but is more than adequate for present purposes.

Coverage

This t.r.f. receiver has been designed primarily for simplicity and cheapness, but it nevertheless provides a useful level of performance. It covers three wavebands, giving coverage from about 1.4MHz to 25MHz. The ranges covered are as follows:

Range 1 1.4 - 4MHz
Range 2 4 - 12MHz
Range 3 8 - 25MHz

The unit does not quite cover up to the 30MHz limit of the short wave range, although it can be adjusted to do so if the wiring to the coil units is kept short enough. This slight lack of coverage is not of any great importance though, since the 13 metre broadcast band is covered by the unit, and is the highest frequency band that is likely to prove worthwhile with a receiver of this type.

In order to avoid the complications of waveband switching the unit uses the alternative of plug-in coils for waveband selection. The Denco plug-in coils that were once the standard choice for a receiver of this type would seem to be no longer available. The coils are therefore ordinary Japanese metal canned types for printed circuit mounting, but fitted onto DIN plugs to facilitate plug-in band changing.

Circuit

The circuit (Fig. 1) is based on the amplifier formed by TR1 and TR2. These operate as common source and common base stages respectively. This unusual configuration is a form of cascode circuit, and is one which gives good high frequency performance. As the amplifier operates both as an r.f. amplifier and as the detector it must handle both r.f. and a.f. signals. Consequently, it has both a.f. and r.f. bypass capacitors in its source circuit (C3 and C4 respectively).

On the face of it, C3 should operate properly at both audio and radio frequencies. In practice it is better to include C4 as many electrolytic capacitors are not designed for operation at high frequencies, and do not perform properly at these frequencies.

An advantage of using a field effect transistor at the input of the circuit is that it has an extremely high input impedance. This helps to minimise loading on the tuned winding of T1, which aids good selectivity. The tuned winding of T1 acts as the gate bias resistor for TR1 — Resistor R1 ensures that TR1's gate is not left floating during coil changes.

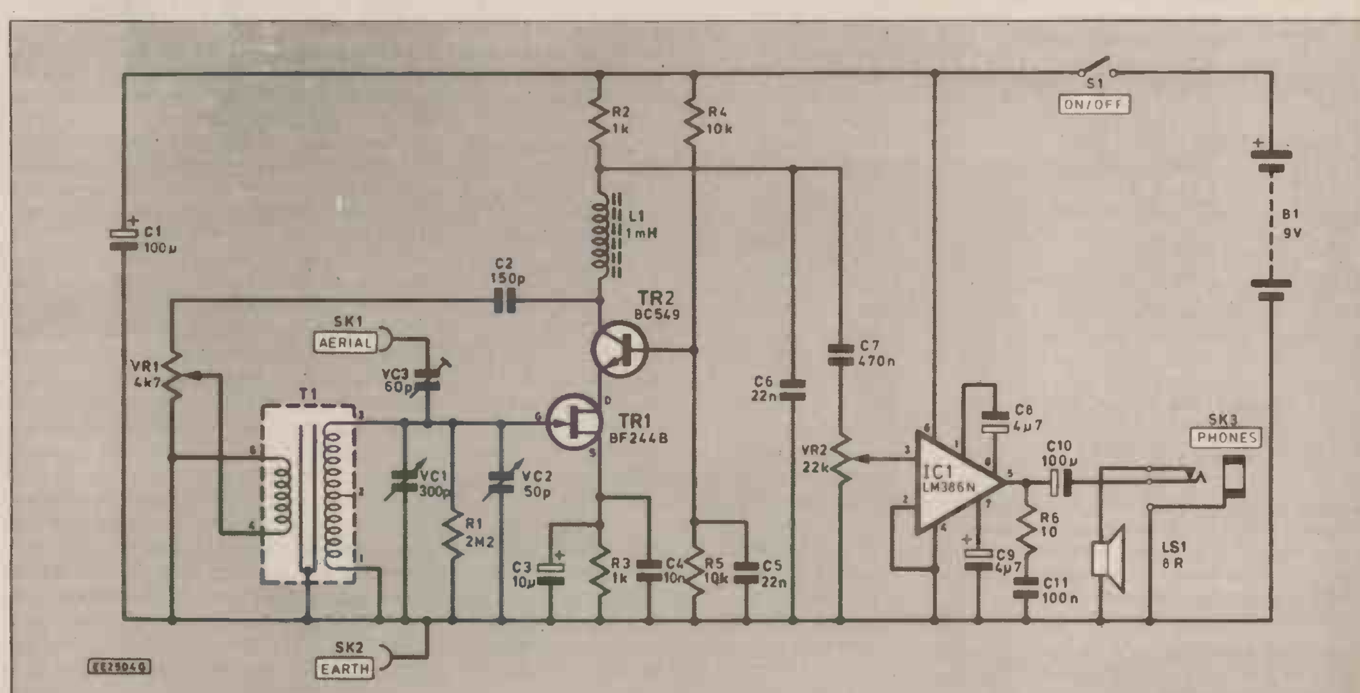


Fig 1. Full circuit diagram of the T.R.F receiver

Variable Capacitor

VC1 is the main tuning control, and VC2 is the bandspread control. Due to its low value VC2 only covers a small part of each tuning range. It is used for fine tuning, and it avoids the complication of fitting a slow motion drive to the main tuning control. The aerial signal is coupled into the tuned circuit via trimmer VC3. This trimmer must be set at a compromise value that gives a good signal transfer, but does not load the tuned circuit to the point where selectivity becomes inadequate.

The positive feedback is obtained by tapping off some of the output signal via C2 and VR1. The latter is connected as a volume control style attenuator and enables the amount of regeneration to be controlled. The input and output of the amplifier are out-of-phase, but T1 is connected to give signal inversion so that the feedback is of the positive variety.

For a regenerative receiver to give good results it is important that the feedback level can be accurately controlled. With some circuits there is a tendency for them to snap into oscillation with the feedback level only moderately advanced. This makes it impossible to set the feedback level just fractionally short of the oscillation level. Quite good control of the regeneration level is possible with this circuit, and good results can be obtained if VR1 is adjusted carefully.

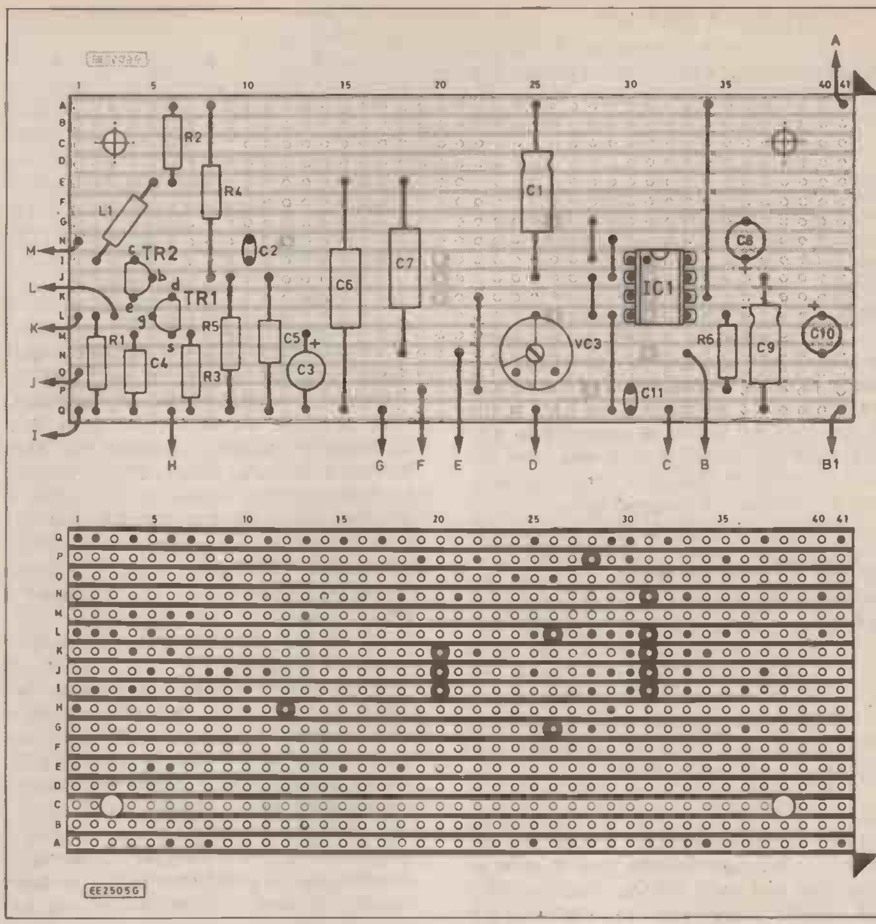


Fig. 2. Stripboard layout details

COMPONENTS

Shop Talk See page 319

Resistors

R1	2M2
R2, R3	1k (2 off)
R4, R5	10k (2 off)
R6	10

Potentiometers

VR1	4k7 lin.
VR2	22k log. with switch (S1)

Capacitors

C1	100µ axial elect. 10V
C2	150p ceramic plate
C3	10µ radial elect. 25V
C4	10n polyester
C5, C6	22n polyester (2 off)
C7	470n polyester
C8	4µ7 radial elect. 63V
C9	4µ7 axial elect. 63V
C10	100µ radial elect. 10V
C11	100n ceramic
VC1	365p air spaced Jackson type "0" (see text)
VC2	50p air spaced (Jackson C804)
VC3	60p plastic foil trimmer

Semiconductors

IC1	LM386N audio power amp
TR1	BF244B Jfet
TR2	BC549 silicon *n.p.n.*

Miscellaneous

LS1	8ohm loudspeaker
SK1	red 4mm socket
SK2	black 4mm socket
SK3	3.5mm switched jack socket
L1	1mH r.f. choke
T1 (range 1)	Toko KANK3333R
(range 2)	Toko KANK3334R
(range 3)	Toko KANK3335R
B1	9 volt (6 x HP7 in holder)

Case about 180 x 65 x 120mm; control knob (4 off); 0.1 inch stripboard 41 holes by 17 strips; 3-way DIN socket; 3-way DIN plug (3 off); battery connector (PP3 type); 8 pin d.i.l. holder; Veropins; wire; etc.

Approx cost. Guidance only **£29**

Choke

L1 acts as the load for r.f. signals, while R2 is the load for demodulated audio signals. C6 is the r.f. filter capacitor. C7 couples the demodulated audio signal to volume control VR2. From here the signal is coupled to a small audio power amplifier built around IC1.

By connecting C8 directly across pins 1 and 8 the amplifier is used with a minimum of negative feedback, and therefore provides maximum gain. This gives sufficient output to drive the loudspeaker at good volume on any reasonably strong station. For maximum output power LS1 should have an impedance of 8 ohms, but loudspeakers having an impedance of up to 80 ohms will work quite well in the circuit.

For DXing the use of headphones is strongly recommended. For reasons I do not pretend to understand, comprehending speech or Morse code signals through a lot of noise seems to be noticeably easier when using headphones rather than listening via a loudspeaker. Headphone socket SK3 has a pair of break contacts that automatically switch out the internal loudspeaker when the headphones are in use.

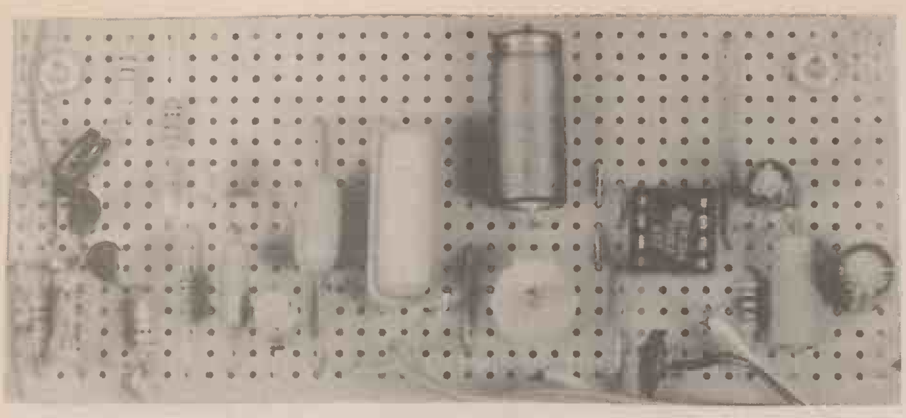
The current consumption of the circuit is about seven milliamps under quiescent conditions. As IC1 has a class B output stage the current drain can be several times higher than this at high output levels. A medium capacity battery such as six HP7 size cells in a plastic holder represent a good choice as the power source.

Construction

Most of the components are fitted on a 0.1 inch pitch stripboard which has 17 copper strips by 41 holes. Details of the board are provided in Fig.2. The board is not sold in this particular size, and you must trim a larger piece down to the correct size using a hacksaw. Cut along rows of holes rather than trying to cut between them. This will leave rough edges, but they can be smoothed using a small flat file.

The dozen breaks in the copper strips can be made using the special spot face cutter tool, or a hand held twist drill bit of about 4mm in diameter will do the job quite well. The two mounting holes for the board are 3.3 millimetres in diameter, and will take 6BA or M3 bolts. Note that short spacers (about 6 millimetres long) must be used over the mounting bolts, between the case and the board. If you use plastic stand-offs instead, the size of the mounting holes must be varied to suit the particular stand-offs used.

Fitting the components on the board is largely straightforward. Start with the resistors, capacitors, and link wires, and then fit L1 and the semiconductors. Be careful to fit the electrolytic capacitors and semiconductors the right way round. Be especially careful with IC1, since it would be difficult to remove it once it has



been soldered in place it is best to use a holder for this component.

The link wires can be made from 22 s.w.g. tinned copper wire, or trimmings from resistor leadout wires will probably suffice. VC3 may or may not fit directly onto the board, depending on the exact type you obtain. If it will not plug into the correct holes, probably the best course of action is to fit pins into the board, and to then mount VC3 on these, using stout connecting wires to bridge any gaps from the pins to the tags if necessary. Pins are fitted to the board at all the points where connections to off-board connections will be made.

Case

The unit requires a plastic or metal case having approximate outside dimensions of 180 by 120 by 65 millimetres or more. The four controls are mounted on the front panel, with VC1 and VC2 towards the left, and the two potentiometers on the right hand section of the panel. SK1 and SK2 are mounted on the rear panel, well towards the right end (as viewed from the rear). A three way DIN socket for the coils should be mounted close to SK1 and SK2. SK3 is mounted towards the opposite end of the panel.

The 365p air spaced capacitor specified for VC1 has an unusual mounting arrangement. It needs a central hole of about 8 millimetres in diameter for its spindle, plus three holes of about 4mm in diameter for the countersunk 4BA mounting screws. These screws fit into threaded holes in the front plate of VC1, and they must be no more than about 6mm long. Otherwise there is a strong risk of them penetrating VC1 too far and damaging its metal plates.

A simple way of marking the positions of the three small mounting holes is to make a card template with the aid of VC1 itself. Alternatively you might simply prefer to glue VC1 in place using a good quality adhesive such as an epoxy type. Any variable capacitor of reasonable quality and having a value of about 300p to 500p should be suitable for VC1.

The prototype used a switched potentiometer for VR2 and S1, giving a conventional combined volume control and on/off switch. Obviously a separate potentiometer and switch could be used if preferred.

The three-way DIN socket requires a main 15mm diameter hole, plus two 3.3mm diameter holes for the 6BA or M3 mounting bolts. Drill the large hole first and then use the socket as a template so that the positions of the smaller mounting holes can be marked.

A grille for the speaker is needed in the top panel of the case, and this can consist of a pattern of small holes of around 4mm in diameter drilled in the panel. Take due care when drilling these holes, since making a neat job of this is not as easy as you might think. Drilling very small holes first and then drilling them out to the required size often gives the best results.

Miniature loudspeakers do not normally have any built-in mounting bracket, and LS1 will probably have to be glued in place. Any good general purpose adhesive should do the job, but try not to smear any over the diaphragm.

Wiring

The wiring is shown in Fig.3, which should be used in conjunction with Fig.2 (point "A" in Fig.2 connects to point "A" in Fig.3 for example). Before commencing the wiring tin the tags of all the controls and sockets with solder. Provided the ends of leads are similarly tinned, there should be no difficulty in completing the joints. Try to keep all the wiring as short and direct as possible, especially the wiring to VC1, VC2, the coil holder, and other wiring around the input section of the circuit.

Fitting the coils onto their three-way DIN plugs is not too difficult, and the correct method of connection is shown in Fig.4. One of the tags on the coil which connects to its metal can must be bent outwards slightly so that it can be soldered to the middle pin of the plug. Do not overlook the link wire which connects together the three tags on the other side of the coil.

It is unlikely the plastic casing of the plug will fit back in place once the coil has been soldered in position. Trying to fit it in place could easily damage the coil or plug. The assembly is quite tough and does not actually need an outer casing, but you can bind round the plug and coil with insulation tape if you want to give the coil assemblies a neater appearance.

In Use

The unit requires a long wire aerial, and the notes on aerials for the crystal set apply equally to this receiver. An earth connection will give better reception on the lower frequency bands, and it can also be beneficial for reception on the higher frequency bands. On these bands there can be problems with hand capacitance effects, which means a slight shift in the tuning when you place your hand near the tuning control or take it away. An Earth connection, even if it is not a very efficient one, should totally remove any slight problems of this type. It is best to use the range two coil when initially trying out the receiver.

Initially set VC3 at about half maximum capacitance. If there are problems with

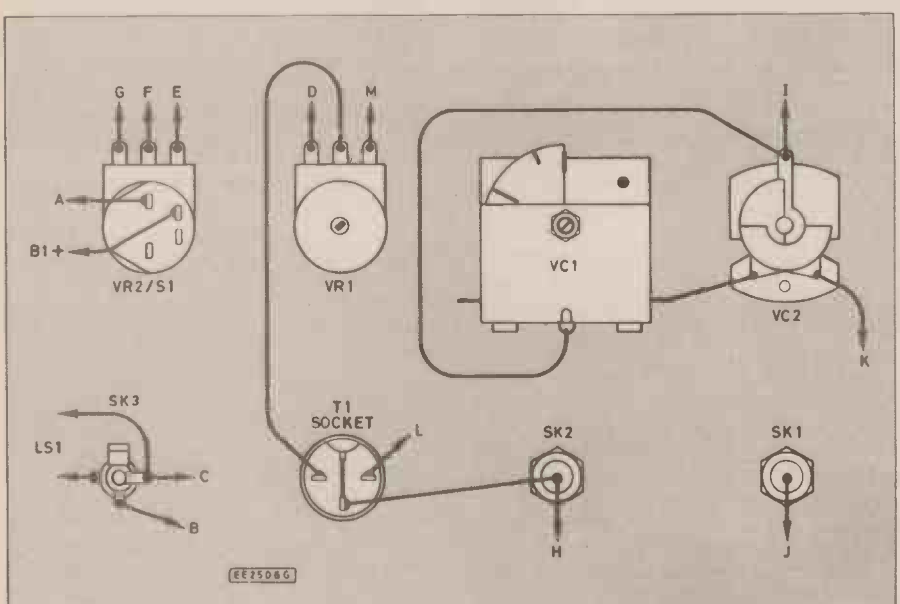


Fig. 3. Details of the wiring (use in conjunction with Fig. 2.).

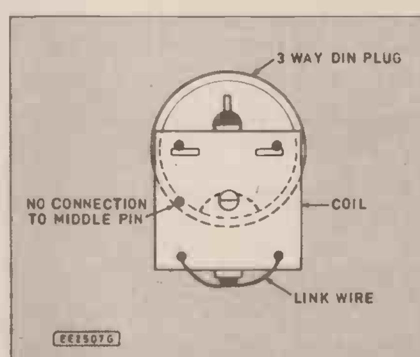
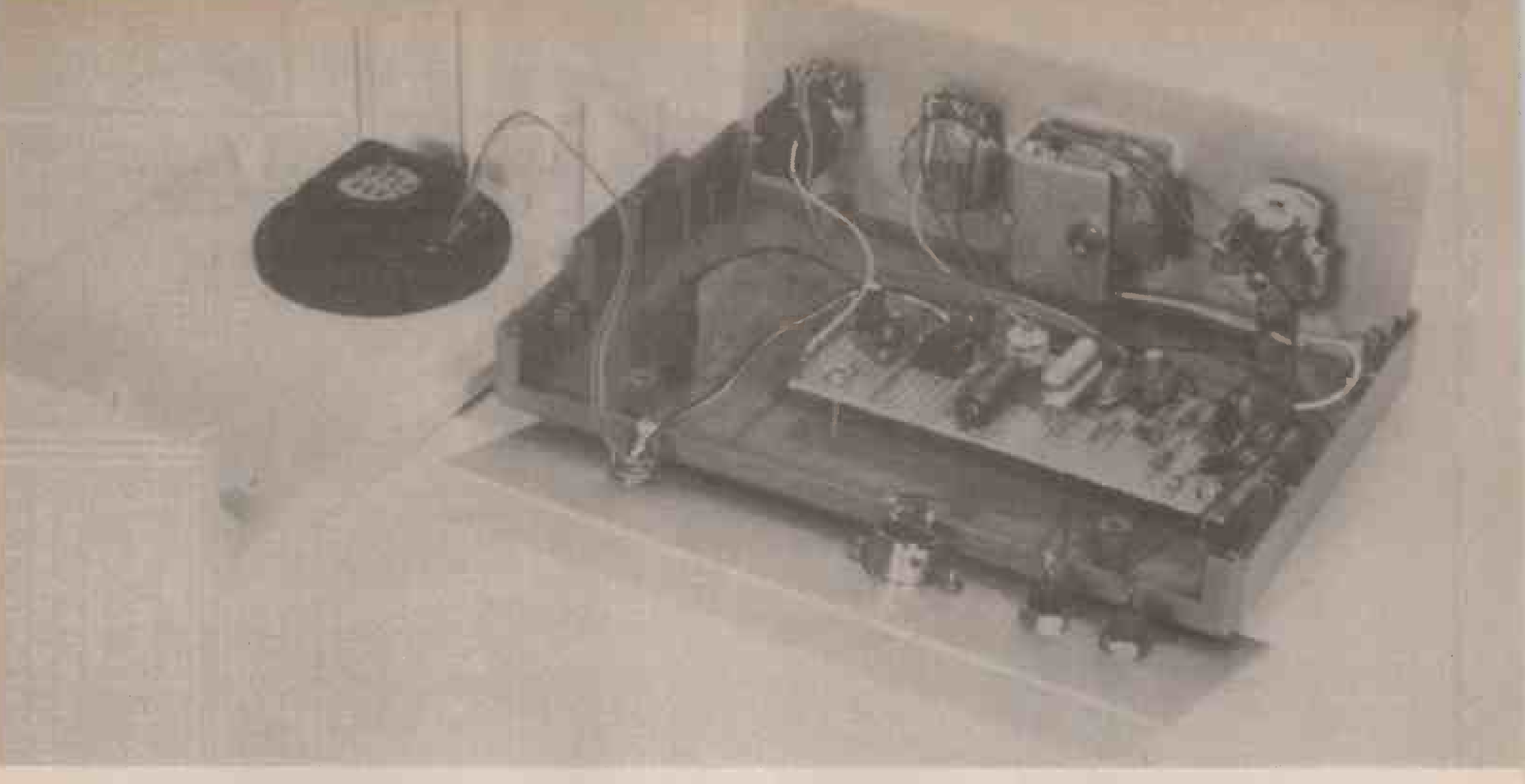


Fig. 4. Method of fitting the Toko coils to three-way DIN plugs



overloading and a lack of selectivity, try using a slightly lower value. Also use a lower setting for VC3 if it is not possible to obtain adequate regeneration at some settings of the tuning control. If, on the other hand, selectivity and regeneration are satisfactory, but sensitivity seems to be lacking, try a higher setting. With a little trial and error over a period of time you should be able to obtain a good compromise setting.

