JUNE 1990

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

£1.40

MARC
VERSATILE REMOTE CONTROL SYSTEM FOR THE HOME

80 METRE DIRECT CONVERSION RECEIVER

CHOOSING & USING TEST EQUIPMENT

MINI BRIDGE AMPLIFIER

ISSN 0262-3617

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PROJECT CONSTRUCTION . ROBOTICS . COMPUTING . THEORY

The Magazine for Electronic & Computer Projects

ONE POUND PACKS

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

BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD9 2 6V 1A mains transformers upright mounting with fixing clamps.
BD11 1 6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
BD13 12 30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
BD22 2 25 watt loudspeaker two unit crossovers.
BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
BD49 5 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
BD139 6 Microphone inserts—magnetic 400 ohm also act as speakers.
BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149 6 Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
BD180 6 Neon indicators in panel mounting holders with lens.
BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201 8 Keyboard switches—made for computers but have many other applications.
BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
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.
BO305 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.

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

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 x 8½in wide. Double-sided on fibreglass middle which is quite thick (about 1/16in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

POWERFUL IONISER

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

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

REAL POWER CAR SPEAKERS. Stereo pair output 100W each. 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.

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

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

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

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

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

ASTEC PSU. Mains operated switch mode, so very compact. Outputs + 12v 2.5A, +5v 6A, ±5v .5A, ±12v 5A. Size: 7½in long x 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.

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 39P1.

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

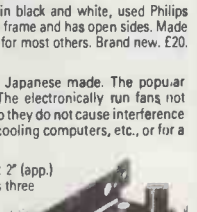
SINCLAIR GEARBOXES These are the original gearboxes and give about 50% reduction in speed and a toothed pulley output. Price for the gearbox AND motor is £40.00. Ref. 40P8.

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

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

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

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



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. Minimum order £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 2SJ99 and its complement 2SK343. Only £4.00 a pair. Our Ref. 4P42.

TIME AND TEMPERATURE LCD MODULE A 12 hour clock a Celsius and Fahrenheit thermometer a too hot alarm and a too cold alarm. Approx 50x20mm with 12.7mm digits. Requires 1AA battery and a few switches. Comes with full data and diagram. Price £9.00. Our ref. 9P5.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

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ABC

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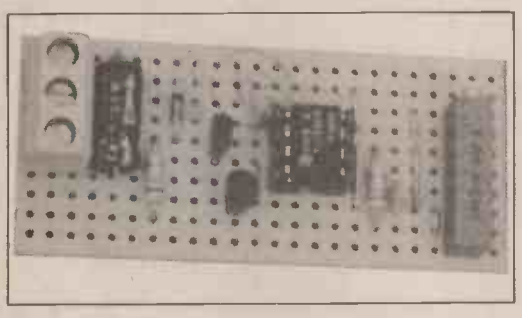
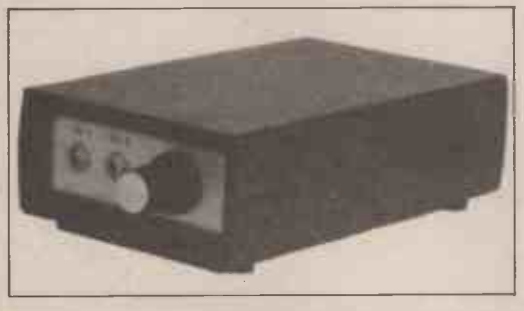
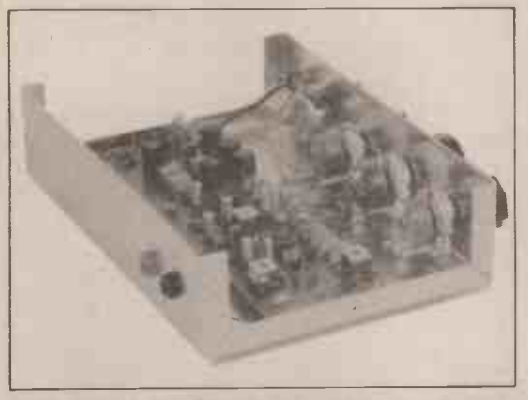
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







Projects

Series

Features

Our July '90 Issue will be published on Friday, 1 June 1990. See page 363 for details.

Cover photograph by Reflections of Bournemouth

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.

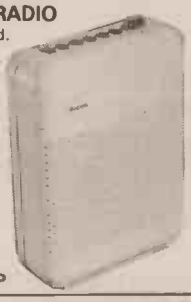
Supplied with:— 2 READY CUT BAFFLES, ALL CROSSOVER COMPONENTS, 2 BASS MID-RANGE, 2 DOME TWEETERS, HOOK UP WIRE, GRILLE CLOTH, SCREW TERMINALS AND SCREWS.

ROSS MULTI TESTER

As new condition but have been returned by customers or shops so they may need some attention. Hence the price of **£3.50** each plus £1.60 P&P. Order five and get the sixth one free. Postage £5.40.

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.

Size 230H x 150W x 65D.
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"×⅜" 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
BP046A	2	606 Mains transformers, PCB mounting. Size 42×33×35
BP047	1	24V 0.3VA mains power supply. Brand new boxed *UK made by MULLARD*
BP047A	1	25V DC 150mA mains adaptor in black plastic case with flying input and output leads new units made for famous sound mixer manufacturer. Size 80×55×47
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 LM1818 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
BP064	12	Coax chassis mount sockets
BP065	1	3mtr Euro-mains lead with chassis socket

MULTIBAND RADIO

VHF 54-176 MHz + AM CB BANDS 1-80
Listen to: AIR TRAFFIC CONTROL, AIRCRAFT, RADAR PUBLIC UTILITIES RADIO AMATEURS AND MANY MANY MORE
SQUELCH CONTROL "RUBBER DUCK AERIAL"

£17.95
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HAND HELD WALKIE TALKIES

Ideal for sports or any outdoor activities. Built-in call button and separate volume control. Range 1.2km maximum. 49MHz crystal control superhet circuit with built-in condenser mic. and speaker. Unit supplied with vinyl carrying case and personal earphone.

£32.90 a pair + £2.60 P&P

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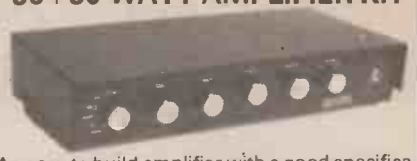
30+30 WATT AMPLIFIER KIT



An easy to build amplifier with a good specification. All the components are mounted on the single P.C.B. which is already punched and backprinted.

- 30W×2 (DIN 4 ohm)
- CD/Aux, tape I, tape II, tuner and phono inputs.
- Separate treble and bass
- Headphone jack

Size (H.W.D.) 75×400×195mm
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.

AMPHONIC 125+125 POWER AMPLIFIER

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

Output power .... 125W RMS max. per channel
Output impedance ..... 4 to 16 ohms (max. power into 4 ohms)
Sensitivity ..... 450V at 22K ohms
Protection .... Electronic short-circuit and fuses
Power ..... 220-240V a.c. 50Hz
Chassis dim ..... 435×125×280mm

£142 +£7.00 p&p

STEREO MIXER

5-channel stereo disco mixer in racking case which can handle up to a total of 10 phono, line and mic inputs, switchable on front panel. Twin 5-band graphic equalizer with insert/bypass switch. Cross fader between channels 1 and 2. Mic channel with low Cut filter and talkover switch. Separate L and R master controls. Output for amp, tape and headphones.

Input Mic ..... 0.3mV 600 ohms
Phono ..... 2.5mV 50K ohms
Outputs: Amp & Tape 1.2V
Headphone ..... 50mV @ 75 ohms
Equalizer control frequencies 60, 250, 1k, 3.5k, 12kHz
Equalizer control range ..... ±12dB boost or cut
Size ..... 350 x 280 x 90mm

£118.90 + £5.80 P&P

BELT-DRIVE QUICKSTART VARISPEED DISCO TURNTABLE

- ★ Quick start Ideal for scratching
- ★ Pitch control
- ★ Pop-up target lamp
- ★ Strobe lamp
- ★ Counterweighted tubular tone arm with plug-in headshell
- ★ Full manual control
- ★ Remote start/stop
- ★ 7.5kg

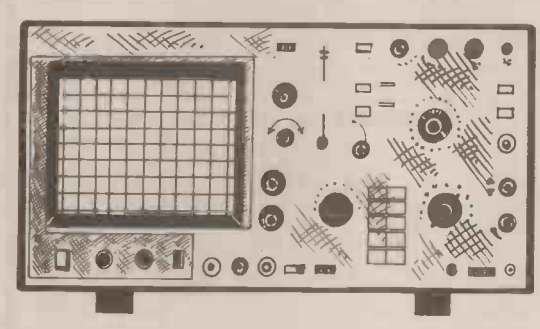
£112.00 + £7.00 P&P

28.0.28V 4 AMP MAINS TRANSFORMERS

With a 5.5V at 0.5A mains input 110-240. Size 90 x 105 x 75 fitted with copper screening band; made for famous HIFI Co. **£6.50** each. Postage £2.80. It's weight is 2.7Kg! Brand new and unused condition.

GRAND NATIONAL — A Day at the Electronic Races

A day at the electronic races! This game provides great fun at parties and could be useful as a fund-raiser at school open days and similar events. The original theme wAs "a day at the races" but the constructor's imagination could turn the basic circuits to many other ideas. Four "horses" to bet on, each with different odds.



CHOOSING AND USING TEST EQUIPMENT — OSCILLOSCOPES

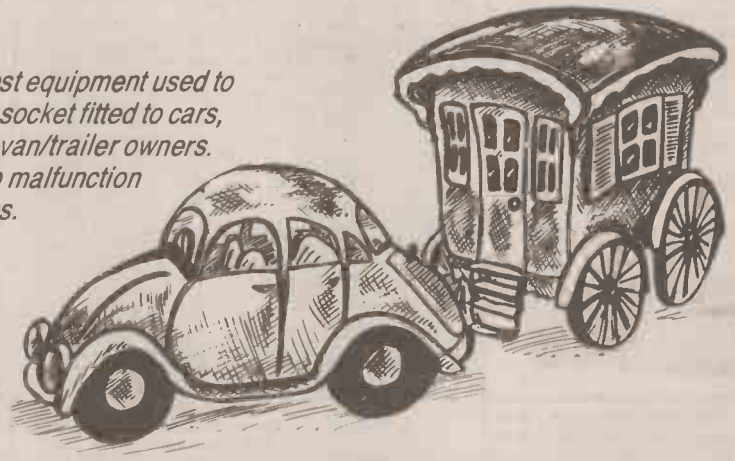
For its shear versatility the oscilloscope has no real competition. It can be used to undertake most of the testing that can be done using a multimeter, plus a great deal besides. It's not that an oscilloscope can reach the parts of circuits that other equipment can not reach, but having reached it an oscilloscope will almost invariably be able to tell you exactly what is happening.

THE TESTER

A handy bench aid with many uses. The Tester performs only one trick, but it does it well. Connect it to a circuit and it makes that circuit oscillate. Simple, but very useful. It can help you to measure inductance, capacitance and Q. It can provide r.f. or a.f. test signals. It can act as a selective amplifier.

THE TOW-TEST

This device is basically a piece of test equipment used to test the correct function of the towing socket fitted to cars, vans etc, and will be of use to all caravan/trailer owners. The sockets fitted to cars are prone to malfunction due to ingress of dirt and broken wires. But the main problem owners face when they find their lighting system faulty is determining whether it is the car or caravan/ trailer electrics at fault. The easy to use Tow-Test will sort out the problem area.



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
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BC537	25p
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BC548	8p
BC549	8p
BC550	8p
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BC560	8p
BC637	20p
BC638	20p
BC639	20p
BC640	20p
BCY32	200p
BCY33	200p
BCY34	200p
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BCY71	16p
BCY72	16p
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BD899	50p
BD901	50p
BD977	50p
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BDX33	60p
BDX53	60p
BDX65	80p
BDW23	55p
BDW24	55p
BDW93	50p
BDW94	50p
BDY20	100p
BDY92	100p
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MPSA93	20p
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MR856	36p
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OC72	50p
OC200	180p
OT121	120p
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R2010B	100p
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S2800M	72p
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T2800M	72p
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VN10KM	60p
VN66AF	100p
VN88AF	115p
ZTX107	11p
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ZTX109	12p
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ZTX503	18p
ZTX504	25p
ZTX550	24p
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2N.698	40p
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2N.708	22p
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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	4p
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
7B18KC	100p
7824KC	100p
LM309K	100p
LM317K	220p
LM317T	180p
LM323K	420p
LM723	40p
78HGKC	570p
78H05KC	800p
78H12KC	700p
78GU1C	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	15p
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	26p
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	40p
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

COMPUTER IC'S

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
874B	1100p
8755	1400p
AY3-1015	290p
SP0256AL2	500p
Z80ACPU	150p
Z80BCPU	400p
Z80ADMA	500p
Z80AP10	220p
Z80BP10	340p
Z80ACTC	200p
Z80BCTC	320p
Z80AS10	460p
Z80AS10-1	580p
Z80AS10-2	580p
Z80ADART	500p

SPECIAL OFFER DRAMS

4164-15	150p
4164-12	175p
41256-10	260p
41256-12	240p
41256-15	220p
41464-12	360p
41464-10	430p
256KX4	1000p
1MBRAM-81	1080p
1MBRAM-10	1000p

SIPP

256KX9-10	3000p
256KX9-8	3800p
256KX9-7	5200p
256KX9-6	6500p

SRAMS

6264LP15	250p
6264LP12	280p
6264LP10	300p
32KX8-12	800p
62256-12	800p
27512	580p

SIMMS

1MX9-10	9500p
1MX9-8	9800p
1MX9-7	10500p
2MX9-10	39000p
4MX9-80	78000p

PLEASE PHONE US FOR TYPE NOT LISTED HERE AS WE ARE HOLDING 5000 ITEMS AND QUOTATIONS ARE GIVEN FOR LARGE QUANTITIES.

Please send 70p p&p and VAT at 15%. Govt, Colleges, etc. Orders accepted. Quotations given for large quantities. All brand-new Components. prices quoted are subject to stock availability and may be changed without notice.

A selection of products from our *BARGAIN LISTS*: Ring or write for a free copy of our latest list + 32 page Spring Supplement.

Z4295 Error Correction Card, made by Tulsedata Ltd, this 130×86mm board contains a 80C85A microprocessor, 82C51×3, 5864-15, 2764-15, + 9 other chips, a 10 way DIL switch R's C's etc . . . There's a 14 way ribbon cable to a small PCB with 2×1489. Originally cost over £70.00. **Our low price £10.00**

Z4300 Nice panel 330×170mm with 3 chunky heatsinks 47×36×32mm, each with TO220 voltage reg. Also 56×74 series IC's including L+LS. 3×40W IDC plugs, few tants etc . . . Attached to the board are 2×0.5 metre long twisted and flat ribbon cables terminated in 50 way IDC sockets. **£4.00**

K575 Plastic Power Pack, mainly TO126 & TO220 transistors, SCR's, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP & BD types. **50 for £7.50**

Z4299 Hourmeter. This has a 12-24V quartz movement and measures to 99999.99 hours (11 and a half years!). Face 52×52mm, depth 50mm. **£4.80**

Z8884 Acoustic coupler for use with Liberator. Made by Sendata, 700F series. One end has PCB with lots of chips plus 4×AA Nicads to power. Other end has socket to take mains power supply (supplied). Also included is a communications cartridge and a comprehensive 46 page manual. **New. £20.00**

Z4279 Interesting little panel (75mm×40mm) with 16 position BCD channel switch (24 pins), two dual green seven seg diplays, two min keyboard switches, and a short a 4093. Attached by a short length of ribbon cable is a second panel (same size) with 4518, 4019 and two × 5068 chips. Supplied with circuit. Only **£2.20**

KEYBOARDS

Z8852 Keyboard: Superb brand new keyboard 392 × 181 with LCD displaying 1 line of 10 characters and a further line with various symbols. 100 keys, inc. separate numeric keypad. Chips on board are 2 × 74HC05, 80C48. LCD + driver chips are easily removable from board. **£15.00**

Z8857 High quality Alphanumeric keyboard on aluminium frame 314 × 150mm. Contactless keys good for 20 million operations. Originally sold at over £100 each, they were used in a 'Printcom' portable terminal. Fully ASCII encoded output. Power supply + 5V and −12V @ 35mA. Supplied with comprehensive data. **£14.95**

Z8856 Cherry computer keyboard. Very slim model 340 × 130 by only 14mm deep, including keys. Matrix output. 67 keys in pale/dark brown. **£4.00**

Z8863 Keyboard. High quality unit made by Micro Switch. 69 pale grey and blue keys. 6 red 5mm LED's, 15 various LS chips and socketed D8048 by Intel. Output via 7 way plug and there is a 4 way edge connector too. Keyboard frame is 317 × 128mm. PCB on which it's mounted is 285 × 170mm.
Price..... **Excellent value at £12.00**

DISPLAYS

Z4243 Display panel 152 × 112mm with NEC 8 digit display (Z1731); 8279-5, MC146818, 3 × uPA80C, & a couple of LS chips, crystal, etc. **£2.90**

Z1731 NEC Vacuum Fluorescent Display FIP8BII. 8 digit multiplexed output 10mm high. Heater voltage 2V, grid/anode voltage 24V. **£2.00**

Z4115 8 digit 12.7mm high LCD and holder. These are 14 segment devices allowing alphanumeric display. Normally costing over £15.00 we are offering these for just **£4.50**

Z4148 LCD as Z4115 but 6 digit, 50 pins. Like RS 588-601. Their price 10.86. ..... **£3.00**

Z1732 Epson LCD 4 digit 8mm high. **£2.00**

Z1637 LCD Display – Direct drive 3½ digit similar to RS 588-572. 12.7mm high digits. Op voltage 4-12 RMS @ 32Hz typ. Supplied with data. ..... **£2.00; 10+/ £1.75; 25+/£1.50; 100+/£1.00**

Z1560 7 seg display, 20mm high. Common anode. ..... **Only 70p! 25+/50p; 100+/42p**

DL1416 Alphanumeric 4 character intelligent display 0.16" **£7.00**

DL3416 4 digit intelligent alphanumeric display with built-in drive and memory. ASCII ROM and multiplexing circuitry. TTL compatible inputs. +5V. Supplied with data.
List price £41.50. ..... **£8.00**

1990 CATALOGUE

128 PAGES OF ELECTRONIC COMPONENTS AND EQUIPMENT. HUGE RANGE! AMAZING VALUE! DON'T MISS OUT — GET YOUR COPY NOW — ONLY £1.50 POST FREE!!!

HIGH QUALITY TEST EQUIPMENT

HITACHI OSCILLOSCOPES
FOR QUALITY AND VALUE

V223 DC-20MHz, dual Channel, single timebase delayed sweep, DC offset, alternate magnifier, 6in screen, 5mV/div vert. sensitivity 0.2μs/div-0.2s/div sweep time. Complete with 2 probes, manual, mains lead. **£475**
Other models from **£339** – full details in catalogue. Ask for colour brochure.

METEX METERS

8 different models in our catalogue! !

- ★ 4½ digit 12mm LCD display
- ★ 30 ranges incl 20A ac/dc
- ★ Frequency counter
- ★ Capacitance test with zero adjust
- ★ Data hold switch
- ★ Diode test
- ★ Transistor test
- ★ Continuity test
- ★ Test leads with 4mm plugs
- ★ Rugged yellow case
- ★ Carrying case

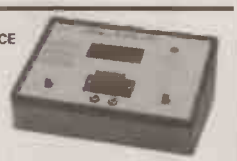
M4650
£94.00

Battery and instruction manual included.
AC volts 0-200m-2-20-200-750Vac ±0.5%
DC volts 0-200m-2-20-200-1000vdc ±0.5%
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

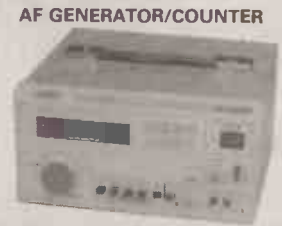
FC5250 7 digit frequency counter for frequencies between 10Hz and 150MHz. Power on/off, ×1/×10 gate time and VHF/HF switches. Inputs via BNC sockets. Supplied complete with instruction manual and test lead. Requires an external 9Vdc nom 200mA power supply.
Price..... **£65.00**

DIGITAL CAPACITANCE METER



CM3300 High accuracy AUTORANGING 3 digit capacitance meter. High resolution measurement in the range 0.1pF to 99900μF with 10 auto ranges. Range hold switch for batch testing capacitors. Range zero control. Inputs via spring terminals or test leads (supplied). Complete with leads and instruction manual.
Price..... **£65.00**

AF GENERATOR/COUNTER



AG2603AD A combined audio frequency signal generator and frequency counter. A six character LED display allows direct reading of internally generated signal or signals from an external source. The frequency generator has a range of 10Hz to 1MHz with either square or sine waveforms and adjustable output level. The frequency counter has a range of 10Hz to 150MHz. Frequency range controlled by a 5-step selector and fine control. Adjustable ouput level with 0/20/40dB attenuator.

AUDIO GENERATOR
Frequency range ..... 10Hz to 1MHz
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:
High frequency 1MHz
VHF 50Ω
Power 240Vac 50Hz
Dims ..... 215 × 150 × 200mm
Price **£175.00**

RF GENERATOR/COUNTER

Similar in appearance to above with same frequency counter. Spec:
Frequency range ..... 100kHz to 150MHz
RF Output ..... 100mV rms (up to 35MHz)
Output control ..... 0/20dB and fine adj.
Modulation ..... Internal 1kHz, external 50kHz-20kHz at less than 1V rms
Price **£179.00**

AMSTRAD SPEECH SYNTHESISER

As featured in last month's issue!

All components inc. PCB, edge conn., etc., for just **£10.95!**

+ **FREE!** An extra SP0256 chip with every kit!!
Suitable Case **£3.00**
SP0256 Speech Chip **£2.50**

SIGNAL TRACER/INJECTOR

Y133 For fault finding on Audio & RF Equip, VU meter and speaker. Level controls, 0-60dB atten. switch. I/P, O/P, ext spkr, and injector skts on Front panel. Size 200×140×96mm. Uses PP3. ..... **£55.00**

MSDOS PACK
Z4305 Epson PCe disk pack

Contents:

1) 364 page MSDOS 3.20 reference manual showing all commands, etc.
2) 100 page book "Everyday with MS-DOS" – an excellent introduction, starting from basics.
3) 95 page book "Setting up and getting started".
4) 61 page book "Diagnostics Users Guide".
5) Pack of 3 5.25" disks – 2 MSDOS 3.20 system/utilities disks and a system dependent utilities disk.

All books are spiral bound. Everything brand new in original carton.

Cost new £55.
Our price **£10.00**

POWER SUPPLIES

(a) SWITCH MODE

ASTEC Model AA12531
I/P: 115/230V ac 50/60Hz. O/P: V1 + 5V 5A; V2 + 12V 0.15A. Size: 160 × 104 × 45mm. Partially enclosed panel with fixing holes in steel case on 120 × 125mm centres. Inputs and Outputs are on colour coded leads; there is also an EEC socket on a flying lead. **£6.95**

Z660 Astec switched mode PSU Type AA7271.
This small PCB, just 50 × 50mm will accept 8-24V Input and give a stable 5V DC at up to 2A output. The 6 transistor circuit provides current overload protection, thermal cut-out and excellent filtering. Offered at the remarkably low price of just **£5.00**

(b) CONVENTIONAL

Z4215 Siliconix mains input, 4.5V DC 150mA output to 3.5mm jack plug on 2m lead. Built-in continental 2-pin plug. Size 62 × 46 × 35mm **£1.50**
Z4170 Plug in power supply. Built in 13A plug. Output 6V DC 300mA on 2m long lead terminated in a 3mm power plug. British made to BS415 ..... **£1.50**
Z4208 Oric Power Supply. Moulded plastic case with built in 13A plug. Output 9Vdc at 600mA delivered to 2m lead with 2.5mm power plug **£3.50**

BREADBOARDS

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

PROTOBLOC 1
G708 Protobloc 1 has a total of 400 tie points consisting of two sets of 30 rows of 5 interconnected sockets plus 4 rows of interconnected sockets running alongside, suitable for use as power supply rails. All contact positions are clearly defined on an alphanumeric grid. ABS polymer board mounted on an adhesive foam base. Will accommodate up to three 16 pin devices. An ideal introduction to solderless circuit development systems. Size 80 × 60mm. **£2.50**

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

PROTOBLOC 2A
G712 As above, but mounted onto a rigid base plate complete with three 4mm terminals for power connections. A mounting bracket which clips into the base is also provided to accept a variety of components including switches and potentiometers, etc.
Price..... **£6.95**

PROJECT BOARD GL24
G724 2 of type G711 mounted onto a rigid baseplate with 3 coloured terminals, for power connections. Overall size 225 × 150mm.
Price..... **£13.95**

PROJECT BOARD GL36
G736 3 of type G711 and an additional strip of 100 tie points mounted onto a rigid base plate with 4 coloured terminals. Overall size 242 × 195mm.
Price..... **£19.95**

GREENWELD
ELECTRONIC COMPONENTS

All prices include VAT; P&P £2.00per order. Min Credit Card £5. No CWO min. Official Orders from Education welcome & min invoice charge £10.00.
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27D PARK ROAD, SOUTHAMPTON, SO1 3TB.

INSULATION TESTER

EE APRIL 85

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

KIT REF 444 **£20.85**

PET SCARER

EE MAY 89

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

KIT REF 812

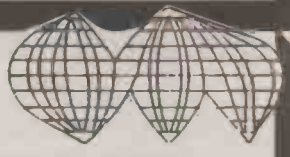
Mains Adaptor £1.98 **£13.80**

DIGITAL CAPACITANCE METER

EE DEC 85

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

KIT REF 493 **£44.25**



3 BAND SHORT WAVE RADIO

EE AUG 87

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

KIT REF 718 **£28.25**

DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

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

KIT REF 563 **£67.98**

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY

EE FEB 88

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

KIT REF 769 **£52.96**

MINI STROBE

EE MAY '86

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

KIT REF 529 **£14.76**

ACOUSTIC PROBE

EE NOV '87

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

KIT REF 740 **£18.65**

4 CHANNEL LIGHT CHASER

EE Jan '90

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

KIT REF 833 **£29.95**

EE EQUALISER

EE MAY '87

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

KIT REF 707 **£16.54**

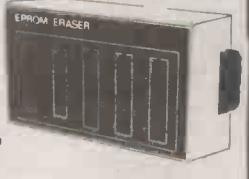
MUSICAL DOORBELL

EE JAN '86

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

KIT REF 497 **£19.95**

EPROM ERASER



EE OCT '88

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

KIT REF 790 **£26.57**

LIGHT RIDERS

EE OCT '86

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

KIT REF 559 CHASER LIGHT	£14.52
KIT REF 560 DISCO LIGHTS	£20.89
KIT REF 561 LAPEL BADGE	£10.86

EE TREASURE HUNTER

EE AUG '89

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

KIT REF 815 **£39.95**

Headphones **£1.99**

STEPPING MOTOR INTERFACE

EE AUG '85

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

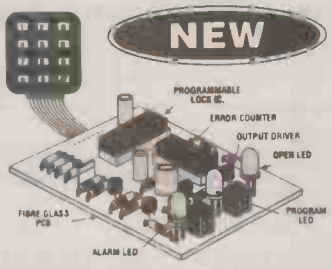
KIT REF 464 **£8.95**

TK FOR KITS

GUARD DOG KIT

One of the best burglar deterrents is a guard dog and this kit provides the barking without the bite! Can be connected to a doorbell, pressure mat or any other intruder detector and produces random threatening barks. Includes mains supply and horn speaker.
XK125 **£24.95**

PROGRAMMABLE ELECTRONIC LOCK KIT



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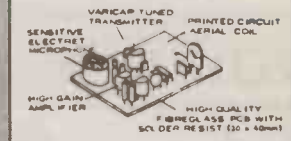

Only 45x25x15mm, including built–in mic. 88–100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **XK128** **£6.35**

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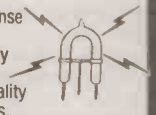
POWER STROBE KIT



Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.
XK124 STROBOSCOPE KIT. **£17.25**

SIMPLE KITS FOR BEGINNERS

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

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

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

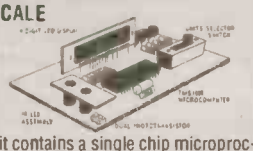
SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire–engine siren and machine gun **£4.50**

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

VERSATILE REMOTE CONTROL KIT

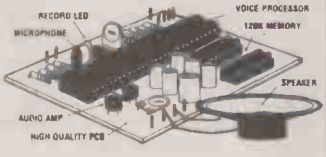
Includes all components (+ transformer) for a sensitive IR receiver with 16 logic outputs (0–15V) which with suitable interface circuitry (relays, triacs, etc details supplied) can switch up to 16 items of equipment on or off remotely. Outputs may be latched to the last received code or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits. Supply: 240V AC or 15–24V DC at 10mA. Size: (exc. transformer) 9x4x2 cms. Companion transmitter is the MK18 which operated from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available–MK9 (4–way) and MK10 (16–way).
MK12 IR Receiver (inc. transformer) **£19.55**
MK18 Transmitter **£8.95**
MK9 4–way Keyboard **£2.75**
MK10 16–way Keyboard **£7.95**
601133 Box for Transmitter ..**£2.95**

ELECTRONIC WEIGHING SCALE



Kit contains a single chip microprocessor. PCB, displays and all electronics to produce a digfital LED readout of weight in Kgs or Sts/Lbs. A PCB link selects the scale-bathroom/two types of kitchen scales. A low cost digital ruler could also be made.
ES1 **£8.25**

VOICE RECORD/ PLAYBACK KIT



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

Size ..... 76 x 60 x 15mm
Message time ..... 1–6 secs normal speed, 2–10 secs slow speed
XK129 **£25.95**

PROPORTIONAL TEMPERATURE CONTROLLER KIT

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TEST GEAR

There seems no end to readers' interest in test gear, we regularly publish test gear projects and they are always popular. This month we start a short series of self-contianed articles entitled *Choosing and Using Test Equipment*.