Capacitor VC1 is used to tune the receiver to the desired band, and then VC2 is used to scan that band for stations. Broadcast stations generally provide by far the strongest signals in the short wave spectrum, and there should be little difficulty in locating these bands.

The cores of the coils can be adjusted (using a proper trimming tool) to give the correct frequency coverage for their respective ranges. However, unless you have access to suitable test equipment it is probably best to simply leave the cores in their initial positions unless the coverage of a range seems to be seriously amiss.

Careful adjustment of the regeneration control (VR1) is essential if the receiver is to provide good results. It must be set just below the point at which oscillation occurs. It is usually pretty obvious when the set has broken into oscillation, since the background noise level will change suddenly, and a tone of varying pitch will be heard as the set is tuned across an a.m. station. Any large changes in the settings of the tuning and bandspread controls will almost certainly necessitate slight readjustment of VR1 in order to maintain optimum performance.

Propagation

When short wave listening it is more than a little useful if you understand some of the basics of radio wave propagation. As many readers will probably be aware, radio waves travel in straight lines, but can overcome the curvature of the earth by bouncing off the upper atmosphere and back to earth. In fact there can be a multiple bounce effect with signals bouncing from the atmosphere down to the ground, being reflected back up into the atmosphere again, and so on. This enables signals to reach the other side of the world.

This is only possible at suitable frequencies, and when conditions in the atmosphere are favourable. On the lower frequency bands the ground wave signal (i.e. the direct signal) provides communications over distances of up to a few hundred miles. It is therefore highly unusual for these bands to go completely "dead". After dark, and sometimes during daylight hours in the winter, reflections from the atmosphere permit communications over greater distances. The reflections are from a relatively low layer of the atmosphere though, and this makes communications over really long distances very difficult (but not impossible).

The high frequency bands are a very different prospect. The ground wave tends to be absorbed by the earth, and it gives very limited range. If the atmosphere is not favourable for long distance communications, the high frequency bands are likely to be completely devoid of signals!

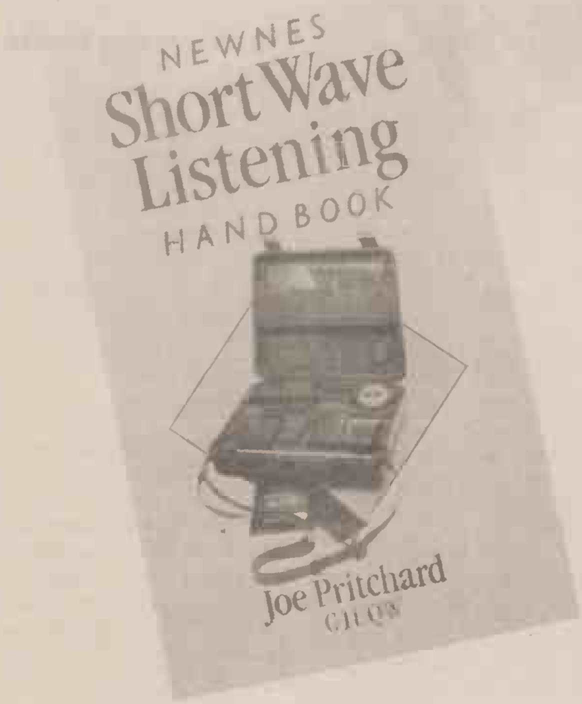
When the atmosphere does reflect signals at these frequencies, they are reflected from a relatively high layer, and even signals at quite shallow angles will be affected. This enables vast distances to be covered by a single hop. The lack of interference from local stations, plus the long distances easily covered by these signals, makes the high frequency bands the best ones for long distance reception.

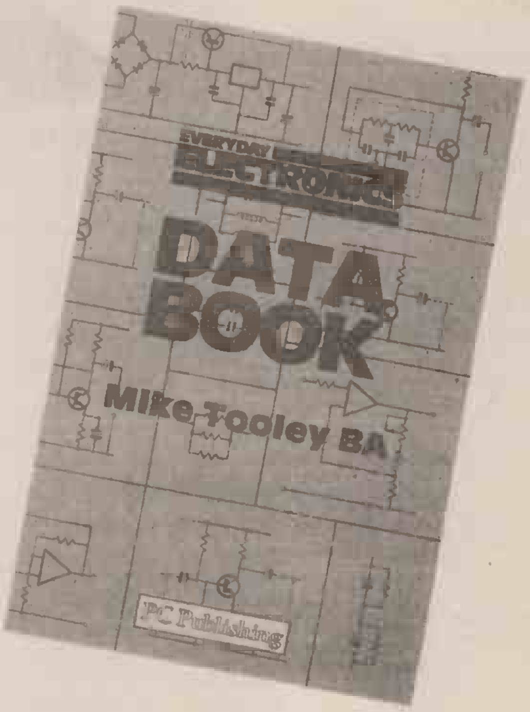
Propagation conditions on the high frequency bands are best during the hours of daylight, and during the summer months when there are long days. Sunspot activity is a crucial factor on the highest frequency bands, and in general, the more sunspots the better reception will be. Sunspots rise and fall on an eleven year cycle, and at the moment we are more or less at a peak of activity. The DX prospects of the high frequency bands are therefore excellent at the present time.

The main mode of operation used on the amateur bands for voice communications is single sideband (s.s.b.). It is possible to resolve s.s.b. signals on a t.r.f. receiver by advancing the regeneration control just beyond the threshold of oscillation. However, this could result in the set radiating illegal interference, and the general level of the set's performance when used in this way is likely to leave something to be desired. Better results on the amateur bands can be obtained using a direct conversion receiver, which is the subject of an article in the next issue of Everyday Electronics. □

SHORTWAVE HANDBOOK

EVERYDAY ELECTRONICS DATA BOOK





NEWNES SHORTWAVE LISTENING HANDBOOK

Written by Joe Pritchard G1UQW this book will be of value to anyone interested in shortwave listening.

Part One covers the "science" side of the subject, going from a few simple electrical "first principles", through a brief treatment of radio transmission methods to simple receivers. The emphasis is on practical receiver designs and how to build and modify them, with several circuits in the book.

Part Two covers the use of sets, what can be heard, the various bands, propagation, identification of stations, sources of information, QSLing of stations and listening to amateurs. Some computer techniques, such as computer morse decoding and radio teletype decoding are also covered.

EVERYDAY ELECTRONICS DATA BOOK

Written by Mike Tooley for EE and published 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!

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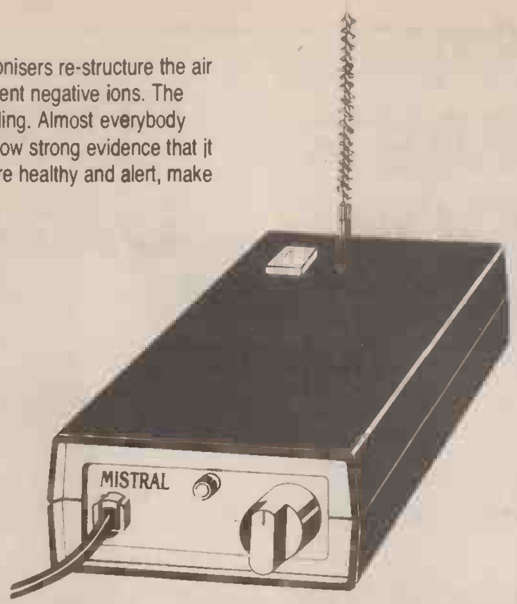

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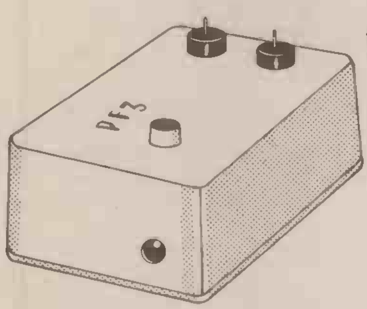

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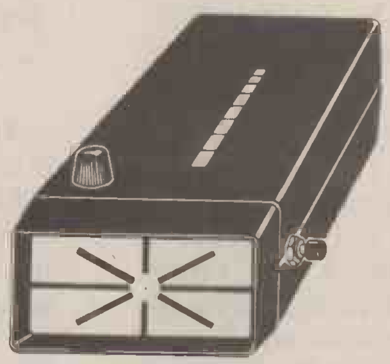

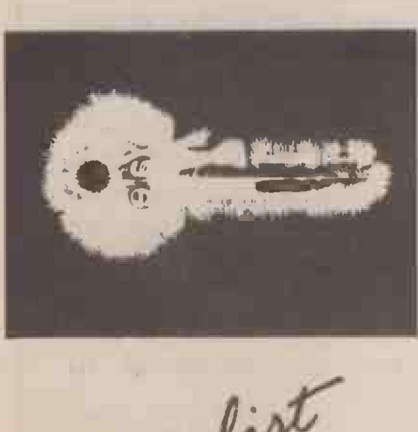

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Bioplasmic fields, auras, or just plain corona discharge? No matter how you explain them, the effects are strange and spectacular. Can you really photograph the missing portion of a torn leaf? Can you really see energy radiating from your finger tips?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

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IONISER EXPERIMENTS

* The Vanishing Smoke Trick

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

* Triffids

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

* The Electric Handshake

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

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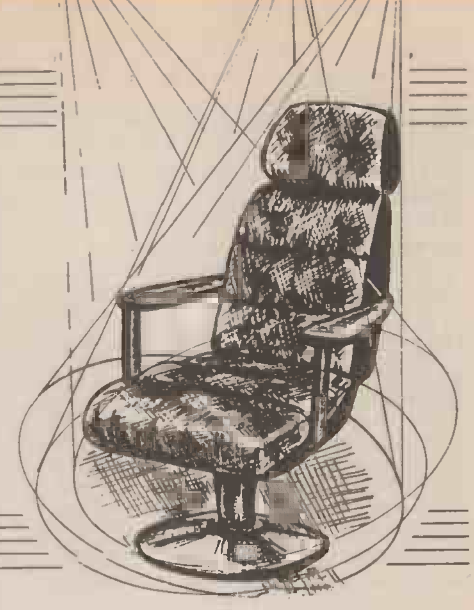


QUIZMASTER

ADRIAN GALEA

An unbiased "umpire" for team quiz games. Indicates to the Quizmaster who pressed their button first.

THE Quizmaster is a "first to press" indicator which was originally designed to be used in a team quiz game similar to the TV programme "*Blockbusters*". It can be used with up to eight contestants, each contestant having his or her own pushbutton which controls a corresponding l.e.d. on the quizmaster control module.

The unit is operated by the question-master who begins the round by pressing the Reset button on the control console. This starts an internal clock which limits the amount of time the contestants have to answer the question; the questionmaster then starts to read aloud the question and the contestants race to press their individual buttons when they feel they know the answer.

If any contestant's button is pressed, the Quizmaster control module lights the corresponding l.e.d., sounds the buzzer and, more importantly, locks out all the other pushbuttons so that only one l.e.d. can be lit at any one time. However, should no button be pressed before the clock times out, the buzzer sounds and all the pushbuttons are locked out.

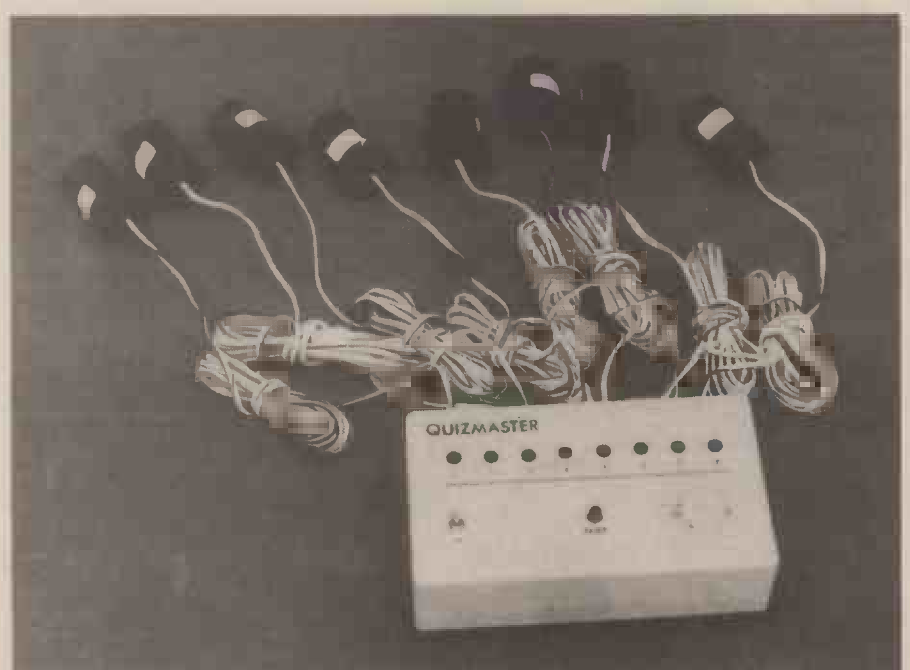
CIRCUIT DESCRIPTION

The complete circuit for the Quizmaster is shown in Fig.1. It can be broadly divided into two sections, the "Logic Circuit" (comprising IC1 to IC5 and their associated components, diodes D9, D10 and resistor R14) and the "Timing Circuit" (IC6 and its associated components, including the buzzer WD1).

The logic circuit monitors the pushbutton switches S1 to S8 and when one is pressed, lights one of the l.e.d.s (D1 to D8) and drives an internal signal (the "GATE" signal) low as described below; this latter action locks out all the other pushbuttons and initiates the buzzer.

The timing circuit is made up of two individual monostable timers IC6a (T1) and IC6b (T2) contained in the same i.c. package. The first monstable (T1) provides the length of time for the question to be asked and the contestants to think about their answer. The second monostable (T2) drives the buzzer and can be initiated by either the first time period ending or by the "GATE" signal going low.

The completed Quizmaster control console and the eight contestant's "answer" buttons.



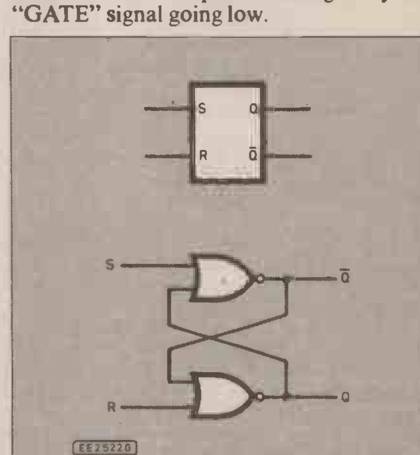


Fig. 2. Block and circuit schematic for the RS latch.

LOGIC CIRCUIT

The operation of the logic circuit is based on a device known as an RS latch (see Fig.2). This is a type of flip-flop or bistable, the operation of which can be summarised as follows:

The RS latch has two inputs (R and S) and two outputs (Q and $\overline{Q}$); the outputs are complimentary so that when Q is at logic 1, $\overline{Q}$ must be at logic 0 and vice versa. The output Q is set to logic 1 by a pulse applied to the S input and reset to logic 0 by a pulse applied to the R input; however, once Q has been set or reset then further pulses applied to that same input have no further effect on the outputs.

RS latch circuits can themselves be built up using either NAND gates or NOR gates; if they are based on NAND gates then the inputs are normally held high and are taken low (i.e. a negative- going pulse is applied) to change the outputs over. On the other hand, if they are based on NOR gates the inputs are normally held low and are taken high (i.e. a positive-going pulse is applied) to cause the outputs to change.

The RS latches used in this circuit (IC3 and IC4) are based on NOR gates. These particular i.c.s are tri-state devices which means that apart from the outputs either being high or low, they can also be "disconnected" from the rest of the circuit; this is achieved by taking the Enable pin low (pin 5 on IC3 and IC4). As the disconnecting facility is not required in this application, the Enable pin *must* be tied high.

Returning now to the circuit diagram Fig.1, on pressing the Reset button (S9) two things happen; firstly, a logic 1 is applied to the R inputs of all the RS latches (IC3 and IC4), resetting each of the Q outputs to logic 0 and thereby setting the NOR gate output (IC5, pin 13) to logic 1 (see Fig.3). Secondly, monostable T1 (IC6a) is initiated (see "Timing Circuit") and so its output (pin 5) is also high.

The outputs of the NOR gate and Monostable T1 are combined together into the "GATE" signal by means of diodes D9, D10 and resistor R14 which form a "hard wired" AND gate. Thus, so long as all the RS latches are reset (i.e. NOR gate output is at logic 1) and Monostable T1 is initiated, the GATE signal is at logic 1.

This GATE signal is fed back to the individual "input AND gates" (IC1 and IC2), each of which has its other input tied down to 0V (i.e. held at logic 0) via resistors R1 to R8. The output of each of the AND gates is therefore at logic 0.

If any of the contestants' pushbuttons is now pressed, both inputs to that AND gate will be at logic 1, setting its output high. This change of output is seen by the RS latch as a positive-going pulse on its S input which sets its Q output to logic 1; current now flows through the l.e.d. and limiting resistor R10. Even if the pushbutton is subsequently released (resetting the output of the AND gate to logic 0), the Q output of the RS latch will remain at logic 1 and so the l.e.d. stays lit.

Each of the l.e.d.s D1 to D8 share the same current limiting resistor; this is because during normal operation of the circuit only one l.e.d. should be lit at any one time. However, when the unit is first switched on it is possible for more than one l.e.d. to be lit; in this case, the current flowing through the limiting resistor stays roughly the same but it is provided by a number of routes, i.e. through each of the l.e.d.s that are turned on. Thus the current flowing through each of the l.e.d.s is only a fraction of that which would be flowing if it alone were the only current path. The l.e.d.s therefore glow dimly.

As can be seen from the short form truth table for the NOR gate (Fig.3.), when at least one of its inputs is high its output is at logic 0; hence the RS latch Q output going high resets the NOR gate output low, thus turning off the GATE signal.

This has two effects; it prevents the output of any of the AND gates going high, thus inhibiting the action of any of the contestants' pushbuttons (including the one that has already been pressed!) and secondly, it initiates Monostable T2 (IC6b) which sounds the audible alarm WD1.

However, should no contestant press his or her button, Monostable T1 times out and its output (IC6a, pin 5) goes low; this turns the GATE signal off, again lock-

SHORT FORM TRUTH TABLE FOR 8 INPUT NOR GATE

INPUTS								O/P
0	0	0	0	0	0	0	0	1
X	X	X	X	X	X	X	1	0
X	X	X	X	X	X	1	X	0
X	X	X	X	X	1	X	X	0
X	X	X	X	1	X	X	X	0
X	X	X	1	X	X	X	X	0
X	X	1	X	X	X	X	X	0
X	1	X	X	X	X	X	X	0
1	X	X	X	X	X	X	X	0

X = don't care

EE25230

Fig. 3. Short form Truth Table.

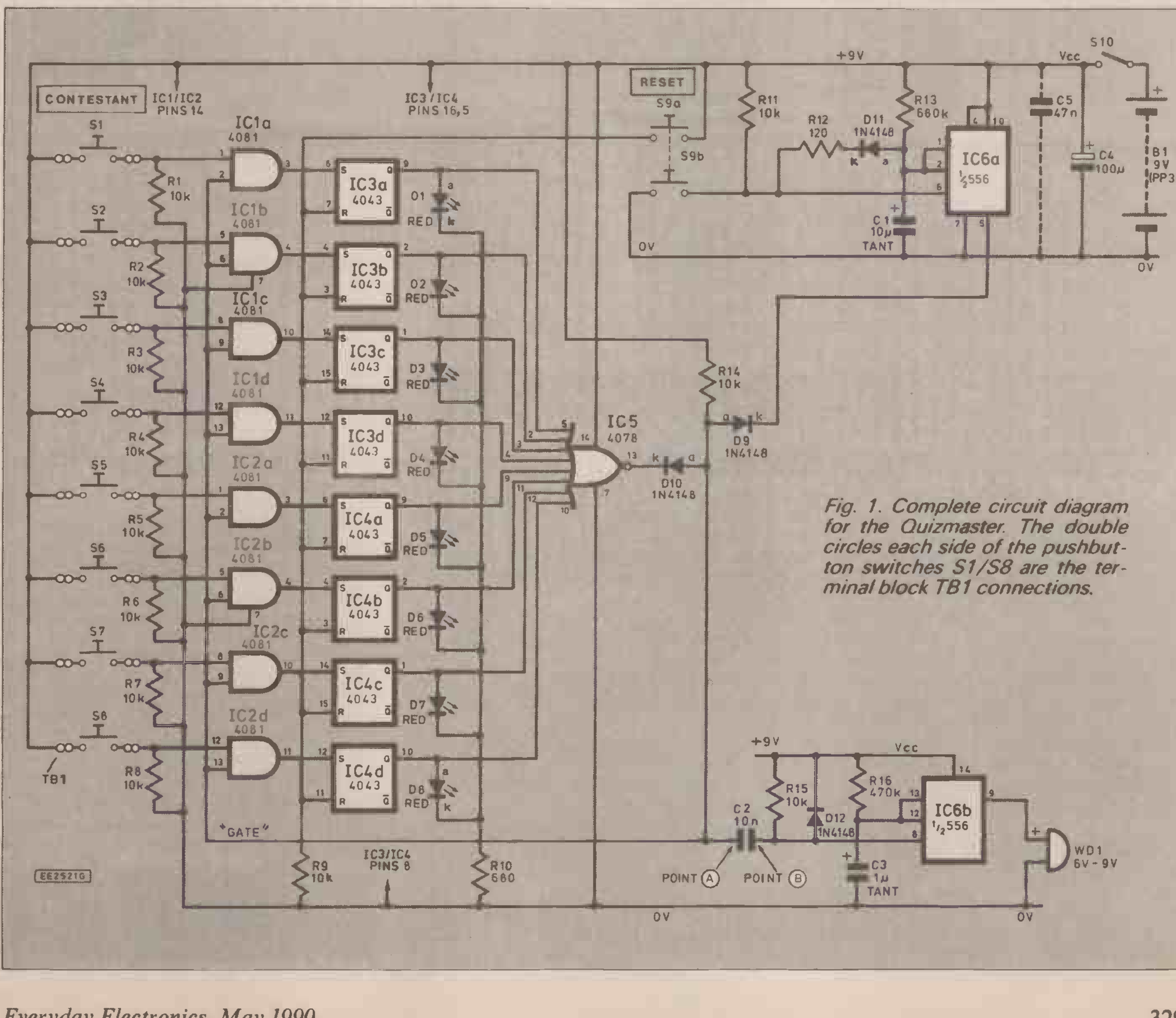
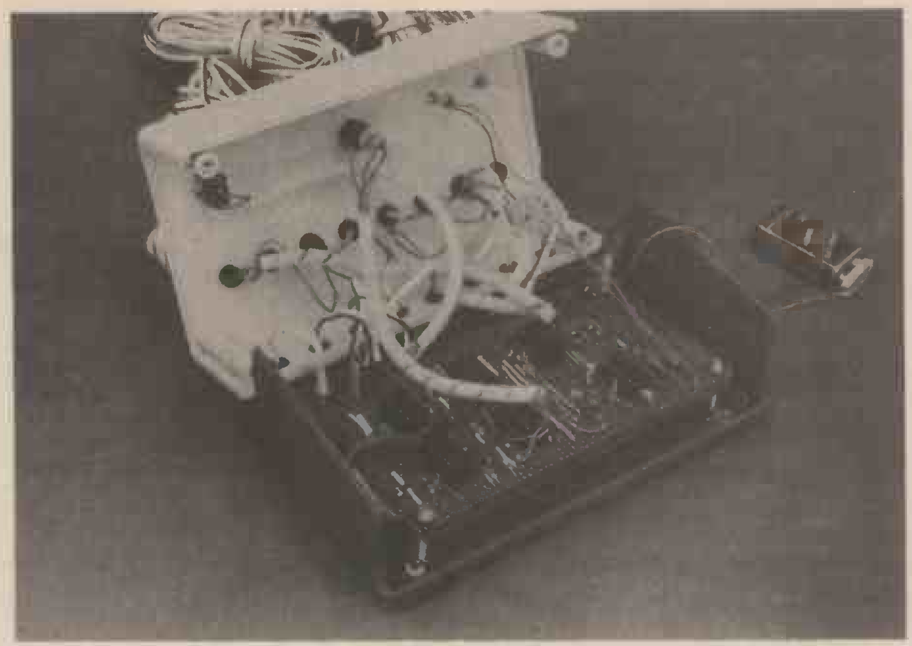


Fig. 1. Complete circuit diagram for the Quizmaster. The double circles each side of the pushbutton switches S1/S8 are the terminal block TB1 connections.