The series, by Robert Penfold, looks carefully at what features are useful, how to understand what you might need and what to look for when buying various items of test equipment. This month the article investigates *The Multimeter* — next month it's *The Oscilloscope* and after that *"The Rest"*.

I'm sure all hobbyists will find the articles interesting and informative even if you already have a well equipped workshop. It's surprising sometimes to find "gaps" in your knowledge and helpful to go over old ground occasionally.

MARC

The quality of the prototype equipment featured in EE is something we try to improve constantly. There is no reason why home built equipment should be poorly constructed or finished. With modern cases and lettering systems it is not difficult to produce professional looking equipment and the *MARC* system (*Mains Appliance Remote Control*) featured in this issue illustrates just how good projects can look.

Not only is the MARC system an excellent, well designed and very useful project it will not look out of place in any home. Why not try to emulate this standard of finish with your projects?

SUBSCRIPTIONS

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Constructional Project

MARC

MAINS APPLIANCE REMOTE CONTROL SYSTEM

CHRIS WALKER

Part One: Handheld Infra-Red Transmitter

Taking the ring route allows up to 15 different household mains appliances, placed anywhere in the house, to be controlled from the safety of your armchair.

Can be linked to the home computer. MARC can improve the quality of life for the elderly and disabled.

THE recurring dream of many an inventive and enthusiastic electronics hobbyist must be to "wire up" his or her home so that several if not all electrical devices within it may be controlled at will by a switch panel situated within easy reach of the most comfortable armchair. Thus the master/mistress of the house has instant command over all systems and environmental factors without having to move a muscle; well almost, a small amount of energy is required to manipulate ones fingers over the buttons! Isn't it a beautiful dream?

Such a luxurious control system need not be aimed solely at the lazy beasts amongst us, those who cannot be bothered to get up to turn the central heating down a degree or two. An *easily installed* household appliance remote control system would be of undeniable benefit to the elderly or disabled who have limited mobility around the house.

Any under-planned thro-house control system fails on the forementioned criterion, namely being tedious to set up and requiring an extensive amount of additional wiring to carry power or control signals to appliances. Such wiring invariably damages decoration and adds a sense of permanence which causes problems should the furniture be rearranged (an event which takes place frequently in our house) or the property be sold.

MARC

The Mains Appliance Remote Control (MARC) system to be fully described over a series of four articles allows up to fifteen different appliances to be independently controlled, each with up to fifteen different functions anywhere in the house with NO extra wiring. Anything connected to the 240V mains (either plugged in or permanently wired) may be controlled.

Eight devices can be governed using a powerful handheld infra-red transmitter. More extensive control can be obtained by using a personal computer linked to the MARC system, details are given.

This latter technique opens up immense possibilities and when used to its full potential it would allow the microcomputer to gain control over practically every electrical appliance in the house. Comprehensive burglar deterrents could be programmed whereby the computer switches on and off lights and radio to mimic the passage of occupants through an empty house.

All is accomplished via *software control*, no permanent wiring is required. Just imagine, you could program your micro to gently awake you in the morning, drawing back the curtains, switching on the kettle and central heating and warming the water for your shower – sheer bliss!

The MARC system has deliberately been

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

designed to be open-ended, encouraging experienced constructors to customise the project to their exact needs. However, the main constructional articles will describe a fully operational system as follows:

1) A description of the MARC system. Infra-Red link.

2) Computer interface and mains encoder.

3) Mains decoder giving on/off control for switching lights, etc.

4) Room thermostat decoder giving remote control of the room temperature, increment or decrement.

RING MAIN

Two simple methods of remote controlling household appliances are outlined in Fig. 1.1. In Fig. 1.1a each device is fed power independently from a main distribution switch box. Such a technique results in heavy duty two- and three-core mains cable running around the house; expensive and inconvenient.

A better system is shown in Fig. 1.1b. Here, thin wires carry current to the coils of relays situated near each appliance.

The relay contacts switch current from the ring main. An enhanced version of this system is often used in theatrical lighting control, but in the home it still implies extra wiring with all its associated drawbacks.

As highlighted earlier, the MARC system does not need extra house wiring and it achieves this status by making use of the ring main power circuit already fitted into the home, Fig. 1.1c. Digitally coded signals are injected into the mains wiring by the encoder which is linked to the computer and the infra-red remote controller.

Each appliance is plugged into the mains via a decoding receiver unit. The coded signals consists of two parts, firstly a number which identifies the receiver to be activated and secondly a function code which causes the selected decoder to perform one of up to fifteen different actions.

Using existing mains wiring to transfer data is an established technique widely used in wireless intercoms, but experience shows that the efficiency of this type of data transmission does depend on the particular ring main in question. Some "noisy" appliances such as televisions and microwave ovens inject short-range interference onto the mains which can affect operation although steps can sometimes be taken to suppress this.

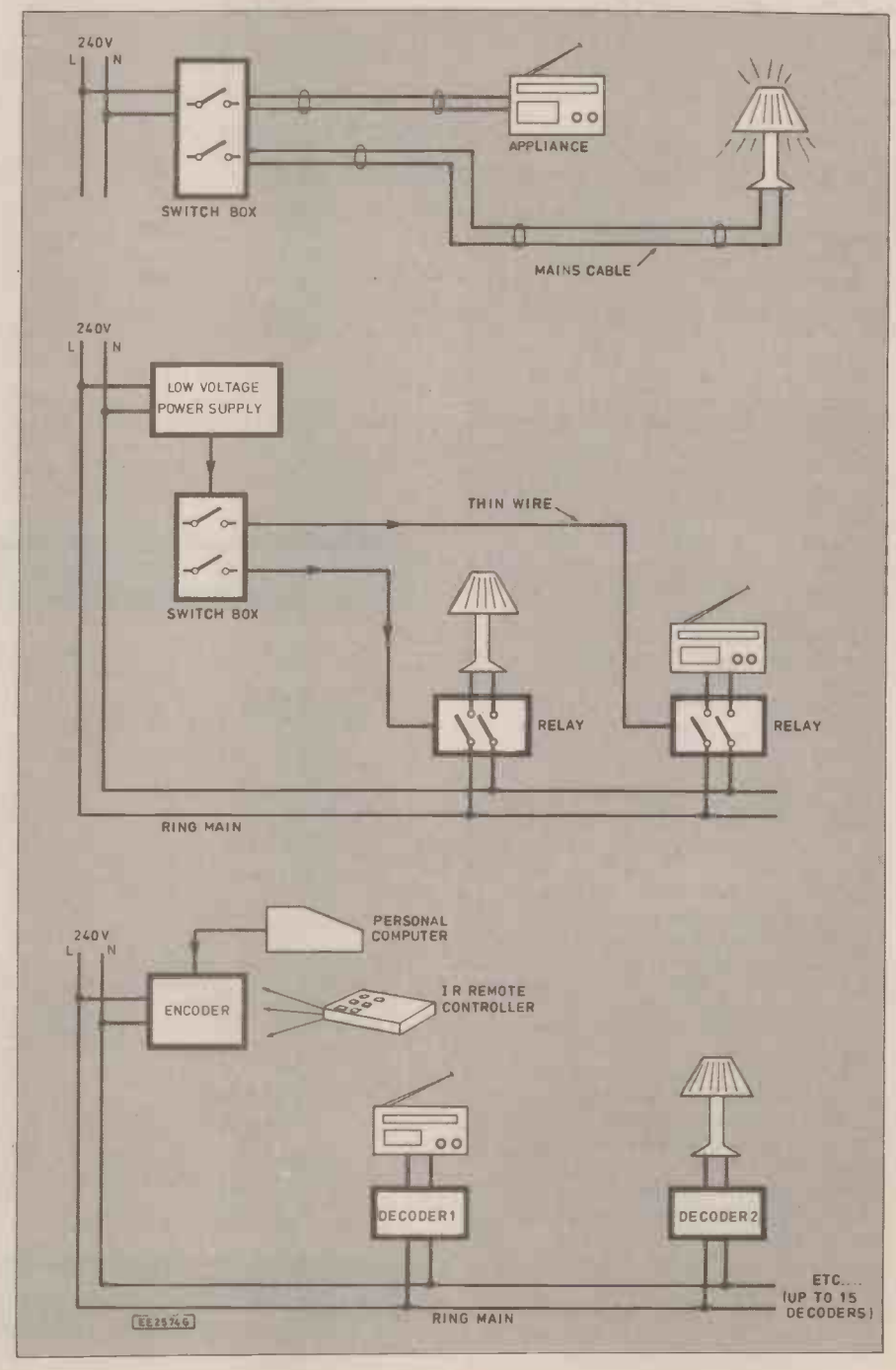
Factors such as line length and impedance also affect the efficiency but the MARC encoder places a rugged signal on the ring main which, in the authors house, can also be strongly detected on the lighting circuit.

INFRA-RED TRANSMITTER

The handheld infra-red transmitter exploits part of the MARC control system by allowing the user to send four function codes to eight different appliances. The complete control signal is sent by sequentially pressing two buttons, the receiver number (1 to 8) followed by the function

The completed decoder, encoder and infra-red transmitter.

Fig. 1.1. Comparing the various possibilities of using the mains.



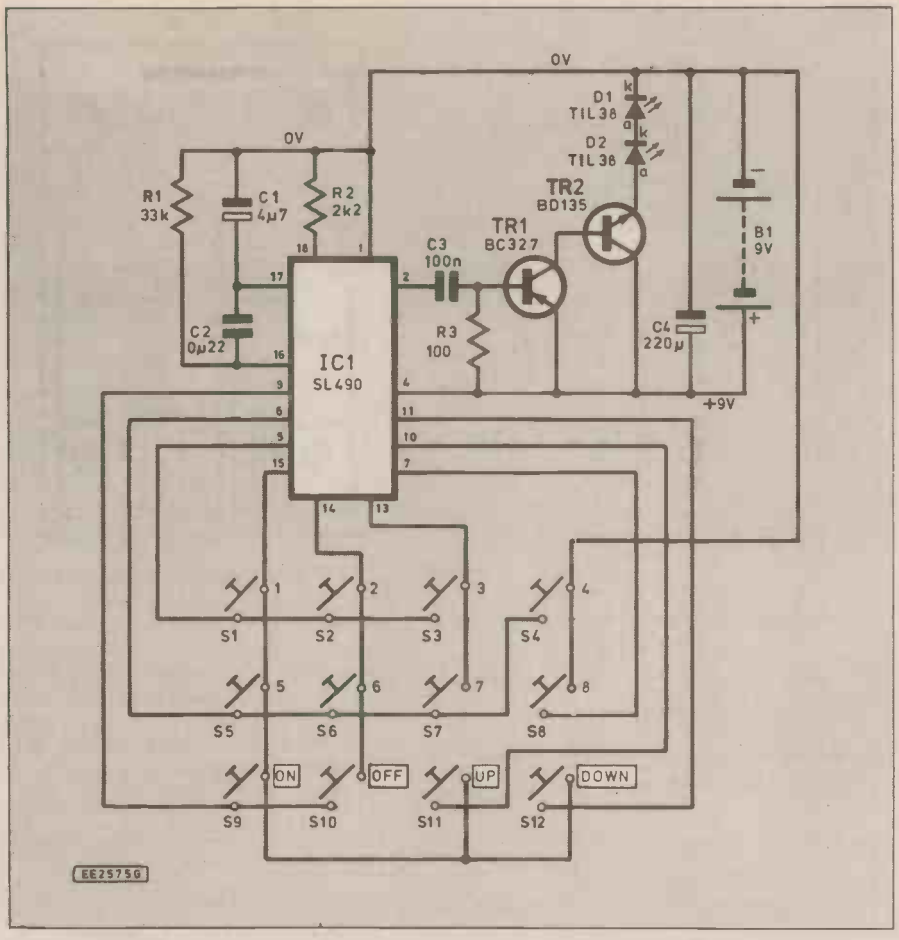


Fig. 1.2. The complete circuit diagram for the handheld Infra-Red Transmitter.

Table 1.1: SL490 Switch Encoding

Switch	Binary Code
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
ON	10001
OFF	10010
UP	10101
DOWN	11001

ON, OFF, UP or DOWN; these give adequate control for most applications. The infra-red signals are received by the encoder unit which then sends digital information along the ring main to control the appropriate appliance anywhere in the home.

The full circuit diagram for the Infra-Red Transmitter is shown in Fig. 1.2. The integrated circuit IC1 is a SL490 remote control encoder which detects when one of the front panel switches S1 to S12 is pressed and converts the switch number into a five bit binary code as listed in Table 1.1. The relevance of these codes will become clear later.

Incidentally, the SL490 is capable of sending all fifteen receiver number codes and fifteen function codes; the prototype is limited simply by the lack of room for more buttons on the case front panel!

The i.c. serially transmits the binary code by pulse position modulation (p.p.m.) outputted at pin 2 of IC1. In this technique a series of short (1.5ms) pulses are sent, and a short gap between each pulse denotes a logical 1 whilst a longer gap encodes a logical 0.

Six pulses are required to send the five bit binary word. Resistor R1 and capacitor C2 control the bit transmission rate which is set at approximately 100Hz with the values shown.

The pulses are coupled via capacitor C3 to the high gain current amplifier created by transistors TR1 and TR2 and are then fed to the high power infra-red emitting diodes D1 and D2. Using two emitters gives an excellent range and the signal can be "bounced off" the walls, a direct "line-of-sight" to the receiver is not required.

Capacitor C4 acts as a reservoir capacitor to cope with the short high current surges (in excess of one amp) fed to the diodes.

CONSTRUCTION – TRANSMITTER

Building the transmitter is very straightforward, two printed circuit boards are used and these greatly simplify internal wiring. These boards are available from the *EE PCB Service*, codes EE692 and EE693.

The transmitter board shown in Fig. 1.3, carries the main components with the exception of the switches and battery. Capacitors C1 and C4 must be polarised correctly and use an 18- pin d.i.l. socket for IC1.

Before mounting transistor TR2, bend the leads through a right-angle so that it lies flat on the p.c.b. with its metal tab underneath. Although this device is a power transistor, no heatsink is required since it only handles very short current bursts.

COMPONENTS

Infra-Red Transmitter

Resistors

R1	33k
R2	2k2
R3	100

All 0.25W carbon

Capacitors

C1	4µ7	tantalum, 16V
C2	220n	polyester layer
C3	100n	monolithic ceramic
C4	220µ	axial elec. 10V

Semiconductors

D1, D2	TIL38	high power infra-red emiting diode (2 off)
TR1	BC327	*pnp* medium power transistor
TR2	BD135	*npn* power transistor
IC1	SL490	remote control encoder

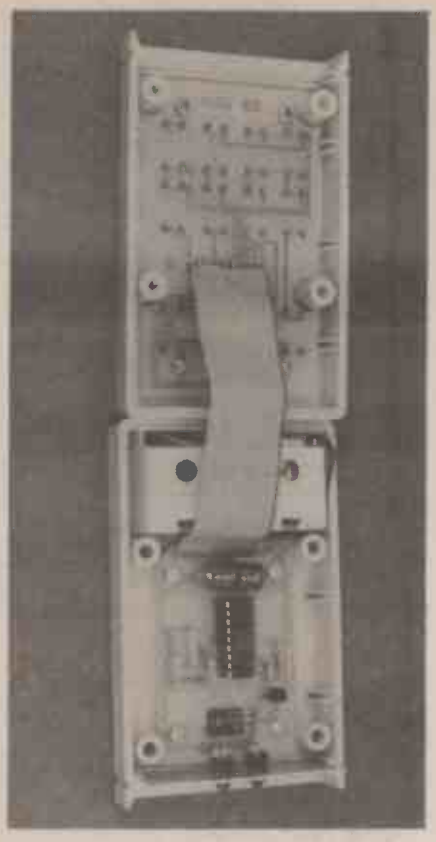
Miscellaneous

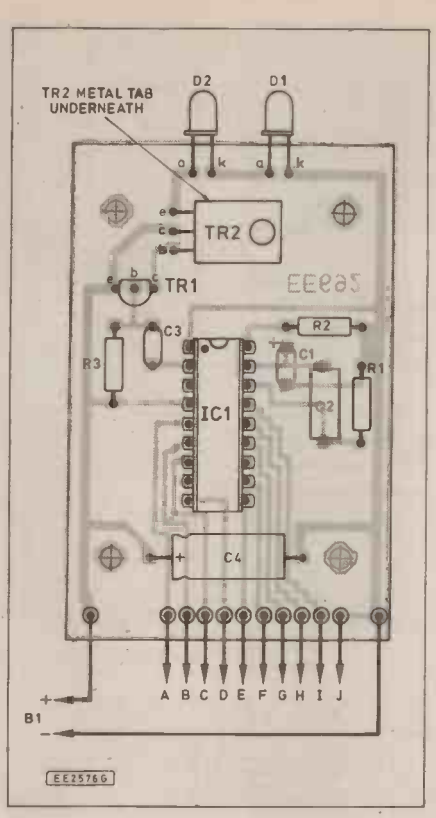
S1 to S12 Type KHC10901 p.c.b. mounted keyswitch with caps (12 off)

Two single-sided printed circuit boards available from *EE PCB Service*, codes EE692, EE693; plastic case 68mm x 10mm x 33mm, with battery compartment; 18-pin d.i.l. socket; terminal pins; PP3 9V alkaline battery and clip; short length of multi-coloured ribbon cable; solder etc.

See Shop Talk page 409

Approx cost. Guidance only **£20**





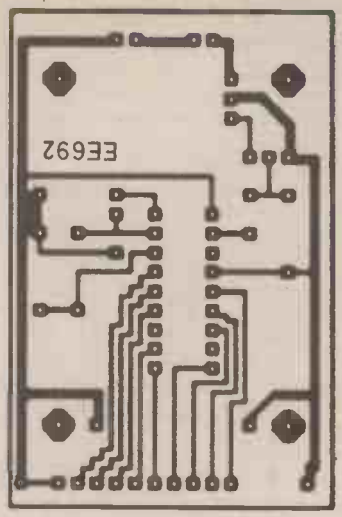
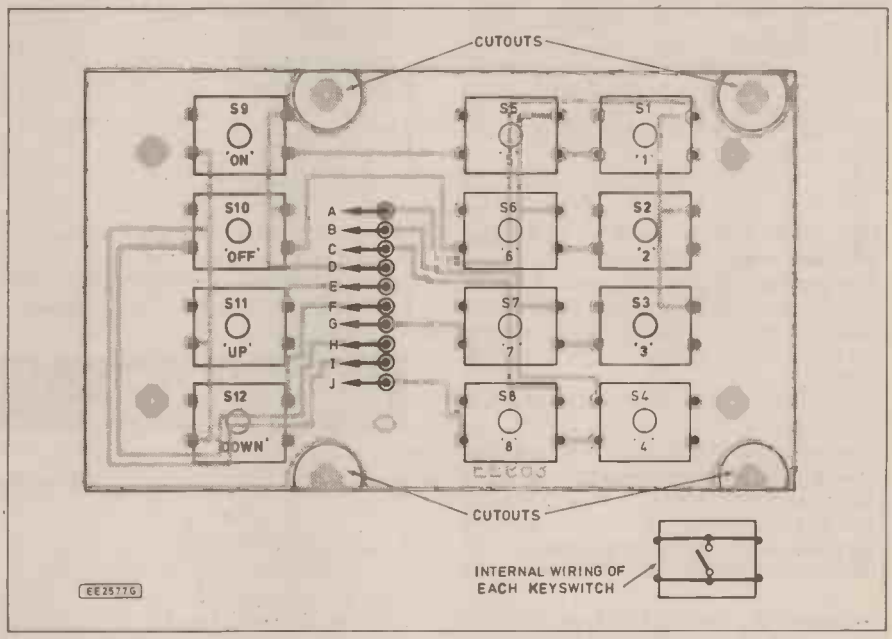
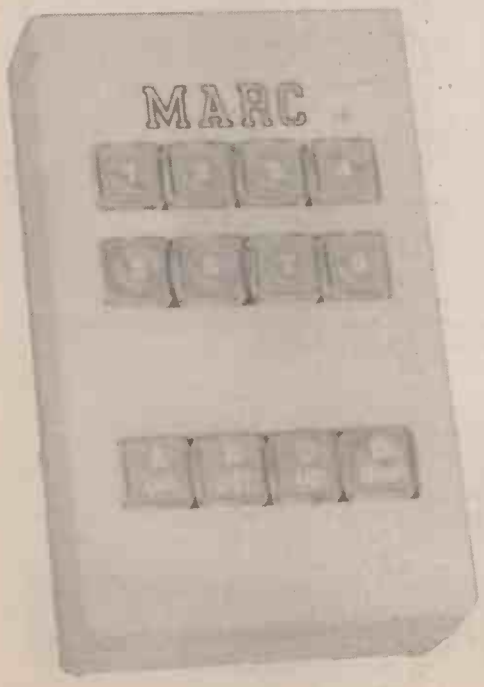


Fig. 1.3. Component layout and full size copper foil master pattern for the transmitter printed circuit board. The connections A to J go to the switch p.c.b.. The photograph on the left shows the two boards mounted in the case and interlinked by ribbon cable. Note the cable is soldered to the track side of the keyswitch board.

The infra-red emitting diodes D1, D2 should be of the high power type (TIL38) and they too are mounted with their leads bent through 90 degrees so that they can protrude through the end of the case when the board is fastened in place. Take care to identify the cathode (k) correctly, it is the lead next to the small flat edge of the diode.

The second printed circuit board, Fig. 1.4, holds twelve keyswitches type KHC 10901 obtained from Cirkit. They are fitted with transparent tops (type KT5) which allow the professional use of rub-down lettering, such as Letraset. If a different type of switch is used check the pin-outs and pin spacing before purchase.





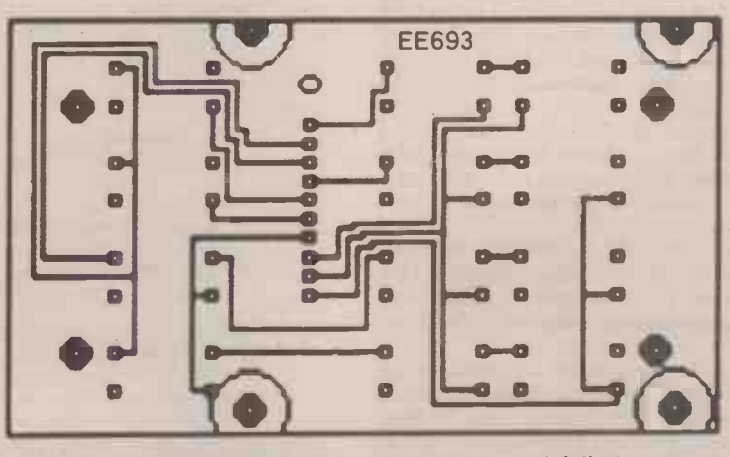


Fig.1.4. Printed circuit board component layout and full size copper foil master pattern for the keyswitch board. The photograph on the left shows the "keypad" layout on the handheld case.

CASE

A plastic case measuring 68mm × 110mm × 33mm with integral PP3 battery compartment makes a good if somewhat cramped enclosure. It is doubtful if a smaller case would contain enough room whilst a larger box loses that "handheld" feel. Carefully prepared cut-outs are required in the top half for the switches S1 to S12.

The prototype case featured plastic pillars to which the circuit boards were anchored using self-tapping screws. With the active component circuit board fastened in the bottom half of the case, the two p.c.b.'s are linked together using a length of 10-way ribbon cable. Connections to the keyswitch board are made by soldering to the *copper track side*, the use of terminal pins is recommended.

Don't forget to insert IC1 at the end of construction although the transmitter cannot be tested just yet unless you have access to an oscilloscope to monitor the ppm output. The infra-red diodes will emit no visible light.

The finished handheld transmitter and next month's encoder unit.

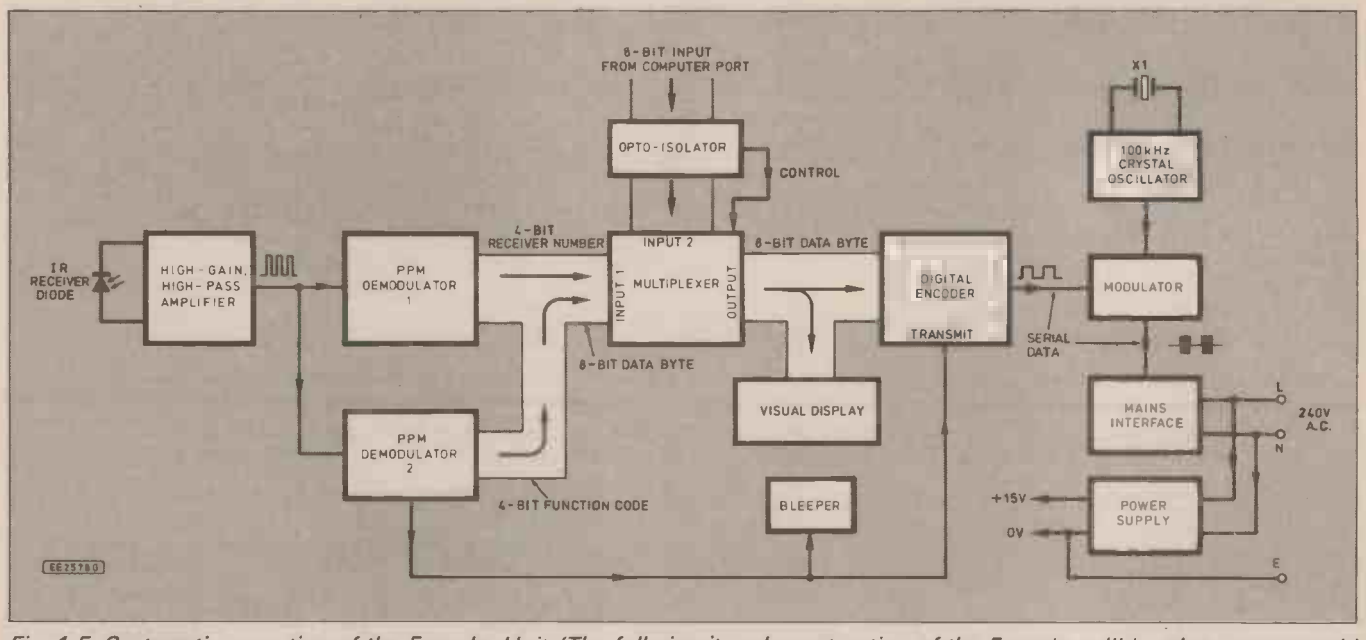


Fig. 1.5. Systematic operation of the Encoder Unit (The full circuit and construction of the Encoder will be given next month).

ENCODER UNIT

The Encoder Unit is the most complicated part of the MARC system. Its job is to receive instructions from the IR Remote Controller or optional external microcomputer and encode these onto the 240 volt mains so that they can be picked up by the various decoder units placed through the house.

The block diagram illustrated in Fig. 1.5 outlines the operation of the Encoder Unit. Very weak infra-red pulses from the transmitter are received by the infra-red sensitive diode, amplified and fed to two PPM decoders. The amplifier incorporates a high-pass filter which helps to prevent the 50Hz signals received from hot incandescent light bulbs in the room from swamping the weak PPM signals.

The PPM Demodulator 1 decodes the pulses corresponding to binary transmitter codes 00000 to 01111 and presents the four least significant bits of the received code to the multiplexer as the lower half of an 8-bit data byte. PPM Demodulator 2 deals with transmitter codes 10000 to 11111 and the four least significant bits at its output form the higher order half of the data byte.

By referring back to Table 1.1 it will be seen that Demodulator 1 is activated when the "receiver number" button on the transmitter is pressed whilst Demodulator 2 responds to the "function code" transmission. Thus the data byte contains all the information required to make the selected appliance perform the selected function: the "receiver number" in the lower four bits and the "function code" in the upper half.

The multiplexer acts as an 8-pole 2-way electronic switch, normally selecting the data byte from the IR Receiver section. However, the presence of data on the computer port automatically causes the multiplexer to switch over to this source.

Since the encoder unit involves direct connection to the mains it is most important, in the interests of safety, to electrically isolate any peripheral device connected to it. The opto-isolator on the computer port provides such protection.