The early stripboard prototype version showing the "wiring looms" to the l.e.d.s.

ing out all pushbuttons and sounding the buzzer.

You may think it is possible for two l.e.d.s to be lit at the same time if a second button is pressed immediately after the first but before the "GATE" signal has had the chance to go low; however, to put this in perspective, using the component manufacturers' literature, the resolution of the circuit is calculated to be about 1/4μS. To illustrate this point, rope in a few helpers and try and deliberately get more than one l.e.d. on at same time; I doubt you'll ever succeed.

TIMING CIRCUIT

The timing circuit is provided by IC6 (and its associated components) which is a 556 timer; this is really two independent 555 timers in one package. The first timer (IC6a) provides the preset time for each question and is set to about eight seconds; the second timer (IC6b, set to about one second) is used to drive the audible alarm, sounded either when a contestant presses his button or when the time allowed has elapsed.

The "on time", *T*, for each monostable is set by the resistor/capacitor connected to the Threshold pin (e.g. R13 and C1 for Monostable T1) according to the formula: $T = 1.1 \times R \times C$ where *T*, *R* and *C* are in seconds, Ohms and Farads respectively.

Notice that both timers have very different triggering circuits; in order to understand why, a brief explanation of the operation of the i.c. is required.

Each timer contains a resistor chain that it uses to derive two reference voltages of 1/3V+ and 2/3V+. These voltages are applied (internally) to comparators which "monitor" the input voltages on the Trigger and Threshold pins. It also contains a transistor that it uses to apply a "short circuit" between the Threshold pin and ground, thus discharging the timing capacitor and preventing it from charging up.

To initiate the device, the voltage on the Trigger input (normally held high) is taken below 1/3V+. Once initiated, the output voltage goes high and the internal transistor is turned off; this allows the timing capacitor to begin to charge up.

When the voltage across the timing capacitor (i.e. the voltage on the threshold pin) reaches 2/3V+, the timer is turned off (i.e. its output goes low) and the internal transistor is turned on again, thus discharging and shorting out the timing capacitor. The monostable is not normally retriggerable, i.e. once initiated it does not respond to further pulses applied to the trigger. However, after using the original Quizmaster unit a few times it was found that it would be preferable if Monostable T1 were retriggerable.

This is because on odd occasions a contestant would interrupt the questionmaster but give a wrong answer; the questionmaster would then press the reset button and start to read the next question. However pressing the reset button merely cleared the l.e.d.s; it did not retrigger the monostable. The monostable would then time out before the questionmaster finished reading the next question.

Consider now Monostable T1 trigger circuit, IC6a. The trigger is normally held high via resistor R11 but is momentarily connected to the 0V rail when the Reset button (S9b) is pressed; the monostable is now initiated and capacitor C1 starts to charge up via resistor R13. Should the Reset button be pressed again before the timing period has elapsed, the capacitor is discharged almost completely via diode D11 and resistor R12; the timing period starts again from scratch. Thus operating the Reset button in effect retriggers monostable T1.

Turning now to Monostable T2 (IC6b), its Trigger input cannot be connected directly to the GATE signal because it is a requirement of the timer i.c. that once initiated, the voltage on the Trigger pin must return to a voltage greater than 1/3V+ before the end of the timing period otherwise the device will be inhibited and the output will remain high (until the trigger voltage rises above 1/3V+). However, once the GATE goes low (either because the NOR gate output goes low indicating that a contestant has pressed his button or Monostable T1 output goes low indicating the end of the time allowed) it will remain so until the Reset button is pressed.

This problem is overcome by means of capacitor C2. When the GATE signal is high both plates of capacitor C2 are held at V+ via resistors R14 and R15; capacitor C2 is therefore discharged. When the GATE goes low, one side of the capacitor (Point *A*) is effectively connected to the 0V rail; as the voltage across a capacitor cannot change instantaneously, the voltage on the other plate (point *B*) also momentarily dips to 0V before the capacitor begins to charge up via resistor R15. The voltage on point *B* therefore rises to V+.

However, when the Reset button is pressed and the GATE goes high again, point *A* immediately rises to V+ and point *B* would theoretically momentarily rise to twice V+ (if the capacitor were fully charged) before starting to discharge through resistor R15 to V+. This potentially destructive spike is eliminated by diode D12 which begins to conduct when point *B* rises to 0.6V above V+.

CONSTRUCTION

The i.c.s used in this project are CMOS types; care must be taken not to damage these static-sensitive devices during han-

COMPONENTS

Resistors

R1-R9, R11, R14, R15	10k (12 off)
R10	680
R12	120
R13	680k
R16	470k

All 0.25W 5% carbon film

Shop Talk

See page 319

Capacitors

C1	10μ tantalum bead, 16V
C2	10n polyester
C3	1μ tantalum bead, 16V
C4	100μ radial elec., 25V
C5	47n disc ceramic

Semiconductors

D1-D8	5mm red l.e.d.s (8 off)
D9-D12	1N4148 signal diode (4 off)
IC1, IC2	4081 CMOS quad 2-input AND gate (2off)
IC3, IC4	4043 CMOS quad 3-state NOR R/S latch (2 off)
IC5	4078 CMOS 8-input NOR gate
IC6	556 dual timer

Miscellaneous

S1-S8	Min. push-to-make switch (8 off)
S9	Min. 2-pole push-to-make switch
S10	Min. On/Off toggle switch
B1	9V PP3 battery, with connectors

Printed circuit board available from *EE PCB Service*, code EE690; case, Verobox 103; 14-pin i.c. socket (4 off); 16-pin i.c. socket (2 off); TB1 12-way screw terminal block; buzzer; l.e.d. bezels (8 off); twin-core bell wire (about 16m, i.e. 2m per "contestant button"); rubber grommets; solder pins; connecting wire; nuts and bolts; solder etc.

Approx cost. Guidance only **£26**

dling and soldering. Because of this, it is preferable if the i.c.s are mounted in sockets rather than being soldered directly to the printed circuit board.

It is suggested that after building the circuit board it is thoroughly tested before the complete unit is assembled in the master control case together with the contestant pushbutton switches. In order to do this (and to facilitate construction), the flying leads from the circuit board for the contestants' pushbuttons are connected to a terminal strip TB1 which will later be fixed to the side or bottom of the case. The reasons for doing this will become apparent when testing the unit.

CIRCUIT BOARD

Construction of the printed circuit board is fairly straightforward and the component layout and full size copper foil master pattern is shown in Fig.4. This board is available through the EE PCB Service, code EE690.

It is suggested that the i.c. sockets be soldered in position first followed by the link wires, terminal pins, resistors, capacitors and then diodes. The flying leads to the l.e.d.s (D1 to D8), on/off switch S10, reset button (S9) and contestants' pushbutons 12-way terminal strip (TB1) can then be soldered in place along with the battery connector and miniature buzzer.

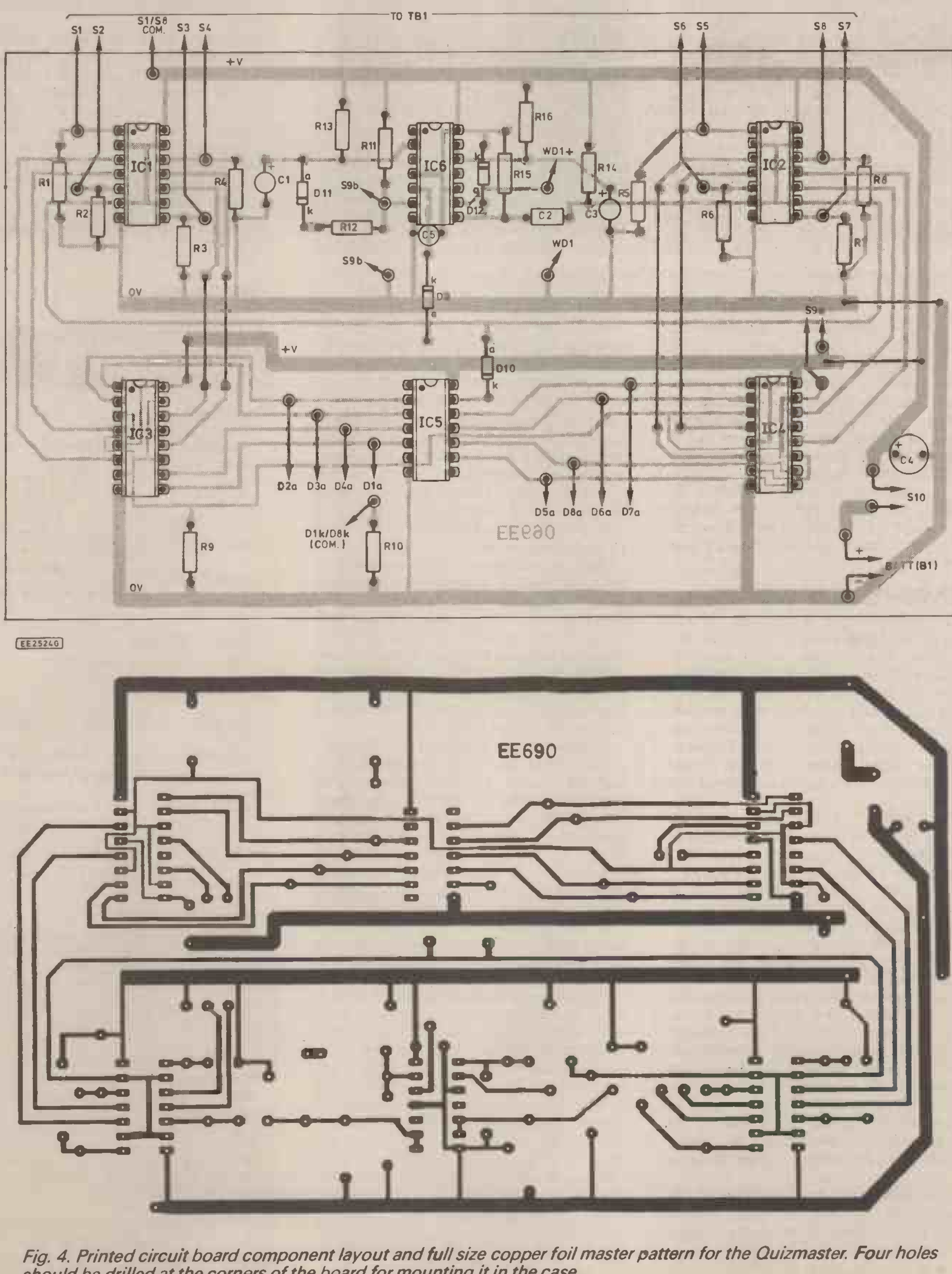


Fig. 4. Printed circuit board component layout and full size copper foil master pattern for the Quizmaster. Four holes should be drilled at the corners of the board for mounting it in the case.

WIRING UP

Single strand light-duty wire was used for the flying leads; for the on/off switch and reset button, 203mm (8in.) lengths were found to be suitable. For the contestants' pushbuttons and l.e.d.s longer lengths 255mm – 305mm (10-12in.) were used; the leads can be bundled together into a "wiring loom" using cable ties or spiral cable wrapping and the ends cut to the required length to suit.

The other ends of the flying leads can then be connected as required; note that the cathodes (k) of the l.e.d.s are all linked together as shown in Fig. 5. The i.c.s can now be inserted.

At this stage carefully check the circuit board over once more; if all appears to be correct, insert the i.c.s taking care that they are oriented correctly (and inserted in the right socket!) and avoid touching the pins. The operation of the circuit may now be tested before assembling the rest of the unit.

Control console front panel layout showing the contestant's l.e.d.s.

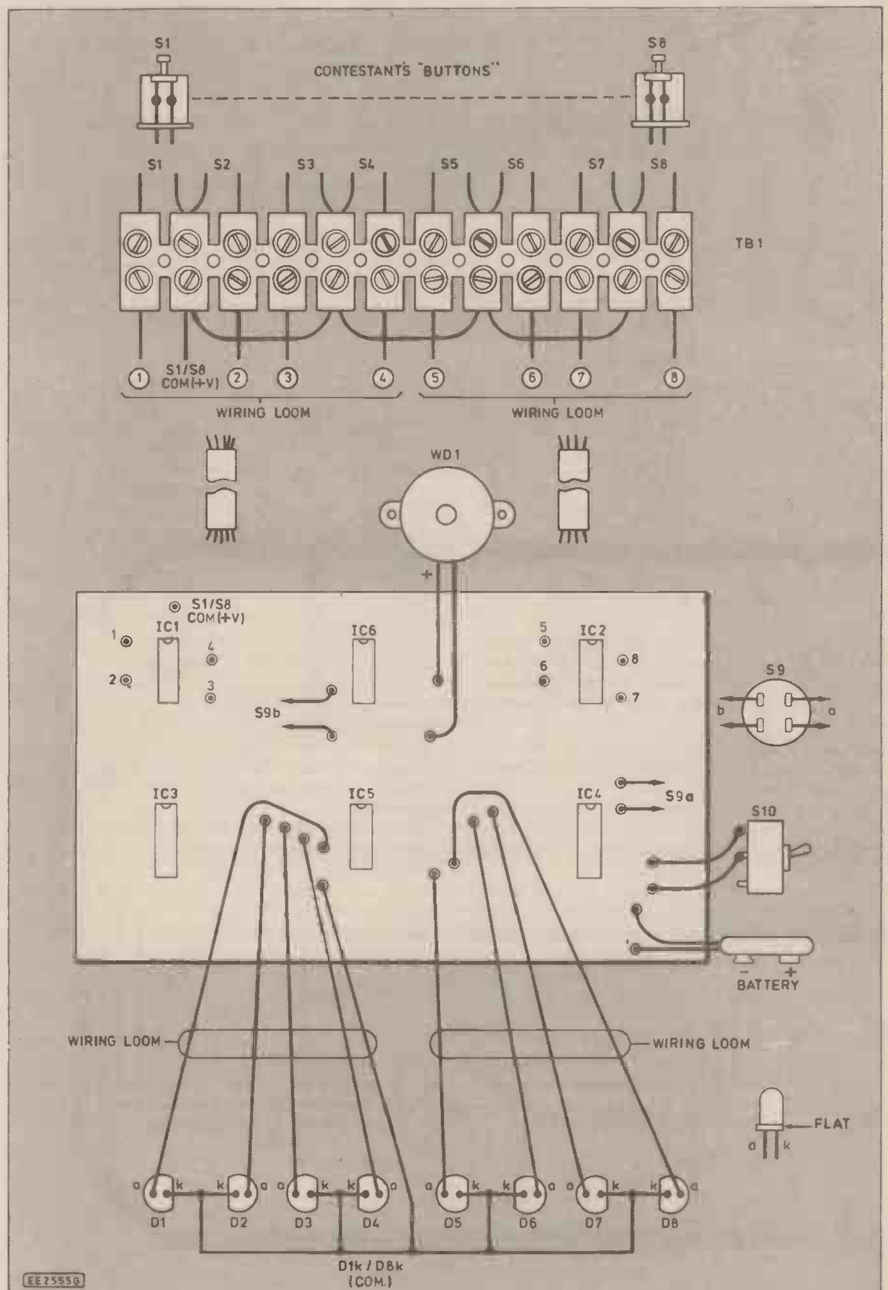


Fig. 5. Interwiring from the printed circuit board to the l.e.d.s, terminal block and contestant switches.

TIMING

The times set for Monostables IC6a and IC6b were those that most suited the author's own use; if it is required, they may be changed by adjusting the values of the timing resistors or capacitors. The type of capacitor used is not important so long as it can physically fit in the space provided. However, it is recommended that electrolytic and ceramic disc capacitors are avoided.

The 556 timer i.c. is available as a CMOS or bipolar device; if a bipolar version is used it is recommended that a 47nF decoupling capacitor (C5) is fitted close to the supply pins (shown dotted in Fig.1). This is not necessary with the CMOS device.

TESTING

Plug the battery into its holder and switch on; some (or all) of the l.e.d.s should now be lit though they may be glowing very dimly indeed. Immediately press the Reset button S9 and all the l.e.d.s should now be extinguished; if not, switch off and carefully check the circuit board before continuing.

If all is well, wait for approximately eight seconds and the buzzer should sound for about one second. Now, using a short length of wire, dab each of the flying leads to the pushbuttons in turn to the positive supply on the terminal strip; nothing should happen!

Press the Reset button again and this time dab the "short" from the positive supply on to one of the pushbutton flying leads before the Monostable T1 times out; this time the corresponding l.e.d. should light (quite brightly) and the buzzer sound immediately. Dab the short on to each of the other flying leads to the pushbuttons in turn; nothing further should happen.

Repeat this test with all the other pushbuton leads in turn. Finally, press the Reset button, wait for a couple of seconds and then dab a short on any pushbutton flying lead; immediately press the reset button and time how long it takes before the buzzer sounds. This time interval should not have changed (it should be about 8s).

If any difficulties are experienced, it is suggested that the unit is switched off and one side of the diode D9 is unsoldered and lifted clear of the circuit board. The logic circuit has now effectively been separated from the timing circuit and can be functionally tested on its own (ignoring the buzzer which should sound every time the GATE signal goes low). Once any faults are cleared, diode D9 can be resoldered and one side of diode D10 unsoldered to allow testing of the timing circuit.

ASSEMBLY

The circuit board has been designed to fit in a type 100 "Verobox" (110mm × 190mm × 60mm) although any other case of at least similar dimensions may be used. At first site it might appear as though the case is rather large and that a smaller size could have been used; however, there are a lot of flying leads to be accommodated and the size of case quoted is probably the minimum that could be used.

Mark the lid of the box and drill the required holes for the l.e.d.s, Reset button, on/off switch and buzzer. Fit the mounting bezels for the l.e.d.s. Drill the base of the box for the circuit board mounting pillars and terminal strip for the pushbuttons. Mount the terminal strip in position and then pass the leads for the switches through the grommets, secure with cable clamps and connect to the terminal strip as shown in Fig.5. Fit the circuit board mounting pillars and connect the pushbutton flying leads to the terminal strip before installing the board in position. Mark and drill the side of the box for the pushbutton cables and fit rubber grommets. Fit the buzzer, on/off switch and reset button in position before pushing each of the l.e.d.s into its mounting bezel.

Solder the pushbuttons to the other ends of the cables and fit them in suitable containers such as plastic 35mm film cases. It is handy if each pushbutton is identified with a number corresponding to the l.e.d. position on the Quizmaster control unit.

FINAL TESTING

Once the unit has been assembled it can be tested in much the same way as before; as a final check you could try "racing" the buttons, operating one slightly before the other.

Before using the Quizmaster in earnest, it is always best to begin by fully testing the unit; this is done by asking each contestant in turn to press his or her button (after pressing the Reset button) to ensure that the corresponding l.e.d. lights and the rest of the contestants then press theirs to ensure that they are locked out.

OPERATING

When in use, you may get the odd complaint (usually from the losing team) that the unit is "rigged" or that a particular button does not respond as fast as some one else's. You may counter these arguments by offering to swop the buttons around or lapse into a detailed description of the circuit operation to demonstrate that their fears are unfounded. Threatening to deduct a point for arguing with the questionmaster is usually far more effective.

Happy quizzing! □

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EE MARKET PLACE MAY '90

a regular feature for the Spectrum Owner...

by Mike Tooley BA

LAST MONTH we showed how readers can make maximum use of the powerful Philips SAA1099 stereo sound generator chip fitted to the MGT SAM Coupé. This month, we have an interesting demonstration software routine which puts some of the facilities offered by this chip to the test. We begin, however, by attempting to catch up with a bumper crop of problems, hints and tips sent in by readers.

Changing Times

Ben Howe writes from Ormskirk to let me know about an error which crept into the Clock/Timer Program (*Everyday Electronics Dec '89*). Ben has been using the program but has found that the clock advances from 23.59 to 24.00 rather than the expected 00.00.

Unfortunately, this was an oversight on my part so, for Mr Howe (and others) who may be using the Spectrum as a clock, here is the solution:

1. Add a line 4055 as follows:
   4055 IF hour = 24 THEN LET hour = 0
2. Add an extra space between the last pair of quotes in line 2120.

Several other readers have commented on the Clock/Timer program and seem to have put this to good use. *M. Sharpe* has written to ask if there is any way that the Spectrum can be made to issue a "tick" every second using the BEEP command.

Whilst a BEEP statement could easily be included within the main timing loop (which starts at line 2100), this would have the effect of slowing the clock down as the BEEP command monopolises the CPU! An alternative solution might be that of flashing the border, alternately between red and green, every second. If this will suffice, the following lines can be added in order to produce this "visual tick":

2125 IF sec/2 = INT (sec/2) THEN BORDER 2

2126 IF sec/2 < > INT (sec/2) THEN BORDER 4

Under the Microscope

Andy Scott is a regular reader of this column and he writes from Avon to request details of sources of information concerning the Ferranti uncommitted logic array (ULA) chip fitted to the Spectrum. In particular, Andy would like some details concerning the internal logic of the device (particularly in the area of the clock and video signal processing).

The "official" Spectrum Service Manual provides little information on the ULA device which is presumably quite deliberately kept "under wraps". Has anyone got any further information which might be worth passing on?