Provision is made for the selected station number to be displayed on the front panel using a 7-segment display, and four single l.e.d.'s indicate which "function code" button has been pressed on the IR Remote Controller. This primarily provides visual feedback and confirmation of selection when using the IR remote unit.

The 8-bit data byte is eventually loaded into the digital encoder which serially sends each bit to the modulator circuit. The instruction to transmit comes from PPM Demodulator 2. Therefore, the data is sent upon receipt of the "function code" and this is accompanied by an audible bleep to confirm transmission.

CWK or FSK?

In order to transmit this low voltage digital signal along the 240 volt a.c. mains it is necessary to superimpose it on a high frequency 100kHz carrier wave. A high logic level outputted from the encoder causes the carrier to be transmitted, a low level ceases transmission. Thus the d.c. digital pulses are sent as a series of a.c. carrier wave bursts.

This simple on-off modulation of the carrier is called "*carrier wave keying*" (CWK), it is precisely the technique used to send Morse code from a radio transmitter although here the logical ones and zeros are represented by short and long bursts (dots and dashes).

Carrier keying is not the most efficient way of transmitting data for this application. The biggest drawback is that the receiving circuits invariably contain capacitors to block the low frequency 50Hz mains and these do not respond well to the transients (electronic hiccups) created as the carrier switches on and off.

The effect is illustrated in Fig. 1.6. The digital signal in (a) causes carrier modulation as shown in (b). However, after being transported along the mains and separated from it at the receiving end, the signal will appear with somewhat rounded edges as in (c).

After demodulation it can be seen that the pulses in the final signal (d) have been lengthened. This immediately imposes an upper limit on the pulse transmission rate because if it is too fast the pulses will smear into one another and become indistinguishable.

Matters can be improved by using a modulation method known as "*frequency shift keying*" (FSK). This technique uses two carrier waves of slightly different frequencies to represent logical 1 and 0. The problems of transients are eliminated because the carrier is never switched off.

Fine, so why don't we use this method in the MARC system? Well, it's a case of "overkill". FSK is the best method for high speed data transmission but it is also more complicated and difficult to demodulate.

Using CWK works quite satisfactorily as long as we keep the data rate down. 1kHz is the transmission rate employed and at this speed it takes less than 200ms between start of transmission and the appliance responding. I'm sure user's will not mind waiting ½s of a second for the light to turn on!

As its name suggests, the job of the mains interface is to connect the carrier wave onto the mains but also to isolate the 240 volts from the low voltage circuits.

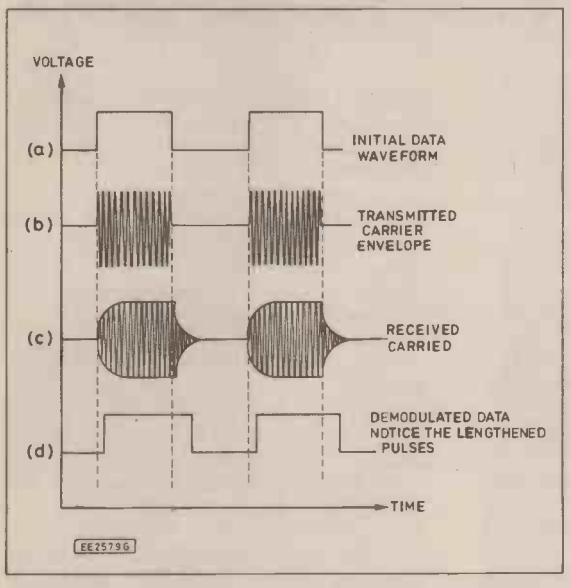


Fig. 1.6. The pulse lengthening observed when keyed carrier modulation is used.

Next Month: Full circuit and constructional details for the MARC Encoder Unit.

Constructional Project

TELEPHONE ALERT

T. R. de VAUX-BALBIRNIE

Has there been a call while you were out? This novel "sound switch" uses a BT approved plug-in ringer to flash an l.e.d.

THIS project provides a signal if the telephone has rung while the user has been away. He or she will then be able to take appropriate action.

To use the Telephone Alert, the telephone system must have the latest pattern of BT jack sockets – *it cannot be used if the telephone is connected direct to the line.* The project works by sensing the sound given by a BT approved plug-in ringer. This is because it would contravene existing regulations to make a connection to the line using non-approved – that is, home-made equipment.

The ringer is mounted inside the new case and connected to the telephone socket using an extension lead. If the device is switched on and the telephone rings, the circuit is triggered and a red l.e.d. indicator mounted on the box flashes briefly at three second intervals approximately. This continues until the circuit is cancelled using a push-button switch.

By making the l.e.d. flash in this way rather than to remain on continuously, power is saved. In standby mode, the current requirement is 10μA approximately which may be regarded as negligible. While operating, the average current is 2.5mA approximately and the internal alkaline PP3 battery could then be expected to give about 250 hours' service. A lithium PP3 battery would last even longer, about 500 hours.

Since the sound produced by the ringer inside the box is very loud, the circuit does not need to be particularly sensitive. This has the advantage of making it reasonably immune to false triggering by everyday noises.

In any case, this is unlikely since the device will normally be used when the house is unoccupied. A sharp sound such as that caused by tapping the unit is likely to trigger it, however. This should be borne in mind if the unit is to be used for other purposes.

CIRCUIT DESCRIPTION

The circuit for the Telephone Alert is shown in Fig. 1. With S2 (On-Off) switched on, crystal microphone insert, MIC1, picks up the sound from the ringer, WD1.

The low-level a.c. signal derived from MIC1 passes, via capacitor C1, to the inverting input (pin 2) of operational amplifier, IC1. Pin 2 also receives a steady d.c. voltage of approximately one-half that of the supply due to the potential divider action of resistors R3 and R4.

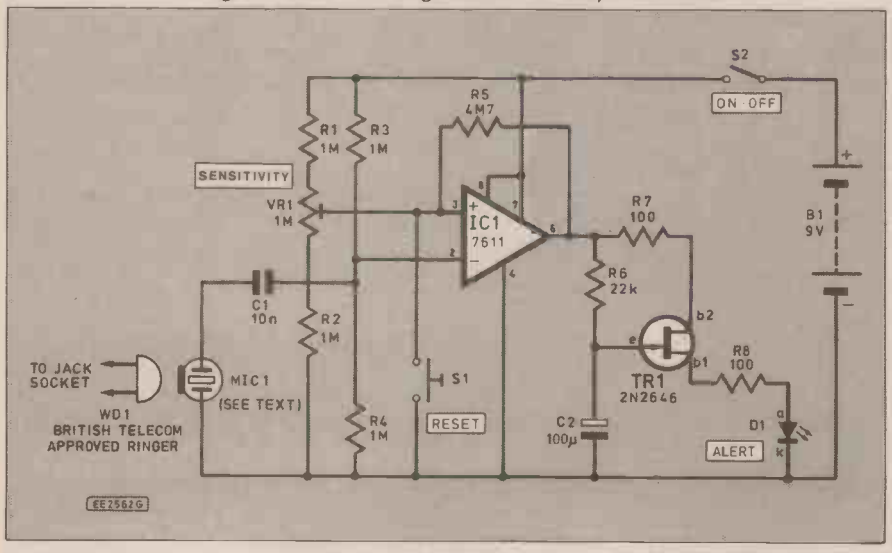
The non-inverting input (pin 3) of IC1 receives a steady voltage dependent on the values of resistors R1 and R2 together with the adustment of preset VR1. At the end of construction, VR1 will be adjusted so that the steady voltage applied to pin 3 is just less than than at pin 2.

Under these conditions, the op-amp output, pin 6, will be low (negative supply voltage) and have no effect. When MIC1 detects sound, a small a.c. voltage is superimposed on the existing one at pin 2 so the voltage will rise and fall rapidly about the steady value. On the first negative excursion, the voltage at pin 2 will momentarily fall below that at pin 3 and the op-amp will switch on with the output, pin 6, going high (positive supply voltage).

The degree to which the steady voltage at pin 2 normally exceeds that at pin 3 determines the loudness of sound needed to trigger IC1. Thus, VR1, acts as a sensitivity control. Note that IC1 is used as a voltage comparator and, as such, is little affected by a fall in supply voltage as will occur as the battery ages.

Capacitor C1 has a low value and acts as a high-pass filter. This makes the circuit less vulnerable to pick-up from low-frequency everyday sounds. It is important to use a *crystal* microphone insert (rather than a dynamic or other type) since this gives a high voltage output and is able to operate the circuit direct.

Fig. 1. Full circuit diagram for the Telephone Alert.



LATCHING

With IC1 on, positive feedback is applied from the output, pin 6, to the non-inverting input, pin 3, via resistor R5. This latches the i.c. – that is, it holds it on even when no further sound is detected. Pin 6 then remains high until the circuit is reset by making the pin 3 voltage less than the pin 2 one. This is achieved by pressing push-to-make switch, S1, momentarily.

The output from IC1 feeds the second section of the circuit, a relaxation oscillator. This consists of unijunction transistor, TR1, resistors R6, R7 and R8, capacitor C2 and light-emitting diode D1 "ALERT".

With a supply established from IC1 pin 6, capacitor C2 charges through R6 and the voltage appearing at TR1 emitter rises. When it reaches a certain value, known as the *peak-point voltage*, the device triggers and C2 suddenly discharges through diode D1 via current-limiting resistor, R8.

It then begins a further cycle and repeats indefinitely.

The time period is given approximately by the product of C2 and R6 – with those chosen this will be somewhere around three seconds. It is often longer than the calculated value since C2, being electrolytic, tends to have a value higher than the nominal one. On pressing S1 "RESET", the op-amp switches off, positive feedback is removed, and the circuit reverts to its state before sound was detected.

CONSTRUCTION

Construction is based on a circuit panel made from a piece of 0.1in. matrix stripboard size 8 strips × 30 holes. Fig.2 shows top and underside details. Drill the two mounting holes in the positions indicated.

Make all copper track breaks and interstrip links then add the soldered on-board components. Do not insert IC1 into its socket yet.

Complete construction of the circuit board by soldering 10cm pieces of light-duty stranded connecting wire to strips *A*, *C*, *D* and *E* on the left-hand side and to strip *H* on the right-hand side as shown. Leave VR1 adjusted fully clockwise.

Insert IC1 into its socket, without touching the pins. This precaution is necessary since IC1 is a CMOS device and therefore vulnerable to possible damage due to static charge existing on the body. Make a care-

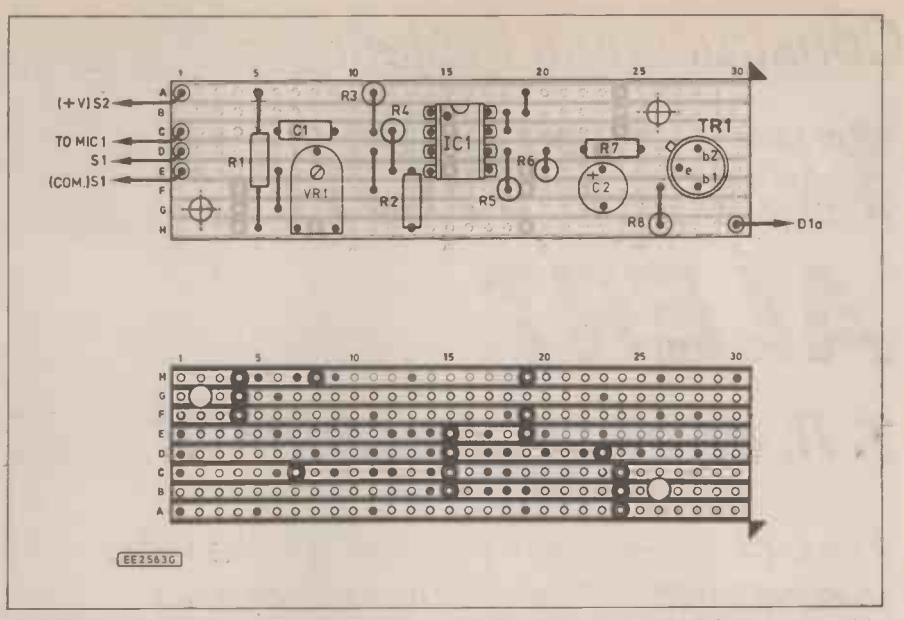
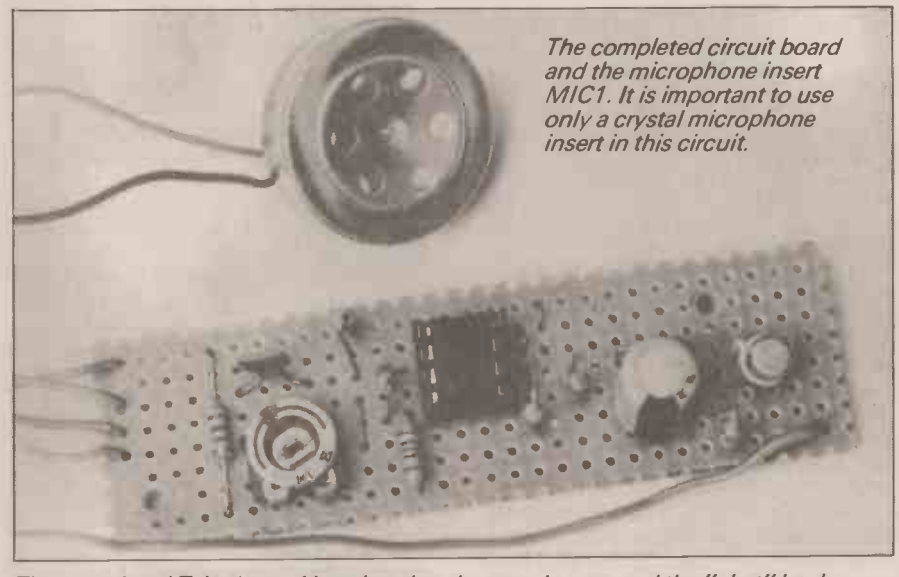
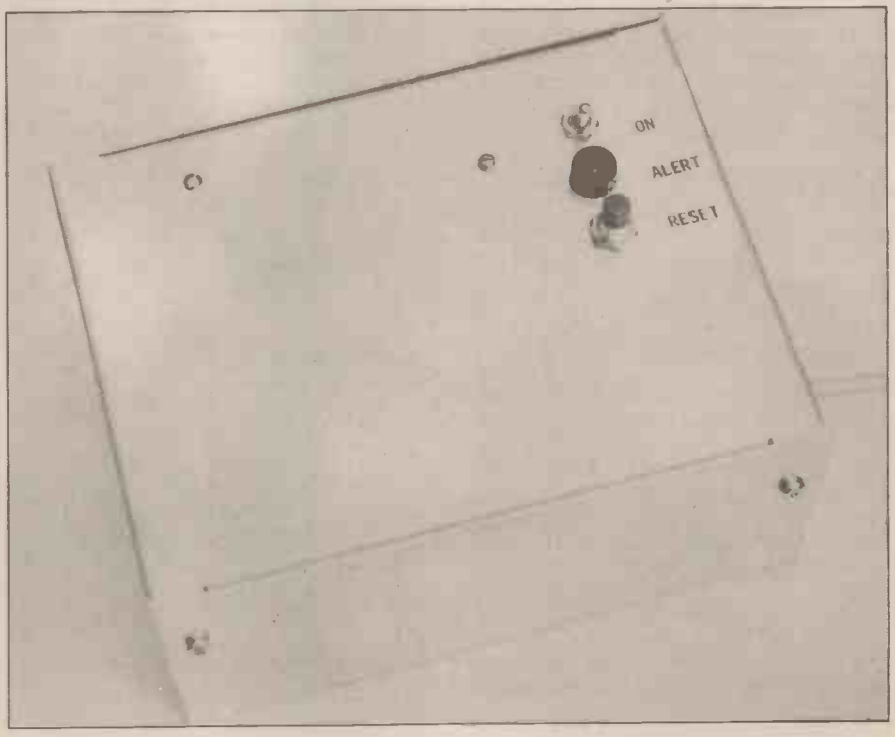


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.



The completed circuit board and the microphone insert MIC1. It is important to use only a crystal microphone insert in this circuit.

The completed Telephone Alert showing the reset button and the "alert" l.e.d. indicator.



COMPONENTS

See Shop Talk page 409

Resistors

R1, R2	
R3, R4	1M (4 off)
R5	4M7
R6	22k
R7, R8	100 (2 off)

All 0.25W 5% carbon

Potentiometer

VR1	1M sub-min. preset horiz.

Capacitors

C1	10n polyester
C2	100µ p.c.b. elec. 10V

Semiconductors

D1	Red l.e.d. indicator (or 5mm red l.e.d.)
TR1	2N2646 unijunction transistor
IC1	ICL7611 micropower op. amp

Miscellaneous

MIC1	Crystal microphone insert
S1	Push-to-make switch, single-pole "make" contacts
WD1	British Telecom approved telephone ringer
S2	Min. s.p.s.t. toggle switch

Aluminium case, size 133mm × 102mm × 64mm; stripboard, 0.1in matrix 8 strips × 30 holes; telephone extension lead, BT type line socket one end and jack plug the other; PP3 battery and connector; rubber grommet; adhesive fixing pads; self-adhesive plastic feet (4 off); small fixings (2 off); stand-off insulators (2 off); connecting wire; solder etc.

Approx cost. Guidance only **£18**

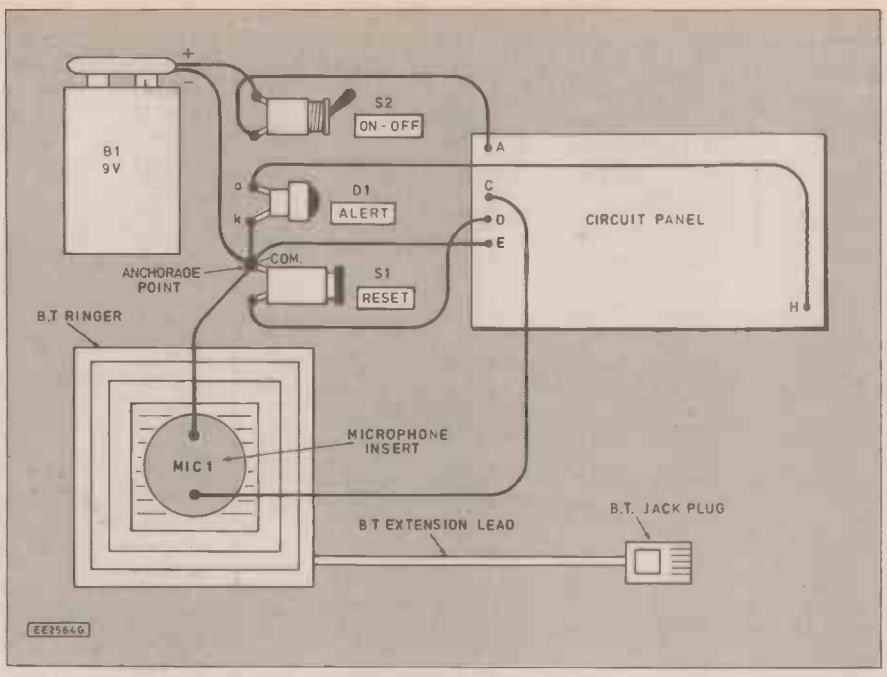


Fig. 3. Interwiring from the circuit board to all off-board components. The board must be insulated from the metal case. The microphone insert should be taped or glued to the ringer case.

ful check for errors – particularly for copper strips which have become accidentally "bridged" with solder.

CASE

The aluminium case specified in the components list leaves ample space for the "ringer" and extension lead connector. Make holes in the box for l.e.d. indicator, D1, and for switches, S2, (On/Off) and S1 (Reset).

Make a hole in the side large enough for the plug on the end of the extension lead to pass through – 14mm diameter approximately. Pass the plug through a rubber grommet of suitable size then through the hole in the box from the inside.

It should be possible to manoeuvre the grommet into the hole in the box. Alternatively, remove the plug, use a grommet in the conventional way and fit a new plug. On no account omit the grommet here as it is essential to prevent chaffing of the wire against the metalwork. Provide some strain relief to the wire inside the case to prevent it from pulling free in service.

RINGER

Mount the ringer as shown in the photograph using adhesive fixing pads or otherwise – the exact method will be dictated to some extent by the type of ringer being used. Refer to Fig.3, mount all remaining components, and complete construction shortening any wires as necessary.

An l.e.d. indicator was used for D1 in the prototype unit as this enhances the appearance of the finished project. However, a plain red 5mm l.e.d. could be used instead and secured in a hole with a little quick-setting adhesive. Take care over the negative S1 (Reset) connection since this is used as a common anchorage point for several wires.

Tape or glue the microphone insert to the ringer in the best position for maximum sound transfer. Secure the circuit panel to the base of the case using two fixings and short stand-off insulators.

Alternatively, a piece of cardboard could be placed between the circuit panel and the box. Whichever method is used, make certain that all connections on the underside of the circuit panel remain well clear of the metalwork.

Secure the battery using an adhesive fixing pad or small bracket. All components are mounted on the *base* of the case so the base becomes the topside of the finished device. This ensures that there is no strain imposed on the wiring when fitting or removing the lid.

TESTING

Connect the battery and switch on S2. The circuit usually self-triggers and if it does, cancel using S1. The l.e.d. should now remain off.

Adjust VR1 carefully anti-clockwise to the point where the l.e.d. lights very dimly (you will probably need to shade the l.e.d. with your hand to see this). After a delay of a few seconds the l.e.d. should begin to flash.

Adjust VR1 very slightly clockwise and again cancel using S1. By trial and error, find the position where the l.e.d. just remains completely off after cancelling with switch S1.

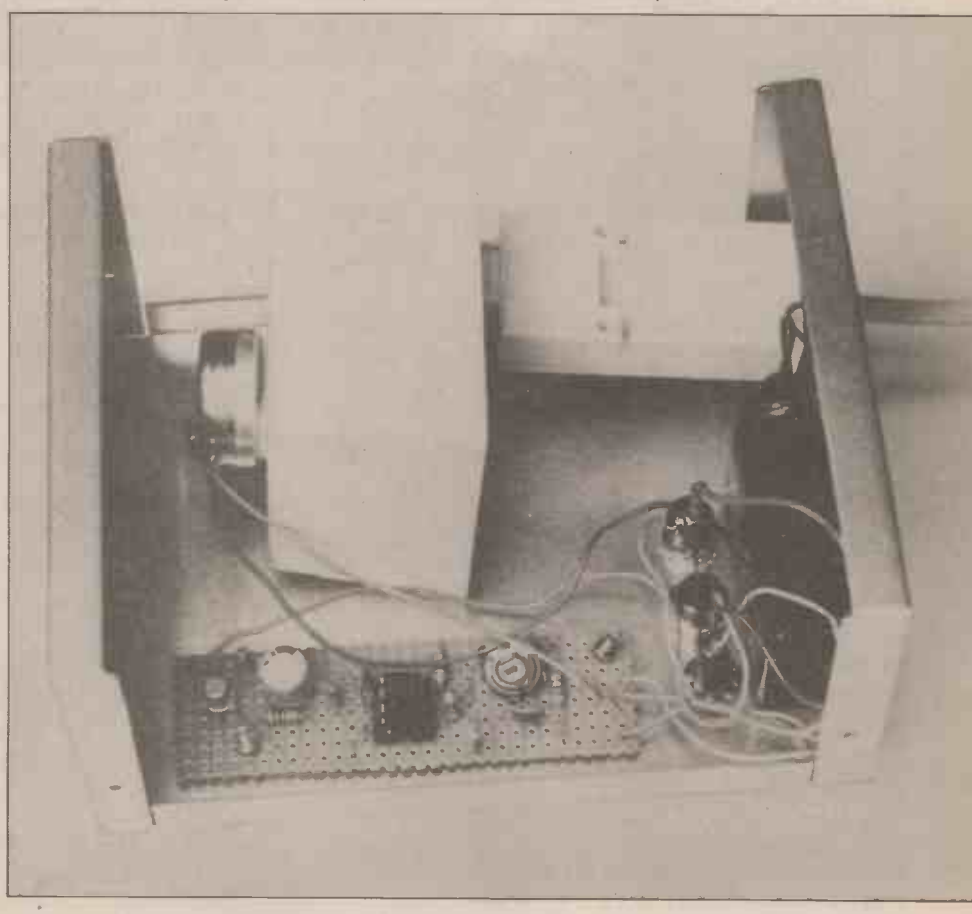
The circuit is now adjusted for maximum sensitivity. If the microphone is now gently tapped, the circuit should trigger and the l.e.d. begin flashing after a short delay.

It may be that the circuit proves too sensitive and VR1 should be adjusted clockwise, as necessary, for best effect. It would be a good idea to check operation with a battery known to be nearing the end of its useful life before making final adjustments to the sensitivity preset VR1

In tests on the prototype unit, with the lid in position, loud hand-claps and music close to the case failed to trigger the circuit. Note that, once triggered, it is normal for the l.e.d. to be lit dimly between flashes.

With final adjustments made, the Telephone Alert may be labelled, fitted with self-adhesive plastic feet to protect the work surface and put into permanent service. □

The completed alert with the metal cover removed to show positioning of the board, switches and ringer on the "base" of the metal case. The microphone insert is attached to the ringer with a strip of double-sided adhesive pad.



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

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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, 100,150, 220,330,470	4p 6p

10% tolerance value in pF

220,330,470,680, 1000,1500,2200	6p
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
2.4,2.7,3.3,3.9,4.7,5.1,5.6,6.2 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

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

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eb...Beeb...Beeb...Beeb...Bee

. . . Morse . . . Computer Communications . . . Radio Teletype . . .

SO FAR we have considered tone decoders for CW and RTTY reception, and touched on the subject of RTTY tuning indicators. This month we will look at a more simple form of tuning indicator (no oscilloscope required!), and consider ways of getting the BBC computer to fully decode the tone decoded signals.

Due to the unusual word format of RTTY serial signals, plus the use of Baudot codes, this task is not quite as simple as you might think.

Tuned In

First I must correct a slip-up in last month's article where I stated that an oscilloscope used as a tuning indicator monitors the voltages developed across the smoothing circuits at the outputs of the filters. In fact, it is the signals at the outputs of the filters that should be monitored. The tuning indicator featured here (Fig.1) is definitely fed from the outputs of the smoothing circuits.

BBC computer plus some software to act as a tuning indicator. The conversion rate of the built-in analogue to digital converter is unlikely to be adequate for the oscilloscope method. A simple double bargraph type display to monitor the outputs of the smoothing circuits should not be too difficult though.

The only real drawback of this method is that the computer might not be able to operate fast enough to simultaneously decode and display the RTTY signals, and provide the tuning indication. I would guess that this would be possible using a machine code program if BBC BASIC proved to be too slow.

Isolation

An important point that must be mentioned here is that there is a slight risk in connecting a mains powered short wave radio to a mains powered computer. In my experience there is no real likelihood of any damage occurring if one or both items of equipment have properly *Earthed* chassis. All the BBC computers would seem to have earthed chassis, as do most communications receivers. Some modern sets are double insulated instead, but in many cases would presumably have an earth connection anyway.

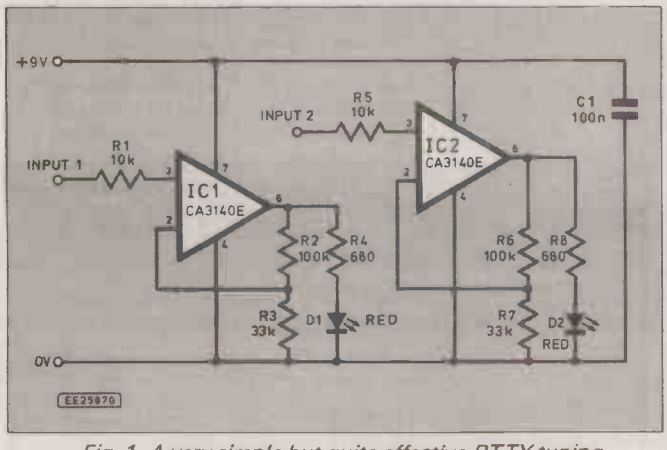


Fig. 1. A very simple but quite effective RTTY tuning indicator circuit.

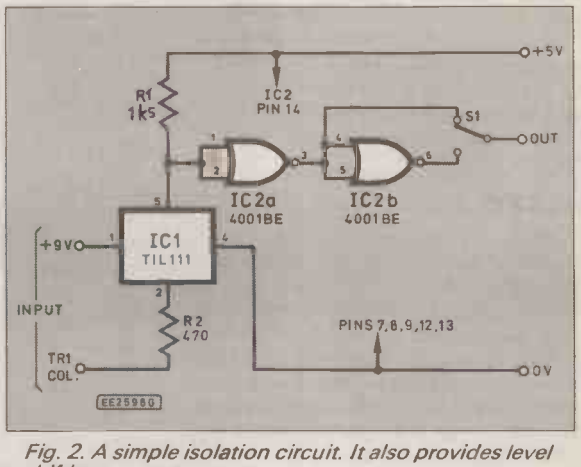


Fig. 2. A simple isolation circuit. It also provides level shifting.

The circuit consists of two identical stages; one to monitor the output of each filter. The basic idea of the unit is to control two indicator l.e.d.s whose brightness varies in sympathy with the strengths of the output signals from the filters. The receiver is therefore tuned for maximum brightness from the two l.e.d.s.