Illogical Logic

Tony Preston, from Cardiff, thinks he may have discovered a problem with the ROM in his Plus-Two. Tony writes:

"Can anyone throw some light on a problem which I have come across when using the Boolean operators, AND, OR etc. Why does Sinclair BASIC produce strange results with these functions? Is there an error in the ROM or have I missed something?"

In short, Tony, the answer is that ZX-BASIC handles the logical operators in a somewhat different manner from that which is employed in several other popular microcomputers. As an example, the following results are obtained:

Logical Operation	Result
1 AND 1	1
1 AND 0	0
2 AND 2	2
2 AND 1	2 (!)
2 AND 0	0

Despite the somewhat surprising outcome (in the case of "2 AND 1" there is some logic behind the Spectrum's handling of Boolean operations which, whilst unconventional, is at least consistent in all versions of the ROM. For the benefit of those who may have had their curiousity aroused by this apparent anomaly, I shall attempt to explain this in a future "*On Spec*".

Machine Code Revisited

Mike Short has requested some details of books which will help him learn to program in Z80 code. Mike writes:

"Like many people, I would like to be able to make my programs more efficient and also more compact. I am a reasonably proficient BASIC programmer. Can you please recommend something which will help me make the quantuum leap into machine code? I have a Plus-Two and a Plus-D with 3.5in. disk drive."

Mike's request is fairly common as most serious users of the Spectrum eventually realise the need for something more powerful than ZX-BASIC. Two books worth looking at are *Spectrum* + 2 Machine Language for the Absolute Beginner by Joe Pritchard (published by Melbourne House, ISBN 0-86161-209-4) and *Spectrum Machine Language for the Absolute Beginner* by William Tang (also published by Melbourne House, ISBN 0-86161-110-1). Despite the similarity of their titles, these two books can be completely different and both can be recommended.

As far as software is concerned, *Hisoft's* DEVPAC is probably the most widely used development tool which provides powerful editing, assembly and debugging facilities. This package can be used to enter, test and debug assembly language programs ranging from the trivial to the most complex.

Mission Control

Stephen Villiers teaches Design and Realisation and his pupils are experimenting with a Spectrum-controlled buggy. Stephen needs an interface which can control four d.c. motors (each rated at 12V, 1A) and provides inputs for six sensors (all of which employ TTL level signals). Stephen writes:

"The interface needs to be fairly cheap to construct (we may have to build several of these!) and must also use a minimum of chips. We would like to have a small keypad with four switches to control the direction of the buggy.

With the four motor drive signals and six inputs, this makes a grand total of ten input signals and four output signals. Can this be achieved using a single Z80-PIO or would you recommend another intergated circuit?"

Fortunately, the solution to this problem appeared in March 1988 *Everyday Electronics* amd takes the form of our "*On Spec*" Add-on I/O Port. The interface uses only three chips (including an 8255 programmable parallel I/O device) and costs in the region of £16 to build.

Since the 8255 has three 8-bit I/O ports (rather than the two available from the Z80-PIO) there should be no problem with the configuration suggested. Hope it all works well, Stephen!

Play It Again Sam!

Readers of this column will be only too well aware that the MGT SAM Coupé offers some remarkably powerful facilities in the area of sound generation. Last month, I promised a routine which would put the SAA1099 though its paces. Here it is:

```
 10 REM SAM Coupe only
 20 SOUND 28,1
 30 SOUND 8,11
 40 SOUND 9,4
 50 SOUND 20,3
 60 FOR x=1 TO 4
 70  SOUND 21,0
 80  FOR y=5 TO 1 STEP -1
 90   SOUND 16,y
100   FOR z=255 TO 128 STEP -8
110    SOUND 8,z
120    SOUND 0,16
130    PAUSE x
140   NEXT z
150  NEXT y
160  SOUND 21,1
170  FOR y=1 TO 5
180   SOUND 16,y
190   FOR z=128 TO 255 STEP 8
200    SOUND 8,z
210    SOUND 0,16
220    PAUSE x
230   NEXT z
240  NEXT y
250 NEXT x
260 SOUND 28,2
```

The program uses only two of the SAA1099's tone generators. Tone sequences of descending frequency (lines 80 to 150) are produced without noise (line 70 disables the noise source) whilst tone sequences of ascending frequency (lines 170 to 240) are coloured with noise (line 160 enables the noise source). Output from the sound generator is enabled by means of line 20 and disabled by means of line 260 which places the chip in the reset state.

NEXT MONTH: We shall be taking a look at MGT's "*Communications Interface*" for the SAM Coupé. In the meantime, if you have any problems, queries or suggestions for inclusion in *On Spec*, please don't hesitate to drop me a line: Mike Tooley, Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey. KT13 8TT.

THE COUPÉ
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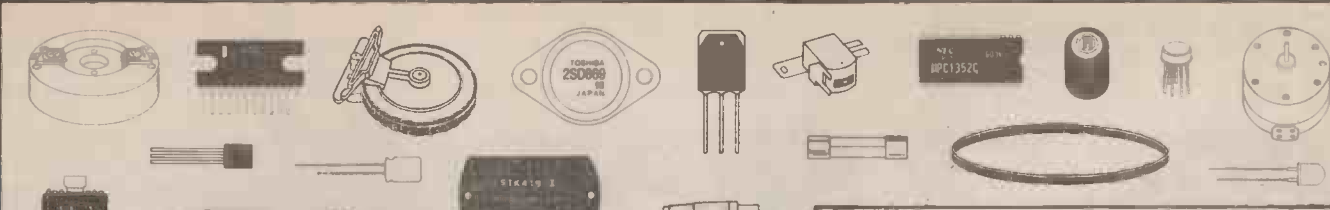

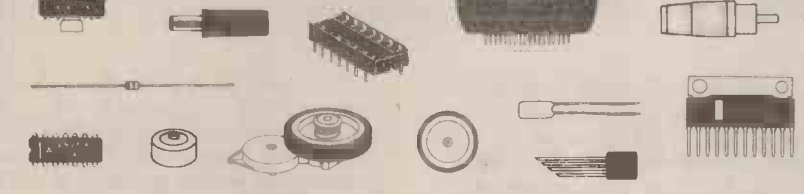

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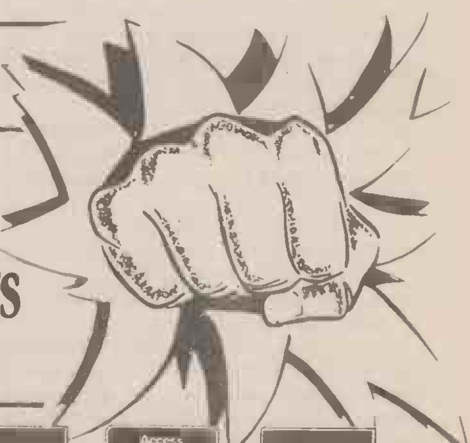

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VIVIAN CAPEL

A straightforward introduction to the design of simple mains power supplies:

MOST PROJECTS have one thing in common, they need a power supply. In many cases a suitable battery is all that is required, but if the circuit takes more than a few mA, or operates for more than a few minutes, battery powering can be expensive.

A mains power supply unit (PSU) is easy to design and build – but there are pitfalls. We hope to point out some of these pitfalls and not only give circuits but examine principles and show how to design your own to suit that special project.

The simplest circuit consists of a diode to rectify the a.c., a resistor to drop the voltage to the required value and a reservoir capacitor to smooth the result (Fig. 1). The main snag with this circuit is ***safety***. One side of the mains supply is connected directly to the negative of the d.c. output which usually in turn is connected to the chassis, case, and flying leads. While you may ensure that the mains plug is fitted so that the neutral is connected to the d.c. negative, the plug could later be removed and replaced incorrectly.

Another snag is that most modern circuits use semiconductors which require only a low voltage. The resistor thus needs to be of high value to drop from the 240V mains, and most of the power is wasted in heating it.

Furthermore, the voltage drop depends on the value of the current taken, if it varies, so does the voltage. If the current ceases due to a malfunction of the project, the voltage rises to well above the mains voltage (why it goes higher we will explain later). If then the capacitor has a low voltage rating, it will object most vigorously, get very hot under the collar, and most likely explode!

One way of reducing the effect of current variation or cessation, is to fit a bleeder resistor across the circuit. To be effective it must pass at least two or three times the current taken by the load, which is even more wasteful and generates more heat.

Has this circuit no practical applications at all then? Yes it has, in fact it was the standard method of powering valved TV receivers for a couple of decades. With these, the bleeder was provided by a series chain of valve heaters, and the d.c. supply needed was in the region of 200V so not much had to be dropped. Even so, large wire-wound resistors were used that got very hot.

The circuit should thus be used only when a large constant current is required at near mains voltage. Even then, precautions must be taken to isolate it so that no external leads or metalwork are connected to the mains.

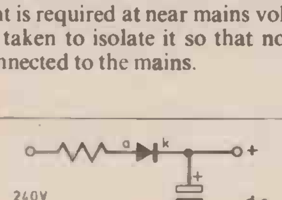

Fig. 1. Simple mains derived d.c. power supply. Principal snag is danger of direct connection of supply to mains.

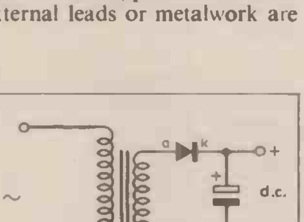

Fig. 2. Half-wave transformer fed rectifier circuit.

The value of any resistors used can be easily calculated by Ohms law from the voltage drop required and current taken ($R = V/I$). Use the same values to calculate their wattage rating ($W = VI$), the current in both cases being in amps.

TRANSFORMERS

The circuit we have just considered is more usually fed from a transformer as shown in Fig. 2, so first of all a few relevant points about transformers. A simple transformer as shown has a *primary* (pri.) winding and *secondary* (sec.) winding that are in close proximity and sharing a common iron core. The magnetic coupling between them induces a voltage across the secondary which is proportional to their turns ratio in relation to the voltage applied to the primary. So, a turns ratio of 1:10 produces 24 volts from a primary voltage of 240V.

It follows from this that a choice of voltages can be obtained by arranging for tappings on the secondary to provide different ratios. Usually the most common is a centre tap (ct.) which gives two equal voltages but in opposite phase, that is the end of one section goes negative as the other is going positive. This has its main application in full-wave rectifiers and split polarity systems as we shall see. Many transformers have several secondaries each having a different voltage and current rating.

Transformers are rated in VA which is volt-amps. This specifies the maximum power that can be taken without overloading. The current rating for a particlar winding is the maximum for that winding, but it does not follow that the maximum can be taken from *all* windings at the same time. The products of the voltage and current in amps taken from all windings when added must not exceed the VA figure for the transformer.

So for example, a transformer with a 6V 1A and a 12V 0.5A winding is rated at 6VA. Either of those secondaries can be fully loaded but not both. Alternatively, 0.7A could be taken from the 6V winding (4.2VA) as well as 0.15A from the 12V (1.8VA), or any other combination that added up to 6VA.

The power flowing in all secondary windings is equal to that in the primary minus a few per cent due to various losses. So, ignoring losses, in the mains primary the current is only a tenth of what it is in a single 24V secondary. Thus it can be wound with much thinner wire.

This is useful when identifying unmarked windings. The thin wires are the high voltage ones which in most cases is the mains primary, and the thick ones are the low-voltage wires. If the wires are concealed by sleeving right up to the tags, they can be identified by resistance measurements, the high resistance one being the primary.

When measuring any winding that is centre-tapped it will be found that one half has a higher resistance that the other. This may give rise to doubts as to whether the centre-tap is true. There is no need to worry though. The reason for the unequal resistance is that the windings are wound on a bobbin which gets thicker as more turns are added, so the outer half will have more wire than the inner, although both have the same number of turns. As it is the number of turns that matter, the resistance difference can be disregarded.

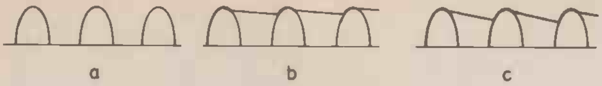

Fig. 3a. Rectifier suppresses negative half-cycles, so output consists of a series of positive pulses with equivalent gaps.

Fig. 3b. Addition of a reservoir capacitor bridges the gaps due to the stored charge.

Fig. 3c. When current is taken, the capacitor partially discharges between each half-cycle thereby producing ripple.

When the full rated current is being taken from the secondary the resistances of both primary and secondary cause a voltage drop, and there are also magnetic losses. The result is that the voltage at full load is less than it is off load.

The difference is given by the *regulation* figure which is quoted as a percentage. For large transformers the figure is typically 5 per cent, but in the case of miniature ones it can be as high as 25 per cent. For medium-sized units, 10 to 15 per cent is normal. Transformers are usually wound to give their rated voltage at full load.

This means that for a 10 per cent regulation, the voltage off load will be 10 per cent higher than the full-load rating. If the load fluctuates, so also will the voltage between the two limits. This may be important with some circuits.

For the mathematically inclined, the formula for regulation is:

$$\text{Regulation } \frac{V_{OL} - V_{FL}}{V_{OL}} \times 100\%$$

In which V_{OL} is the off-load voltage, and V_{FL} is the full-load voltage.

Toroidal transformers are of particular interest for powering audio equipment especially where low-level signals are present. They have a doughnut shaped construction which gives a very low flux leakage, hence a low hum field.

Care though must be taken in mounting them. They are usually secured by a single bolt through a metal clamping disc at the top, down to the chassis. No earthed strut or other member should be fixed to the top of the bolt as this would form a single shorted turn which would overload the transformer.

RESERVOIR CAPACITOR

The "reservoir capacitor" is a much misunderstood component, it is generally believed to just smooth the hum from the d.c. Well it does that, but there is much more to it.

Without this capacitor the output from a half-wave rectifier using a single diode as in Fig. 2 is a series of positive humps with a gap in between them where the suppressed negative half cycle should be, Fig. 3a. Half of the time the volts are zero, and for the rest, are somewhere between zero and peak. A meter connected across the circuit gives about 0.45 of the transformer voltage rating.

With the capacitor connected, the reading jumps dramatically. The capacitor charges to the value of the first peak, and drops only slightly due to capacitor leakage and the current taken by the meter, until the next peak which restores it to full value again, Fig. 3b. The voltage reading is thus that of the a.c. voltage peak.

Now a.c. voltages and currents are not specified by their peak values as these would be of little real use when the values are just as often zero as they are at peak. An average value which is 0.636 of the peak, may therefore be considered more useful, but is still not right.

Instead, the practical value chosen to describe an a.c. sine wave, is that of a d.c. voltage current which would produce the same heating effect in a wire element. This is known as the root- mean-square (r.m.s.) value and is 0.707 the value of the peak.

So all ordinary meters read the r.m.s. value, and transformers are rated at it. The peak value is the reciprocal of 0.707 which is 1.414, so when we take a reading after adding a reservoir capacitor, it indicates the peak value and therefore jumps from 0.45 to 1.414 times the transformer rating.

This gives the rather surprising effect of a 9V transformer producing 9 × 1.414 = 12.7 volts d.c. off load. It gives us an important rule when designing a power supply with a reservoir, the transformer must be chosen to be about three-quarters that of the required d.c. voltage.

When a load is applied, the reservoir capacitor discharges through it as soon as the peak has passed, but is recharged on the next peak. The effect is illustrated in Fig. 3c. Now the greater the current drawn, the faster the discharge and the steeper the discharge curve. This produces a more pronounced ripple on the d.c. supply, which is evident when comparing Fig. 3b in which there is very little current, with Fig. 3c.

This incidentally, can give a clue to excess current in an audio amplifier. If a hum suddenly develops it can be the result of heavy current, usually due to a fault in the output stage, causing a steep discharge of the reservoir capacitor between peaks, thereby increasing the ripple.

There can of course be other causes of hum, but if it appears suddenly in a previously hum-free amplifier, this is a very likely cause. It as as well to switch off quickly before wisps of smoke from the output stage confirm it!

But back to the reservoir capacitor. If we fit a higher value it will take longer to discharge so producing shallower discharge curves and less ripple. So, the value of the reservoir capacitor should be chosen in relation to the required load current. High values are needed for high currents if ripple is to be kept low.

SURGE LIMITER

When using high values though, it means that a high current flows into the capacitor in a short space of time near the tip of each peak. In addition a high current flows into it at switch-on from the fully discharged state. To reduce this surge a small-value resistor termed a *surge limiter* may be wired in series with the rectifier either on the a.c. or d.c. side.

This short-duration high current at each positive peak is some 3½ times that of the load current, and is supplied by the transformer which must be capable of delivering it. Therefore the available load current in only 0.28 of the transformer a.c. current rating.

The reservoir capacitor, as all other capacitors, must be of adequate voltage rating for the intended circuit. It is always wise to use one with a good safety margin, at least 25 per cent higher than the applied voltage. It has been found that reliability is closely related to the difference between the rated and applied voltage; those with a large safety margin rarely give trouble.

One factor with potentially disastrous results that is often overlooked in the selection of a reservoir capacitor, is the *ripple current rating*. From our investigation of the function of the reservoir capacitor, it is evident that current equal to that of the total d.c. load is constantly flowing into and out of it.

It must therefore be capable of passing that current which is why reservoir capacitors in high current circuits are physically large. If it is not, it will get hot and can explode. Be in no doubt, an exploding reservoir capacitor is a fearful sight to behold!

The rule is that the ripple current rating of the reservoir capacitor must be equal to or greater than the maximum load current likely to be drawn from the circuit. Physically small capacitors, although of adequate voltage rating and capacitance rarely have a sufficient ripple current specification unless the required load current is small. Most reputable suppliers can give the ripple current rating of capacitors they stock even if it does not appear on the capacitor itself, so be sure to check it before using one.

RECTIFIERS

Silicon rectifiers are now universally used because of their small size and big current ratings. They are a far cry from the rectifiers of a few years ago which were large and had an array of cooling fins that had to be mounted vertically to allow a free flow of air through them. They frequently deteriorated resulting in a lowered supply voltage, and commonly developed a short-circuit to the earthed-fixing bracket with spectacular results and a dreadful smell that hung around for days.

All those little pleasantries are fortunately in the past and the present devices are comparatively trouble-free if they are treated properly. Current ratings must not be exceeded, but this is no problem as rectifiers are available up to very high currents. Choose one with a generous current safety margin as the cost difference is minimal.

The point to watch is the Peak Inverse Voltage rating (PIV). If we take a look at Fig. 4, we shall see what happens on the negative half-cycle when the rectifier is non-conducting. The transformer winding is negative at the top end and positive at the bottom, while the reservoir capacitor is negative at the bottom and positive at the top. The combined voltage, in series, of the winding and the capacitor thereby add together and is applied across the rectifier. As the capacitor and transformer winding each have the peak voltage appearing across them, the total reverse voltage applied to the rectifier is twice that peak. This amounts to 2.8 times the r.m.s. voltage.

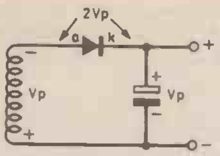

Fig. 4. During negative half-cycles when rectifier is non-conducting, the peak voltage stored in the capacitor in series with the negative voltage in the transformer winding imposes a reverse voltage of twice the peak or 2.8 times the r.m.s. across the rectifier.

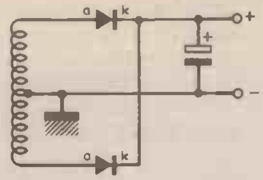

Fig. 5. A full-wave rectifier circuit using a centre-tapped winding.

Fig. 6. Both half-cycles are positive with a full-wave circuit, so the capacitor discharge is less and ripple is reduced.

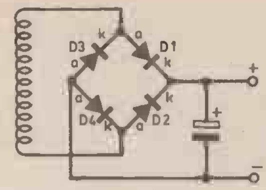

Fig. 7. A bridge circuit provides full-wave rectification without a transformer centre tap.

So the PIV rating of the rectifier must be greater than about three times the r.m.s. voltage of the transformer secondary. If it is not, the rectifier will fail prematurely. Overlooking this point is a common cause of rectifier failures.

Silicon rectifiers drop about 0.6V irrespective of the load current so that must be allowed for in low voltage PSUs. Should this cause a problem an alternative is to use a *germanium* diode as these drop only about 0.15V to 0.2V. A useful one is the OA47 which has a current rating of 110mA and PIV of 25V.

If by the way, you are one of the many folk who can never remember which way round a rectifier goes, a good mnemonic is to remember *pp*, which reminds us that the arrow *p*oints to the *p*ositive. The physical shape of most rectifiers is also pointed at the positive end, so the same aid applies.

FULL-WAVE RECTIFIER

The circuit we have so far considered is known as a "*half-wave rectifier*" because it rectifies only the positive halves of the a.c. cycle. A "*full-wave*" circuit rectifies both halves. The transformer secondary winding has a centre tap, or more usually two separate windings, which can be connected end-to-end. Having separate windings means that they can be used for separate isolated functions if required and so are more versatile.

The important thing with twin windings is to ensure they are connected the right way round. The start of one must be connected to the finish of the other, if two starts or two finishes are connected together there will be zero voltage output. Two diodes are used, one at each end of the winding, and their cathodes (k) are connected together to the positive of the reservoir capacitor. The centre tap of the windings is the negative and is usually earthed, Fig. 5.

As the reservoir capacitor is being topped up at each half- cycle instead of alternative ones its capacity can be less and also the ripple is less, Fig. 6. It is still supplying the whole load current at the a.c. zero points though, so the same ripple current applies as for the half-wave circuit.

The d.c. voltage produced is the same as for the half-wave circuit if we consider each half of the winding and its diode as a separate half-wave rectifier. Thus the d.c. voltage is 1.4 times the a.c. rating of the half of a single centre-tapped winding, or of one of a pair. If the rating of the whole winding is used, then the d.c. voltage is half that, which is 0.7 times the a.c.

Current is supplied on both half-cycles, so the d.c. current is equal to the a.c. flowing in the secondary. This is a big improvement on the half-wave system in which it is only 0.28 times the a.c. Smaller windings can thus be used, although there must be the equivalent of two secondaries. As each diode behaves as a half-wave rectifier, the same peak inverse voltage limits apply.

BRIDGE RECTIFIER

The bridge is also full-wave, but is usually so called to distinguish it from the circuit already described. As shown in Fig. 7, it has four diodes in a diamond configuration and is fed from a single untapped transformer winding. Two anodes are taken to the negative d.c. line, while the two cathodes of the other pair are connected to the positive. The two anode/cathode junctions then go to the ends of the winding.

If you have problems remembering the diode connections for the other circuits this may seem a lot worse. However, the same *pp* rule applies as before; all arrows point toward the positive, even D3 and D4, the ones nearest the winding because they point through D1 and D2.

The bridge works as follows: When the top of the winding is positive and the bottom negative, diode D1 conducts the positive charge to the positive line and diode D4 conveys the negative charge to the negative line. Diodes D2 and D3 are non-conducting. When the polarity reverses and the top of the winding becomes negative, D3 conducts the charge to the negative line, while D2 connects the bottom of the winding which is now positive to the positive line. Thus the diodes that are diagonally opposite conduct together on alternate half cycles.

This arrangement halves the amount of wire in the transformer secondary because the whole winding is conducting at both half cycles whereas with the full-wave circuit each half of the winding conducts only on alternate ones. The transformer yoke can be made smaller and there are also fewer winding lead-outs and terminal tags. So, the transformer is cheaper for the cost of two extra inexpensive diodes. The net saving may not be spectacular for a one-off, but for a production run of several thousand is considerable. Hence the popularity of the bridge circuit with equipment manufacturers.

D.C. voltage is 1.4 times the a.c. rating of the whole winding in contrast to the 0.7 times of the whole winding of the centre-tapped circuit. Current though is lower, being 0.62 times the a.c.

SPLIT-POLARITY FULL-WAVE

Many i.c.s require both negative and positive supplies relative to a central "earth" or 0V point. In some cases they will work with a pair of resistors across a single-pole supply, the centre connection going to the 0V point, but not all will. A split supply circuit is shown in Fig. 8. At first glance it looks like a bridge circuit but it is not, it is in fact a *dual* polarity full-wave p.s.u.

If you ignore diodes D3 and D4, it can be seen that diodes D1 and D2 comprise a normal full-wave rectifier circuit with transformer centre-tap the same as Fig. 5. Diodes D3 and D4 make up another full-wave circuit using the same transformer but with their anodes taken to the output which is therefore negative. The reservoir capacitor for this section has its negative connected to the supply line and its positive to earth or 0V.

Just as with a single pole full-wave circuit, a transformer with twin secondaries can be used in place of a single centre-tapped winding.

The d.c. voltage is the same for each section as that of the single full-wave circuit, that is 0.7 of the whole winding, or 1.4 times the half, or one of a pair. As the same secondary is supplying both circuits, the d.c. current for each is half that of a single full-wave circuit, which is also half the a.c. rating.

REGULATORS

If a *constant voltage* is required that will not vary in spite of wide variations in load current, a *regulator* can be included in the power circuit. One important bonus with a regulator is that because it keeps the voltage constant, it also reduces ripple to a low order. Ripple can cause many unexpected snags with otherwise trouble-free circuits, and it produces hum or buzz in audio circuits.

A regulator should be included as a matter of course with all low level audio circuits such as microphone mixers and moving-coil gram stages as it provides a super-smooth supply to a degree that is difficult to attain by RC decoupling. It also gives a high rejection of signal coupling via the supply and so reduces the possibility of instability.

Fortunately all these advantages can be obtained quite easily, as there is a wide range of regulator integrated circuit (i.c.) chips available that are inexpensive and easy to use, most have only three connections, an "in", "out", and "common" earth. They are also available in positive or negative versions.

All regulators reduce the applied voltage to the specified output value, so unlike a capacitor they cannot maintain the voltage if it dips below it. If there is any chance of this happening, a suitable capacitor should be connected to the input side to maintain the voltage during such lows, leaving the regulator to smooth out the voltage variations above it. The supplied data thus specifies a minimum input voltage which is a few volts above the regulated output. There is also a maximum.

A popular regulator i.c. which has built-in overload, thermal and short-circuit protection is the 78, and 79 series. The 78L is rated at 100mA, positive output, the 79L at 100mA negative output, the 78 and 79 give 1A positive and negative respectively, and the 78S, 2A positive output. There are many other types but these are perhaps the most useful for general work. Each type has a suffix which denotes the output voltage.

The devices are encapsulated with a three-pin lead-out which is the same for the 78 and 78S series, but not the 79 which has the same encapsulation but different pin connections. The 78L and 79L are housed in TO92 type cases.

A heatsink is required for the 78, 79 and 78S but not the 78L and 79L. In most cases heat sinking can be achieved by bolting the device to a main member of a metal case. A little heatsink grease smeared on the back of the mounting lug before it is fitted will improve the heat-transfer.

Regulator Data

Device	Output Voltage	Input Voltage	Equivalents
7805	+5V (±0.2V)	7.0-25V	μA7805UC; LM340T-05; MC7805CP; SN72905.
7812	+12V (±0.5V)	14.5-30V	μA7812UC; LM340T-12; MC7812CP; SN72912.
7815	+15V (±0.6V)	17.5-30V	μA7815UC; LM340T-15; MC7815CP; SN72915.
7824	+24V (±1.0V)	27.0-38V	
78L05	+5V (±5%)	7.0-30V	
78L12	+12V (±5%)	14.5-35V	
78L15	+15V (±5%)	17.5-35V	
78L24	+24V (±5%)	27.0-35V	
7905	−5V (±0.2V)	7.0-25V	
7912	−12V (±0.5V)	14.5-30V	
7915	−15V (±0.6V)	17.5-30V	μA7915UC; LM320T-15; MC7915CP.
7924	−24V (±1.0V)	27.0-38V	
79L05	−5V (±10%)	7.0-30V	
79L12	−12V (±5%)	14.5-35V	
79L15	−15V (±5%)	17.5-35V	
79L24	−24V (±5%)	27.0-35V	
78S05	+5V (±0.2V)	8.0-35V	
78S12	+12V (±0.5V)	15.0-35V	
78S15	+15V (±0.6V)	18.0-35V	
78S24	+24V (±1.0V)	27.0-40V	

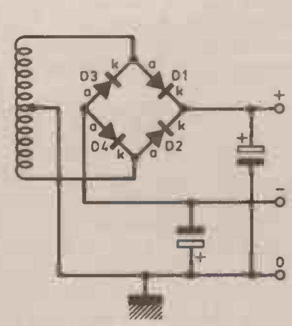

Fig. 8. A split-polarity dual full-wave circuit. In spite of its appearance it is not a bridge.

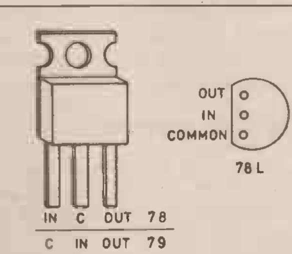

Fig. 9. Pin connections to 78 and 79 series regulators.

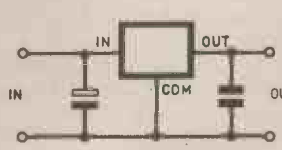

Fig. 10. Regulator circuit.

The pin configurations are shown in Fig. 9. The metal fixing lug is connected to the common earthed pin with the 78 and 78S regulators and so for most circuits can be bolted directly to an earthed metal chassis or case without insulating it. A regulator circuit is shown in Fig. 10.

LAYOUT

There are not many problems in laying out a power supply circuit providing a few simple rules are observed. The components should be physically separated from any low-level signal circuits as far as reasonably possible. This is especially so if the transformer is not toroidal.

If there are separate modules or printed circuit boards in the project being powered, separate negative wires should be brought from each to the same earth tag as the negative of the reservoir capacitor. The same applies to the positives which should be brought back individually to the reservoir positive.

This is an example of preventive fault elimination. In many cases it isn't really necessary, and the supply leads can be looped from one unit to another, but common impedances are thereby introduced. These can cause coupling between circuits which can produce quite baffling symptoms. So, it is usually better to play safe.

If the power supply components are all mounted on a printed circuit board, connect the negative print or pad from the reservoir capacitor to an earth point and do not connect anything else to that print. It may be tempting to earth some other nearby circuit to a convenient point on this print or to the negative of the capacitor itself. However, high ripple current travels along the print from capacitor negative to the earth point and any circuit connected thereto will certainly have ripple voltage fed to it.

DESIGNING A PSU

From the information given we should now be in a position to design a PSU for any specific requirement. We will now go through the steps for a particular case as an example. The project is a Stereo Power Amplifier 30 watts per channel, requiring a 35V supply, but with a pre-amp needing 12V.

The first stage is to find a suitable transformer from those locally available and then design the circuit around it. To supply 60W of audio power, the mains transformer must be able to provide that and an extra margin to allow for losses. If the amplifiers are class A, a much higher power would be needed as losses are greater, but these are rare and we can assume that the amplifiers are class B. A transformer with an 80VA rating should be about right.

The a.c. voltage required is 0.7 of the d.c. output so we need a winding giving 25V. We find that most transformers offer twin windings so we can connect them end-to-end to give full-wave rectification using only two diodes.

An alternative which may appeal to hi-fi enthusiasts is to drive each amplifier from a separate power supply, which is said to improve sound quality and stereo separation. In this case each winding can be connected to a bridge circuit of four diodes so needing eight in all.

Next, comes the reservoir capacitor. The working voltage should provide a margin over the 35V supply, so 50V should be chosen. On peaks at full power, the amplifiers will be taking 60W ÷ 35V = 1.7A, so the ripple current must be at least this. Usually, large value electrolytics at high working voltage have a high ripple current rating. A typical example of 4,700μF at 50V has a ripple current of 4.1A. It is at lower voltages and capacitances that the ripple current must be watched.

For the diodes, we need a PIV of 35 × 2.8 = 98V minimum, and a current rating of 1.7A minimum. The *1N5402* has a PIV rating of 200V and a current rating of 3A, so it should do nicely.

Now we have to provide the 12V supply for the pre-amp which has a current drain of 20mA. A 12V regulator, the *78L12* will take up to 100mA and does not require a heatsink. Its maximum input voltage is 35V which could just about work off the 35V supply. However, the maximum load on the transformer occurs only on the peaks in the music; during quiet passages and silences, the power amplifier curent is minimal. Assuming a 10 per cent transformer regulation, the d.c. voltage will then rise some 3.5V to 38.5V.

A resistor in series with the input to the regulator will drop the voltage to a safe level below the maximum. At 20mA, a 470 ohm drops 9.4V, so the input voltage will then range from about 26V – 29V. The regulator also gives a 55dB ripple rejection, which is highly desirable for a pre-amp.

This example illustrates how the various factors we have described can be applied to produce a correctly designed PSU for any project. □

DOWN TO EARTH

BY GEORGE HYLTON

IF YOU'RE interested in the ways things are invented, the radio valve provides both information and amusement. It may have lessons for today. The man who made the pioneering discovery didn't realise its significance. The man who did realise it got the credit. And the man who turned it into the amplifying device which started the first electronic revolution didn't know how it worked.

EDISON EFFECT

Edison was one of the pioneers of filament lamps. (He's often credited with inventing them, but in fact the earliest examples were made by a Brit called Swan.) Anyway, in the course of experimenting with lamps, Edison discovered that if a metal plate is placed near the filament (Fig 1), current flows as shown if this plate is made positive, but not if made negative.

This was a very interesting discovery. It showed that current can flow through a vacuum (the early lamps were vacuum lamps, not inert-gas-filled ones as now). Since a vacuum is empty space, with nothing in it to conduct current, this was surprising. It might have been expected to act as a perfect insulator. Since substantial current flowed only when the plate was made positive with respect to the filament, this suggested that negatively charged particles ("thermions") were being thrown off the hot filament and attracted to the positive charge on the plate.

FLEMING

Edison was a busy man and didn't follow up his discovery. About 20 years later, in Britain, Ambrose Fleming realised that the Edison Effect, as it was called, could be put to use as a means of "detecting" the radio waves which were then being vigorously promoted for communications by Marconi.

Fleming patented his "thermionic diode" detector in 1905. By then, the nature of the negatively charged particles was known. In Britain, one physicist J.J. Thompson, had identified the electron in 1899. Another, O. W. Richardson, saw that electron flow explained the Edison Effect.

The "thermions" were electrons, given enough thermal energy to leave the filament. Fleming's diode was called a valve by analogy with fluid engineering. It acted as a one-way gate for current. This enabled it to rectify a.c. signals, including radio waves (Fig. 2.).Rectifiers were called detectors because, in their various forms, they enabled radio waves to be "detected"; i.e. turned into d.c. to operate some sort of indicator such as a galvanometer.

In fact, the diode valve (or vacuum tube as the Americans said) wasn't a very good detector of feeble signals. Other detectors were more sensitive. The diode really came into its own much later, after it had become possible to amplify radio signals.

LEE DE FOREST

An American physicist, Lee de Forest, became interested in the diode. There was a problem in using it – Fleming held the patent. So de Forest set about modifying the diode to get round the patent protection. He was hampered by a firm belief that diode detection required the presence of a thin gas inside the envelope.

The important change made by de Forest was to add a third electrode (Fig. 3). The signal was applied between filament and the extra electrode. Output was taken at the plate, which was given a strong positive bias. It was found that the triode detector worked better if the signal electrode had the form of a wire grid.

Looking at Fig. 3 with our modern knowledge of transistors and f.e.ts. it seems incredible that de Forest didn't immediately recognise that he had constructed an amplifying device. To us, with hindsight, the filament is an emitter or source of electrons. The plate is a collector. The grid is a gate, controlling the flow between emitter and collector.

Yet, although de Forest patented his grid triode detector in 1907, it wasn't until 1912 that he (in common with several other workers in other places) discovered that it could be made to amplify as well as detect. The ensuing legal battle over patents was won, in the USA, by de Forest.

As to the exploitation of the triode, that was done by more competent workers who disregarded de Forest's quaint ideas about the need for gas and designed efficient triodes which used a hard vacuum.

LESSONS

Perhaps the most significant lesson to emerge from this bizarre story is the usefulness of publishing discoveries. Making known the Edison Effect laid the foundation for other work. But the story also shows the benefits of simply playing about with things. Adding a third electrode to the diode was just playing about but its consequences were momentous.

Of course, if de Forest had ceased believing that the presence of gas was necessary, and instead had looked at his triode in terms of electron flow he might well have discovered the amplifying ability much earlier. But he didn't. Playing about is fine, but playing about plus careful thought is finer. As Pasteur said, chance favours the prepared mind.

TRANSISTORS

The search for the transistor was more purposeful. It took longer because the materials technology was very difficult, but at least the researches at Bell Telephone laboratories knew what they were after; a solid equivalent of the triode valve. It's said that the first transistor (the point-contact transistor) was really discovered accidentally in the course of experiments which aimed to produce what we know as the field-effect transistor. Maybe, but its significance was understood at one, and soon led to the invention of the junction transistor which paved the way to the micro-electronic revolution.

VALVE REBORN?

It's just possible that the valve, now used for only special applications, may be reborn, but in a new form. Vacuum devices have one property which has become very important as computing speed has risen. Electrons, once launched into a vacuum, can move freely. In transistor language they have very high mobility, which is what you want for high-speed computing circuits.

There are two drawbacks. One is that traditional valves are too large. The other is that relatively enormous amounts of

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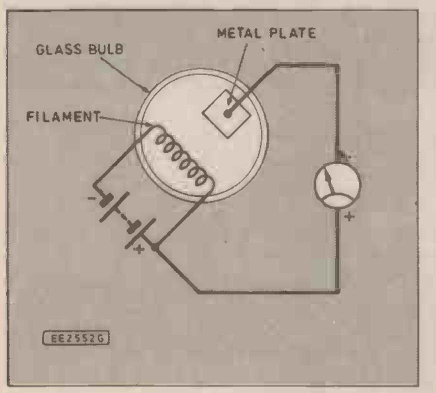


Fig. 1 Edison Effect.

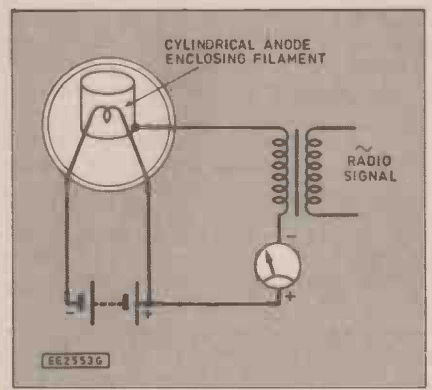


Fig. 2 Diode valve.

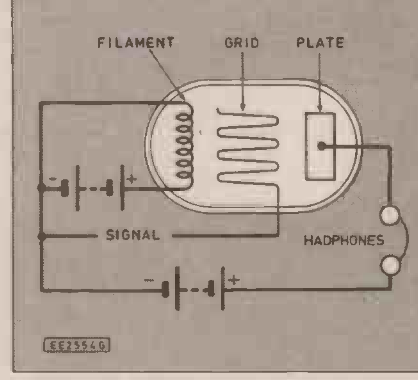


Fig. 3 De Forest's Triode Detector

Constructional Project

AUTO MEMO

OWEN BISHOP

Make sure your memo's are seen and inwardly digested with this neat attention getting note pad.

HAVE YOU ever left a message for someone and they did not notice it? There is little chance of this happening with the Auto-Memo. This electronic memo pad *insists* on being noticed. Its l.e.d. flashes in a eye-catching way and its distinctive-sounding bleeper demands the attention of the ear. The only way to stop it is to pick it up and turn it face down (but read the message first!)

The circuit is housed in a small plastic case, one side of which has a panel of plastic laminate suitable for accepting messages in pencil or felt-tip pen. When finished with, messages are wiped off with a damp cloth. In one corner of the message panel is a large l.e.d. mounted in a chrome bezel. From within the case comes the sound made by an audible warning device.

The switch is a non-locking click-key on the underside of the case. The Auto-Memo rests on this key and its weight keeps the key depressed.

You write the message on the "pad" and put the Memo firmly down on the table. The switch clicks on and the Memo is in action. It remains active until it is picked up and turned over.

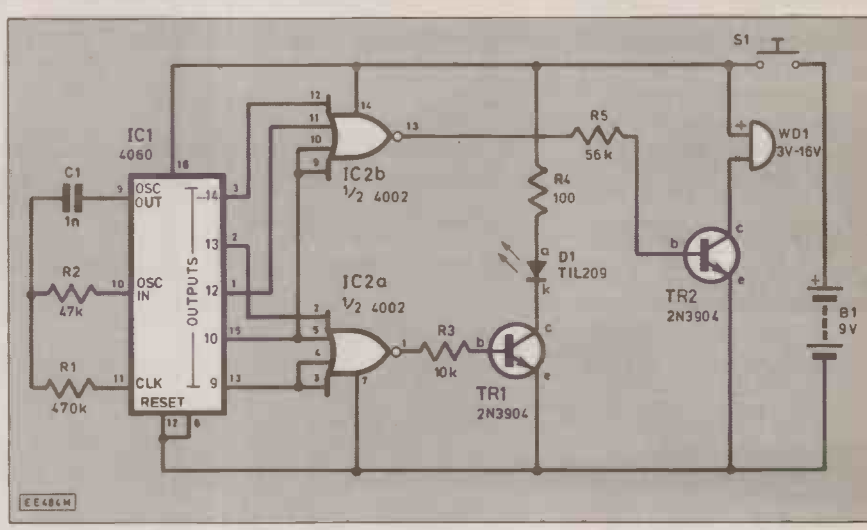


Fig. 1. Circuit diagram of the Auto Memo

The circuit is specially designed for low current consumption. The average current is only 7mA, so it operates for about 70 hours on a PP3 battery.

HOW IT WORKS

The circuit for the Auto-Memo is based on a CMOS 14-stage counter i.e., the 4060 (Fig 1). This has its own in-built clock circuit, so all we need to supply are the timing capacitor C1 and resistors R1 and R2.

The clock runs at high frequency (8kHz), which is divided down by the counter to give a range of output frequencies. In this circuit we use five of these frequencies:

Output	*Frequency (Hz)*
9	16
10	8
12	2
13	1
14	0.5

Outputs 10, 12 and 14 are fed to a NOR gate IC2b. The gates have four input terminals so one of the signals goes to two input terminals. These frequencies each differ by a factor of 4.

The output of the NOR gate IC2b goes high only when all four of its inputs are low. This output is used to turn on a transistor TR2 which operates the audible warning device WD1. This is a ready-made unit having its own internal oscillator running at 3.7kHz. It emits a piercing high-pitched tone when switched on.

The effect of the logic is to turn on the WD1 for two short bursts, followed half a second later by two more bursts. The sequence is repeated every two seconds. The result is an intermittent and attention-catching chirping sound, easily distinguished from the sounds of microwave cookers, alarm watches, warbling phones and other hi-tech products that assail the ears in the modern home.

The warning buzzer takes about 10mA when operating but, since the logic switches it on for only one eighth of the time, the average current is only 1.25mA. This saves battery power yet gives an effective alerting sound.

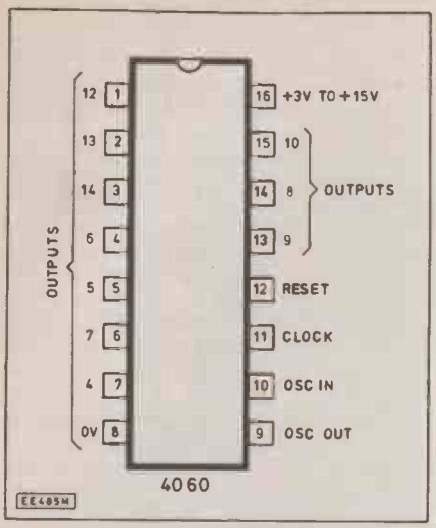


Fig. 2. Pin-out of the 4060

The flashing l.e.d. D1 is also controlled by feeding three counter outputs to NOR gate IC2a. This time we use outputs 9, 10 and 13. Since output 9 runs twice as fast as output 10, while output 13 runs *eight* times slower than output 10, the gate produces a rather different output signal from that used for operating the buzzer.

The l.e.d. is switched on and off eight times in rapid succession, taking one second for this. Then there is a pause of one second before the flashing is repeated. The series resistor R4 is only 100 ohms to give high-intensity illumination.

The l.e.d. takes around 30mA when on but, since the pattern of flashing results in the l.e.d. being on for only an eighth of the time, average current consumption is only around 3.75 mA. this is an attention-getting but economical display.

COMPONENTS

Resistors

R1	470k
R2	47k
R3	10k
R4	100
R5	56k

All 0.25W 5% carbon

Shop Talk See page 319

Capacitors

C1	1n, polystyrene

Semiconductors

D1	TIL209 l.e.d. (or similar), with chrome mounting bezel
TR1, TR2	2N3904 *npn* silicon
IC1	4060 CMOS 14-stage counter
IC2	4002 CMOS dual 4-input NOR gate

Miscellaneous

WD1	3V-16V buzzer, p.c.b. mounting
S1	Click-effect push to make switch (or microswitch), p.c.b. mounting.

Stripboard, 0.1in matrix 10 strips x 42 holes and a small off-cut piece for mounting S1; 1mm solder pins (4 off); 14-pin i.c. socket; 16-pin i.c. socket; PP3 battery and connector; plastic case, 122mm x 63mm x 32mm; plastic laminate, 70mm x 55mm; contact adhesive; connecting wire; solder etc.