Diodes D1 and D2 are never actually switched on simultaneously, since only one tone signal or the other will be present at any one time. However, normally they will be flashing on and off at quite a high rate, and it is not usually too difficult to adjust the receiver for maximum brightness from both l.e.d.s.

It is possible to add in smoothing circuits to hold the l.e.d.s in the on state for a short period, so as to avoid the flashing. In practice this seems to be something of a mixed blessing though, and the delays produced can be a bit misleading. Overall, I found this simple setup gave the best results.

An idea that might be worth pursuing would be to use the analogue inputs of the

Opto-Isolator

If you wish to take no chances, or you are using a computer other than a BBC type, an opto-isolator can be used between the tone decoder and the computer. Although the BBC computers have earthed chassis, this would seem to be an unusual feature for a home computer. Most are double insulated, and could be damaged by connection to a short wave set due to the high voltage difference that can occur between the chassis of the two pieces of equipment.

This voltage should be at a high impedance, but as semiconductors are very vulnerable to damage by high voltages, it can result in damage to the receiver or the computer. I once did some serious damage to a Commodore 64 computer in this way, and it is not a purely academic problem.

High speed communications via an opto-isolator can be difficult due to the relatively slow switching times of these devices. In this case we are only dealing with baud rates of up to about 300 baud, and a maximum fundamental frequency of about 150 Hertz. This is low enough to be easily handled by an ordinary "bog-standard" opto-isolator, such as the popular TIL111 or any similar type. A suitable isolation circuit is shown in Fig.2.

The infra-red l.e.d. at the input of the opto-isolator (IC1) is driven from the open collector output stage of the tone decoder via current limiting resistor R2. R1 is the collector load resistor for the *npn* transistor on the output side of the device. No connection is made to the base of this transistor (IC1 pin 6).

IC2 is a CMOS quad 2-input NOR gate, but in this case only two of the gates are used. These each have their inputs wired together so that a simple inverter action is provided. The four unused inputs are connected to the 0 volt rail to prevent spurious operation and possible damage due to static charges.

Switch S1 can be used to select either an inverted or a non- inverted output signal. Remember that the signal must be of the correct phase if the system is to give a properly decoded output.

Having this option is not strictly necessary, since switching from upper sideband to lower sideband reception (or vice versa) will also result in an inversion of the signal. However, switching sidebands normally requires retuning of the signal, and this method is more convenient.

Even if you do not require the isolation provided by this circuit, you might care to use it anyway. It provides the level shifting needed from the tone decoder to the com-

puter, plus the option of an inverted signal. It is also quite inexpensive.

Codes and Software

Although the BBC computers have an RS423 serial port, this is not much use for most radio communications work. Some signals are sent in standard ASCII codes, and at standard baud rates which the BBC computer's serial port can handle.

In order to decode these it is merely necessary to couple the output of the tone decoder to the data input of the serial port, and to use the appropriate operating system commands to set up the serial port correctly. Although the signal levels are not correct for an RS423 port, it will almost certainly respond to them correctly anyway, but do not use a long connecting cable.

A lot of radio amateurs, and others, still use the old Baudot method of coding, together with the unusual word format of one start bit, five data bits, and one and a half stop bits. The baud rate for amateur RTTY is 45.45, but there has been a definite trend towards the more normal rate of 50 baud. I must admit that I do not know how the unusual rate of 45.45 came into being – if anyone knows I would be pleased to receive details.

One method of decoding RTTY serial signals is to feed them into the computer via any spare digital input, and to rely on software routines to provide the serial to parallel conversion. This method can be quite effective, but requires some relatively complex software. Even given the quite low baud rates involved, it would probably require the speed of a machine code program. For those who are suitably expert at BBC programming this represents an interesting line of research.

UART

Probably the easiest way of handling 5-bit serial signals using the BBC computers is to decode them using a UART (universal asynchronous receiver/transmitter), and to feed the five bit parallel data into the user port. The user port has sufficient spare lines to provide "handshaking", and it can even generate a suitable clock signal for the UART using the timer/counters of the 6522 VIA. A suitable circuit is shown in Fig.3, and this is based on the 6402 industry standard UART.

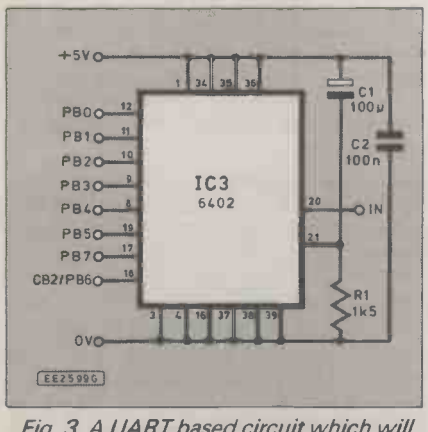


Fig. 3. A UART based circuit which will decode 5-bit RTTY serial signals.

The only discrete components required are supply decoupling capacitor C2, and a $C - R$ timing network (R1 – C1) to provide a positive reset pulse at switch-on.

Table. 1 – Baudot Codes

Letters	*Figures*	*Code No.*
unused	unused	0
A	-	3
B	?	25
C	:	14
D	$	9
E	3	1
F	%	26
G	&	20
H	1/2	20
I	8	6
J	'	11
K	(	15
L	)	18
M	.	28
N	,	12
O	9	24
P	0	22
Q	1	23
R	4	10
S	Bell	5
T	5	16
U	7	7
V	;	30
W	2	19
X	/	29
Y	6	21
Z	"	17
Linefeed	Linefeed	2
Space	Space	4
Return	Return	8
Figures	Figures	27
Letters	Letters	31

The required word format is selected by connecting pins 34 to 39 to the appropriate logic levels, and the method of connection shown gives the correct format for RTTY decoding.

The serial output signal from the tone decoder is fed to pin 20, and the decoded output signal appears on pins 8 to 12. The latter are connected to PB0 to PB4 of the user port which are configured as inputs.

The signal on pin 17 must be a clock signal at sixteen times the required baud rate. This is produced from the computer's system clock and the VIA's timer counters, with the output on line

Handshaking is needed in order to ensure that bytes are not missed or read twice. The UART has an output (data received) at pin 19 which goes high when a complete byte has been received and is ready on the parallel output lines. It has an input (data received reset) at pin 18 which must be pulsed low in order to reset the handshake output. PB5 is set as an input to monitor the handshake output, while CB2 or PB6 operates as an output which drives the reset input. CB2 is probably the better choice, as this can easily be made to generate the required short reset pulses.

With only five data bits per character, it is obviously not possible to use the ordinary seven bit ASCII codes. Instead, the earlier system of Baudot codes is used, and this has two sets of thirty two characters (including control characters).

The main control characters are the shift ones, which operates rather like the shift key of a QWERTY keyboard. However, it does not provide a shift between upper and lower case characters. Instead there is a character set that consists mainly of letters, plus one which consists mainly of numbers and punctuation marks.

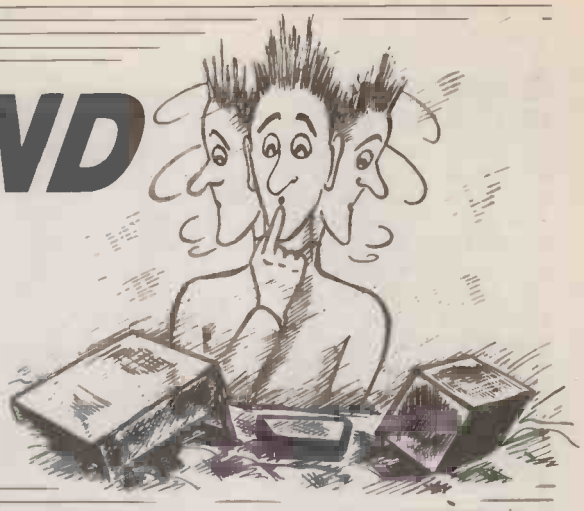
There is a major restriction with this method in that the letters are all upper case, but remember that this system is only designed for the conveyance of simple messages. Table.1 shows a full list of Baudot code numbers and characters. The numbers are ordinary decimal ones from 0 to 31 incidentally.

The frequently used characters, such as spaces and linefeeds are available in both character sets. The shift system does not work on a toggle basis, but has separate numbers and letters shift characters that can be used to force the system into the desired character set, or will have no effect if it is already using that character set.

NEXT MONTH: We will conclude our look at computer aided communications by looking at the software side of things.

Special Feature

CHOOSING AND USING TEST EQUIPMENT



Robert Penfold

THE MULTIMETER

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

IF YOU work on electronics publications, a steady flow of "how long is a piece of string" style questions has to be regarded as an occupational hazard. Most of these are hard (or impossible) to answer satisfactorily, but one exception is the answer to "what piece of test gear should I buy first?" The standard advice is to buy a multimeter first, and probably few would put forward any other suggestion.

While a multimeter may not always provide the answers, most of the faults that occur in electronic projects can be located with the aid of one. On a usefulness versus cost basis, a good low cost multimeter must offer the ultimate in test gear value for money.

It might be tempting to buy the components for an extra project rather than buying a multimeter, but this would almost certainly be a myopic approach. Things can and do go wrong, including projects, and without a multimeter you are likely to get seriously stuck on an uncooperative project sooner or later.

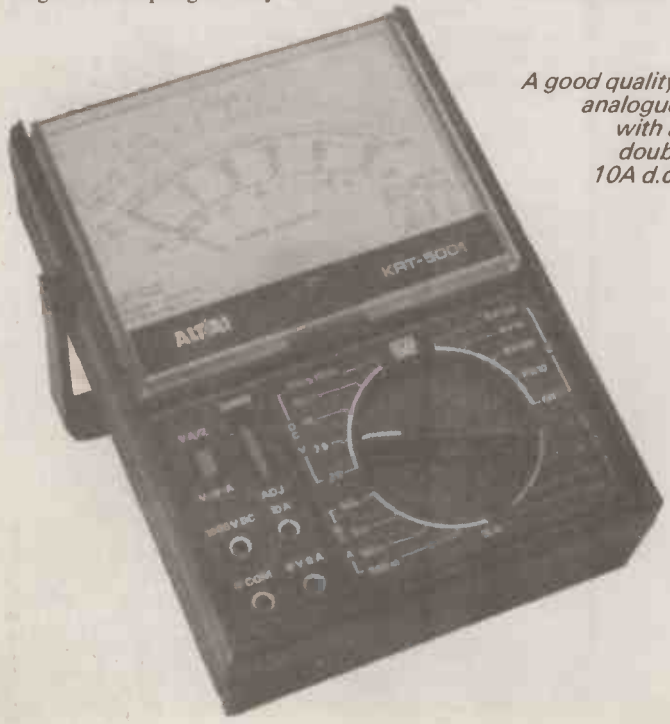
ANALOGUE SENSITIVITY

Deciding on a multimeter as your first piece of test equipment might be easy enough, but deciding which multimeter to buy is likely to be a much tougher decision. There are two basic types of multimeter – the digital and analogue types.

The obvious difference between them is that one has digital readout via (usually) a liquid crystal display (l.c.d.), while the other has analogue readout by way of a moving coil meter. The difference between the two is much more fundamental than this though. In order to fully understand the difference between the two types you need to understand multimeter sensitivities.

For d.c. voltage measurement an analogue multimeter uses a circuit of the type shown in Fig.1. The current that flows through the selected series resistor and the meter is proportional to the applied voltage, and so the meter can be calibrated in terms of input voltage.

Most analogue multimeters are based on a 50 microamp meter movement. With (say) a 100k series resistor, 5 volts is needed in order to produce a current flow of 50 microamps and give full scale deflection of the meter's pointer (0.00005 amps multiplied by 100000 ohms = 5 volts). If you work out a few examples you will find that there is always 20k of resistance for each full scale volt. In specifications for multimeters you will often come across figures such as 20k/volt or 1k/volt.



A good quality 25k/v analogue meter with a range doubler and 10A d.c. range

MISLEADING

On the face of it the ohms-per-volt sensitivity of a multimeter might not seem to be very important. For much checking, such as testing supply voltages, the sensitivity of the multimeter is quite irrelevant. On the other hand, much modern electronics operates at quite low currents, and the current tapped off by a multimeter can have a significant effect on the circuit under test.

As an example of a circuit that is apt to give misleading results, consider the opera-

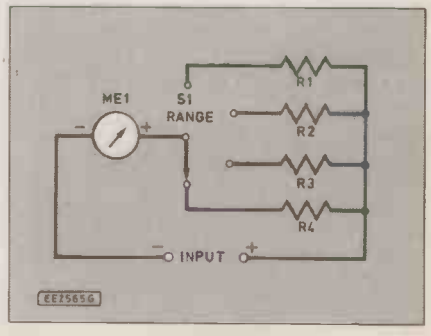


Fig. 1. Basic analogue multimeter circuit for d.c. voltage measurement.

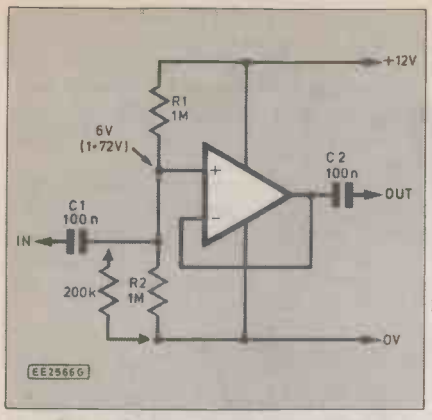


Fig. 2. A high impedance circuit of this type is vulnerable to loading by the multimeter.

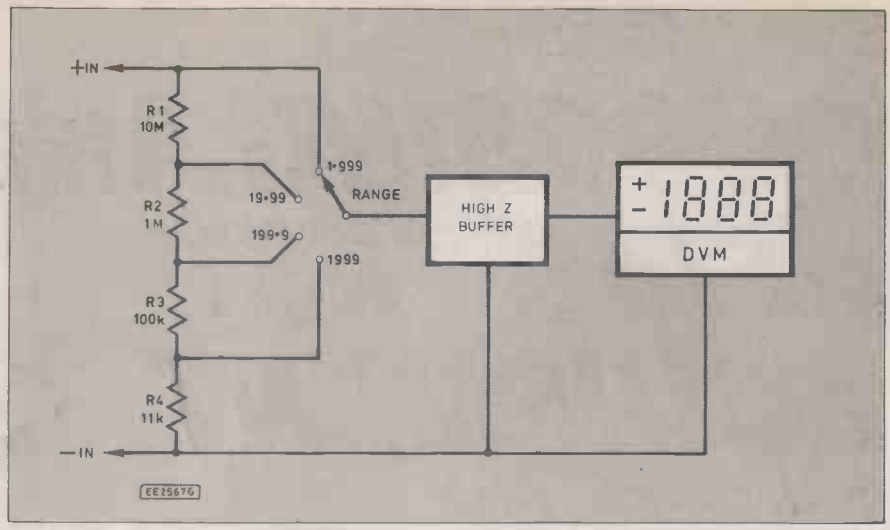


Fig. 3. Basic arrangement used in a DMM on its d.c. voltage ranges.

tional amplifier circuit of Fig.2. This has a potential divider formed by R1 and R2 to bias the non-inverting input of the amplifier to about half the supply voltage, which in this example means about 6 volts.

If the voltage at the junction of R1 and R1 is measured with a 20k/volt meter switched to the 10 volt d.c. range, this places the 200k resistance of the meter in parallel with R2. This 200k is obviously much lower than the 1M resistance of R2, and will effectively reduce its value by a substantial amount.

If you work out the parallel resistance of R2 and the multimeter you should obtain an answer of about 166k. This gives less than 2 volts at the junction of R1 and R2 instead of the expected 6 volts.

The reading obtained is obviously a very misleading one, but it is not true to say that it is an incorrect one. The meter is reading the true voltage at the test point. However, this voltage is only valid while the multimeter is connected to the circuit, and in this respect it is invalid.

In order to minimise loading of test points the multimeter should have a high ohms/volt rating. In practice few analogue multimeters offer anything over 20k/volt since this requires a very sensitive meter movement which tends to be rather delicate.

A sensitivity of 20k/volt is adequate for most electronic testing, but it will result in very low readings when testing high impedance circuits. This should not result in you being misled provided you are aware of this fact, and take it into account when assessing results.

Some cheap multimeters offer quite low sensitivities, with 1k or 2k per volt being quite common. An instrument of this type is better than nothing, but is far from ideal for electronic testing. Using a multimeter of this type will result in frequent heavy loading of test points, and many of the readings obtained will be of dubious worth.

DIGITAL MULTIMETERS

On their d.c. voltage ranges digital multimeters are very different to their analogue counterparts. They use an arrangement of the type outlined in Fig.3. This is based on a digital voltmeter circuit that has a sensitivity of (usually) 1.999 volts or 0.1999 volts full scale. It is preceded by an attenuator that either lets the input voltage go straight through to the voltmeter, or lets only a certain percentage of the input voltage through to the voltmeter.

The attenuator normally reduces the input voltage by factors of 1, 10, 100, 1000, and 10000. With a basic sensitivity of 0.1999 volts, this gives ranges of 0 to 1.999, 19.99, 199.9, and 1999 volts.

The input resistance of the digital voltmeter is extremely high indeed, and is usually some thousands of megohms or more. The input resistance of the multimeter is therefore virtually the same as the series resistance through the attenuator resistors. This is a high resistance which is almost invariably about 10 or 11 megohms.

You will not normally see the sensitivity of a digital multimeter quoted in terms of ohms per volt. This is because the input resistance is the same on all ranges, but the full scale voltage is not. The ohms per volt sensitivity is therefore different for each range. It varies from around 50 megohms per volt on the lowest range to about 5k per volt on the highest one.

One the highest voltage ranges the sensitivity is comparable to that of an analogue multimeter, but on the lower ranges it is clearly vastly superior. As most measurements are likely to be made on these lower voltage ranges, this gives digital multimeters a strong advantage over analogue types.

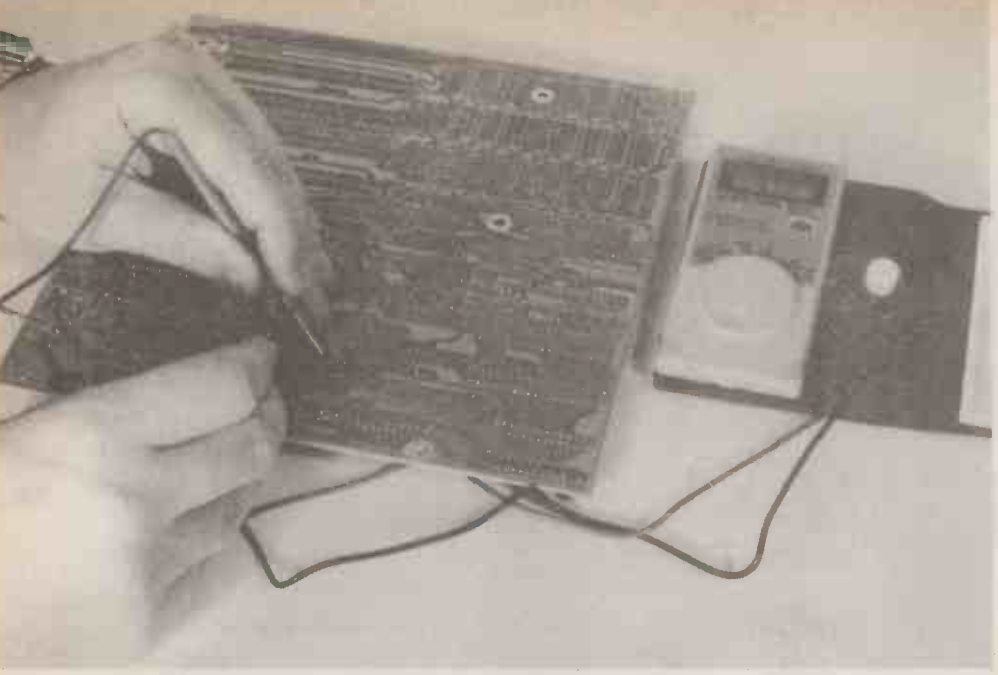
If we return to our example of Fig.2, shunting the 10 or 11 megohm input resistance of a digital multimeter across R2 will reduce its effective value, but by less than 10 per cent. The voltage reading obtained will be somewhat low, but should be accurate enough to show whether or not the amplifier is correctly biased.

OTHER FACTORS

The higher sensitivity of a digital instrument is a definite advantage, but there are other factors to consider when choosing a multimeter. In terms of accuracy, digital types are generally somewhat better than the analogue variety. Apart from any slight problems with the linearity of moving coil meters, the limiting factor on accuracy is likely to be the precision with which the scale can be read.

Analogue multimeters are often equipped with meters that have a "mirrored scale". One problem when trying to accurately read the pointer of a meter is that, because the pointer is not right against the scale, its apparent position on the scale varies slightly depending on your view point. A mirrored arc enables this parallax problem to be avoided. If you are positioned correctly, the reflection of the pointer will be obscured by the pointer itself.

A good quality digital multimeter with capacitance ranges and a transistor tester.



Using a multimeter to make continuity checks on a complex circuit board.

This improves matters, but is obviously not as convenient as being able to read a digital readout with perfect accuracy from virtually any angle. Also, the accuracy with which the scale can be read is still relatively low, although more than good enough for most purposes. The tolerance ratings of most components are such that readings with an accurancy of less than one percent are unlikely to be vital.

Despite their relative lack of sophistication, I still prefer analogue multimeters for much testing. Possibly this is just straightforward prejudice due to being brought up in the pre-digital era. I suppose the real attraction of analogue instruments for many users is that you can make a series of tests very rapidly.

When making voltage checks it is rarely necessary to measure voltages with any great precision. With an analogue multimeter you can quickly see whether the pointer has gone to the right area of the scale, and move on to the next text almost before the pointer has finished moving.

The multi-digit displays of digital multimeters often take some time to settle down, and cannot be read quite as quickly. Another advantage of analogue multimeters is that their cost tends to be substantially less than that of digital instruments.

RUGGED

One major drawback of analogue multimeters is their lack of ruggedness. There are actually some "ruggedised" types available, but the cost of these is too high for all but the very "well heeled" electronics hobbyist.

Accidentally knocking an analogue multimeter from the test bench to the floor is quite likely to result in its accuracy being impaired, possibily with problems such as the pointer tending to stick. A few falls of this type could well result in the unit being totally unusable.

By contrast, digital multimeters are very tough and are unlikely to be troubled by repeated dropping or knocks. They are aided in this respect by their relatively small size and lightness. Even with rough use a digital instrument is likely to give many years of service. These days both types have good resistance to electronic overloading. They are not indestructible though, and measuring the mains voltage with a multimeter inadvertently left on a resistance range could well leave you with something not worth repairing.

If funds are limited, then an analogue multimeter will probably be your only option, but a good 20k/volt type should fulfil your needs, and will give many years of service if you look after it well. If you can afford a digital type, then this is probably the safer option, and will almost certainly offer greater versatility. Most hobbyist will probably finish up with both types in due course.

RANGES

For a.c. and d.c. voltage checking the ability to measure potentials from about 0.5 to 500 volts is needed. Looking at the specifications of a number of multimeters, none of them seem to be deficient in this respect. Some cannot measure low a.c. voltages very accurately though, with perhaps a lowest a.c. voltage range of 10 volt full scale. This can limit their usefulness when testing audio circuits.

A real weakness of most digital multimeters is that their frequency responses do not extend beyond a few hundred hertz on the a.c. voltage ranges. This is fine for measuring voltages at the 50 hertz mains frequency, but makes them of relatively limited value for audio testing. This is a pity, as they are mostly capable of measuring quite small a.c. voltages, which would otherwise make them well suited to audio testing.

Analogue multimeters are usually equipped with decibel scales for power and gain measurement, but this is something that is normally absent from digital instruments.

The number of resistance ranges offered seems to vary significantly from one instrument to another. Analogue multimeters have reverse reading non-linear resistance scales, but you soon become accustomed to using these. The non-linear scaling means that a wide spread of values can be covered by each range, and that a few ranges can cover resistances from less than one ohm to a few tens of megohms. However, the accuracy at the high end of each range is poor as the scale is very cramped.

Ideally there should be four or more resistance ranges so that virtually any resistor can be measured at the low end of a range where excellent accuracy will be obtained. Digital multimeters seem to invariably have the ability to measure resistances down to about one ohm, but some are not so good at the other end of the range.

Resistors of up to 10 megohms are commonly used in electronic circuits, but a highest resistance range of two megohms is not uncommon for digital multimeters. I would strongly urge the purchase of one which has a 20 megohm range.

CURRENT RANGES

Digital multimeters invariably seem to be able to measure currents from the microamp region to a couple of amps or more. The cheaper analogue instruments tend to be a little less versatile in this respect, and sometimes only offer two or three ranges.

The range of currents covered might seem to be quite good, but there will be gaps in the coverage that result in some currents having to be read on a range where they represent only a few percent of the full scale value. This gives rather poor accuracy, and it is better if you find an instrument that has four or more current ranges.

While digital multimeters usually offer a.c. current measurement as a standard feature, it is rare for analogue types to have this facility. I have had multimeters capable of a.c. current measurement for many years now, and may make a measurement of this type one day! This is not a feature that is particularly important for electronic fault finding.

OTHER RANGES

It is not uncommon for multimeters to be equipped with ranges other than the usual voltage, current, and resistance types. Probably the most common extra is a transistor testing facility. The built-in transistor checkers are mostly quite crude, but are effective and adequate for most purposes.

A less common extra is a built-in capacitance tester. This is a feature of some digital multimeters, and is a very worthwhile facility. In fact any extra facilities are well worth having, but a good basic specification is probably of greater importance.

IN USE

A multimeter can be used for checking resistor values, but not while they are in-circuit. Disconnect one leadout before measuring an in-circuit resistor.

The resistance ranges can also be used to test diodes. With an analogue multimeter, there should be a low resistance reading if the positive and negative test prods are respectively connected to the cathode and anode leadouts (the cathode is the one indicated by a band around the body of the component). Reversing the test prods should give a very high resistance reading.

With silicon diodes an infinite reading should be obtained, but a serviceable germanium diode can have a reverse resistance as low as 50k. These tests can be undertaken using a digital multimeter, but the first test will give a high reading and the second one will give a low reading.

Some digital multimeters have a "hi-low" switch, and for diode testing this should be in the "hi" position. Otherwise

the test voltage will be inadequate to forward bias the diode, and a high reading will be obtained with the test prods connected either way round.

CONTINUITY

The resistance ranges of a multimeter can be used for continuity checks on circuit boards. For this type of testing some form of audible indication is advantageous as it avoids the need to keep looking away from the test prods to view readings.

A few multimeters incorporate a "beeper" for use when making continuity checks. If the meter has a "hi-lo" switch, it is advisable to set it to the "lo" mode when continuity testing. The unit then ignores semiconductor junctions, and will only indicate continuity when there is genuinely a low resistance across the test prods.

When a newly constructed project fails to work there is a strong possibility that the problem is due to something like a short circuit due to a solder splash, or a broken p.c.b. track somewhere. Most multimeters get used a great deal for continuity testing.

VOLTAGES

The other main use for a multimeter is making voltage and current checks on circuit boards. The warning that has to be given here is that testing mains powered equipment can be extremely dangerous. Beginners would be well advised to only build and test battery powered equipment until they have gained the experience necessary to deal with mains powered projects.

A useful initial test of any newly completed project is to measure its current consumption. Many articles and books which describe projects specify the typical current drain. Connect the positive test prod to the positive terminal of the battery, and the negative test prod to the positive battery clip.

If the current consumption is about as expected or less, it is in order to press ahead with further checks with the circuit powered up. If the current consumption is high by more than about 100 per cent it is advisable to switch off at once and recheck the wiring.

The standard initial voltage test is to check that the battery is not flat, and that its output is actually reaching the circuit board. It is advisable to check the supply voltage at several places on the board as a broken track could result in it reaching some parts of the circuit but not others. Faults in switches and battery connectors are far from rare, and there is a fair chance that a lack of supply voltage will be the cause of a problem.

If the supply is present and correct, it is then a matter of checking voltages at various points in the circuit. If you are lucky, the circuit diagram might show typical test voltages. If not, you will have to work out likely voltages at strategic points in the circuit. Whether or not this is practical depends on the circuit.

Some integrated circuits can be difficult, since their internal circuitry is an unknown quantity, as are their pin voltages. Sometimes the relevant data sheet will provide some useful information regarding typical voltages.

GUESSTIMATING

Linear circuits are the most suitable for voltage testing. These usually have potential dividers to provide biasing, and it is not difficult to work out the voltages provided

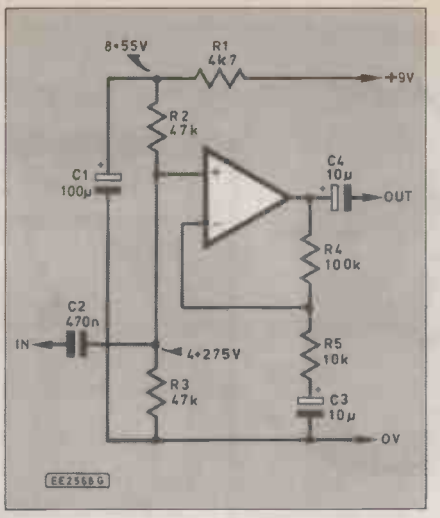


Fig. 4. Estimating voltages produced by a potential divider.

by these divider circuits. This requires the application of Kirchhof's voltage law, but it is not normally necessary to indulge in any detailed calculation.