Approx cost. Guidance only **£6**

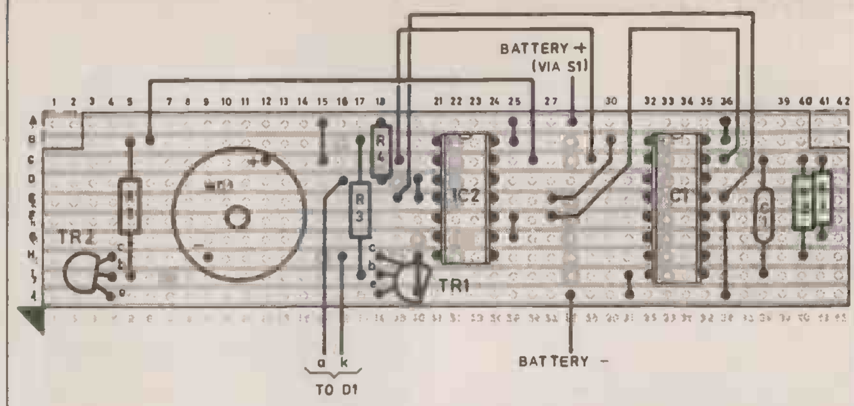
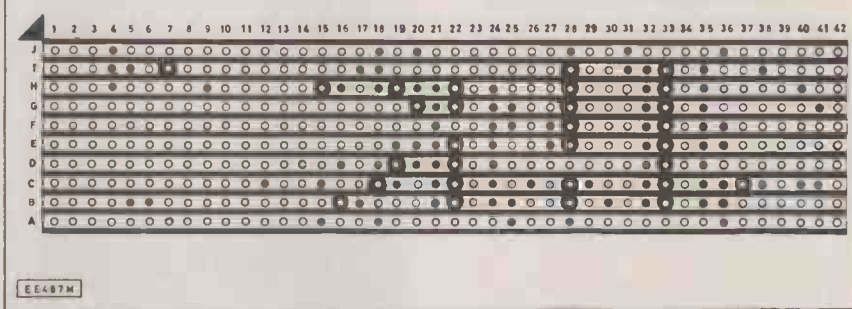
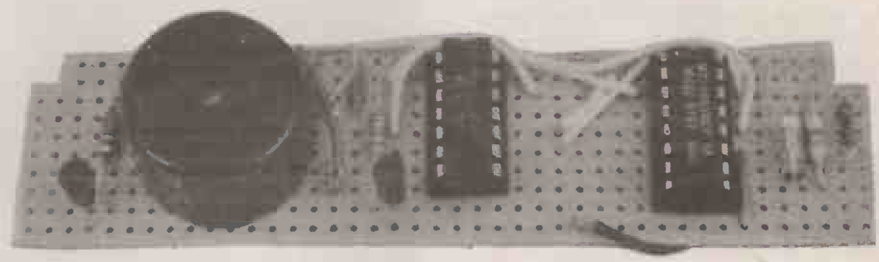


Fig. 3. Veroboard layout and wiring for the Auto Memo.





OPTIONS

There is plenty of scope for playing around with the logic of this device. By varying the connections, a wide range of different audible and visible signals may be produced.

The prototype NORs three outputs for each type of signal but you can NOR two, three or four outputs from IC1 if you wish. You can also make use of the other outputs. Fig.2 shows the pinout of the 4060. Note that stages 1 to 3 and stage 11 are not available.

CONSTRUCTION

The case used in the prototype has internal slots which hold the main circuit-board which is built on a piece of strip-board (42 holes x 10 strips) running the length of the case.

The component layout and details of cuts required in the underside copper strips is shown in Fig. 3. The rest of the components are packed tightly into the case, as can be seen in the photographs.

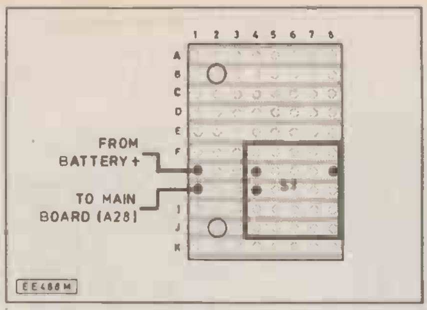


Fig. 4. Circuit board for S1.

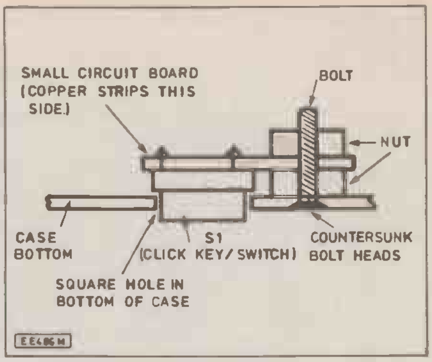


Fig. 5. S1 mounting details.

If the case used is the same as that used in the prototype, it is necessary to cut the top corners of the board as shown in Fig 3, to allow the lid to drop into position. Note that one of the strips beneath IC2 (across pins 5 and 10) is *NOT* cut, but is used as a connection to simplify the wiring. The same applies to the connection between IC1 pin 3 and IC2 pin 12.

The circuit is powered by a 9V "transistor" battery (PP3). Off-board wiring runs to the battery connector with the click-key S1 in the positive lead. The battery fits comfortably in the space shown in the photographs and does not need any special retaining clip.

The audible warning device is a type that operates on any voltage between 3V and 16V d.c. It has two pins at its rear, suitable for soldering directly to the circuit board. The board is held in slots so that the buzzer comes close to the front of the case. Holes are cut in the case to allow the sound to escape.

The l.e.d. used in the prototype has a threaded chromium-plated bezel. This is mounted in a hole drilled in the top corner of the case. The photographs show where the l.e.d. is situated when the lid is in position.

The message panel is cut from a scrap of Formica or similar plastic laminate, preferably white or any other light colour. This is fixed to the lid of the case, using impact adhesive.

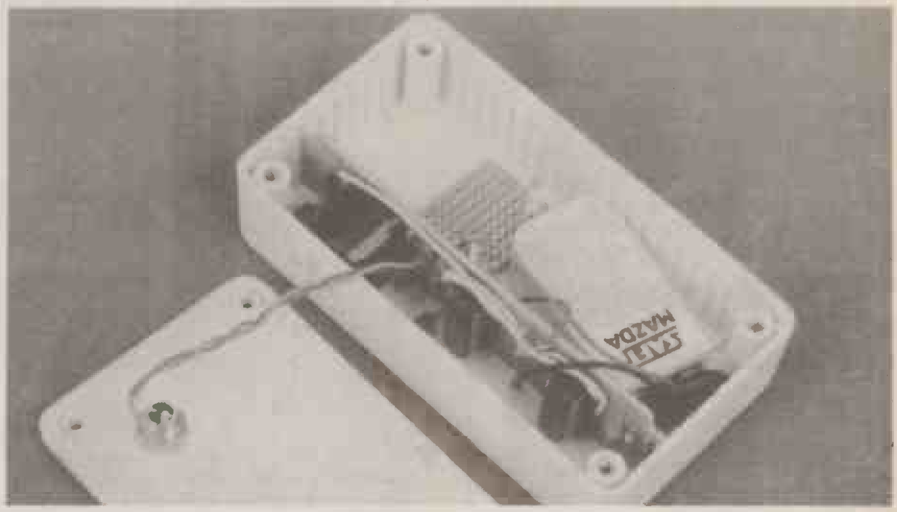
The key-switch S1 is mounted on the small circuit board, (Fig.4 and Fig. 5). The board has two holes drilled in it so that it may be supported by two bolts. A square aperture is cut in the bottom of the case, as well as two holes for the bolts.

The key-switch should protrude through the aperture so that the surface of the key-top is about 2mm below the bottom surface of the case. Check that the key contacts close when the key-top is pressed flush with the bottom of the case. If necessary, additional nuts or washers can be threaded on to the bolts to bring the key to the correct position.

It is important to check that the weight of the case and its contents (including battery) is sufficient to hold the key-switch S1 depressed. If it is not, put some ballast in the case. A large metal nut (preferably wrapped in insulating tape) or similar compact but massive object should do what is required. A small plastic bag full of small nails can be shaped to fit between the hardware in the region just around the switch.

The positive lead from the battery clip goes to one terminal of S1. Wire a lead from the other terminal of S1 to the pin at *A*28 on the board. The negative lead from the battery clip goes to the pin at *J*28. Run twin leads from the pins at *D*16 and *H*16 to the l.e.d. taking care to observe the correct polarity.

When the lid has been bolted down, the Auto-Memory is ready for leaving messages for the family, your friends and — if you are as absent-minded as the author — for yourself! □



DOWN TO EARTH

CONTINUED FROM PAGE 340

heat are needed to make electrons leave the filament (or cathode). Some research sponsored a few years ago by the US Navy suggests that both drawbacks might be avoided.

It proved possible to use the sort of fabrication methods used in i.c. manufacture to make arrays of tiny vacuum diodes. These diodes did not have heated cathodes. Instead, they made use of a process called field emission. This, in a nutshell, consists of subjecting a cathode not to heat but to a high voltage stress. If the stress is great enough electrons are pulled out of the unheated surfaces.

The effect is well known and is the basis of an instrument, the field emission microscope, used by physicists to enlarge surfaces to the point where single atoms are visible. What is needed for field emission is not high voltage as such but a high voltage-gradient between cathode and anode. You can get a high gradient by applying a relatively low voltage to anodes and cathodes spaced very close together. This is where the new fabrication techniques come in handy; electrodes can be made which are only a few microns apart.

HEMTs

It's one thing to make field emission diodes and quite another to make triodes. We may never see "vacuum tube integrated circuits". New types of f.e.t. may render them unnecessary. These "high electron mobility" transistors (HEMTs) are based on the idea that solid matter is mostly empty space. An electron, released into the space between atoms, can move with perfect freedom - until it hits something.

In a perfect crystal, where the atoms are arranged in nice straight lines, an electron ought to be able to travel long distances without hitting anything. Unfortunately, in order to make ordinary transistors work, the crystal has to be doped with impurities. These scatter the electrons, reducing their mobility. In the HEMT, the electrons do most of their travelling in an undoped region where collisions are minimal.

The HEMT exists, but it's hard to make. At present it's used as a discrete device in microwave amplifiers. It's just possible that somebody may hit upon a way of making vacuum micro-triodes more easily than HEMTs. In that case, the radio valve will make its comeback, though in a form undreamed of by Fleming and de Forest.

Reference:

Scientific American March 1965

ONE POUND PACKS

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

BD152	1	Gas or liquid shut off valve, clockwork dial, setting can be on for up to 12 hours.
BD153	1	Same as DB152 but thermostatically operated.
BD154	1	12v operated drip proof relay, ideal for outdoor or in-car operation
BD158	4	12 way 5 amp screw down polythene bodied connector strips. Used to be called choc blocks when made of Bakelite.
BD159	2	12 way 25 amp connector blocks.
BD160	1pr	Plug together 12 way connector bolcis. Ideal for quick joints in leads.
BD168	2	Component mounting tag strips each with 50 stand-up tags.
BD169	4	Short wave air spaced trimmers 3-30pf. Screwdriver operated.
BD170	4	Assorted neon type numicator tubes made by HIVAC.
BD175	1	2 watt mains motor driving gearbox, final speed 200rpm
BD177	5	12v Lilliput bulbs.
BD178	3	Panel mounting slim line indicator lights with amber lens. These take Lilliput bulbs.
BD179	3	Oblong mains neon indicator lights, approx 1inx½in.
BD181	100	PVC grommets for insulation through ¾th hole
BD182	1	25pf air spaced tuning capacitor, small hole fixing with ¼in spindle.
BD189	1	20 amp double pole switch on flush plate which fits standard 3x3 electrical box, illuminated when on.
BD190	1	20 amp dp switch but surface mounting, oblong shape.
BD191	6	Lamp holder adaptors which takes two pin plug, also supplied
BD193	6	5 amp 3 pin flush sockets brown.
BD197	2	Thermostats, spindle setting — adjustable range for ovens etc.
BD199	1	Mains operated solenoid with plunger 1in travel.
BD201	8	Computer keyboard switches with knobs, pcb or vero mounting.
BD205	1	Very small 12v operated relay with one pair change-over contacts.
BD211	1	Electric clock, mains driven, always right time — not cased.
BD212	1	Mains transformer 230v primary and two 8v ½amp secondaries
BD213	2	5 core curly leads, tinsel wire for phones, etc.
BD214	2	Sub-min toggle switches double pole double throw.
BD215	4	Mini dpdt slides switches with chrome dolly instead of the usual plastic toggle.
BD216	1	Stereo pre-amp Mullard EP9001.
BD217	100	Standard wire ending push-ons for standard ¼in tags
BD218	100	Ditto, but right angled.
BD219	100	Soldercon tags. With these you can make your own sockets for ICs etc.
BD224	1	Battery operated motor made for 9v cassette players but speed controllable by lowering voltage.
BD227	4	50k quad pots. Standard ¼in spindle single hole fixing.
BD228	1	Ice stat thermostat. Ideal for controlling water pipe antifreeze coils.
BD229	1	Instrument buzzer, variable low, medium or soft.
BD233	2	Eagle educational kits. One makes chemical balance with weights and the other has electricals for experiments.
BD237	1	Computer grade electrolytic 3150µf at 40v.
BD243	2	6x4 16 ohm loudspeakers permanent magnet, 5 watts.
BD245	4	Standard size pots. ½ meg with dp switch.
BD248	1	A noise suppressor/mains filter.
BD249	1	13A socket on plate with spur, fits normal electrical box.
BD253	1	Open thermometer — bimetal type, reads 200-500 deg F.
BD266	1	Mains transformer 9v ½A secondary split primary so ok also for 115V.
BD267	1	Mains transformer 15v 1A secondary p.c.b. mounting.
BD291	1	Ten turns 3 watt pot ¼in spindle 100ohm.
BD298	1	15 amp round pin plug.
BD300	1	Mains solenoid with plunger compact type.
BD303	1	12 pole 3 way ceramic wave charge switch.
BD310	2	Oven thermostats.
BD316	1	Round pin kettle plug with moulded on lead.
BD453	2	2¼in. 60ohm loudspeakers.
BD454	2	2¼in. 8ohm loudspeakers.
BD465	3	5A round pin plugs will fit item BD193.
BD466	4	7 segment l.e.d. displays.

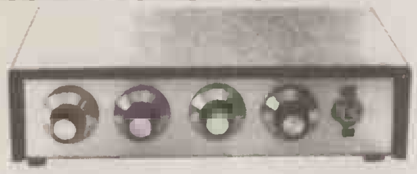
EPSON DISC DRIVE Ref no SP540. 5¼in double sided, double density, supplied with data. Brand new, £55.00. Our ref 55P1.

VENNER TIME SWITCH

Ex-Electricity Board. Guaranteed 12 months.

Mains operated with 20 amp switch. One on and one off per 24 hours, repeats daily automatically correcting for the lenghening or shortening day. An expensive time switch but you can have it for only £2.95 without case, metal case — £2.95, adaptor kit to convert this into a normal 24hr time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30

SOUND TO LIGHT UNIT



Complete kit of parts of a three channel sound to light unit controlling over 2,000 watts of lighting, use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and outputs are by ¼in sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £16

12v MOTOR BY SMITHS

Made for use in cars, etc, these are very powerful and easily reversible. All 3in dia. They have a good length of spindle – ⅒hp £4.00 ⅛hp £6.00 ⅙hp £8.00

25A ELECTRICAL PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake — switch on lights to ward off intruders — have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. A beautiful unit at £2.50

PRINTER PLOTTER prints on plain paper in four selectable colours, made by the famous Jap SHARP company for use with their PC MZ700/800, but with a simple interface details of which we expect to have shortly. This will in all probability work with your computer. We have to clear a store room so you can have this at only a fraction of its proper price, brand new with leads and makers instruction data, yours for only £16, but act quickly or you may miss the super bargain order ref is 16P3.

15 WATT WOOFER 8in circular with separate matching 3in tweeter, 8ohm coils. £3.00 a pair. Our ref 3P98.

RE-CHARGEABLE NICADS 'D' SIZE 4 AMP These are tagged for easy joining together but tags, being spot welded, are easy to remove. Virtually unused, tested and guaranteed. £2.00 Our ref 2P141 or 6 wired together for £10.00 Our ref 10P47.

RECORD PLAYER DECK. 12 volt operated, belt driven with an 11in turntable, stereo cartridge. Will play 7in-10in or 12in individually at either 45rpm or 33rpm. Fitted speed selector and pick-up cueing lever. Price £12 plus £3 postage. Our ref 12P4.

ATARI 65XE COMPUTER We have a few of these left. New and perfect but less handbook and PSU. Real bargain at £39.00. Our ref 39P2.

PAPST AXIAL FAN—Manufacturers Ref No. TYP4580N. This is mains operated. 15 watt rating and in a metal frame with metal blades so OK in high temperatures. Body size approx 4¾in square x 1½in thick. £6.00 each, plus £1.00 postage. Our ref 6P6.

VERY POWERFUL MAGNETS. Although only less than 1in long and not much thicker than a pencil, these are very difficult to pull apart. Could be used to operate embedded reed switches etc. Price 80p each, 2 for £1.00. Our ref BD642.

ORGAN MASTER is a three octave musical keyboard. It is beautifully made, has gold plated contacts and is complete with ribbon cable and edge connector. Brand new, only £15 plus £3 postage. Our ref 15P15.

ULTRASONIC TRANSMITTER-RECEIVER Small, nicely cased, will detect movement in a room up to 10m x 10m. Ingenious construction makes it independent of the mains; cannot be switched off, even with its on/off switch, until you know the secret, has delayed action enabling you to switch it on and leave the room; it has an inbuilt piezo sounder which is very penetrating and high pitched and would frighten away most intruders. Has internal switching and could be coupled to an outdoor alarm if required.

It is the basis of a very efficient burglar alarm, or has other uses. For instance: you could disconnect the internal sounder and using the internal switches you would know when somebody arrives without that person being aware that you know. Similarly, the unit could be used to operate other equipment ultrasonically. It is brand new, guaranteed OK, complete but less battery (PP3 alkaline type). Price is £18. Our ref 18P3

110 DECIBEL HORN For use with the ultrasonic intruder detector. Ideal for external positioning to attract the attention of neighbours should you have an intruder. This unit has its own mounting bracket and comes complete with good length of lead. Price £4. Our ref 4P60. Incidentally, this could also be used as a loudspeaker.

DON'T MISS THESE

20V-0-20V Mains transformers 2½ amp (100 watt) loading, tapped primary, 200-245 upright mounting £4. Our ref 4P24.

HIGH-VOLT CAPS. Not ceramic, but the much more reliable foil type. Good range from 1nf to 35u at voltages 1kv to 2.5v. Keen prices, good quality discounts. Request list.

BATTERY OPERATED TRAVEL MECHANISM On a plastic panel measuring approx 9in x 3½in. is driven by a reversible 12v battery motor, fitted with pulley and belt which rotates a threaded rod and causes a platform to travel backwards and forwards through a distance of approx 5in. Price £5. Our ref 5P140.

MAINS OPERATED WATER VALVE with hose connection for inlet and outlet suitable for low pressure. Auto plant watering, etc. Only £1 each. Our ref BD370.

20 VOLT 4AMP MAINS TRANSFORMER Upright mounting with fixing feet, price £3. Our ref 3P59.

12 VOLT SOLENOID. Has good ½in pull or could be made to push if fitted with a rod. Approx. 1½in long by 1in square. Price £1. Our ref BD232A.

16 OHM PM SPEAKERS. Approx 6in x 4in. 5 watts. Offered at a very low price so you can use two in parallel to give you 10 watts at 8 ohms. £1 for the two. Our ref BD684.

EHT TRANSFORMER 4kv 2mA Ex-unused equipment. £5. Our ref 5P139.

VERY USEFUL MAGNETS. Flat, about 1in long, ½in wide and ¼in thick, very powerful. 6 for £1. Our ref BD274A.

CLEAR LAQUER. Quick drying for the protection of transfers, markings, maps, etc. Also protects wood and metal. Exceptionally clear. Large can for £1. Our ref BD660.

CASE WITH 13A PRONGS. To go into 13A socket, nice size and suitable for plenty of projects such as battery trickle charger, speed controller, time switch, night light, noise suppressor, dimmers etc. Price 2 for £1. Our ref BD565.

ALPHA-NUMERIC KEYBOARD. This keyboard has 73 keys giving trouble free life and no contact bounce. The keys are arranged in two groups, the main area is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13in x 4in. Brand new but offered at only a fraction of its cost, namely £3, plus £1 post. Our ref 3P27.

4-CORE FLEX CABLE. Cores separately insulated and grey PVC covered overall. Each copper core size 7/0.2mm. Ideal for long telephone runs or similar applications even at mains voltage. 20 metres £2. Our ref 2P196 or 100 metres coil £8. Our ref 8P19.

METAL PROJECT BOX. Ideal for battery charger, power supply etc., sprayed grey, size 8in x 4½in x 4in high, ends are louvred for ventilation other sides are flat and undrilled, price £3. Our ref 3P75.

CAPACITOR BARGAIN. Axial ended — 4700µf at 25V. Jap made. Normally 50p each, but you will get 4 for £1. Our ref 613

SINGLE SCREENED FLEX. 7.02 copper conductors, pvc insulated then with copper screen, finally outer insulation. In fact quite normal screened flex. 10m for £1. Our ref BD668.

3 CORE FLEX BARGAIN No. 1. Core size 5mm so ideal for long extension leads carrying up to 5 amps or short leads up to 10 amps. 15m £2. Our ref 2P189.

3 CORE FLEX BARGAIN No. 2. Core size 1.25mm so ideal for long extension leads carrying up to 13 amps or short leads up to 25 amps. 10m £2. Our ref 2P190.

DISPLAY 16 CHARACTER 2 LINE As used in telephone answering and similar machines. Screen size 85mm x 36mm x 9.3mm. Alpha-numeric, dot matrix module with integral CMOS micro processor, LCD display. Made by the EPSON Company, reference 16027AR. Price £10. Our ref 10P50.

SUPER 8mm CINE PROJECTOR. 600ft film capacity, reel to reel loading and governor controlled projection speeds of 18 and 24 fds. Sound output 3.5 watts, complete with zoom lens, recording microphone and handbook. Price £39.50. Our ref 39P2.

THERE IS GOING TO BE A BURIAL! For several years now we have been offering mains operated clocks at only £1 each. These are cooker clocks which in addition to telling you the time would also switch things on and off at pre-set times. However, despite this silly price these have been very slow sellers and as we have still almost 10,000 of them in a store which we have to clear we are making one even sillier final offer before burying them. You can have 16 brand new clocks still in original packing for only; £5. Our ref 5P151. Add £3 post if not collecting.

CAMERAS. Three cameras, all by famous makers, Kodak, etc. One disc and two different instant cameras. All in first class condition, believed to be in perfect working order but sold as untested. You can have three for £10, which must be a bargain if only for the lenses, flash gear, etc. Our ref 10P51.

FLIP-OVER DIGITAL CLOCK. Quite an eyecatcher, this is mains operated. The figures flip-over per minute and per hour and give a larger than usual visual display. Supplied complete with front and perspex panels to glue together to make its case. £2.00 each. Our ref 2P205.

BT HANDSET. With curly lead terminating with flat BT plug. Colour cream. Price £5. Our ref 5P123.

SINGLE SCREENED FLEX. 7.02 copper conductors, pvc insulated then with copper screen, finally outer insulation. In fact quite normal screened flex. 10m for £1. Our ref BD668. Ditto, but solid conductor. 10m for £1. Our ref BD668a

WHITE CEILING SWITCH. 5 amp 2 way surface mounting with cord and tassle. Made by the famous Crabtree Company. Price £1 each. Our ref BD528. Ditto but brown. 2 for £1. Our ref 528B.

EHT TRANSFORMERS. Normal primary, secondary 3kV at 3mA continuous or 20mA intermittent. Ideal as a spark generator for boiler lighting, etc., or with a simple voltage doubler circuit would make a good ioniser. Price £7. Our ref 7P7. 8kV secondary 3mA. Price £10. Our ref 10P56.

MAINS TRANSFORMER. Upright mounting. Normal mains input, gives 28V at 3.5A so should be ideal for big amplifier, variable P.S.U., etc. Price only £4. Our ref 4P24, please add £1 postage.