Almost invariably the bias circuits are designed to set the output of each stage at about half the supply voltage. Checking the output of each stage to see if it is at about this figure will often turn up a grossly incorrect voltage, and the faulty stage.

If you do apply Kirchhoff's voltage law, guesstimating the voltages is not likely to prove too difficult. As an example, take the potential divider circuit of Fig. 4. If you work out the total value through R1 to R3 (which is simply the sum of their resistances), and then work out what fraction of the total each resistor provides, the voltage across each resistor will be the same fraction of the supply voltage.

The total resistance is obviously just under 100k, and R1 provides only about 5 per cent of this; 5 per cent of 9 volts is 0.45 volts, and with this dropped through R1 there is about 8.55 volts (9 − 0.45 = 8.55) at the junction of R1 and R2. The rest of the supply voltage is split evenly between R2 and R3, giving about 4.275 volts across each one (and about 4.275 volts at the junction of R2 and R3).

Even with just a quick look at the circuit values it should be obvious that there is a little under half the supply voltage at the junction of R2 and R3, with virtually the full supply voltage at the junction of R1 and R2.

Note that voltages are usually measured relative to the earth rail. This is a negative earth circuit, so the negative test prod is connected to the 0 volt earth rail, and the positive test prod is connected to the various test points.

Bear in mind that component tolerances can result in measured voltages that are legitimately 10 per cent or so different to the theoretical circuit voltages. Also, the loading of the test meter and the circuit driven by the potential divider can affect the actual voltage measured.

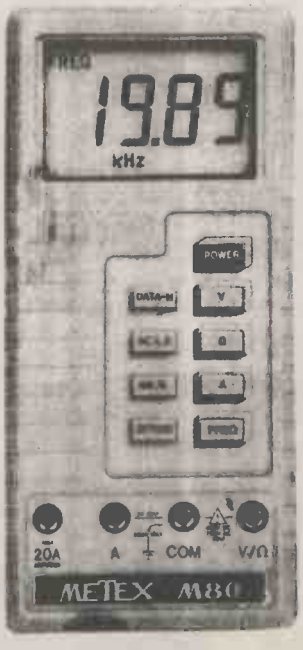
An operational amplifier is unlikely to provide a significant amount of loading, but in a discrete transistor circuit it is not uncommon for loading by several percent to occur. For this reason it is probably not worthwhile bothering to make detailed calculations to determine likely test voltages. You are really searching for a voltage that is grossly incorrect, rather than one which is a few percent out.

Voltage testing will usually only indicate the area of the circuit where the fault lies. You will need to follow it up with checks on the board and joints, plus some component tests, in order to determine the precise nature of the fault. This is where some additional items of test equipment, or a multimeter which has such facilities as a transistor checker and capacitance ranges, can prove invaluable.

LOGIC CIRCUITS

A multimeter is not the ideal tool for checking digital circuits. It can be used to test that static outputs are at a legal voltage. For CMOS circuits this means 0 to 30 per cent and 70 to 100 per cent of the supply voltage for the logic 0 and logic 1 levels respectively. For TTL circuits running from the usual 5 volt supply this means 0.8 volts or less for logic 0, and 2 volts or more for logic 1.

The problem here is that what might seem like a static signal at an illegal voltage could in fact be a pulsing signal which is rapidly switching between valid logic 0 and logic 1 voltages. For logic testing there are low cost devices which are better suited to the task, but that is another story, covered in a later article. □



Two useful Metex meters that are now generally available. The one on the left is autoranging with a 0-20kHz frequency range while that on the right includes frequency to 200kHz and capacitance to 20µ plus a transistor tester.

ELV

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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.

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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
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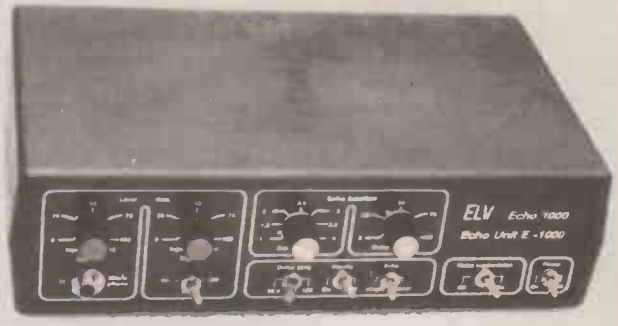


Specification

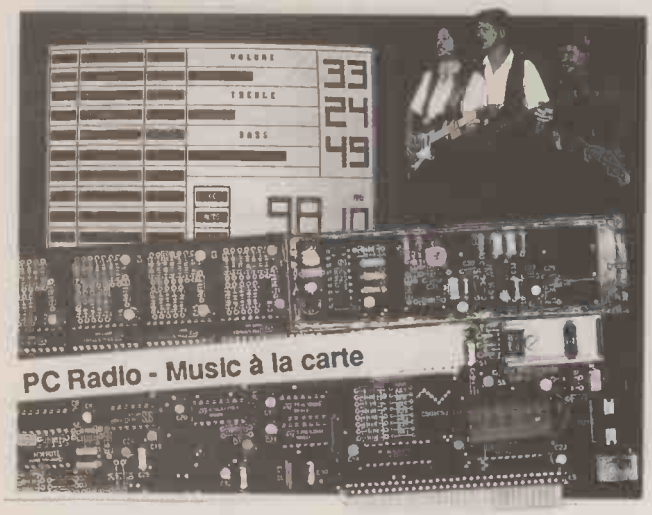
Input sensitivity:
Input 1 : 2 mV
Input 2 : 200 mV

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

RFK 7000 RGB-CVBS Converter

(Elektor Electronics October 89)

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

Complete kit
44.525BKL ..... £ 66.50

Ready assembled module
44.525F ..... £ 119.50

FRK 7000 CVBS-RGB Converter

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

Complete kit
44.509BKL ..... £ 66.50

Ready assembled module
44.509F ..... £ 119.50

Ordering and payment:

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

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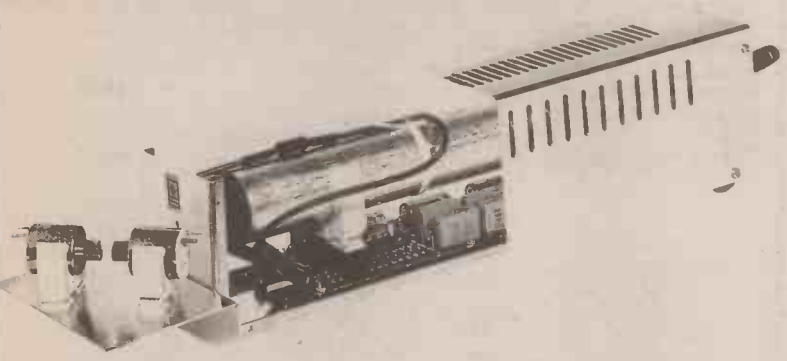
ELV

LPS 8000 / LC 7000 Low Cost Show Laser

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



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

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

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

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

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

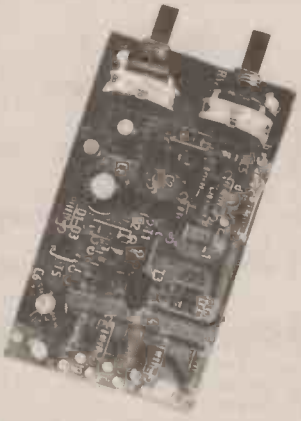
LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F ..... £ 104.30

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

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

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

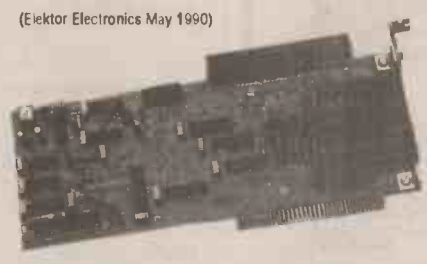


Complete Kit
(including Box, PCB and all parts
44.324BKL ..... £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

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



Complete kit
44.517BKL ..... £ 77.95

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

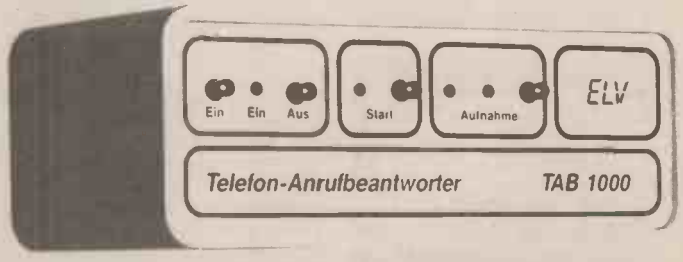
TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

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

Complete kit
44.433BKL ..... £ 45.65

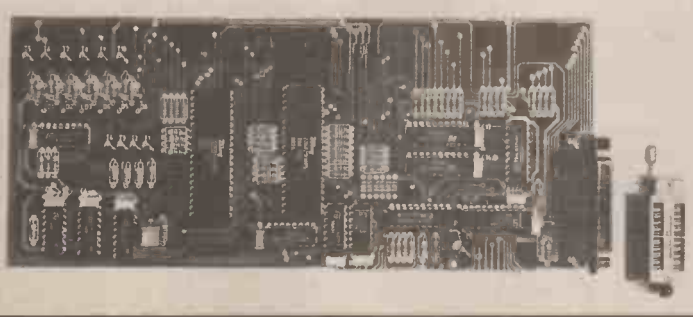
Ready assembled module
44.433F ..... £ 87.25



IC TESTER for IBM-PC-XT/AT

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

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



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

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

Software, single
44.474SW ..... £ 17.85

389

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

YOUNG AMATEUR OF THE YEAR AWARD 1990

The DTI is sponsoring the *Young Amateur of the Year* Award for the third time. It is open to anyone under 18, not necessarily a licensed amateur, who is keen on DIY construction; or is interested in using radio and gaining operating skills; or uses radio for a community service such as helping the disabled, or in emergency communication networks; or is good at encouraging interest in amateur radio; or is involved in amateur radio in any way, such as in a school scientific project.

A prize of £250 will be awarded for the most outstanding achievement between 1 August 1989 and 31 July 1990. The winner and runners-up will be invited to see the DTI's radio experts at work at its monitoring station at Baldock in Hertfordshire. Additional prizes will be donated by, among others, the Mobile Radio Users Association, Icom (UK) Ltd, and Navico.

Applications or nominations should be sent to *The Secretary, Radio Society of Great Britain, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE*, by 31 July 1990. An information sheet for entrants is available.

MICROSATS

The W5YI REPORT recently interviewed Doug Loughmiller, KO5I, president of the Radio Amateur Satellite Corporation (*AMSAT*) about the recent successful launch of six amateur radio microsats (EE April).

He said that the spacecraft were so small, nine by nine inch cubes, that the North American Air Defence Command was having trouble locating them on radar. Despite their size, however, "there is the equivalent of an IBM AT on board each one with eight megabytes of RAM, transceivers, batteries, charge circuitry and experiment modules."

"The idea that free launches continue to be available is a misconception. Our launch costs were much less than the primary payload because launches are sold by mass and volume. This was the challenge that led us to explore how small we can go...."

The microsat concept developed and owned by *AMSAT* has been exclusively licensed to Interferometrics Inc., an aerospace firm which believes there is a commercial need for low cost satellites to support worldwide store-and-forward communications and other scientific data collection missions. Calling the system *"EYESAT"*, Interferometrics state that "for 10 to 20 million dollars a company can have the prestige of owning their own satellite communications system."

Meanwhile, according to W5YI, another company, Orbital Sciences Corporation, is proposing to create a new communications service based on 20 small satellites providing personal, business and emergency services and position fixes called *ORBCOMM*. Interferometrics are suing OSC over an alleged conspiracy to take technology developed by *AMSAT* which is licensed to Interferometrics. It is not known yet if the lawsuit will affect the ORBCOMM proposals.

AMATEURS LEAVE QUEEN MARY

For more than 10 years Long Beach California radio amateurs ran an amateur station, W6RO, located in the radio room aboard the liner *Queen Mary*. Some 100 amateur operators kept the station open all year round, giving millions of tourists the opportunity to see amateur radio in action.

Last September, according to the USA based WESTLINK REPORT, new management of the tourist complex, a subsidiary of the Walt Disney Corporation, notified the amateurs that the only way they could continue operation was by having more interaction with the tourists.

A statement by the amateurs says, "At this point, the management was advised that operating under their orders would be a violation of FCC regulations that prohibit control of an amateur station by a commercial venture. When they continued not to agree to the amateurs' request for continued autonomous operation, management was notified that operation of W6RO would be terminated effective September 5, 1989."

MORE ON PITCAIRN

In the March issue I outlined the history of amateur radio on Pitcairn Island, gleaned from articles which appeared last year in *Amateur Radio*, journal of the Wireless Institute of Australia. Today's Pitcairn is still well served by amateur radio. The remoteness of the island, with supplies and mail reaching it only two or three times a year makes the facility more significant than it is in some other parts of the world and the proportion of amateur operators to total population, six out of fifty, is the highest anywhere!

Public electricity is available for relatively short periods each day so many islanders have private diesel generators requiring expensive fuel supplies. Among the radio amateurs, call prefix VR6, solid state transceivers powered by 12 volt batteries are becoming popular since the batteries can be charged when public power is available.

A number of medical emergencies have been handled over the years by amateurs. Now a government sponsored shortwave station, ZPB, has twice-daily communications with New Zealand, some 3,000 miles away, while for emergency purposes a "retired" weather satellite in geostationary orbit allows the Pitcairn station to telephone the USA at any time, via an autopatch, to obtain emergency medical advice from a designated hospital in the Chicago area.

SPECIAL ARRANGEMENT

For the day-to-day non-emergency needs of the islanders, amateur operators on Pitcairn have regular contacts with American amateurs. Under a special agreement with the British government the Pitcairners can use amateur radio to organise and obtain personal requirements. Some ships departing from US ports call at Pitcairn as a courtesy to the island and bring a limited number of parcels from American friends.

Previously, an islander had to travel to New Zealand to take the radio amateurs' examination but recently it has been possible to sit the exam, including a Morse test, under the supervision of the Island Government Officer who also serves as the school teacher. Most Pitcairners already have some knowledge of Morse as the code is used on the island's single-party-line telephone system with each resident having his or her own Morse designator to indicate an incoming call!

During January all VR6 stations used the call VR200PI followed by the last two letters of their own calls to celebrate the 200th anniversary of the landing of the Bounty mutineers on the island in 1790. This year, 1990, is a year-long bicentennial celebration for the operators of Pitcairn, and amateurs around the world will be particularly pleased to work VR6 stations during their special year.

TAPE MAGAZINE FOR BLIND AMATEURS

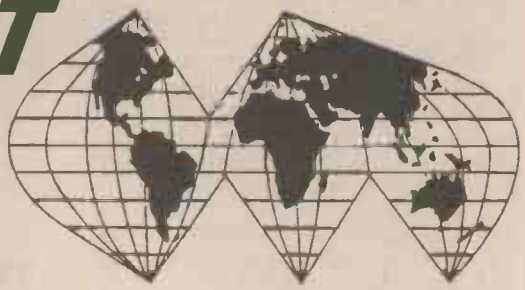
"QTI" (Quotations of Technical Interest) is produced by QTI Talking Newspaper Association, a voluntary organisation dedicated to helping visually handicapped radio amateurs and shortwave listeners to enjoy radio and electronics magazines.

Each issue is a compilation of technical articles from current magazines and recorded on tape by readers from all parts of the UK. The magazine comprises two C90 cassettes and goes out about every three weeks, mainly to the UK, but also to several European countries, to India, Canada, and the USA. A copy is also sent to Australia where it is copied and distributed to listeners in Australasia.

QTI is available to all handicapped radio amateurs and SWLs for a voluntary subscription of just £3.50. Under Post Office arrangements for the blind post is free. In other cases postage has to be paid for. The Association is always in need of helpers, plus funds to cover the maintenance and/or replacement of up-to-date recorders and fast copiers.

Donations, large or small, are gratefully accepted, especially if convenanted. There is also a "Sponsor a member" scheme to pay the subscription of members on small incomes. Enquiries, donations or offers of help should be made to ***Harry Longley, QTI Talking Newspaper Association, 7 Anderson Close, Lancaster LA1 3JE.*** ☎ 0524 33207.

80 METRE DIRECT CONVERSION RECEIVER



Robert Penfold

Listen-in to the world of amateur radio. This receiver and the chosen frequency make an ideal introduction to the world-wide movement of amateur communication.

RECEPTION of short wave broadcast stations is possible using relatively simple equipment due to the use of very high transmitter powers, and ordinary amplitude modulation (a.m.). The sheer power of the transmissions from some stations does make it difficult to pick up a nearby transmission that is weak, but even a simple receiver can provide quite good results on the short wave broadcast bands.

The short wave *amateur* bands are a very different proposition. The maximum permitted output powers are relatively modest, and are in fact minute by broadcast station standards. They are typically only about one thousandth of the power used on the broadcast bands. This has led to the widespread use of single sideband (s.s.b.) in order to make optimum use of the available output power, and also to ease overcrowding on some of the more popular amateur bands.

This makes the requirements for a basic amateur bands receiver somewhat more stringent than those for a simple broadcast band set. Selectivity is important for both types of receiver, but is probably that much more important for an amateur band receiver. The same is true for sensitivity.

Tuning stability is very much more important for a receiver that will be used for s.s.b. reception. As we shall see shortly, even a minute shift in the tuning can render an s.s.b. signal unintelligible, and will, necessitate readjustment of the tuning control. This contrasts with an ordinary a.m. receiver, where tuning drift of a few hundred hertz is unlikely to be noticed at all.

DIRECT CONVERSION

A simple t.r.f. receiver (such as the one described last month) can be used for amateur bands reception, but is unlikely to prove highly successful. It is likely to be lacking in sensitivity, selectivity, and tuning stability.

The normal approach to low cost amateur band reception is a simple receiver of the direct conversion type. This uses a very basic approach to s.s.b. reception, but one which is often highly successful. Comparing results obtained on a simple but well designed direct conversion receiver with those obtained on a complex superhet receiver often reveals surprisingly few stations that the latter can receive but the former cannot.

S.S.B.

In order to understand the way in which a direct conversion receiver functions you need to have at least a basic understanding of s.s.b. In fact tuning in an s.s.b. signal is nothing like as straightforward as tuning in an ordinary a.m. or f.m. broadcast station, and a reasonable knowledge of s.s.b. is a decided asset if you are going to use an amateur band short wave receiver.

A single sideband signal could be regarded as a standard a.m. type, but with certain parts of the signal removed. Indeed, this is basically the system used in many transmitters to generate an s.s.b. signal. An a.m. signal consists of the basic r.f. signal, or "carrier wave" as it is termed, plus upper and lower sidebands that are generated when the transmitter is modulated.

In the example of Fig.1 there is a carrier wave at 3.7MHz, and audio modulation components at 1, 1.5, and 2.5kHz. These result in sidebands at 3.7MHz plus these frequencies (the upper sideband), and 3.7MHz minus these frequencies (the lower sideband). The strength of each sideband component reflects the relative strength of the audio component that produced it.

Using the filter method of s.s.b. generation, a filter having an extremely rapid roll-off rate is used to substantially attenuate one sideband *and* the carrier wave. In a practical system it is difficult to obtain much attenuation of the carrier wave as it is so close to some of the frequencies in the wanted sideband. This is overcome by using a balanced modulator that gives what is typically 40dB or more of carrier wave suppression.

There is an alternative method of sideband generation, which exists in a variety of forms, and makes use of balanced modulators, phase shift networks, and phase cancelling techniques to generate the signal.

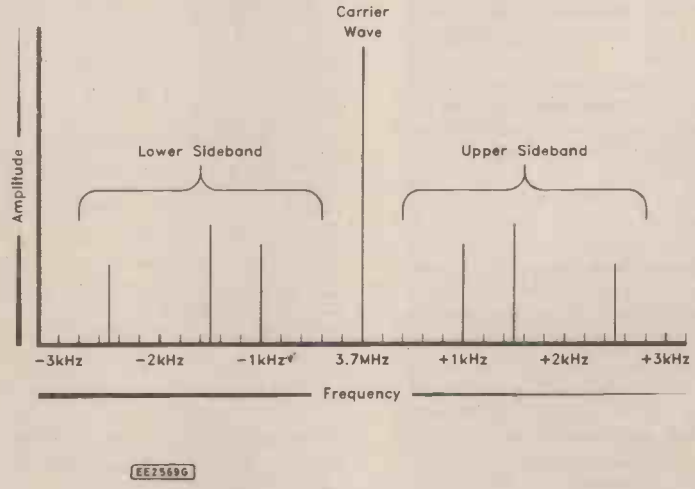


Fig. 1. Sidebands produced by amplitude modulating a 3.7MHz carrier wave with input frequencies of 1kHz, 1.5kHz and 2.5kHz.

S.S.B. RECEPTION

Whatever method of generation is used, an s.s.b. signal represents a more difficult problem for the receiver than does an ordinary a.m. signal. As we saw with the *Crystal Set* and *T.R.F. Receiver* last month, in order to demodulate an ordinary a.m. signal it is merely necessary to rectify it and apply some simple lowpass filtering. Using this technique with an s.s.b. signal gives a totally distorted and unintelligible output.

The problem is not the missing sideband, which merely duplicates the information present in the other sideband. It is the missing carrier wave that results in the unusable audio output signal.

A simple method of demodulating an s.s.b. signal is to use an ordinary a.m. detector, but to have an oscillator which effectively replaces the missing carrier signal. This represents a very simple method of adding an s.s.b. mode to an ordinary a.m. receiver, but it does not necessarily give particularly good results in practice. A better method is to use a balanced mixer plus an oscillator to provide demodulation.

understand (known as the "Donald Duck" effect for obvious reasons).

A small error in the opposite direction results in all the audio frequencies being fractionally too low, and is again not of major importance. A larger error results in a total scrambling of the audio signal, rendering it totally unintelligible.

Very accurate tuning is therefore of vital importance with an s.s.b. signal, and tuning in a signal of this type can be quite awkward at first. Fortunately you soon get the hang of it.

THE BAND

Obviously this receiver could be built as a multi-band type if desired, but single band operation on one of the low frequency bands has its advantages. One of these is simply that it makes the unit easier to construct. It also makes alignment much easier, which is a major consideration if you are not equipped with suitable test gear to aid the alignment process.

Another factor is that operation on a single low frequency band makes it relatively easy to obtain adequate sensitivity and stability. The risk of problems with instability are relatively low.

There are a lot of amateur bands to choose from (see Table 1), but the 80 metre band is the standard choice for a receiver of this type, and with good reason. During the daytime this band will usually provide reception of a number of UK stations, plus perhaps a few stations on the European mainland. At night these comparatively short range signals can still be picked up, but longer distance reception will also be possible.

This band is not as good for DX reception as some of the high frequency bands, but it still has good potential and can provide long distance reception when conditions are right. A major plus for 80 metre band operation is that it is virtually unknown for such a low frequency band to go totally "dead". This contrasts with the high frequency bands which tend to fade out totally at night, and which in some cases can be "dead" for weeks or even months at a time.

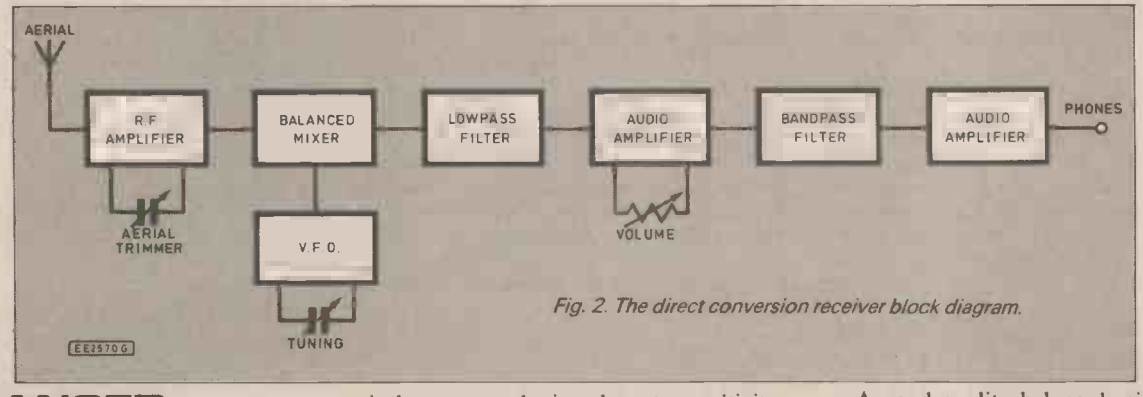


Fig. 2. The direct conversion receiver block diagram.

BALANCED MIXER

A balanced mixer generates sum and difference frequencies from the two input signals. This method of mixing is called "heterodyning." Suppose that the upper sideband signal of Fig.1 is mixed with the signal from a 3.7MHz oscillator. Deducting 3.7MHz from each of the three sideband frequencies gives answers of 1kHz, 1.5kHz, and 2.5kHz. In other words, the difference frequency gives the required audio output signal.

Similarly, if we take the lower sideband signal of Fig.1 and deduct the frequencies it contains from 3.7MHz, we again get answers of 1kHz, 1.5kHz, and 2.5kHz. Whether the signal is an upper or lower sideband type, mixing it with an oscillator operating at the appropriate frequency will provide the required demodulation.

The sum frequency, plus any breakthrough of the input frequencies, are easily eliminated from the output of the mixer. They are all at radio frequencies and will be removed using a simple lowpass filter.

An important point to note here is that the correct demodulation is dependent on the oscillator being tuned to the correct frequency. If it is offset from the correct frequency in one direction, all the frequencies in the audio output signal will be raised by an amount equal to the error in the oscillator's frequency.

A small error will not matter much, and will give a perfectly intelligible and quite natural sounding audio signal. A large error will result in an audio signal that sounds most odd, and may be difficult to

SYSTEM OPERATION

The block diagram of Fig.2 shows the general make up of this receiver, which is a fairly standard direct conversion type. A tuned r.f. amplifier at the input of the receiver provides a certain amount of gain, although this is quite modest compared to the gain in the audio stages.

This amplifier provides a useful and important boost in sensitivity, but its main contribution is to provide two stages of bandpass filtering. This minimises the risk of breakthrough from strong transmissions at frequencies close to the 80 metre band. In particular, it combats problems with breakthrough from the adjacent 75 metre broadcast band.

One of the tuned circuits is a relatively wide bandwidth type which has preset tuning. The other has a narrower bandwidth, and can be adjusted (via the so-called "aerial trimmer" control) to accommodate changes in the tuning controls and maintain peak performance.

The conversion to audio frequencies is provided by a variable frequency oscillator (v.f.o.) and a balanced mixer, with a lowpass filter removing all but the required difference signal. The v.f.o. is a very simple L/C type, but it is quite stable, and is free from "pulling" when the aerial trimmer control is adjusted.

The recovered audio signal is passed to a volume control and audio amplifier stage, and then into an audio bandpass filter. With no intermediate frequency (i.f.) amplifiers and filtering to give a receiver of this type good selectivity, good audio filtering is crucial to receiver performance.

A good quality balanced mixer is also important, as this will ensure that there is no significant breakthrough of audio signals at the output from signals that have not been properly converted by heterodyning.

As pointed out in previous articles in this series, the main problem with short wave reception is not so much picking up a weak DX signal as sorting it out from a plethora of very strong signals on nearby frequencies. Even with two tuned circuits in the front end of the unit, the r.f. bandwidth is very wide and it is the balanced mixer plus the audio filter that are responsible for providing the set with its selectivity.

The audio filter used here is a passive type using five L/C tuned circuits to give an

Table 1: Amateur Band Frequency Limits

Band	Frequency Range
160 Metres	1.8-2.0MHz
80 Metres	3.5-3.8MHz (3.5-4.0MHz in some countries)
40 Metres	7.0-7.1MHz (7.0-7.3MHZ in some countries)
30 Metres	10.1-10.15MHz
20 Metres	14.0-14.35MHz
17 Metres	18.068-18.168MHz
15 Metres	21.0- 21.45MHz
12 Metres	24.89-24.99Mhz
10 Metres	28.0-29.7MHz

excellent passband characteristic. The final stage of the circuit is a second audio amplifier. This can drive most types of headphone, but does not provide sufficient output to drive a loudspeaker.

Headphones are generally better for DX reception anyway, but it is probably not a good idea to use a loudspeaker with a direct conversion receiver where problems with microphony and acoustic feedback can so easily occur.

CIRCUIT OPERATION

The full circuit diagram for the 80 Metre Direct Conversion Receiver appears in Fig.3. The r.f. amplifier uses TR1 and TR2 in a cascode arrangement, similar to that used in the t.r.f. receiver design. The aerial signal is coupled to the input tuned circuit via a low impedance winding on T1, and VC1 is the aerial trimmer control. T2 and tuning capacitor C2 form the collector load for TR2, and as this tuned circuit has a fairly broad response (broadened still further by R1) it has preset tuning.

The balanced mixer is formed by IC1, this is a special communications device which is specifically designed for applications of this type. It requires a supply potential of about 6 volts, and this is derived from the 9 volt battery supply via dropper resistor R5 and decoupling capacitor C7.

The v.f.o. uses TR3 in a simple common source amplifier, with frequency selective positive feedback provided by T3. VC2 is the main tuning control, while VC3 is the fine tuning control. These just about give coverage of the 3.5MHz to 3.8MHz U.K. 80 metre band.

If coverage of the full 3.5MHz to 4.0MHz band (as used by the U.S. and a few other countries) is required, VC2 should be increased to a value of 100p. C8 provides r.f. filtering at the output of IC1.

The audio output from IC1 is coupled to volume control VR1, and then on to the first audio amplifier. This is a simple non-inverting operational amplifier type based on IC2, and having a voltage gain of over 40dB (100 times).

The output of IC2 is coupled to the audio bandpass filter by C18. The filter is based on a design from *The ARRL Handbook*, but has undergone extensive changes in the circuit values so that it can be built using standard "off the shelf" components having preferred values.

Please note that the inductors should be the specified type, and that other components of the same value might not work properly in the circuit. Some inductors having suitable values are only intended for operation at relatively high frequencies, and will not work properly at audio frequencies. Also, some types of inductor will provide strong coupling between the five inductors in the circuit, severely degrading the performance of the circuit.

The specified types offer a good combination of price performance at audio frequencies, and freedom from mutual coupling. Higher quality types should work well in the circuit, but would be extremely expensive, would not give a significant increase in performance, and would probably not fit easily into the printed circuit board layout.

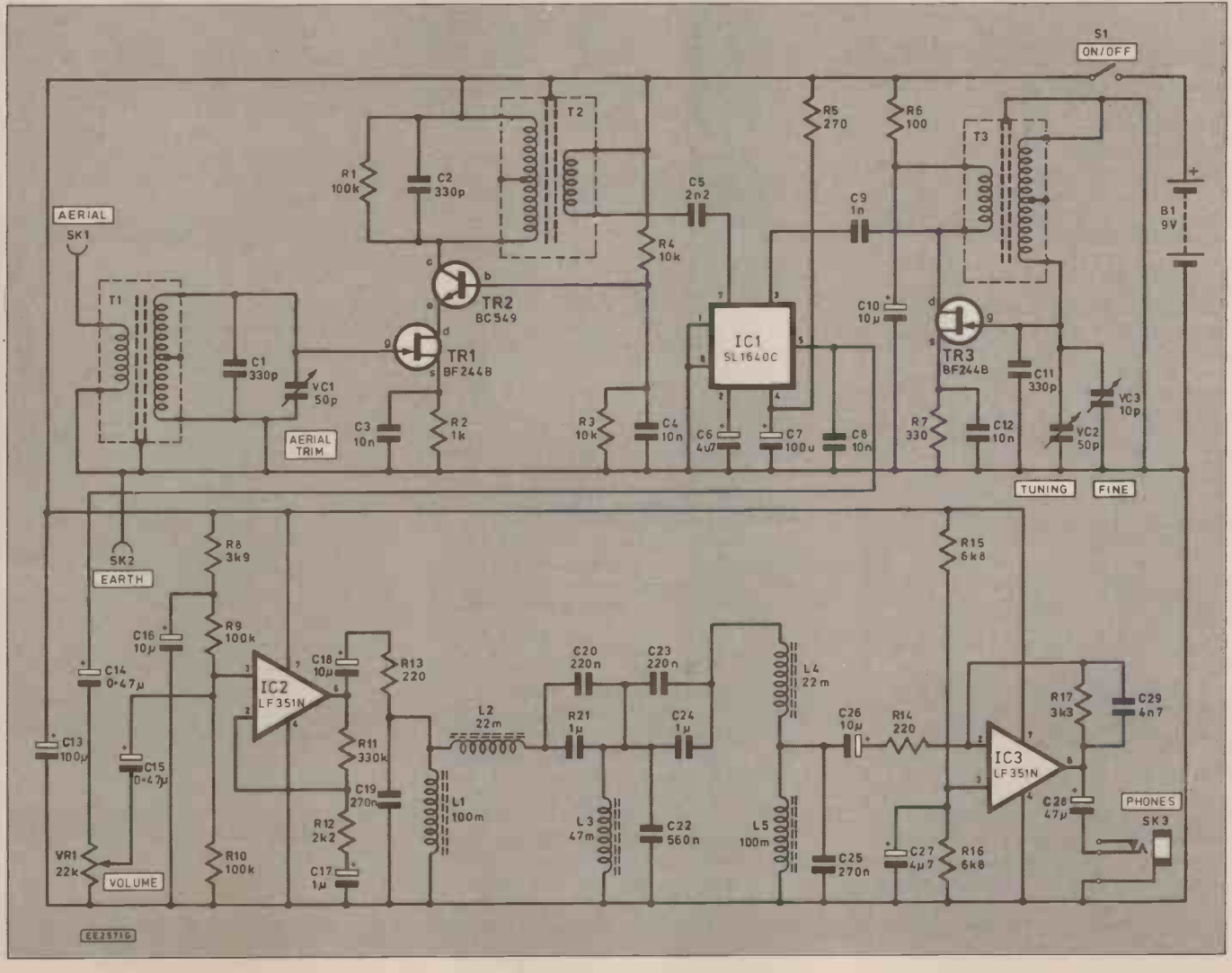
The performance of the circuit is extremely good. It was designed to give −6dB points at about 300Hz and 2.5kHz, with 60dB of attenuation at 100Hz and 10kHz. The bandwidth at the −6dB points is perhaps fractionally narrower than intended, but this does not seem to have any adverse effects in practice. The attentuation at 100Hz and 10kHz is within a few dB of the required figure.

There are no serious ripples in the passband, which does in fact seem to be remarkably flat and free from irregularities. The filter adds significantly to the cost of the receiver, but with today's crowded conditions on 80 metres it is well worth the extra cost, and transforms the performance of the receiver.

This type of filter must have specific source and load impedances if it is to function properly. In this case R13 sets the correct source impedance, while R14 sets a suitable load impedance. R14 acts as part of the negative feedback loop in the output amplifier. This is a simple inverting mode circuit based on IC3, and having a voltage gain of a little over 20dB (ten times). C29 provides a small amount of additional high frequency roll-off.

The circuit is powered from a 9 volt battery, and the current consumption is approximately 20 milliamps. This merits the

Fig. 3. Complete circuit diagram for the 80 Metre Direct Conversion Receiver.



use of a medium capacity battery, such as six HP7 size cells in a plastic holder.

CONSTRUCTION

With the exception of the controls, sockets, and battery, everything fits onto the printed circuit board. Details of the board are provided in Fig.4.

As usual, start with the resistors and capacitors, and then add the inductors, semiconductors, r.f. transformers, and pins at the points where connections will be made to off-board components. The integrated circuits are not static sensitive types, but I would still recommend the use of holders, especially for IC1 which is a relatively expensive type. Note that IC1 has the opposite orientation to the other two integrated circuits.

The capacitors are all printed circuit mounting types. The polyester capacitors have a pitch of 7.5 millimetres, apart from C21 and C24 which have very high values, and are 10 millimetre pitch types.

Treat the five inductors with due care. They are based on a form of ferrite pot core, and ferrite materials are both very hard and very brittle. Dropping them onto a hard floor could easily result in the ferrite pot cores being smashed.

CASE

A metal instrument case is probably the best kind for a project of this type. The case for the prototype measures about 210 by 150 by 52 millimetres, and anything much smaller than this may fail to accommodate everything.

The front panel layout must be one that enables all the r.f. wiring to be kept reasonably short, and this dictates that VC1 should be towards the left end of the panel, with VC2 and VC3 towards the middle, and VR1, S1, and SK3 well towards the right hand end of the panel. SK1 and SK2 are mounted on the rear panel, more or less opposite VC1.

Use good quality air spaced variable capacitors such as the Jackson C804 type. Cheaper solid dielectric types might not provide adequate stability for an application of this type.

The printed circuit board is mounted across the middle of the case on the usual stand-offs or using 6BA fixings including spacers about six millimetres long. Mount it just behind the variable capacitors so that the connecting leads do not have to be any longer than is absolutely necessary. This should leave sufficient room for the battery pack to the rear of the board. Connections to the plastic battery holder are made via a standard PP3 style battery clip.

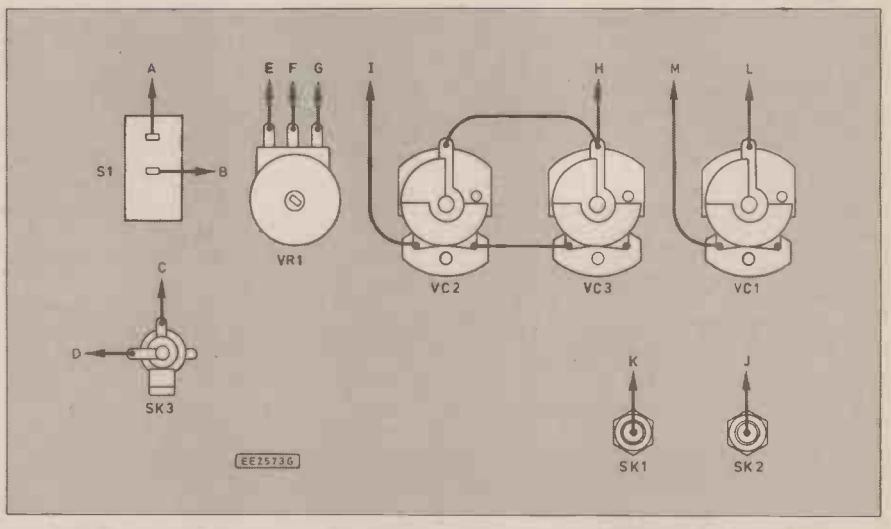


Fig. 5. Wiring details from the front and rear (SK1/SK2) panel mounted components to the circuit board (Fig. 4). Join A to A, B to B, and so on.

HARD WIRING

Details of the hard wiring are provided in Fig.5, which is used in conjunction with Fig.4 (e.g. point "A" in Fig.4 is connected to point "A" in Fig.5). Try to keep the wiring to the variable capacitors as short as reasonably possible.

The wiring in the audio section of the unit is less critical, but try to keep the wiring to SK3 well separated from that to VC2 and VC3. There is a potential problem with stray feedback at high volume control settings if this wiring is not kept well separated.

ADJUSTMENT

The receiver will work using most types of headphone or earphone. With low or medium impedance headphones it is best to connect the two phones in series, while parallel operation is likely to prove better if you use high impedance headphones.

Good results were obtained with the prototype by using a pair of inexpensive medium impedance headphones of the type sold as replacements for personal stereo units. A crystal earphone is a good very low cost solution, but a low impedance magnetic earphone is unlikely to give good results.

For reception on a low frequency band such as 80 metres there is a lot to be said in favour of using an earth connection and a fairly long aerial. Quite good results can be obtained using an indoor aerial provided an earth connection is used. Quite good results can also be obtained using a fairly long outdoor aerial with no earth connection. In order to get worthwhile results you really must have either a reasonably long aerial or an earth connection, and having both of these is obviously ideal.

The receiver requires a certain amount of alignment before it is ready for use. With the unit set up and switched on it will probably be possible to receive a few signals of some description, but probably marine band and not amateur band types. By adjusting VC1 and the cores of T1 and T2 it should be possible to peak any received signals.

Only use a proper trimming tool when adjusting the cores of the r.f. transformers. A small screwdriver will tend to shift the tuning slightly when it is close to a core,

The completed printed circuit board wired to the tuning capacitors and Aerial and Earth sockets.

COMPONENTS

80m AMATEUR BAND RADIO

Approx cost. Guidance only **£50** (excl. Phones)

Resistors

R1, R9, R10	100k (3 off)
R2	1k
R3, R4	10k (2 off)
R5	270
R6	100
R7	330
R8	3k9
R11	330k
R12	2k2
R13, R14	220 (2 off)
R15, R16	6k8 (2 off)
R17	3k3

All 0.25W 5% carbon film

Potentiometer

VR1	22k log.

Capacitors

C1, C2, C11	330p polystyrene (3 off)
C3, C4, C8, C12	10n polyester (4 off)
C5	2n2 polyester
C6, C27	4µ7 radial elect. 63V (2 off)
C7, C13	100µ radial elect. 10V (2 off)
C9	1n polyester
C10, C16, C18, C26	10µ radial elect 25V(4 off)
C14, C15	0.47µ radial elect. 63V. (2 off)
C17	1µ radial elect. 63V
C19, C25	270n polyester (2 off)
C20, C23	220n polyester (2 off)
C21, C24	1µ polyester (2 off)
C22	560n polyester
C28	47µ radial elect. 10V
C29	4n7 polyester

See Shop Talk page 409

Variable Capacitors

VC1, VC2	50p air spaced Jackson C804 (2 off) — see text
VC3	10p air spaced Jackson C804

Inductors

T1, T2	Toko KANK3334R (2 off)
T3	Toko KANK3337R
L1, L5	100mH type 10RB (2 off)
L2, L4	22mH type 10RB (2 off)
L3	47mH type 10RB

Semiconductors

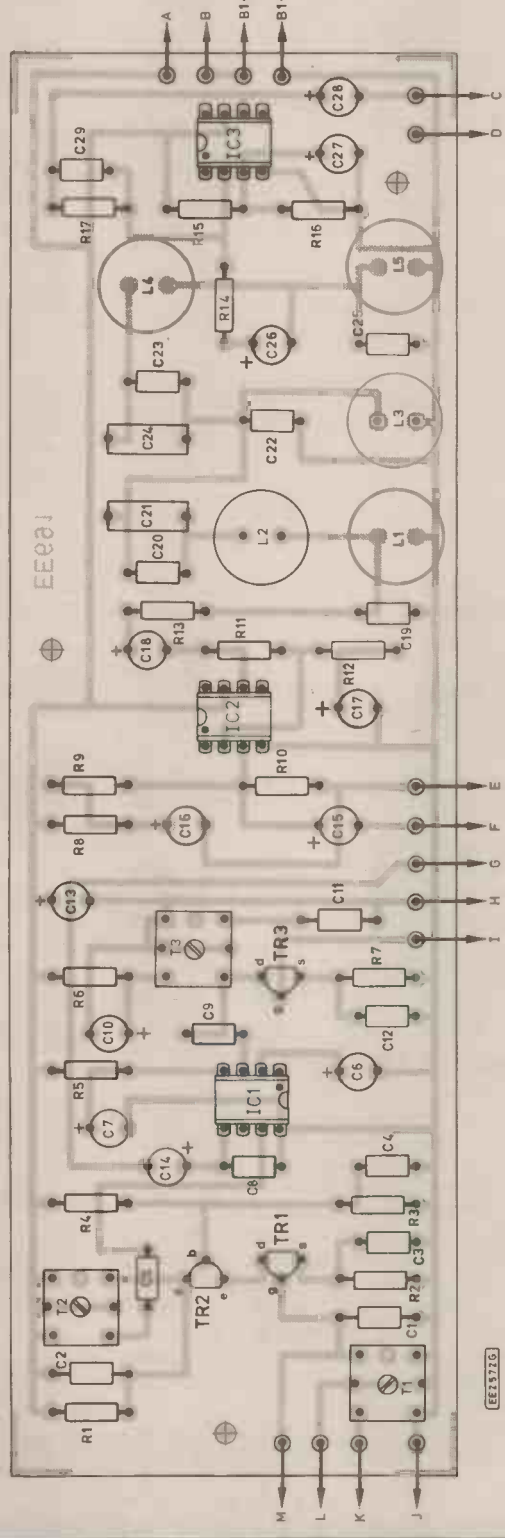
IC1	SL1640C double balanced mixer
IC2, IC3	LM351N bifet op amp (2 off)
TR1, TR3	BF244B *n* channel Jfet (2 off)
TR3	BC549 silicon *npn*

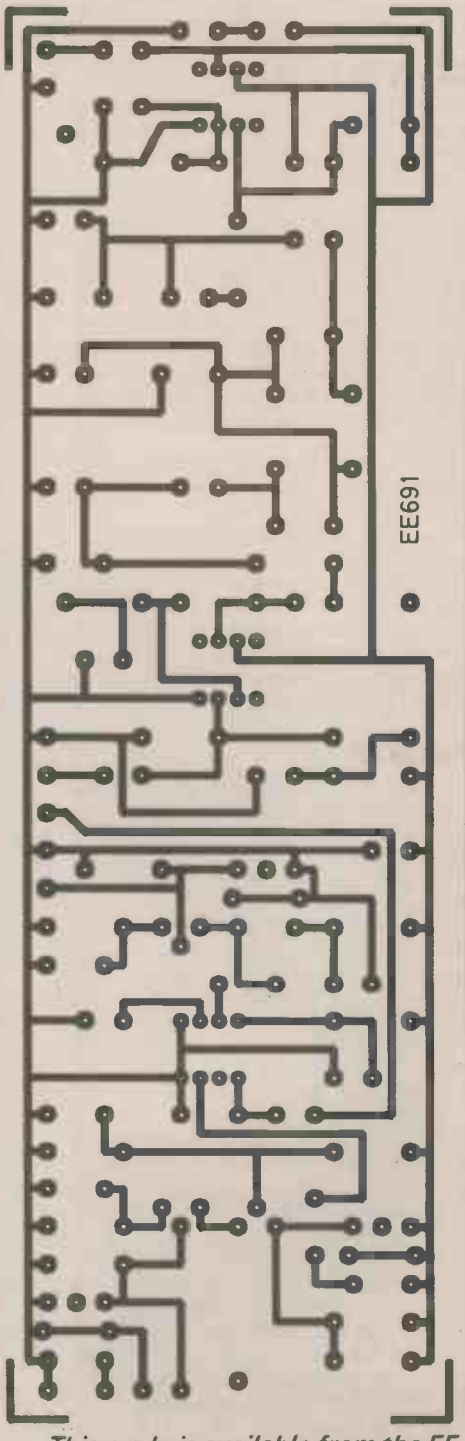
Miscellaneous

S1	s.p.s.t. miniature toggle
B1	9 volt (six HP7 size cells in holder)
SK1	Red 4mm socket
SK2	Black 4mm socket
SK3	3.5mm jack socket

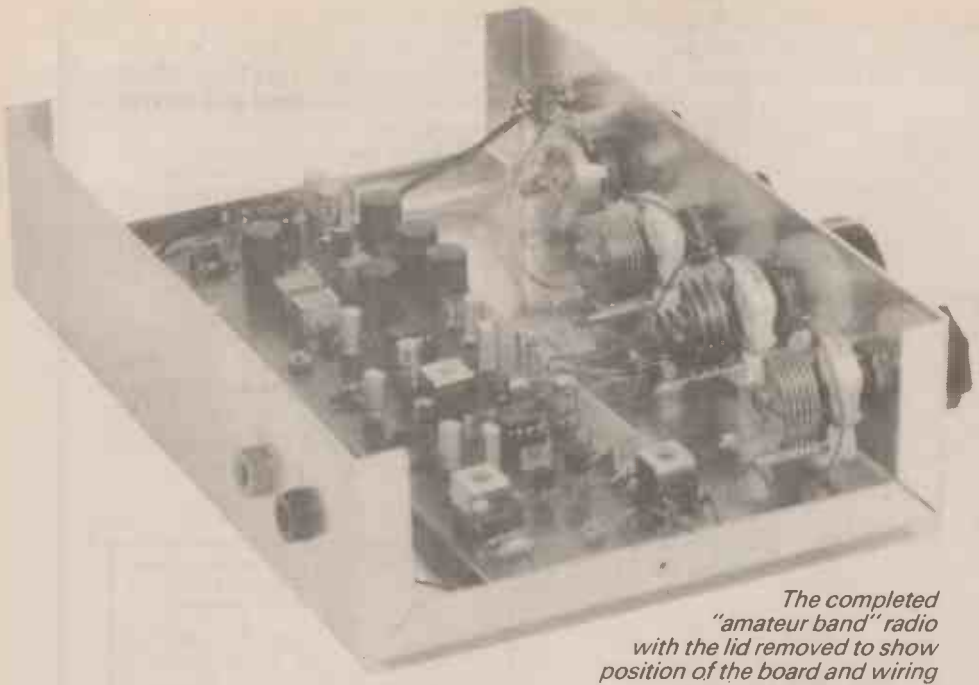
8 pin d.i.l. i.c. holder (3 off); battery connector (PP3 type); control knob (3 off); large control knob (see photo); printed circuit board, available from *EE PCB Service*, code EE691; metal instrument case about 210 x 150 x 52mm; medium impedance headphones with 3.5mm plug; wire; solder; etc.

Fig. 4. Printed circuit board component layout and full size copper foil master pattern.





This p.c.b. is available from the EE PCB Service, see page 420



The completed "amateur band" radio with the lid removed to show position of the board and wiring to rear of the front panel.

making accurate adjustment impossible. the wedge shape of a screwdriver blade is also ideal for cracking and chipping brittle ferrite cores.

If a suitable r.f. signal generator is available, this can be used to set the core of T3 to provide full coverage of the 3.5MHz to 3.8MHz band. In the absence of suitable test gear it is a matter of trial and error. Try the core of T3 at various settings, with T1 and T2 being adjusted to peak received signals.

The idea is to find a setting that gives a lot of amateur band signals over the tuning range of VC2 and VC3. Setting up the core of T3 is easiest when the band is crowded, which means virtually any evening, but particularly at weekends. Bear in mind that the signals at the low frequency end of the band will be mainly c.w. (Morse) and not s.s.b. transmissions.

When a suitable setting has been located, adjust all three variable capacitors for half maximum capacitance. Then adjust the cores of T1 and T2 to peak any received signals, or the background noise level in the absence of any signals. The unit is then ready for use.

IN USE

As pointed out earlier, s.s.b. signals must be tuned in very carefully if an audio output at a suitable pitch is to be obtained. As lower sideband is the standard one for a low frequency band such as 80 metres, it is generally easier to start at the high frequency end of the band and scan downwards in frequency (i.e. start with the vanes of VC2/3 fully unmeshed).

As you home-in on a signal the pitch of the audio output signal will gradually fall to the correct level, making accurate tuning quick and easy. If you start at the low frequency end of the band and scan upwards you will have to tune right through each signal and then back-off VC3 slightly in order to reduce the audio pitch to the correct level.

A direct conversion receiver is able to receive c.w. signals properly. With these it is just a matter of adjusting the v.c.o. to give the desired audio tone, and it does not matter whether the v.c.o. is set higher or lower in frequency than the c.w. signal. □

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Installing your Vistel couldn't be easier—you just unplug your telephone, pop the Vistel's connector into the socket, plug your telephone into the back of the Vistel, push the Vistel's mains plug into the nearest outlet, and you're up and running.

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While you're waiting for the postman to deliver your Vistel, why not ask BT to send details of their Prestel and Telecom Gold services? Call them up on 0800 200700—it's a freefone number, so you won't even be charged for the call. The bumph they send out includes info on Games City, Mailbox, music, current affairs, stock market and sports services, and lots more.

The bulletin boards and special interest groups are usually run by enthusiasts for free. Very professional some of them are, too. Try this: set the Vistel's modem to V23, 8-bit, no parity, one stop bit. Now dial 0772 735122. Once you hear the ringing tone, press the 'Khd Modem' switch, which allows the Vistel to work as an interactive terminal. After a few minutes the log-on message will appear on the Vistel's screen, and you're in!

You've just contacted the Hobbit's Armpit bulletin board. While you're there you can call up the newsletter, find a brief history of the world (how the Egyptians learned to make bread without straw—all very silly, but what the hell? It's free!), or download bits of software, or whatever else may be on offer at the time you phone through.

Here are some more numbers you can try:

PRESTEL DEMO Obviously they're trying to get you to subscribe to the full service, so they let you poke around a little to see what's on offer. A good opportunity for hackers, maybe...

Tel: 01 (South) or 021 (Midlands) or 061 (North) or 041 (Scotland) followed by 618 1111. To log on, use ID 4444444444 (ten 4s) and password 4444. Modem setting: 7 bits, even parity, one stop bit.

PACKET BBS A free service run by the RSGB. Dial: 01 547 1479. Hit CR for response. Modem setting: 8 bits, no parity, 1 stop bit.

INDEX 3 A Swedish bulletin board for the adventurous, and for those with no worries about running up outrageous telephone bills. Dial: 010 46 42138 476.

HAWK'S CASTLE An interesting bulletin board which often has numbers for yet more bulletin boards. Who knows where you might end up? Dial 0344 411621.

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- IBM keyboard emulator available.
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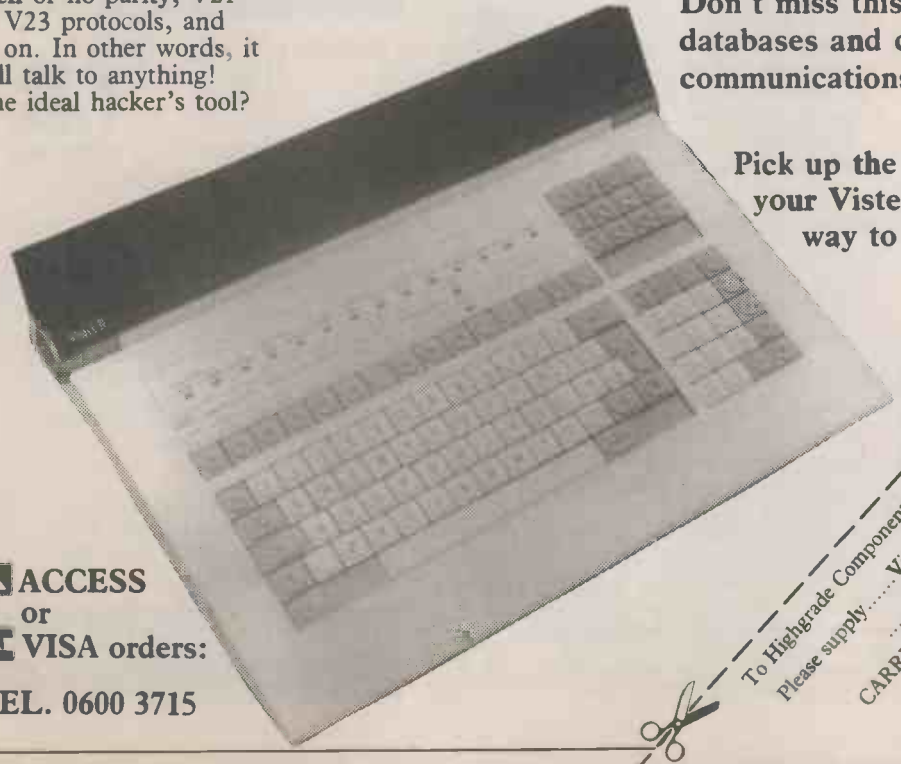

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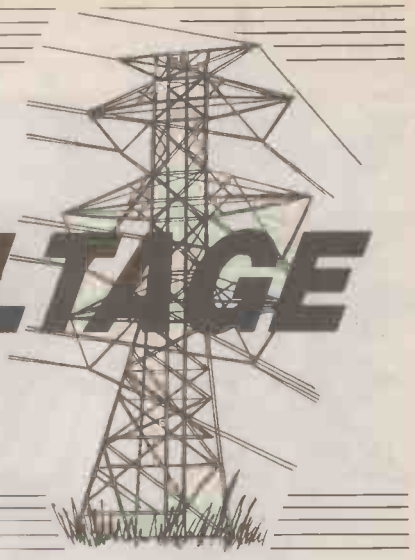
Constructional Project

MICROPOWER STABILISED VOLTAGE REGULATOR



ROGER LIDDIARD

A useful little adjustable low voltage controller which consumes less than 20μA.

AS THE power consumption of integrated circuits gets lower and the capacity of modern batteries increases, more and more circuits are designed to run on batteries rather than use the mains, especially where battery replacement is required after years rather than months.

Battery voltage falls during life. A typical 9V battery may start its life operating at just below 8V and fall gradually to a level where the circuit ceases to operate. This is quite acceptable if the circuit can operate over a wide range of supply voltage, but many circuits require a stabilised supply. Analogue circuits in particular demand a fixed voltage supply; so do some logic circuits.

In many cases standard voltage regulators consume too much power to be used in "micropower" applications – for example, a typical 5V regulator requires a supply current of a few milliamps – a relatively heavy drain in a circuit only intended to supply a few hundreds of microamps over long periods. Using a Zener diode to overcome this problem is generally unsatisfactory because most Zeners also require milliamps to achieve their operating voltage.

The following circuit uses two remarkable low power devices to produce an adjustable voltage controller which consumes less than 20μA yet can supply stabilised output voltages at currents in excess of 50mA. It is fully adjustable over a wide range of supply voltages, provides a highly stable output even when supplying high frequency circuits and uses a minimum of components.

MICROPOWER STABILISED VOLTAGE REGULATOR

The full circuit diagram for the Micropower Stabilised Voltage Regulator is shown in Fig.1. The LM334 adjustable current source, IC1, provides a fixed current of just over 1μA, giving a reference voltage of about one volt at the non-inverted input of the TLC251 low current operational amplifier IC2. The diode D1 effectively eliminates any variation in reference voltage caused by changes in ambient temperature.