TRANSFORMER IN WATERPROOF METAL CASE. 24V 5A output. Ideal for garden lighting or to operate pond pump etc. Case has cable glands for mains in and low voltage output leads. Price £8. Our ref 8P17.

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ACTUALLY DOING IT!

by Robert Penfold

I HAVE often advised beginners to electronics construction to steer well clear of mains powered projects, and make no apologies for giving the same advice again here. Projects powered from a humble PP3 battery enable you to make mistakes and learn from them, with little risk to the components in the project, and none to yourself.

With a mains powered project a mistake could easily result in some expensive components (literally) going up in smoke, and any carelessness on the part of the constructor would be potentially fatal. Leave mains powered projects until you have gained enough experience to tackle them confidently.

PRIMARY CONSIDERATIONS

Sooner or later, and preferably later, you will no doubt wish to build a mains powered project of some description. This will probably not present too many difficulties, since the wiring around the mains transformer and on/off switch is likely to be pretty basic stuff. However, there are a few possible problems, and these mainly revolve around correctly identifying and connecting the transformer's windings. Many manufacturers seem to employ some unusual arrangements in what is presumably an attempt to make their transformers as versatile as possible.

The primary winding is unlikely to give too much difficulty, as in many cases there will simply be two tags. These will probably be marked something like "0V"and "240V", or they may simply be marked with a common "240V" marking. Either way, the mains input is applied to these two tags, and it does not matter which way round they are connected.

It is not uncommon for mains transformers to have tapped primary windings, so that they can be used with several mains voltages. The standard U.K. mains supply potential is 240 volts, and the mains input should therefore be connected across the tags marked "0V" and "240V". Ignore any other tags associated with the primary winding.

The convention is to have the "N" mains lead connected to the "0V" tag, and the "L" lead connected to the "240V" tag. The opposite method of connection is perfectly satisfactory though, and the transformer will provide isolation between the primary and secondary windings with either method of connection.

Some mains transformers have twin primary windings. These are usually in the form of two 120 volt mains supplies using the two windings connected in parallel, or a 240 volt supply if they are series connected.

Obviously series connection is required for use on the 240 volt U.K. mains supply, and Fig. 1(a) shows the correct method of connection. Note that in this case the phasing of the two windings is important, and that they must be connected as in Fig. 1(a), and **not as in Fig. 1(b) or Fig. 1(c)**. Getting the phasing of the windings incorrect will probably not cause any damage, but one winding will cancel out the other to give zero output from the secondary winding(s).

I have encountered one or two mains transformers which have twin 240 volt secondary windings. These must be connected in parallel, as shown in Fig. 2 (the same basic method of connection is used if twin 120 volt secondary windings are to be used with a 120 volt mains supply)

I am not sure why a transformer should have twin 240 volt primary windings since, as far as I am aware, there are no 480 volt mains supplies for operation with series connection. I can only assume that for some reason it is cheaper and easier to manufacture them this way. Fortunately, these rather awkward components seem to be something of a rarity.

SECONDARY CONSIDERATIONS

The secondary winding or windings of mains transformers are potentially more confusing, as there are often centre tappings, multiple tappings, and multiple windings to contend with. With the most basic of transformers there is a single secondary winding marked "0V" and "9V" in the case of a 9 volt component for example. With a transformer of this type it does not normally matter which way round the secondary winding is connected.

Mains transformers having a single untapped winding are something of a rarity. Some have multiple tappings and can provide numerous output voltages. A typical transformer of this type would have outputs ar 0V, 10V, 12V, 15V and 17V. Normally such a transformer would be used by taking the output from across the 0V tag and the one corresponding to the required output voltage (the "0V" and "15V" tags for an output of 15 volts for example).

The output voltage is equal to the difference between the voltage figures for the two tags used, and it is quite possible to obtain (say) 5 volts by using the 15 volt and 10 volt tags (15V − 10V = 5V). However, using a multi-tapped transformer to provide an output voltage that is well below its full secondary rating is very inefficient. You would be using a component that was physically much larger than really necessary, as well as being relatively expensive.

CENTRE TAPPED

Many power supply circuits utilize push-pull rectification (the type which has two rectifiers), and these need a centre tapped transformer. The central ("0V") tapping connects to earth, while the other two tags connect to their respective rectifiers. Note that some power supply circuits use bridge rectification (the four rectifier type) with the centre tap on the secondary winding then being ignored. The output potential of the transformer is then double the normal voltage rating (e.g. a 9V-0V-9V type effectively becomes an 18 volt untapped type).

Mains transformers having centre tapped secondary windings seem to be getting rather scarce in the component catalogues, apart from the ever popular 6, 9, and 12 volt miniature types. Instead, many suppliers now seem to offer mains transformers having twin secondary windings. These can be used as centre-tapped types using the method of connection shown in Fig. 3(a). In this example the transformer is a 9 volt type, but obviously the same basic method of connection can be used for components having different voltage ratings.

Some constructors run into difficulty when using a twin secondary component

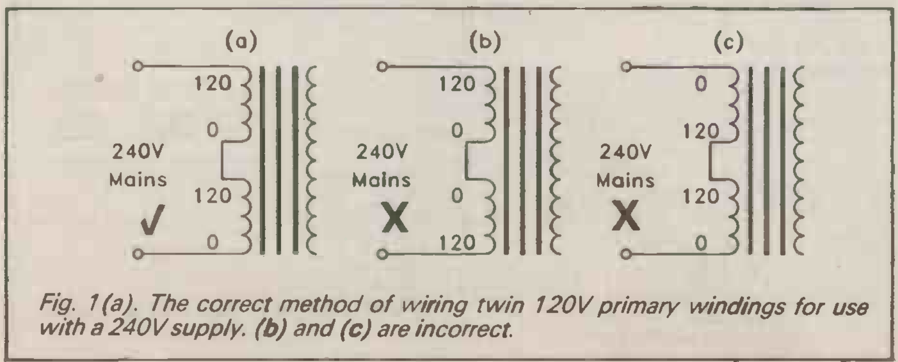


*Fig. 1(a). The correct method of wiring twin 120V primary windings for use with a 240V supply. **(b)** and **(c)** are incorrect.*

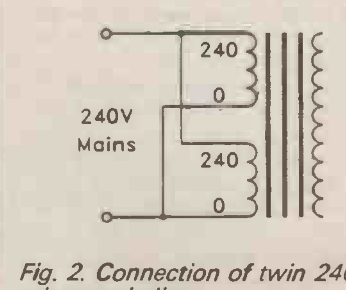


Fig. 2. Connection of twin 240V primary windings

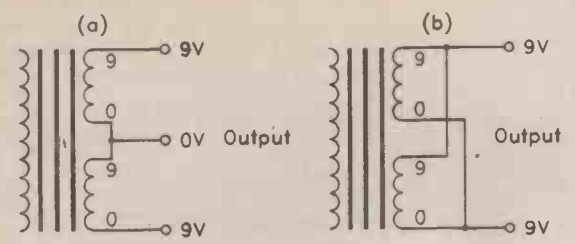


Fig. 3(a) Connecting twin secondary windings to effectively give a centre-tapped secondary, and (b) connecting matched secondaries in parallel.

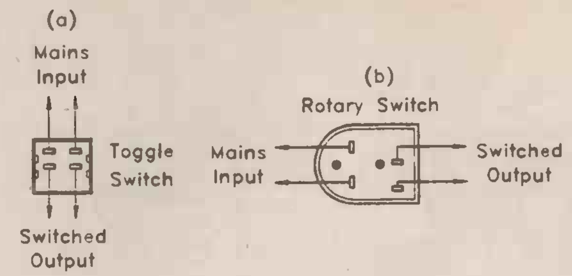


Fig. 4. Wiring to (a) a toggle switch and (b) a rotary switch.

in this way, as they take the logical course of action, and use the two "0V" tags as the centre-tap, and drive the rectifiers from the "9V" tags. Superficially this may seem the logical method, but in reality it will not work. The circuit is effectively reduced to a simple half wave type, giving a lot of "hum" on the output and a greatly reduced maximum output current.

If the transformer has its secondaries connected together, as in Fig. 3(a), but the centre-tap is ignored, it will give double the voltage provided by a single winding (e.g. 18 volts in the case of our 9V-0V-9V component). The current rating will be equal to the current rating of each secondary.

Most twin secondary mains transformers have accurately matched windings so that they can be connected in parallel, as in Fig. 3(b). This effectively gives a single 9 volt winding in our example of a twin 9 volt component, but the current rating is doubled. If you require a 9 volt 2 amp transformer for instance, it is perfectly acceptable to use a twin 9 volt 1 amp type having its secondaries connected in parallel.

Note though, that parallel connection should only be used if the manufacturer's or retailer's literature specifically states that this is acceptable. Otherwise, it is quite possible that a slight miss-match in the output voltages would result in one winding forcing a high current through the other one. This could clearly have dire consequences.

Occasionally I find that the markings on a mains transformer in the spares box have become erased, making it unclear which set of tags connect to the primary winding and which set connect to the secondary or secondaries. Getting it wrong could be very dangerous indeed. A high current would flow through the wrongly connected secondary winding, and the transformer would give a voltage step-up. The voltage from the primary winding could be a few thousand volts!

A quick check on a low voltage mains transformer using a resistance meter will determine which is the secondary winding and which is the primary one. The resistance through the primary will be very much lower than that through the secondary winding.

TURNED ON

You need to take due care when wiring up the on/off switch of a mains powered project. It is often far from obvious as to which two tags constitute each pole of the switch. Incidentally, you should always use a double pole on/off switch in mains powered projects, so that both the "N" and "L" leads are switched (the earth lead must not be switched, and should connect straight to the equipment's chassis).

It will be obvious if you have made a mistake when wiring up the on/off switch — you will short circuit the mains supply as soon as you switch on the project! While this can be dangerous, providing the mains plug is fitted with a suitable fuse, which means a 2 or 3 amp type for virtually all projects, no real harm will be done. However, due to sparking at its contacts and the high initial current, the on/off switch may not survive the experience.

Toggle switches, and several other types, are connected in the manner shown in Fig. 4(a). I often use rotary mains switches, and the type sold by most component retailers have a rather confusing tag layout. Fig. 4(b) shows the correct method of connection for one of these. If you are in any doubt about the correct method of connecting any switch, remember that a few quick checks with a continuity tester are all that is needed in order to sort things out.

In the case of a double pole on/off switch, close the switch and find the pairs of tags that are connected together. Each pair of interconnecting tags is one pole of the switch.

With switches it is always a good idea to make checks of this type before wiring it into circuit, rather than making assumptions and hoping everything is all right. This is especially so when dealing with mains wiring, where **guesswork is definitely not good enough.**

Many constructors, in their eagerness to try out a newly constructed project, do not bother to do a final check of the wiring before switching it on and trying out the unit. With a battery powered project there is probably little at risk with this approach. In the case of a mains powered project you should curb your enthusiasm, and at the very least **check all the power supply wiring very carefully prior to switch on.**

CYRIL BOGOD

Cyril bogod was the founder of the British Amateur Electronics Club and Chairman for twenty four years until his death on March 5th 1990.

I first met Cyril in January 1966, and we remained friends for the whole of this time. He was a kind, gentle man with a quietly determined manner, and it is due to his enthusiasm and generosity that the B.A.E.C. has been so successful and able to withstand the rigours of time. He was always ready to help beginners in electronics, particularly the young, and he achieved a great deal of success in this aim through the regular weekly meetings of local members of the club at Penarth, where many novices graduated into knowledgeable amateurs.

Until his illness last year Cyril also edited the B.A.E.C. Newsletter; a quarterly magazine of a high standard, which is the principal means of contact between members, providing instruction, news and views on all aspects of electronics. He also organised the annual B.A.E.C. exhibition, held in Penarth as part of the "holiday week" activities, and through this was able to raise considerable sums of money for Cancer Research.

It is with great sadness that I find myself writing this tribute to Cyril, and I know that all those members who knew him personally will feel the loss as keenly as I do. His passing also signifies the end of an era in the history of the British Amateur Electronics Club.

John Margetts.
Secretary of the B.A.E.C. since its inception.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

MORSE DECODERS AND KEYBOARDS

I was interested to read Mike Tooley's comments on Morse decoders in *On Spec* in the February issue. For those who don't know Morse, these enable the text of coded signals to be read as plain language on a computer screen. Add a Morse keyboard, which enables typed letters and figures to be transmitted as good quality code, and you have a modern Morse teleprinter.

However, the use of such aids to Morse operation in amateur radio is the subject of controversy among Morse enthusiasts. Purists say that true enjoyment of Morse operation can only be achieved by using a personal knowledge of the code to send and receive it. They also fear an erosion of traditional skills.

Nevertheless, many high speed operators do use keyboards, sending Morse much faster than is possible with other instruments, at the sametime reading the Morse coming back at them by ear. Dr Gary Bold ZL1AN, in *The Morseman* column in *BREAK-IN*, journal of New Zealand's national radio society, May 1988, described the evolution of the Morse keyboard, "... Two types of Hams were mainly responsible. One group were just experimenters, obsessed (as all good Hams should be) in pushing back the frontiers, seeing the production of a Morse keyboard as a challenge to be overcome.

HIGH SPEED OPERATORS

"The other group had found that their code reading ability had so far outstripped their sending skill that slow, frustration-filled, 35 words per minute QSOs grew increasingly unsatisfying. I became friendly with a group of such operators in 1977 . . . They were predominantly non-technical and had bought commercial keyboards simply to have more enjoyable chats with each other. Their standard conversational speed (reading, of course, in their heads) was about 65 w.p.m., but on good nights some would go up to 80.

"At first their Morse sounded like the high speed twittering of conversing robots, but after repeated listening I copied some callsigns. When I called them individually they readily changed down to 35 w.p.m. to talk to me. Although I felt rather as if I was conversing with creatures from some higher existence they did not think they were doing anything particularly clever.

"One . . . told me that after he had bought his keyboard his receiving speed had gone from 35 w.p.m. to 65 w.p.m. in three months . . . these people were from that small, exceptionally 'Morse-talented', group who find code reading comes easily and have difficulty understanding why others can't do it . . ."

LITTLE ENJOYMENT

It can be seen from the above that while some Morse enthusiasts may use keyboards for sending they are not likely to use decoders for receiving. For someone who knows and likes using Morse there can be little enjoyment in having the code deciphered by a "machine" which, in any case, is not too efficient for radio work.

For satisfactory decoding, the incoming Morse has to be perfectly formed and received as a strong, interference free signal. Keyboards send the quality of Morse required, but few operators of manual or electronic keys do, and conditions on the radio bands are typified by QSB (fading) and QRM (interference).

So what good are decoders? They are of interest to computer buffs who like experimenting with new ways of using their computers. They may interest shortwave listeners who want to decipher the unintelligible code signals they can hear across the bands from a variety of sources. They may even encourage an interest in acquiring the skill to read Morse "in the head".

For learning to send Morse properly the decoder offers a valuable facility for self-tuition. Unlike the trained human ear, which can often decipher a wrongly sent letter correctly, the computer displays exactly what has been transmitted.

Properly sent, for example, the letter H is four dots with identical spaces between each dot. If an operator using a conventional hand key hesitates slightly after the first dot the decoder picks up one dot followed by a group of three dots, and displays the letters E and S instead of the intended letter H.

The learner is thus able to practice sending to a decoder checking constantly on the accuracy of individual letters or numbers, and concentrating on those which cause problems until they can be sent and received perfectly.

CHANGING CIRCUMSTANCES

At present discussion about Morse learning is of great interest to most UK amateurs because it is necessary to pass a Morse code test in order to obtain a class A licence to operate on the amateur bands up to 30MHz – although there is no Morse test to qualify for a class B (v.h.f. only) licence.

The test arises from a requirement of the International Radio Regulations that operators on frequencies below 30MHz should have a knowledge of Morse. They need to understand instructions to close down or move frequency if they interfere with official or emergency transmissions, a requirement going back to the early days of radio when virtually all transmissions were in Morse.

Circumstances have changed over the years and from 1992 ships at sea will begin to phase in new emergency/safety arrangements using satellites and other systems without a Morse code requirement. Because of this, pressure is building up within the amateur radio movement for the Morse test to be abolished.

This can be seen in the USA which at present requires all types of licensee to pass a Morse test. According to the W5YI REPORT, the Federal Communications Commission, having received twelve petitions including one from the national society (ARRL), announced proposals in February to create a new amateur licence class, for frequencies of 222MHz and higher, which will not require a Morse test. This will be a beginner's licence and will replace the existing Novice and Technician licences. It is likely to be introduced at the end of 1990.

ISRAEL PROPOSES ALTERNATIVE TEST

One comment made on the need to abolish the Morse test is that young computer enthusiasts, who are seen by many national societies to represent the future for amateur radio, are not willing to learn Morse to get an amateur licence.

On these lines, Israel's national radio society (Israel Amateur Radio Club) has made a formal proposal to be considered at the International Amateur Radio Union Region 1 Conference in Spain on 1-6 April. This suggests that in view of the new maritime radio arrangements the Morse test for amateurs should be replaced "by some form of operating proficiency test more suitable to the present day data operating modes of amateur radio." It goes on to suggest that the ITU be asked to revise the International Radio Regulations to give effect to this.

The proposal says "It is felt that introduction of the measures proposed . . . will prove attractive to the 'Computer Generation' . . .". Whether the prospect of having to take a test in computer operating proficiency will appeal to non- computer enthusiasts thinking of taking up amateur radio is not discussed!

What existing radio amateurs think of the proposal is not known as for some reason it has not been publicised by the Radio Society of Great Britain in advance of sending its delegates to the conference. It will be interesting to see how the conference deals with this suggestion. The idea of abolishing the Morse test will undoubtedly be popular, but there are bound to be reservations about adopting an alternative as most societies are committed to the idea of making entry to amateur radio much easier than it is at present.

Build your own SHORT WAVE RECEIVER ... see the supplement

eb...Beeb...Beeb...Beeb...Be

...Morse...Computer Communications...Radio Teletype...

In last month's *Beeb Micro* article we looked at the ways in which CW and RTTY signals can be interfaced to a computer such as a BBC model B. This month we will continue on this theme, and a couple of practical interface circuits will be described

These are reasonably simple and straightforward to build, but it is only fair to point out that in order to set them up ready for use you should ideally have access to suitable test gear. An audio signal generator and an oscilloscope or a.c. millivoltmeter are particularly useful. The alternative is an indordinate amount of trial and error.

PLL Decoder

As explained last month, a simple but effective tone decoder can be built around a phase locked loop integrated circuit such as the NE567N. A simple decoder circuit of this type appears in Fig.1. TR1 and TR2 act as an input buffer stage and a simple bandpass filter. Although a phase locked loop decoder has good immunity to noise, better results are possible if some filtering is used to reduce the noise content on the input signal.

Some short wave receivers have a built-in CW filter with a bandwidth of a few hundred hertz. With a receiver of this type there is little point in using the input stages of this circuit. Instead, the signal could be coupled straight into IC1 via d.c. blocking capacitor C5 (but note that the polarity of C5 should be reversed if you adopt this method). Also, the centre frequency of the phase locked loop would have to be set up to match the centre frequency of the receiver's CW filter.

The input stages consist of a common emitter amplifier based on TR1, feeding into an emitter follower buffer stage which utilizes TR2. TR1 has a substantial amount of negative feedback introduced by R2, plus built-in bandpass filtering due to the use of a parallel tuned circuit (L1/C4) as its collector load. The latter provide a centre frequency of a little over 1kHz. Transistor TR2 prevents loading of the tuned circuit damping it to the point where a useful level of filtering is no longer provided.

Note that L1 must be a type that will operate efficiently at audio frequencies, and *should not be an r.f. choke* (these are not normally available in such a high value anyway). On the other hand, it does not need to be an expensive type based on a very high quality potcore. I used a Cirkit type 10RB, which seems to work well in this application.

IC1 is the NE567N phase-locked-loop tone decoder. This has C8, R6 and VR1 as the timing circuit for its v.c.o., and VR1 is adjusted to provide a centre frequency that matches that of the input filter. C6 and C7 are the filter capacitors in the smoothing circuit and lowpass filter. The open-collector output is at pin 8 of IC1, and R5 acts as the collector load for this. D1 is an optional l.e.d. indicator which has R4 to provide current limiting. In practice this l.e.d. is virtually essential, as without it the task of tuning signals so that the decoder locks onto them is difficult. With the indicator included, it is obvious when lock is achieved, as the l.e.d. will flash on and off in sympathy with the CW signal.

Power is provided by a 9 volt battery. The standby current consumption is about 10 milliamps, but it is very much higher than this when lock is achieved. A fairly high capacity battery should therefore be used, such as a PP9 size or six HP7 size cells in a plastic holder.

Although it is very simple, this circuit will work quite well as a CW tone decoder. It is certainly a good one to try if you wish to experiment with this type of equipment. In order to set up VR1 correctly, temporarily wire a resistor of about 470k to 1M in value between pin 5 of IC1 and the input of the unit. Then adjust VR1 for maximum output level at the emitter of TR1. Use an a.c. millivolt meter or an oscilloscope to measure the signal level here.

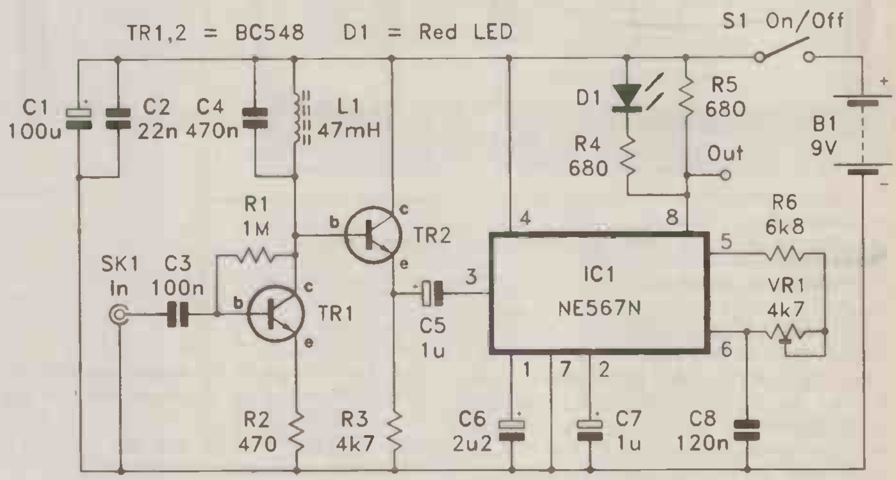


Fig. 1. A simple CW Tone Decoder based on a phase-locked-loop i.c.

Interfacing

It is probably best to get the unit operating satisfactorily before it is interfaced to a computer. Its output should not be directly connected to a computer input port (such as a line of the BBC computer's user port) as it is not at standard logic levels.

One method of interfacing is to use some form of level shifter circuit. Another option is to omit D1, R4, and R5, and to connect the open collector output to the input line of the computer. As the BBC computer's user port inputs have internal pull-up resistors, this method should be perfectly satisfactory.