The reference voltage is amplified by the operational amplifier whose gain can be adjusted by changing the feedback applied to the inverting input. Effectively the voltage at both inverting (pin 2) and non-inverting (pin 3) inputs on the amplifier IC2 will be the same.

The output voltage is given by the equation:

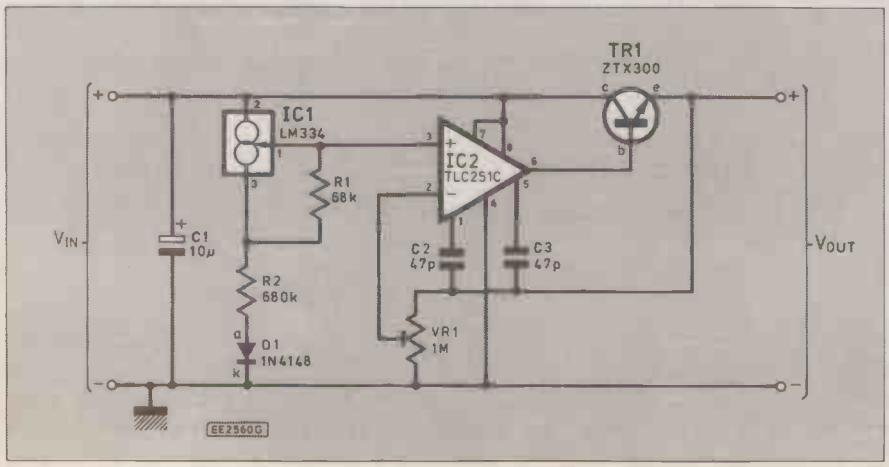
$$V_{OUT} = 1\text{ Volt} \times \text{Amplifier Gain}$$

$$= 1\text{ Volt} \times \frac{\text{Resistance between output and inverting input}}{\text{Resistance between inverting input and ground (0V)}}$$

Which is adjustable using the preset potentiometer VR1. An 18-turn cermet potentiometer was chosen for this application to facilitate the accurate adjustment of the selected output voltage.

The output from the operational amplifier is connected to transistor TR1, acting as an emitter follower. Feedback is provided by VR1 so that any variation in output voltage – due to changing load, for example – is immediately corrected.

Fig. 1. Complete circuit diagram for the Micropower Stabilised Voltage Regulator



COMPONENTS

See Shop Talk page 409

Resistors

R1	68k
R2	680k

All 0.6W 5% carbon

Potentiometer

VR1	1M 18-turn cermet preset

Capacitors

C1	10μ axial elec. 25V
C2, C3	47p ceramic plate (2 off)

Semiconductors

D1	1N4148 signal diode
TR1	ZTX300 *npn* gen. purpose
IC1	LM334Z adjustable current source
IC2	TLC251C lin. CMOS op. amp

Miscellaneous

Stripboard, 0.1in matrix 24 holes × 10 strips; case; 8-pin d.i.l. socket; 3-way p.c.b. terminal block; connecting wire; solder etc.

Approx cost. Guidance only **£6**

Those of you who followed the series on power regulation in the July, August and September '89 issues of *Everyday Electronics* will be aware that no voltage controller is complete without appropriate compensation for the effects of alternating loads. The Micropower Voltage Regulator is no exception in this respect.

To overcome low frequency effects (up to 10kHz) capacitor C1 is needed on the *battery* side of the regulator. (Putting a capacitor on the output side actually makes the effects of alternating loads much worse.) High frequency effects are eliminated by linking the output to the offset null pins (1 and 5) of the operational amplifier via capacitors C2 and C3, both valued at 47pF.

The TLC251C operational amplifier IC2 has selectable bias at pin 8. In this application it is connected directly to the positive supply rail to minimise the drain current required by the circuit.

CONSTRUCTION

This project has been designed to be constructed on a small piece of 0.1in matrix stripboard, sized 24 holes by 10 strips. Commence construction by breaking the underside copper strips in the eight locations shown in Fig.2.

Next mount and solder the components in position starting with the links (seven in number), followed by the 8-pin i.c. socket and the other components, ending with the 3-way terminal block TB1. Correct polarity must be observed on capacitor C1, diode D1, transistor TR1 and the LM334 IC1. Check the circuit carefully for short-circuits and dry joints before inserting IC2 into its socket, again ensuring the correct orientation.

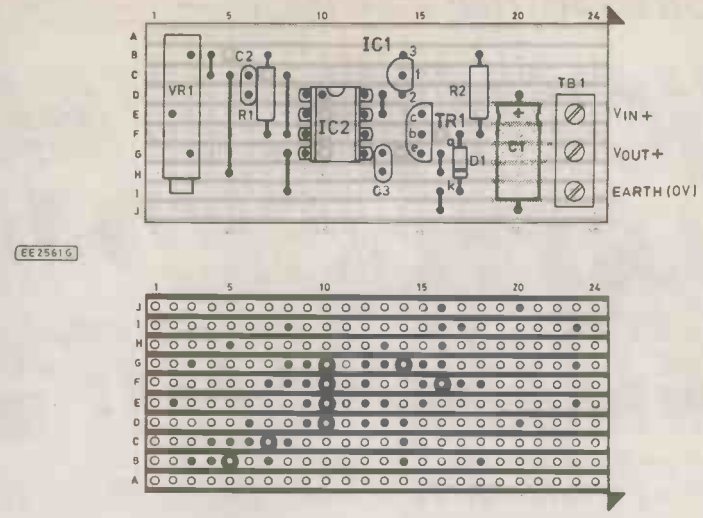
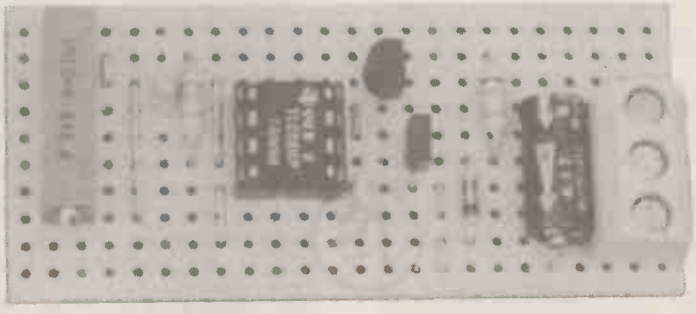


Fig. 2. Stripboard component layout and details of breaks in the underside copper tracks.



The completed circuit board showing the p.c.b. mounting screw terminal block and the multi-turn potentiometer

SETTING-UP

Using a 9 volt battery across the input supply terminals, wind preset VR1 through its full travel while measuring the output voltage. The output should be fully adjustable between about 1 volt and 8 volts.

Applying a 1k resistor across the output should have no effect on the selected voltage. For precision output voltages, it should be possible to adjust the regulator on load to within 0.01V.

PERFORMANCE

Stabilised voltages can be selected from the reference voltage to about one volt below the input voltage; just how close depends on the load current being drawn through the transistor TR1. The maximum permitted input voltage is 16V.

At an output voltage of 5V, the regulator is capable of supplying loads switching between zero and 20mA at all frequencies from d.c. up to 10MHz with the output voltage constant to within ±0.02V.

When supplying 5V output on no load, the drain current of the Micropower Stabilised Voltage Regulator is less than 20μA, of which preset VR1 consumes about 5μA and the LM334 takes just 1μA. Leakage through capacitor C1 is about 3μA (provided you use the axial type specified) and the operational amplifier takes about 10μA. □

Special Series

MICRO IN CONTROL

JOHN HUGHES — Part Seven

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

The logic of the lift now comes under scrutiny.

Designing a model lift

T We decided, remember, to have a lift working just between two floors to start with, but to add at least one extra floor afterwards.

S *So we'd better design our model with three floors, then use only as many as we need at each stage.*

T That's just what we thought, too, when the kits were put together for you to use (unless you prefer to build your own before our next meeting). Our design is intended to have enough features to give us practice in our electronic skills without including the "de luxe" features of a proper lift. Some extras could, of course, be added later, or you could incorporate them into your own version.

S *We decided on call buttons and sensors for each floor, though we didn't discuss what kind of sensors.*

T Yes, and a check that the doors are closed.

S *And perhaps some limiting devices/indicator lights/etc.*

T Right. Well, our model doesn't have indicators at the moment, but they might be easy to add. We'll bear them in mind. Nor does it have any "speed-sensitive" sensors. We are assuming that the motor runs at more or less the same speed all the time.

S *And that the cords don't break!*

T Indeed. Let's list what we DO have:

– Three floors, each having its own call button, and its own sensor to detect when the lift is present. – A door on each floor, also with means to detect that the door is closed. – A reversible motor (in this case a small d.c. type) which is controlled by two relays. – Transistor driver circuits for the relays, designed to respond to standard (TTL) signal levels (i.e. 0V and 5V). So our task, for this Exercise, will be to devise the kind of control logic to do what we wish, and to try it out.

S *We'll need more detail, won't we? Such as the logic levels of the sensors/and to make the motor go up or down.*

T Good. Let's spend a moment considering these points. Firstly, the sensors. As mentioned before, it's often convenient to use a sensor which gives a logic 0 signal; one whose output drops from (about) 5V to (about) 0V when it's activated. Many chips have "active-low" inputs, as we've already noted (for example, the gates in the counter chip and the J and K inputs of the flip-flop). We've also noted a circuit for a call button (Fig. 7.1). The same circuit could be used for any sensor which closes a pair of contacts.

S *Such as a microswitch as a "lift present" sensor.*

S *(another) or a "home-brew" contact arrangement.*

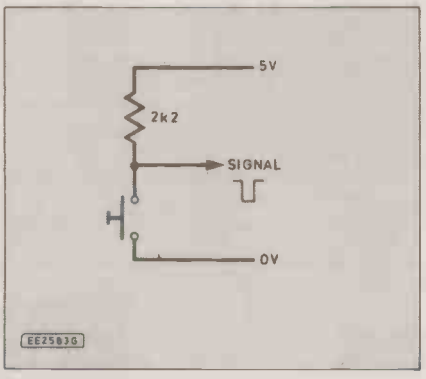


Fig. 7.1. The push-button could be replaced with, say, a reed switch.

T Exactly. But make sure your home-made contacts are reliable, and light enough not to stop the lift in its tracks, as happened in one model we saw!

S *Couldn't we make the lift interrupt a light beam/or operate a reed switch?*

T Sure. There are "proximity switches" using light, magnetic or capacitive effects. Take your pick. We've used reed switches in the prototype, as you'll see. The lift carries a small magnet which closes each switch when it's near enough to it.

S *And there's a reed switch on each floor.*

T Right. The only snag is that with the small model, the switch can be less precise than we'd like, so bear this in mind. On our model, we've stuck the reed switches on to a couple of fairly long leads so that we can adjust their position. Of course, on a larger scale, the fact that it may operate over a few centimetres isn't so important as it appears on the small model.

S *I see. If the reed is too near, it switches too soon as the magnet approaches, but if it's too far away it may be unreliable. How could a light cell be connected?*

T Can anyone help? Yes, that's the idea (Fig. 7.2). A phototransistor (or diode) is smaller than an l.d.r. The change in resistance is used to make a transistor conduct (or not conduct).

S *The effect is amplified/the transistor "switches".*

T That's right. There are, of course, i.c.s

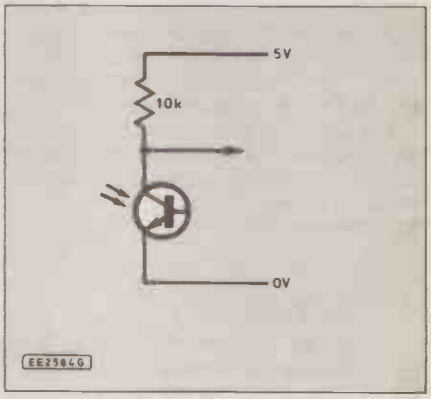


Fig. 7.2. Phototransistor sensor circuit. A small lamp or l.e.d. may be used as a light source.

to do this. And driver i.c.s to control the motor relays, too.

S *So we end up with logic 0 pulses as inputs?*

T Yes, and now, what about the motor control signals? That is, the OUTPUTS of our system.

S *We will need at least two outputs, for UP and DOWN.*

T We will. We've already worked out how to make the motor GO or STOP. Can you see how to make it REVERSE?

S *A second relay could reverse the motor supply.*

T Yes. Care to sketch a circuit for us?

S *It takes a two-pole changeover relay, thus (Fig. 7.3).*

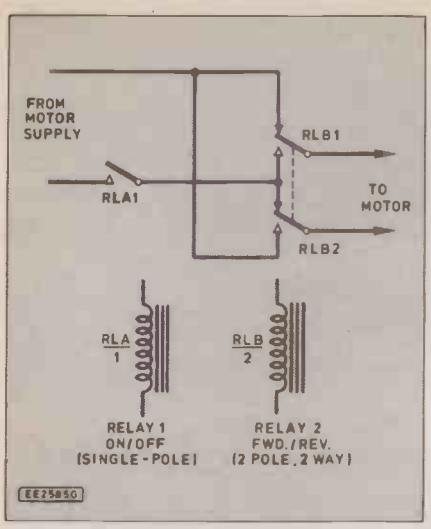


Fig. 7.3. Adding a reversing relay.

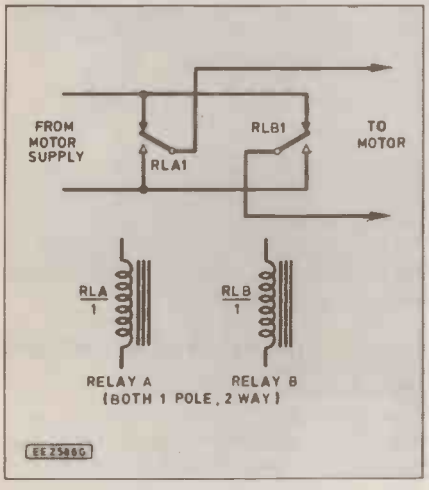


Fig. 7.4. Alternative relay circuit.

T Spot on. A circuit worth noting for the rest of you.

S *(another) I've seen a circuit using two single-pole relays, I think. A sort of symmetrical circuit?*

T There is such a circuit which can be used if you prefer (Fig. 7.4). In fact, we can use it on our model, for these relays are easier to use, and cheaper! But, of course, the output logic has to be designed to suit whichever relays we select.

S *This one is like an "exclusive-or" gate.*

T It is rather. Let's write down its behaviour, using two input signals A and B (they will be the OUTPUTS of our "box", won't they):

SIGNALS B	SIGNALS A	MOTOR ACTION
0	0	STOPS
0	1	GOES UP (say)
1	0	GOES DOWN
1	1	STOPS

S *We don't need the last line.*

T We can just ignore it, for now. Now we can draw our "box" with labelled inputs and outputs (Fig. 7.5), and start to consider what we put in it. Then, we'll look at the mechanical features of the lift, and check that it works as expected. The sketch (Fig. 7.6) shows the main parts. Our kits are made of perspex, cemented together, with holes for the motor and gearbox, and with sufficient clearance to allow the "car" to slide up and down freely.

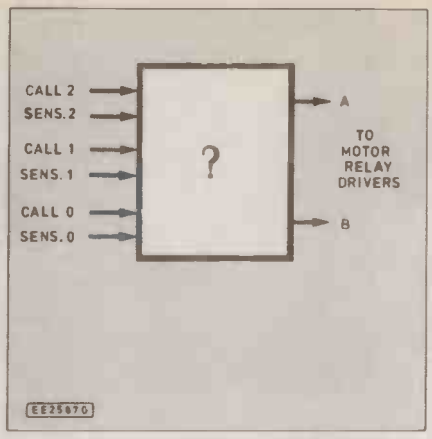


Fig. 7.5. Inputs and outputs for a three-floor model.

You'll notice that it's made up of a number of perspex rectangles stuck together, to make it easier to cut. The "lift" and "doors" are made of slightly thinner material to allow them to slide easily. We've used sliding doors, too, with wire contacts which are separated when the door is opened. Old relay contacts would be good. Keep the contacts clean, of course. The reed switches have been positioned so that they are closed when the lift magnet is near (but not too near!). If you use reeds, don't forget to make their position adjustable at first. They must close reliably, but not when the lift is still well away from its floor.

S *This means it won't stop in exactly the same spot on its way up or down.*

S *(others) But near enough/I'll use a microswitch.*

T OK. But use one which has an easy action, and doesn't stop the lift from passing.

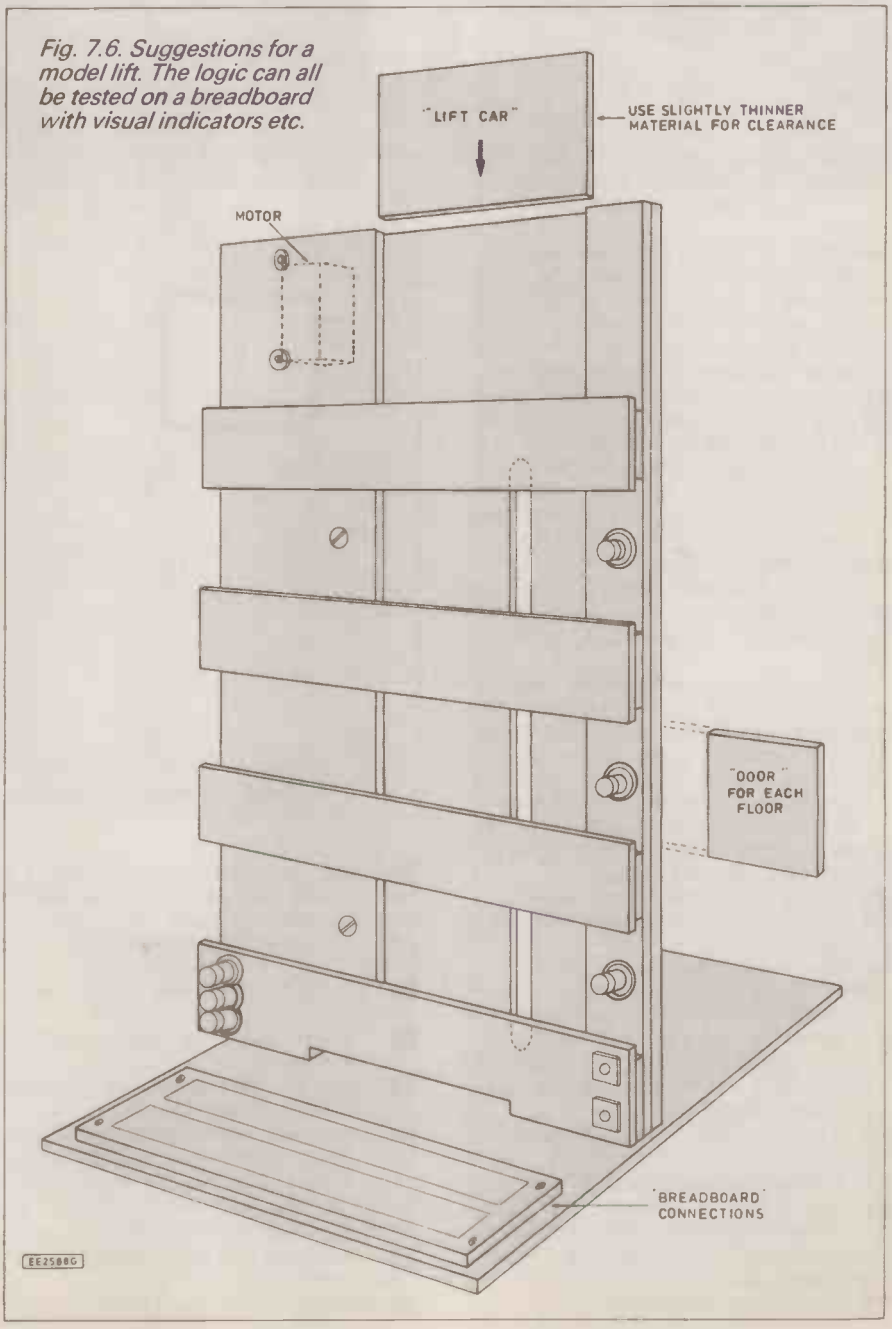
S *(another) I think I prefer the light beam type. I'll have a go at my own version of the whole thing.*

T Good. The mechanical design challenge is fascinating, isn't it?

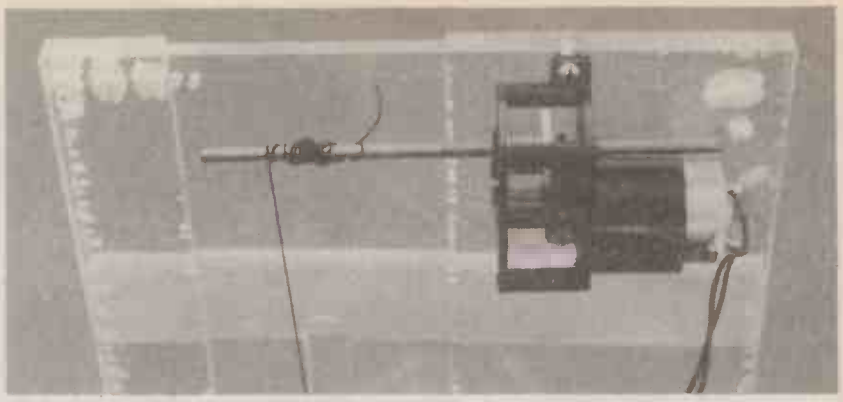
S *Can I test my lift before starting?*

T Good idea. You should all do it when you're ready. Check that each call button

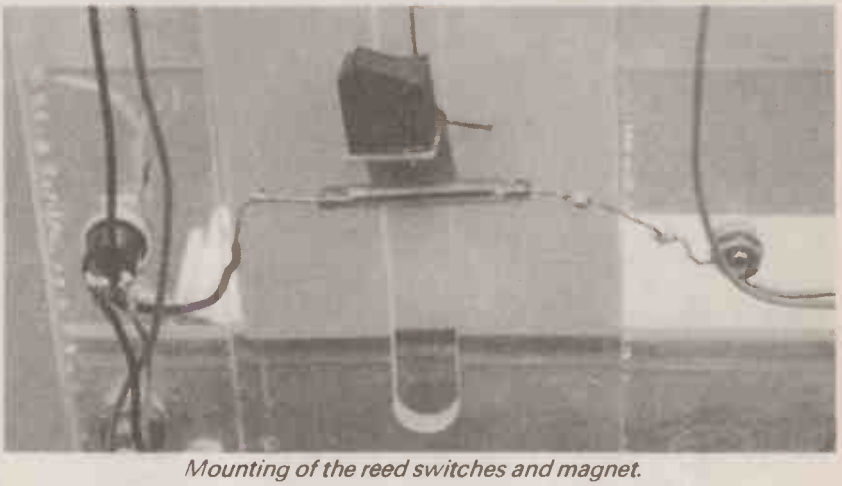
Fig. 7.6. Suggestions for a model lift. The logic can all be tested on a breadboard with visual indicators etc.



The basic lift structure



Simple motor and "cable" arrangement



Mounting of the reed switches and magnet.

and each sensor gives logic 0 by linking to an indicator. Afterwards, use signals from two switch units, linked to A and B motor drivers, and confirm that the motor goes up or down or stops as planned. Be ready to switch power off if it seems necessary!

S *The motor supply is separate, as before?*

T Right again. Now we'll start thinking about the logic for just two floors. Have a think yourselves first, then you may like to take up this simple technique, which always works with any combinational logic system, and to some extent with the sequential ones as well:

STEP 1. Consider each OUTPUT in turn, and note what input arrangements are needed for that output to be logic 1 (ON).

STEP 2. If there are only a few inputs, write them out as for a Truth Table (all possibilities), and mark those which are to put our output at 1. If there are many inputs you may get away with just listing these, in words to start with, if your prefer.

STEP 3. For each case (each line of the Truth Table), write an AND expression for all the inputs which are at logic 1.

S *What if we want logic 0 instead of 1?*

S *(another) Write "NOT whatever-it-is" instead.*

T Good for you. Just so.

STEP 4. Finally, link all these expressions with the OR function to cover all the cases (i.e. all the lines with 1 as output). Here's how it might work for our TWO-FLOOR lift: There will be four inputs, won't there?

S *Yes, a call button and a lift sensor for each floor.*

S *(another) and a door sensor.*

T Yes, that would make six, but I suggest we leave the door question out, and the limit stops as well, to start with. We can bring them in later.

S *Keep it simple at first, eh?*

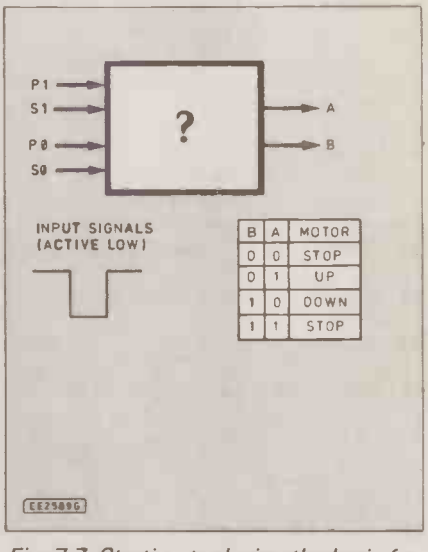


Fig. 7.7. Starting to design the logic for a two-floor model.

T Quite. Let's label them as in Fig. 7.7, and consider what input values we want to give output A a value of 1.

S *That means "Going Up" doesn't it/if B is at 0.*

T Yes, for Up, we agreed it's A = 1 while B = 0.

S *So we want it if push-button 1 is pressed; if P1 = 0.*

S *(another) But not if the lift is already there, at floor 1; that's if S1 = 0.*

T Right, so P1 = 0 AND S1 = NOT 0 = 1. OK? That's our first line, and we write it so as to show the two signals which have to be logic 1. Thus for P = 0, then NOT P1 = 1 AND S1 = 1 and the term is $\overline{P1}$.S1.

S *There won't be any alternative, so no more terms for output A?*

T Perhaps. It looks good so far, anyhow. If you have the model working and tested, you could try it.

S *Couldn't we test our lift logic on a plain breadboard, without having to build the working model? I'm not very good at making, or even assembling, mechanical devices. Besides, I'd like to get on with the electronics.*

T It's a valid point. The difficulty is that, in order to be useful in practice, the system would HAVE to work with a real lift, and we might find conditions we hadn't allowed for. However, if you can make your input and output signals behave EXACTLY as they would in a real system, a lot can be tried out and learnt without using the model, as you suggest.

S *You'd have to remember to change the sensor signals to represent the lift moving away/or up to it/and the lift will be slow, so you might have to allow for the time between floors.*

T Nevertheless, if you wanted to test an idea, and a suitable model isn't available, the bread-board can be very useful, as we've already seen with the "lock" Exercise.

In fact, as you know, electronic simulator circuits are widely used in design and for training purposes. My advice is to use the breadboard when it's much more convenient, but to grab any opportunities for trying out real, or even model, systems just to make sure.

S *(eventually) My lift goes up OK and stops OK, but that's it. I haven't got reverse working yet.*

S *(another) The B signal will give reverse. It's symmetrical, like this:* $B = \overline{P0}.S0$ *meaning the lift must go down if called from the ground floor AND if it's NOT already there. My lift works, too, but I didn't expect to have to hold the call button down until the lift arrives.*

T You certainly don't have to for a real

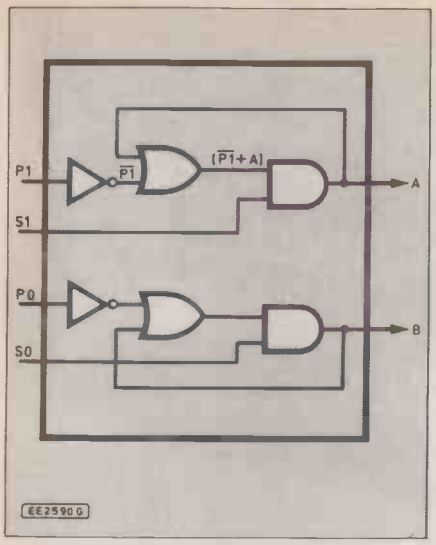


Fig. 7.8. First try at logic control — using ⅓ of 7404, ½ 7408 and ½ 7432.

lift. Can we do anything to make it unnecessary?

S *We could use a bistable at each call button/that would be handy to drive an indicator light, too.*

T Yes. If you wish you can include one, but remember, you'll have to provide reset signals as well as set signals for each one.

There is an alternative, though, for the two-floor version. You may get a clue by thinking back to the "electronic candle" we built right at the start of our Exercises. It kept itself alight, didn't it, once it have been lit (by a match).

S *I see. We can use feed-back again. Once A is on, it can provide the logic 1 even after the button is released.*

T Exactly. And it won't come on until started by the button. In fact, we're making the whole circuit into a big bistable system (Fig. 7.8) and our equations become: $A=(\overline{P1}+A).S1$ $B=(\overline{P0}+B).S0$

T That's fine. You seem to have cracked it, don't you?

S *(yet others) I'm trying both buttons at once/you would!/But you COULD have two customers calling it.*

T Well, what happens?