The lack of an indicator l.e.d. is a slight nuisance, and it could be overcome by including D1 and R4, but connecting the anode of D1 to the +5 volt supply of the computer rather than the +9 volt supply of the tone decoder. However, a more practical solution might be to have software provide an on-screen indication of the output level from the decoder.

Two Tone Circuit

Although the circuit of Fig.1 is very good for CW reception, it is less well suited to RTTY decoding. This is generally handled more efficiently using more sophisticated tone decoders, such as the twin filter type that was broadly described in last month's Beeb Micro article. The circuit for a decoder of this type is provided in Fig.2.

IC1 simply acts as a buffer stage at the input. It drives two bandpass filters that are based on IC2 and IC3, and are of a well known design. These must have frequencies that match those of the RTTY signal. RTTY signals are normally transmitted in the form of a carrier wave switched between two frequencies, rather than a carrier wave which is amplitude modulated by a two-tone input signal.

In order to provide a two-tone audio output from the receiver it must be set to the s.s.b. mode (assuming no mode specifically for RTTY is included), so that the input signal is heterodyned with the beat frequency oscillator (b.f.o.). Within reason, the receiver can then be tuned to obtain any desired audio frequencies having a spacing that is set at the transmitter. For amateur RTTY transmissions the standard tone spacing is 175Hz.

Accordingly, it does not matter too much what centre frequencies are used for the two filters, provided they are 175Hz apart. The frequency of the filter based on IC2 is preset at about 1.1kHz. The centre frequency of the filter based on IC3 can be adjusted by means of VR1, and can be set

175Hz higher or lower than the other filter frequency, as desired. I set it 175Hz lower in frequency, but setting it 175Hz higher would probably make no noticeable difference to the performance of the decoder.

The outputs of the filters feed into separate rectifier and smoothing circuits, which in turn feed into voltage comparator IC4. This has a small amount of hysteresis provided by R15. This ensures that the output switches cleanly from one logic level to the other, and also reduces the risk of problems with "jitter" on noisy input signals. TR1 is a common emitter output stage of the open collector variety. This will drive any logic input which has a pull-up resistor, including one of the BBC computer's user port input lines.

The circuit is powered from a 9 volt battery, and the current consumption is only about 6.5 milliamps. Even a small (PP3 size) battery should be adequate as the power source. a larger type would probably prove to be more economic though, if the unit will receive a great deal of use.

Having located the peak frequency, set the audio signal generator 175Hz lower in frequency. Use the a.c. millivoltmeter or oscilloscope to monitor the output level at pin 6 of IC3, or use the multimeter to measure the voltage across R14. Then adjust VR1 for the highest possible output level. It should provide a pronounced peak, and must be adjusted very carefully. The unit is then ready for use.

In the absence of a calibrated signal generator, a short wave radio tuned to a carrier wave and having the b.f.o. switched on will provide a variable audio tone. This can be adjusted to the centre frequency of the filter based on IC2, and adjusted for a slightly lower pitch. VR1 is then adjusted to peak this lower frequency signal. This is obviously a bit hit and miss, and you will probably need to experiment a little in order to obtain the right shift frequency.

The filters have quite narrow bandwidths in order to give good performance. An unavoidable consequence of this is that the unit needs to be adjusted quite accurately if it is to operate properly.

impossible. Some form of tuning indicator is essential.

The ideal method is one which uses an oscilloscope set to the mode where the timebase is switched out, and signals can be fed to the X and Y amplifiers. The X input monitors the voltage across R8, while the Y input is fed with the voltage from R14. Both inputs should have the same sensitivity.

Using the oscilloscope in this way you do, of course, get it to draw lissajous figures. In this case it will draw some quite interesting ones, with something like Fig.3(a) if a signal is tuned correctly. If the tuning is slightly off in one direction, the display will look more like Fig.3(b), while Fig.3(c) shows the sort of display to be expected if the tuning is amiss in the opposite direction.

If the tuning is well out, the display is likely to be just a total jumble of lines, but there is usually no difficulty in getting close using the tuning "by ear" method. With this type of tuning indicator it is then very easy to get the tuning absolutely spot-on.

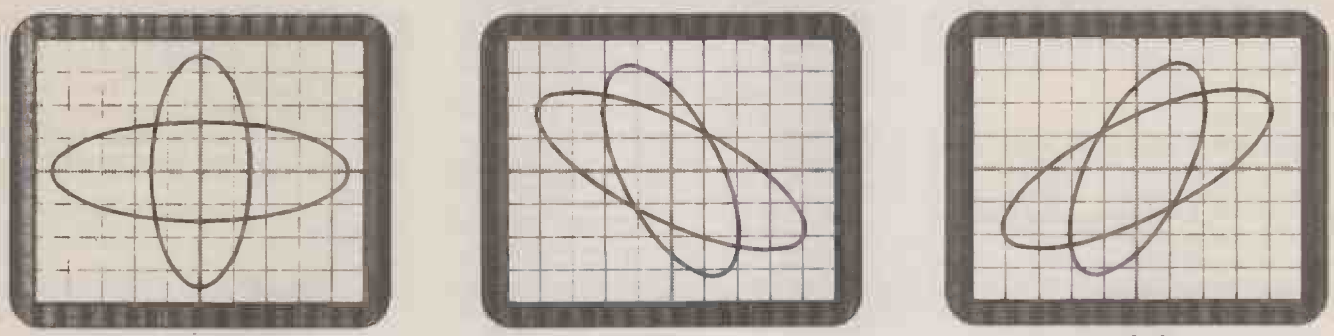


Fig. 3. Using an oscilloscope as a timing indicator. (a) indicates correct timing. While (b) and (c) show tuning errors in opposite directions.

Setting Up

In order to accurately set up the unit ready for use a calibrated audio signal generator and an oscilloscope, a.c. millivoltmeter, or multimeter are required. The output of the audio signal generator is fed to the input of the unit, and the millivoltmeter or oscilloscope is used to monitor the output level at pin 6 of IC2. A multimeter set to read about 10 volts d.c. full scale can effectively monitor the output level from IC2 if it is used to measure the voltage across R8.

Adjust the frequency control of the audio signal generator to find the frequency at which the filter based on IC2 has its peak response. Be careful not to use an excessive input level, as this will prevent a definite peak frequency from being obtained.

The unit will work well with the "tape" output of a receiver. If overloading seems to occur, a resistor of about 100k in series with the input should rectify matters. The unit can also be fed from a "phone" output, but changes in the volume control setting will then alter the input level to the filter. Obviously the volume control must then be given settings that will provide a suitable input level for the decoder.

Tuning

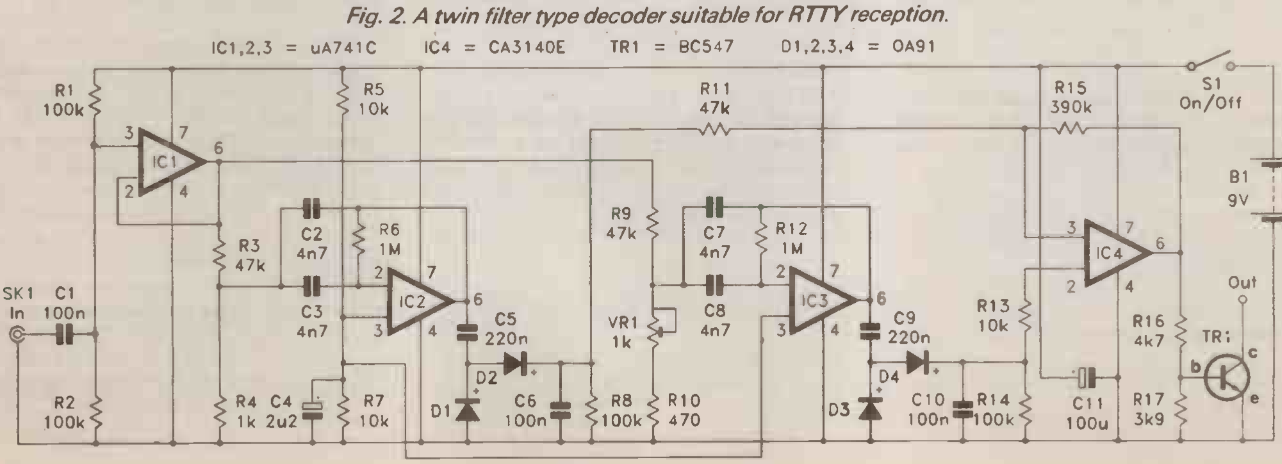
The narrow bandwidth of the filters and the small frequency shift used for amateur RTTY not only makes units of this type difficult to set up properly, but also makes accurately tuning in stations quite tricky. Even if you have a really good sense of pitch, accurately tuning the warbling sound of an RTTY signal "by ear" is virtually

Note that in practice there will often be noise and fading of one or both tones, and that the traces may not be quite as perfect as depicted in Fig.3. Tuning signals is still reasonably easy, and if things are not perfect at first, during the periods when signals come through strongly you can do some readjustments to get things just right.

It is surprising just how bad the input signal can get, with a well decoded output still being produced. If the horizontal and vertical sections of the trace are not at right angles to one another, either the transmission has the wrong tone spacing, or the tunable filter of the decoder is not set up correctly.

Next month: We will consider a more simple form of tuning indicator, and using a UART to give decoded parallel data that can be read by the user port.

Fig. 2. A twin filter type decoder suitable for RTTY reception.



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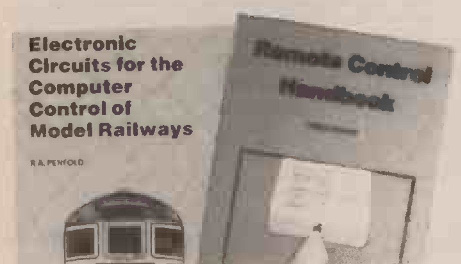

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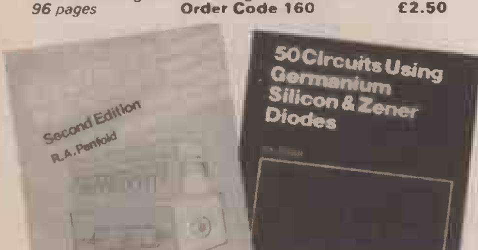

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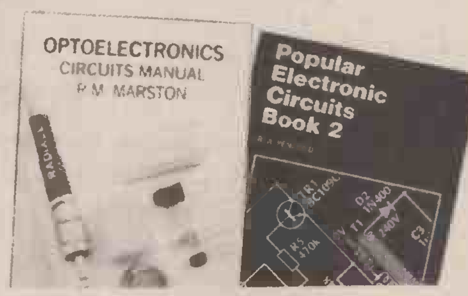

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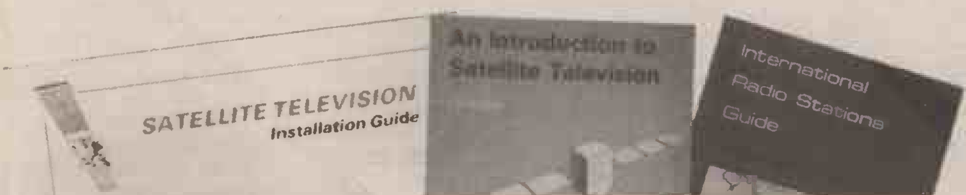

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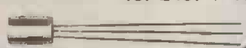
1000 SEMICONDUCTORS for £40! + VAT



CONNECTORS

If you ever again need to connect anything to anything else, the chances are you'll find the plugs and sockets for it in this parcel. Computers? There are D connectors, printer connectors, RS232 connectors, and so on. PCBs? There are edge connectors and pin connectors. RF connectors? No problem. Audio? There are speaker plugs and sockets, DIN connectors and much more. And all for 10p or less apiece! How can you resist it?

PARCEL 10A:
100 ASSORTED CONNECTORS for £10! + VAT
PARCEL 10B:
300 ASSORTED CONNECTORS for £25! + VAT

RESISTORS

Supplied to you as they arrive with us: some bagged, some bandoliered, some reeled, some loose. The mixture has ¼W resistors in every single E12 value, with some E24 and an assortment of E96 precision types. Then there are ½W resistors and a nice selection of power types to 5W and above. The proportions vary from parcel to parcel, but you'll certainly have an excellent range of types and values.

I have absolutely no intention of counting out tens of thousands of resistors, so these are sold by weight. As a rough guide 1000 ¼W resistors weigh about 240g, so there are over 4000 of these to the Kg.

PARCEL 13A:
10Kg RESISTOR PARCEL £30 + VAT

PRESETS

An attractive and very functional pack of preset pots. The parcels contain a high proportion of top quality cermets, both single and multi-turn. In fact they outnumber the carbon types! All styles and types are represented: open, enclosed, vertical, horizontal, square, round, ¾" and 1¼" multi-turns, and so on. All values from a few ohms to several megs.

PARCEL 11A:
200 PRESETS for £6 + VAT
PARCEL 11B:
1000 PRESETS for £25 + VAT

MONSTER OPTO PARCELS

If it has anything to do with light, it's in here. There are LEDs of all shapes, sizes and colours, seven segment displays, infra-red senders and receivers, bar graph assemblies, opto switches, and who knows what else. The larger parcels have LCDs too. An excellent selection of top quality devices.

PARCEL 12A:
100 OPTO DEVICES for £10 + VAT
PARCEL 12B:
300 OPTO DEVICES for £25 + VAT

JUNK!

Bits of equipment, PCBs, components, hardware, mags, books, data, everything electronic turns up at some time or other in our legendary JUNK parcels. There's so much unsorted stuff around the place we hardly know what goes in there ourselves! The components won't be neatly packed – once we've combed their hair and dressed them in their Sunday best, they go onto one of lists. In the JUNK parcel you see them in the raw state.

The first 10Kg is yours for £18 + VAT. After that, the price is £1 per Kg, so 11Kg will be £19 + VAT, 12Kg will be £20 + VAT, and so on. Have as much as you like!

JUNK SPECIAL:
1 cwt for £50! + VAT

SWITCHES

Take a rocker switch in one hand, a roller microswitch in the other, and have yourself a rock 'n' roll party! OK, the the jokes aren't up to much, but the switches are superb. Lots of rocker switches – ideal as spares for household gadgets. Some, so I'm told, fit the dashboard cut-outs on Ford cars, so just think of the extra lights and stuff you could fit! Then there are the toggles, the push switches, the rotaries and the sliders. All tucked up snugly, bless their cotton socks, in our switch parcels. And all for 10p each or less – it's enough to make you explode with joy. Well, nearly enough.

PARCEL 14A: 100 ASSORTED SWITCHES for £10! + VAT
PARCEL 14B: 300 ASSORTED SWITCHES for £25! + VAT

H.V. POLYESTERS

Above 100n or so the price of non-electrolytic caps starts to rise steeply. To get one above 1μF will cost the earth, or at least a major planet. And not even an asteroid for change. These parcels contain caps to at least 4μ7. Replace those nasty non-polar electrolytics in your speaker crossovers, connect them across electrolytic smoothing and coupling caps in your hi-fi, stop using back-to-back tants in your projects. The larger caps will easily cost several £££s each from normal suppliers. We've got too many, so . . .

PARCEL 15A:
200 HV POLYESTERS for £10 + VAT
PARCEL 15B:
600 HV POLYESTERS for £25 + VAT

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H5

PCB SERVICE

Printed circuit boards for certain constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to **The PCB Service** ***Everyday Electronics*****, 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everday Electronics* (Payment in £ sterling only).

Boards for some older projects – not listed here – can often be obtained from Magenta Electronics, 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST. Tel: 0283 65435 or Lake Electronics, 7 Middleton Close, Nuthall, Nottingham NG16 1BX. Tel: 0602 382509.

NOTE: While 90% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail. Please check price and availability in the latest issue before ordering. We can only supply boards listed in the latest issue. Boards can only be supplied on a payment with order basis.

PROJECT TITLE		Order Code	Cost
Video Guard	FEB '87	556	£3.80
Spectrum I/O		557	£5.35
Computer Buffer/Interface	MAR '87	560	£3.32
Fridge Alarm	MAY '87	565	£3.00
Mini Disco Light	JUNE '87	567	£3.00
EE Buccaneer Metal Detector	JULY '87	570	£4.10
Monomix		571	£4.75
Noise Gate	SEPT '87	577	£4.41
Electronic Analogue/Digital Multimeter		579	£6.40
Transtest	OCT '87	580	£3.32
BBC Sideways RAM/ROM	NOV '87	585	£4.10
Twinkling Star	DEC '87	588	£3.00
Audio Sine Wave Generator		589	£3.03
Capacitance Meter	JAN '88	590	£4.10
Transistor Curve Tracer		592	£3.00
	FEB '88		
Game Timer		583	£3.55
Semiconductor Tester	MAR '88	594	£3.19
SOS Alert		595	£3.00
Guitar/Keyboard Envelope Shaper		596	£4.23
Stereo Noise Gate	APR '88	597	£6.65
Pipe & Cable Locator		598	£3.00
Inductive Proximity Detector		574	£3.00
Multi-Chan Remote Light Dim	MAY '88		
Transmitter		599	£3.00
Receiver		600	£3.07
Door Sentinel		605	£3.00
Function Generator – Main Board		606	£5.91
Function Generator – Power Supply		607	£4.19
Multi-Chan Remote Light Dim	JUNE '88		
Relay/Decoder		601	£4.86
Dimmer Board		602	£3.07
Power Supply		603	£3.00
Mother Board		604	£7.76
Headlight Reminder		611	£3.00
Video Wiper	JULY '88	612	£6.75
Isolink		613	£4.21
Tea Tune	AUG '88	609	£3.00
Time Switch		614	£4.84
Suntan Timer		610	£3.07
Car Alarm		615	£3.12
Breaking Glass Alarm	SEPT '88	617	£4.27
Amstrad PIO		618	£6.77
Eprom Eraser	OCT '88	620	£4.07
Doorbell Delay	NOV '88	616	£3.56
Micro Alarm		621	£3.12
Infra-Red Object Counter Trans } £9.28 as a set		622	£4.61
Receiver		623	£3.23
Display		624	£3.05
Seashell Sea Synthesiser		625	£4.84
Reaction Timer Main Board	DEC '88	626	£3.46
Display Board		627	£3.00
Downbeat Metronome		629	£4.84
EPROM Programmer (On Spec)	DEC '88	630	£8.29
Phasor		631	£5.64
Monkey/Hunter Game	JAN '89	634	£3.36
Continuity Tester	FEB '89	619	£2.67
4-Channel Light Dimmer		635	£7.67
Mini PSU		636	£3.23
Sound-to-Light Interface	MAR '89	637	£6.24
Midi Pedal		639	£7.00
Midi Merge		640	£3.00
Audio Lead Tester		641	£5.77
Light Sentinel	APR '89		
Main Control Board		632	£9.20
Remote Interface (4 boards)		633	£4.59
Electron User Port		638	£6.64
4-Channel Auto-Fader Interface		642	£6.80
Pet Scarer	MAY '89	644	£3.00
Electron A/D Interface		645	£4.84
Spectrum EPROM Programmer	JUNE '89	628	£7.87
Bat Detector		647	£4.95
Programmable Pocket Timer	JULY '89	648	£3.82
Electronic Spirit Level	AUG '89	649	£3.85
Distance Recorder		651	£5.23
Treasure Hunter		652	£3.73
Xenon Beacon	SEPT '89	650	£4.13
Probe Pocket Treasure Finder		653	£4.12
Power Supplies { – Fixed Voltage		654	£4.08
– Variable Voltage		655	£4.48
Music on Hold	OCT '89	646	£3.85
Power Supplies – 25V 700mA		656	£4.35
– 30V 1A		657	£4.55
EE Seismograph – Control		658	£4.08
– Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49
Wash Pro	NOV '89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
– Processor		662	£4.56
Power Supplies – 1.5V–25V 2A		663	£4.78
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC '89	665	£3.98
Biofeedback Signal Generator	JAN '90	666	£4.08
Four-Channel Light Chaser		667	£6.70
Quick Cap Tester	FEB '90	668	£3.92
Weather Station			
Anemometer – Freq/Volt Board		670	£3.94
– Optional Display		669	£3.73
Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
EE Weather Station	MAR '90		
Display Driver		671	£4.47
Display & Sensor Boards		672 & 678	£4.22
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver			
Tuner/Audio Amp		679/680	£4.22
Stereo Noise Generator	APR '90	681	£4.24
Digital Experimenter's Unit			
Pulse Generator		682	£4.46
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen(687)/Sunlight Sen(686)		686/687	£4.16
Amstrad Speech Synthesiser	MAY '90	689	£4.68
Quizmaster		690	£4.74

Please note it is important to give project title as well as order code.

EE PRINTED CIRCUIT BOARD SERVICE

Please send me the following p.c.b.s.

Order Code	Project	Quantity	Price
....			
....			

I enclose cheque/PO for £ ....

Name........

Address........

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Please allow 28 days for delivery (see note above)

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Kits

KITS. Microtransmitter, VHF/FM, 14×25mm, including free microphone, £4.50. VHF/FM bleeper tracking transmitter, £7.99. Voice operated switch, £8.99. Telephone transmitter, VHF/FM, £4.99. Automatic telephone recording switch, £7.99. SAE list. ACE(EE). 99 Greenheath, Hednesford, Staffs. Access orders 05438 71902 (24 hrs).

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Miscellaneous

PROTOTYPE PRINTED CIRCUIT BOARDS one offs and quantities, for detils send s.a.e. to B.M.A. Circuits, 38 Poynings Drive, Sussex BN3 8GR, or phone Brighton 720203.

FOR SALE Jeckson NiCad battery chargers. Output d.c. 2-4V and 9V. £5.25 inc p&p. A.C.W. Computer Repairs, 2 Forge Cottages, High Street, Ewelme, Wallingford, Oxon OX10 6HQ.

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This very high quality 2m/70cm FM dual band mobile transceiver has been specially designed to provide maximum performance and operating convenience in an ultra compact package. An impressive array of features gives maximum flexibility in mobile installations. The transceiver has an output power of 45W (VHF) 35W (UHF) and incorporates a high/low power switch. The unit is provided with 10 programmable memories. Channel spacing is in 5, 10, 12.5, 20 and 25kHz steps. There are four scanning modes:

1. VFO scanning of the entire band. 2. Memory scanning of selected memories. 3. Programmed band scanning of a selected segment of the band. 4. Priority scanning allows selection of a frequency, in VFO or memory, to serve as a priority frequency.

A duplexer is built-in so that when an antenna for both bands is in use, only one feeder cable for the transceiver is necessary.

The unit is supplied with a comprehensive instruction manual. It is illegal to transmit with this unit unless you hold a Radio Amateur's Class B (or A) licence.

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- ★ *Ultra compact, lightweight design*
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A 12V 700mAh battery pack with integral DC-DC converter which allows the transceiver to be powered from a car cigarette lighter socket.
A charger is also available for use with this pack.
Battery Pack **NBP20 £59.95** Charger **NBC20 £14.95**

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- ★ *6W VHF/5W UHF Output Power (with optional 12V battery pack)*
- ★ *Cross Band Full Duplex Operation*
- ★ *Frequency selection by Direct Keyboard Entry or Step Up/Step Down*
- ★ *Automatic Battery Save Function*
- ★ *20 Memory Channels*
- ★ *Built-in DTMF Keypad and Encoder*
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Quote Reference DHT20 **£369.95**

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