S *The lift stops between floors/because both A and B are then logic 1/the fourth line/sounds like a play title/what can we do about this?*

T Let's consider the situation if the lift has been called UP, has set off, then call button 0 is pressed. What effect do we now require? And is this what we have?

S *We want NO effect from it/but it stops the lift at present/we need to cut out its effect.*

T The trouble is, output B becomes 1 when A is already at logic 1. Well?

S *We could add a gate to prevent this from happening; to say that B can be 1 only when A is 0, as well as the conditions we already have. And the same for A = 1.*

T Very good thinking. We can write, then: $B=(\overline{P0}+B).S0.\overline{A}$ and $A=(\overline{P1}+A).S1.\overline{B}$

S *Yes, so now either can come on if the other got there first, and the lift will continue on its journey. But we need THREE-INPUT gates.*

T Yes, or an extra two-input one for each side. These arrangements are equivalent (Fig. 7.9).

S *We could use a three-input NAND (7410) followed by a section of a 7404 inverter.*

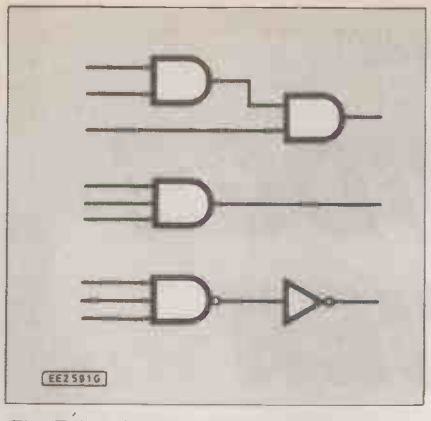


Fig. 7.9. All these alternatives would give the same logic output (a three-input AND gate).

T Excellent. Try it now. A 7420 (ignoring one input) would leave you a "spare", just in case.

S *(holding BOTH call buttons down) Look! It's gone mad. It's oscillating up and down non-stop.*

S *(another) Well, give it a chance. Let go of one of them.*

T It WOULD be tricky for a passenger wanting to leave a real lift, wouldn't it? What now?

S *Can we make it pause at each floor/add a delay circuit/a timer/or a counter/or make it stop until a call button is pressed again?*

T All sound ideas. There seems no harm in its going on AFTER a short pause. Real lifts seem to do this. We could add some kind of delay. There are two approaches.

S *Analogue and digital, I bet.*

T You'd win your bet. We could build a monostable type of delay (this is the analogue one) using resistor-capacitor circuits (we'd need large values) or we could have a digital counter to make the lift stop while it counts pulses from a "clock" generator. In either case, we'd also need to reset the delay whenever the lift stops.

S *There's more to this than one would imagine.*

T You can see the advantage of a lift boy (or girl).

S *Especially if she's pretty. (Another) Or he's handsome!*

T Back to our logic. Can you see the idea of a suitable circuit now? Let's try to write our "Boolean" equations once more (did you realise we're doing Boolean algebra?).

S *We'll need an extra gate input again/for the timer.*

T Let's call it T. And we may need another OUTPUT (R) to reset the timer (Fig. 7.10). Our equations become: $A=(\overline{P1}+A).S1.\overline{B}.T$

$B=(\overline{P0}+B).S0.\overline{A}.T$

I think the 7420/7404 combination is called for. We'd better draw "the circuit so far" (Fig. 7.11), then try it out carefully, with all our built-in fool-proof features.

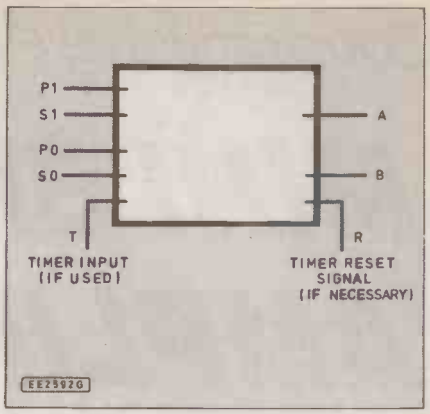


Fig. 10. Extra timer signals if a delay is to be added.

S *Could we temporarily "forget" the timer, like we did with the door and limit circuits?*

T Why not, if you prefer. It too can be added later, as it seems it applies to all the floors equally.

S *Can we tackle the three-floor version now?*

T Yes, in a moment. But I did promise to discuss the safety arrangements; the doors, and the limit stops. We COULD include them in the logic, but . . . ?

S *We'd need still more gates/bigger gates.*

T Yes. And they're all required to STOP the lift if anything isn't as it should be.

S *One big AND or NAND gate would take the lot.*

T It would. But we don't even need i.c. gates. If we have contacts which are opened whenever anything isn't "right", we need only connect them all in series with the motor supply and they form the AND system you mentioned (switches in series do perform the AND function, right?).

S *And in parallel they become an OR system.*

T They do. The rest of you, think about it. OK? So we'll do that on our model. It's a good "fail-safe" approach, too. When the door and limit switches are in place they are wired in series with the supply to the motor; then we can, we hope, forget them.

Next month: three floor lift logic.

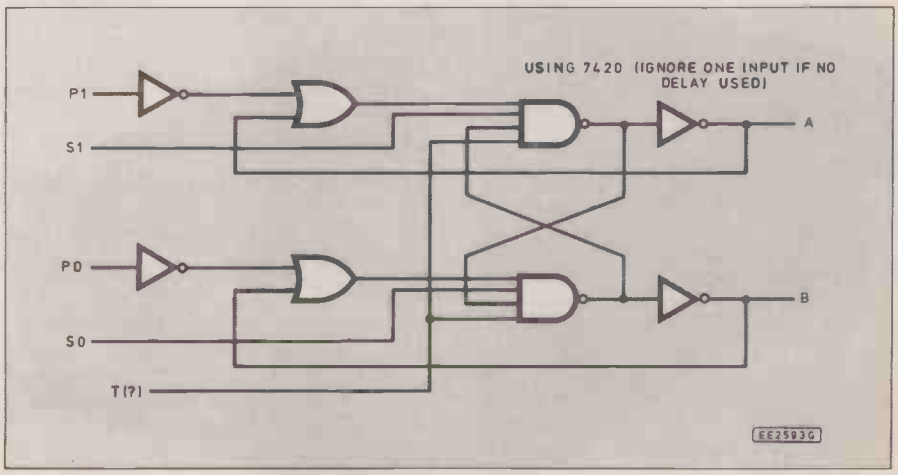
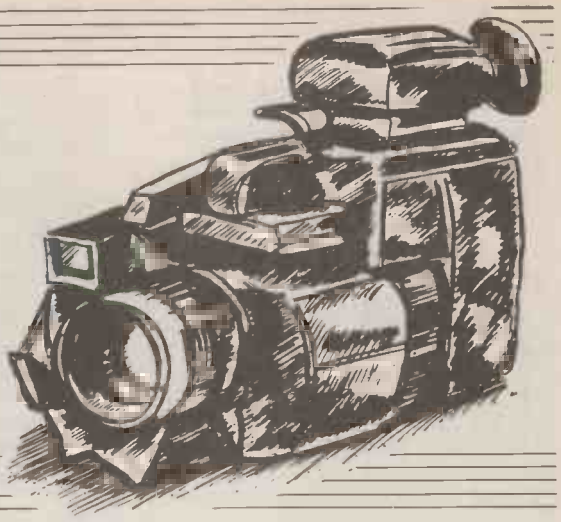


Fig. 7.11. Improved version for two floors.

Constructional Project

MINI BRIDGE AMPLIFIER



Robert Penfold

Stimulated by readers requests, this truly portable, mini amplifier will deliver up to 1.2W r.m.s. into 8 ohms at under 1 per cent distortion.

DESPITE an endless procession of new electronic gadgets, the humble audio power amplifier seems to maintain its popularity. Sooner or later, practically everyone involved in electronic project construction needs to amplify the output of some audio device or other. Letters from readers requesting a particular type of audio amplifier are not exactly a rarity.

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 portable amplifier suitable for use with video equipment. The unit should be equally suitable for operation with a guitar pick-up, or for use as a general purpose test amplifier.

LOW VOLTAGE – LOW POWER?

Where a physically small power amplifier is required, there is a definite advantage in using a low supply voltage and a high efficiency output stage. This enables a smaller battery to be used which, as well as aiding portability, also gives lower running costs.

In the past, low voltage power amplifiers have almost invariably been very low output power types. With today's transformerless output stages, a low supply voltage gives a very limited maximum output voltage swing, which produces an output power of just a few hundred milliwatts when applied to a standard 8 ohm impedance loudspeaker. It provides perhaps no more than 50 milliwatts when applied to a high impedance loudspeaker.

This all assumes that the output stage is operating at close to peak efficiency. At low supply voltages the inevitable voltage drops through the output transistors can be quite significant, and can reduce the actual output power to only about half the theoretical maximum for the supply voltage in use.

Obviously for many applications a very low output power is adequate. However, there are plenty applications where a slightly higher output power of about one watt r.m.s. or so into a somewhat larger loudspeaker would give more suitable volume and better quality reproduction. This can be achieved using a higher supply voltage, but as pointed out previously, this generally means using a larger battery with associated increases in running costs.

NOT IDEAL

Audio power amplifier integrated circuits which offer a solution to the problem with good output powers from relatively low supply voltages are not particularly new. A lot of these devices have been less than ideal for the home constructor though. Some are of the surface mount variety, and many seem to be prone to problems with instability.

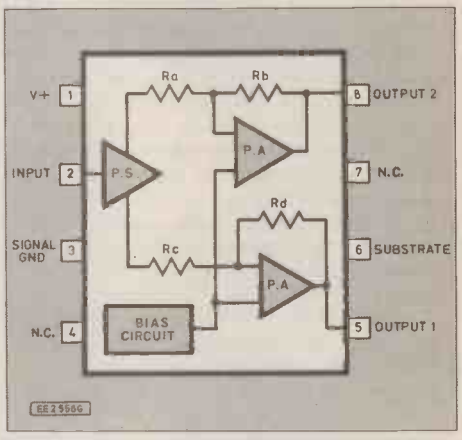


Fig. 1. TDA7052 internal block diagram and pinout details.

Most of these devices are based on the bridge amplifier principle. This will be described in detail later in this article, but it basically involves driving the loudspeaker from two power amplifiers, rather than from one amplifier and the earth rail.

This, in theory, permits double the output voltage swing and four times the output power to be obtained for a given supply voltage. Unfortunately, this type of circuit is inherently less stable than a single-ended design, which presumably accounts for the stability problems encountered with some bridge amplifier devices unless they are used in very carefully designed layouts (which often means using an earth plane on the top side of the board).

The Mini-Bridge Amplifier described here is based on a relatively new audio power amplifier device, the TDA7052. This is a bridge amplifier, but it does not seem to be any more fussy about the component layout than other modern audio power amplifier integrated circuits.

The TDA7052 is contained in a standard 8 pin d.i.l. plastic package, and no stability problems were encountered with the prototype which is built on stripboard. Double-sided printed circuit boards with

earth planes would seem to be totally unnecessary with this device.

PERFORMANCE

Performance of the circuit is more than respectable, with a maximum output power of about 1.2 watts r.m.s. into an 8 ohm impedance loudspeaker. In order to achieve this output power a supply potential of only 6 volts is required. Total harmonic distortion is well under 1 per cent at most output powers.

There are two inputs which have approximate sensitivities of 30 millivolts r.m.s. into 100k, and 3 millivolts r.m.s. into 10k. The former is sensitive enough for use with most items of equipment, including most low output guitar pickups.

The higher sensitivity input is suitable for operation with very low level signal sources, including some types of microphone. It is better suited to operation with higher impedance microphones (not crystal types) than low impedance types, but most low impedance dynamic microphones will work with this unit.

Outputs for an 8 ohm impedance loudspeaker and medium impedance headphones are provided. The loudspeaker is automatically switched off when the headphones are connected to the unit.

BRIDGE AMPLIFIER

The block diagram of Fig.1 shows the internal arrangement used in the TDA7052, together with pinout details. The two output terminals are fed from separate power amplifiers, and these are basically ordinary inverting mode circuits.

A bias circuit sets the quiescent output voltages, and two twin resistor networks set the closed loop voltage gains of the amplifiers. The voltage gain is set by these internal components at about 40dB (one hundred times).

It is vital that the output voltages are accurately matched, since any mismatch will result in a strong current flow through the low resistance of the speech coil in the loudspeaker. It would be possible to include a d.c. blocking capacitor at the output, but this is not entirely satisfactory as a high value component would be needed. It would therefore need to be an electrolytic type, but the correct polarity for this component could only be determined by measuring the output voltage, and then fitting it the appropriate way round!

The TDA7052 has an accurate biasing circuit that results in only a minute offset voltage across the outputs, and there is no risk of its low quiescent current consumption of four milliamps being compromised.

Low voltage power amplifiers often utilize bootstrapping capacitors which couple the output signal back to the supply input of the driver stage. This effectively boosts the supply voltage to the driver stage, enabling a higher positive output voltage to be obtained, and giving increased output power for a given supply voltage.

The TDA7052 has no provision for bootstrapping capacitors, and achieves high efficiency by having an output stage configuration which has an innately low voltage drop through each output transistor. In order to achieve an output power of 1.2 watts into an 8 ohm impedance loudspeaker using a supply potential of just 6 volts, the voltage drop across each output device has to be kept down to no more than about 0.8 volts.

ANTI-PHASE

Simply driving the inputs of the two power amplifiers from the same signal source does not give the desired power boosting action. The two output voltages would vary in sympathy with one another, giving no voltage difference across the outputs, and zero output to the loudspeaker.

In order to get the increased output power available from a bridge type output stage, the two power amplifiers must be driven in anti-phase. In other words, as the output of one amplifier goes more positive, the output of the other amplifier must go negative by the same amount. The required anti-phase drive signal is generated by a phase splitter stage at the input of the TDA7052.

When the output of one amplifier is fully positive, the other is fully negative. With a theoretically perfect output stage, this gives a voltage across the loudspeaker that is equal to the supply voltage.

On the opposite signal peak, we again have the output of one amplifier fully positive, and the other one fully negative. Also as before, this gives the full supply voltage across the loudspeaker. However, the polarity of the voltage is the now changed. With a 6 volt supply, it is therefore possible to obtain an output voltage range of +6 volts to −6 volts, giving a peak to peak output voltage of 12 volts. This compares with the 6 volts of a single-ended output stage.

Power is equal to voltage multiplied by current. In doubling the maximum output voltage, the output current is also doubled. In terms of output power, a bridge amplifier gives a theoretical fourfold increase. In practice the increase is likely to be a little less than this, as the increased output current is almost certain to be accompanied by an increase in the inevitable voltage drops through the outputs transistors.

The practical result should still be a substantial increase in the output power for a given supply voltage and loudspeaker impedance, with the actual amount not much less than four times.

CIRCUIT OPERATION

The full circuit diagram for the Mini Bridge Amplifier is shown in Fig.2. IC2 is the TDA7052, and as will be apparent from the diagram it requires few discrete components. In fact it requires only supply decoupling capacitors C1 and C2, and volume control VR1.

Like many modern audio power amplifier devices, no d.c. blocking capacitor is required between the input terminal and the volume control. SK3 is the headphone socket, which is a 3.5 millimetre stereo type having twin break contacts. The latter cut off the signal to the loudspeaker jack (SK4) when a plug is inserted in SK3. The earth tag of SK3 is not used, and the phones are series connected across the output of IC2.

PREAMP

A simple preamplifier stage is formed by IC1. It is, more or less, a standard operational amplifier inverting mode circuit. Two inputs are provided, with each one having its own input resistor and d.c. blocking capacitor.

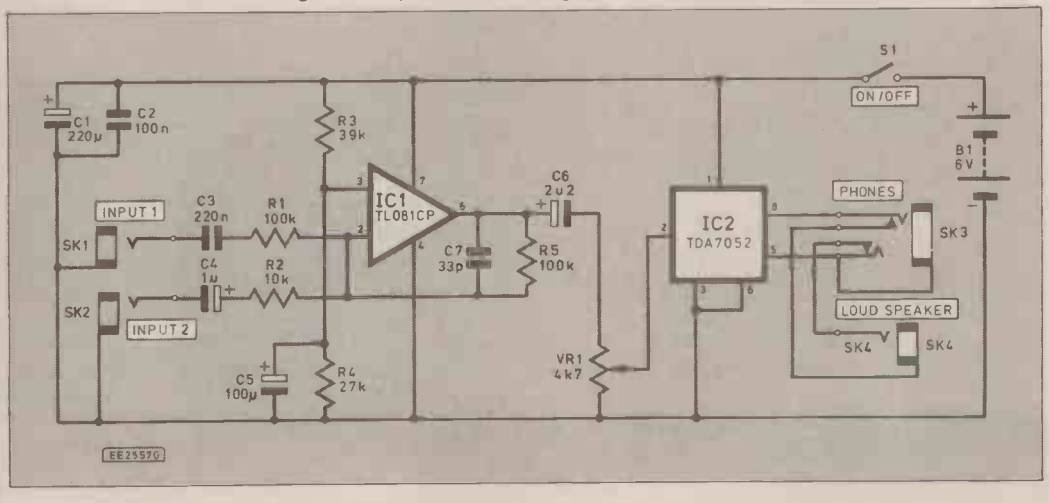
The closed loop voltage gain of IC1 is equal to the value of R5 divided by the value of the input resistor (R1 and R2). The input impedance is equal to the value of the input resistor. IC1 therefore provides no voltage amplification to any signal applied to SK1, but it does act as a buffer amplifier giving a reasonably high input impedance of 100k. The input impedance is lower at SK2, but IC2 provides a voltage gain of ten times at this input.

The input sensitivity at SK1 is more than adequate for most signal sources, such as tuners, tape decks, video equipment, etc., and this is the one that will normally be used. SK2 is only needed for very low level input signals, which mainly means microphones.

If necessary, the voltage gain can be boosted (at the expense of reduced input impedance) by making R2 lower in value. However, more than a modest boost in gain is likely to result in instability. No input selector switch is included – you simply connect an input signal to whichever input you wish to use.

IC1 will function as a simple summing mode mixer stage if signals are applied to both inputs, and no harm will come to the amplifier or equipment connected to the inputs if both inputs are used at once. In the interest of good performance with a low background noise level it is advisable

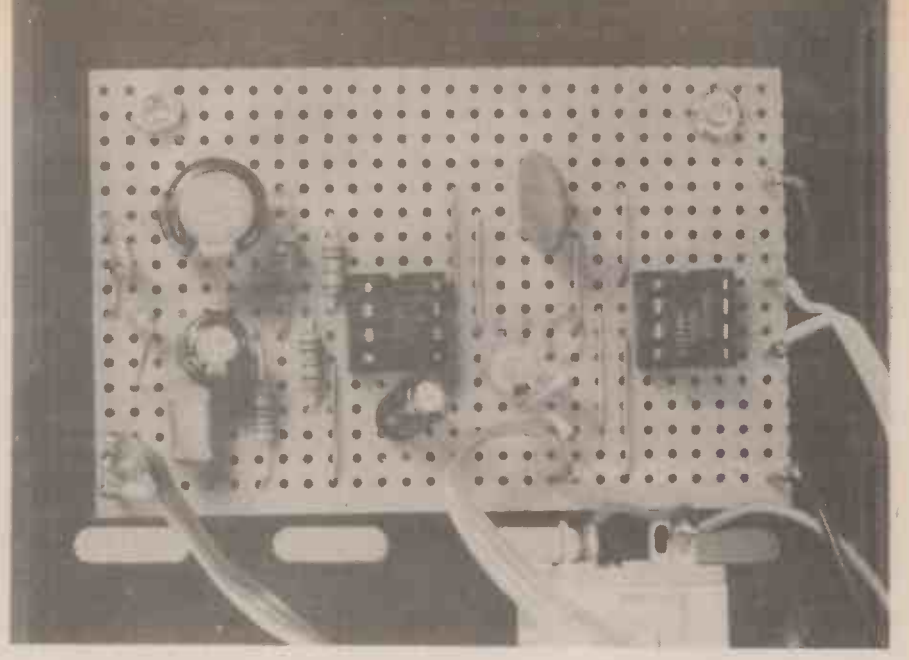
Fig. 2. Complete circuit diagram for the Mini Bridge Amplifier.



to disconnect whichever input is not in use.

Resistors R3 and R4 provide biasing to the non-inverting input of IC1. The biasing has purposely been made non-symmetrical, so as to match the non-symmetrical characteristics of IC1's output stage. This optimises the unclipped output voltage swing from IC1, which is more important than usual due to the rather low supply potential of 6 volts.

Although the quiescent current consumption of IC2 is only about four milliamps, and IC1 will only add to this a further one or two milliamps, IC2 has class B output stages that will consume quite high currents at high volume levels. In fact the current consumption can be around 200 to 300 milliamps at high volume levels. This necessitates the use of a reasonably high capacity 6 volt battery, and one which has a low source impedance. Four good **quality** HP7 size cells represent about the *minimum* power source that is likely to give good results.



CONSTRUCTION

The amplifier is based on a 0.1 inch pitch stripboard which has 28 holes by 17 copper strips. Details of both the component layout and the underside of the board are provided in Fig. 3.

Start construction by cutting out a board of the appropriate size. This is easily accomplished using a hacksaw or junior hacksaw, cutting along rows of holes, not between them.

This leaves rather rough sawn edges to the board, but they are easily filed to a neat finish. Next make the fourteen breaks in the copper strips, taking due care to get them all in the right place. They can be made using the special spotface cutter tool, or a hand-held twist drill bit of about four millimetres diameter will do.

Two mounting holes are required, and for M3 or 6BA fixings these can be 3.3 millimetres in diameter. If you mount the board on plastic stand-offs, then the diameter of these holes must be chosen to suit the particular stand-offs used.

The board is then ready for the components and link wires to be fitted. Construction is probably easiest if you add the integrated circuit holders first, and then add the resistors, capacitors, and link wires around them. The link wires are made from 22 s.w.g. tinned copper wire, or trimmings from resistor and capacitor leadout wires will suffice.

For the capacitors to fit into the layout properly they must be the appropriate printed circuit mounting types. Be careful to connect the electrolytic capacitors with the correct polarity. At this stage single-sided pins are fitted to the board at the points where connections to off-board components will be made.

CASE

The minimum size of case that can be used depends on the exact form the unit will take. If, like the prototype, it is constructed for use with an external loudspeaker and using four HP7 size batteries as the power source, a case of about 86 by 144 by 42 millimetres is adequate. If the loudspeaker is built-in, or a higher

COMPONENTS

Resistors

R1, R5	100k (2 off)	See
R2	10k	Shop
R3	39k	Talk
R4	27k	page 409

All 0.25W 5% carbon film

Potentiometer

VR1	4k7 log. with switch (S1)

Capacitors

C1	220µ radial elect. 10V
C2	100n ceramic
C3	220n polyester (7.5mm pitch)
C4	1µ radial elect. 10V
C5	100µ radial elect. 10V
C6	2µ2 radial elect. 63V
C7	33p ceramic plate

Semiconductors

IC1	TL081CP J—f.e.t. Op. amp
IC2	TDA7052 1.2W power amp

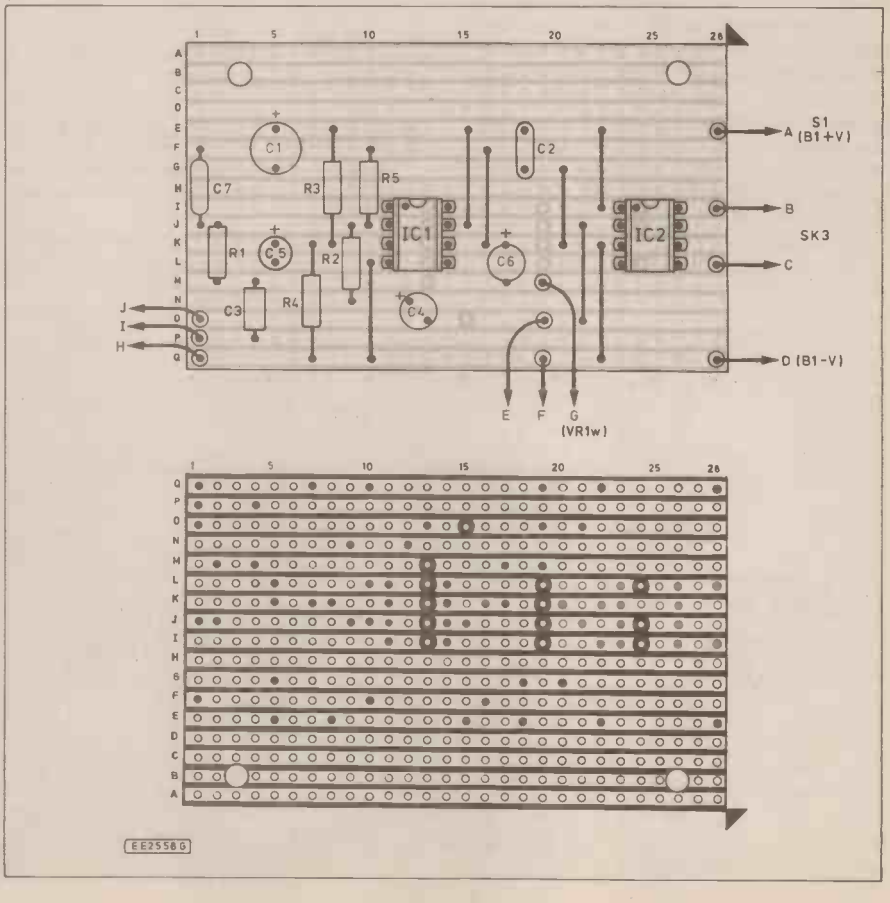
Miscellaneous

SK1, SK2, SK4	3.5mm jack socket (3 off)
SK3	stereo 3.5mm jack socket
B1	6 volt (4 x HP7 size cells in plastic holder — see text)

Stripboard, 28 holes by 17 strips; case about 86mm x 144mm x 42mm; 8 pin d.i.l. i.c. holder (2 off); battery connector (PP3 type); control knob; wire; solder; pins, etc.

Approx cost. Guidance only **£12.50**

Fig. 3. Circuit board component layout and details of breaks in the underside copper tracks. The completed board is shown above.



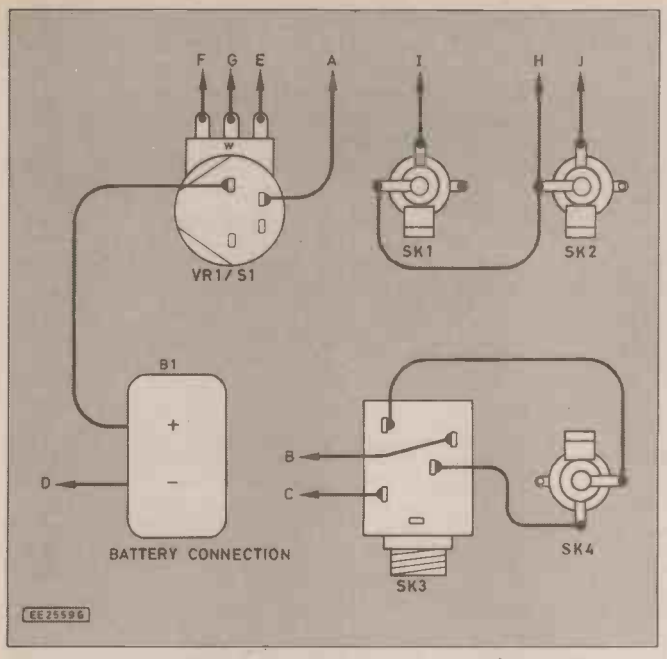


Fig. 4. Interwiring from the off-board components to the circuit board, Fig. 3.

The two front panel mounted input sockets and volume control. The output sockets are mounted on the rear panel.

capacity battery is used, then a very much larger case will be needed.

Remember that the unit has a maximum output power of about 1.2 watts, which is too high for most miniature loudspeakers (about 50 to 80 millimetres in diameter). This power level will probably necessitate the use of a loudspeaker of at least 100 millimetres in diameter.

Assuming the unit is to be built along the same lines as the prototype, the combined volume control and on/off switch is mounted on the front panel, together with the two input sockets. The headphone and loudspeaker sockets (SK3 and SK4) are mounted on the rear panel. There is a potential danger here, in that neither output of the TDA7052 is at earth potential.

If you use a metal case and non-insulated sockets there is a risk of short circuiting one output of IC2 to the earth rail. Using a plastic case, or a plastic type having metal front and rear panels avoids this possibility. If the unit is fitted in a metal case, either SK1 and SK2, and (or) SK3 and SK4 must be insulated sockets.

The circuit board is mounted on the base panel of the case just to the rear of VR1, S1, etc. This leaves sufficient space for the battery in the rear section of the case. The connections to a plastic battery holder for four HP7 size cells is normally via a standard PP3 type battery connector.

HARD WIRING

The hard-wiring is then added, using multi-strand connecting wire or pieces of ribbon cable. Details of this wiring are shown in Fig.4, which operates in conjunction with Fig.3 (e.g. point "A" in Fig.3 connects to point "A" in Fig.4.).

There is no need to use screened cables for the input wiring, but keep this wiring as short as possible. Also, keep the input and output wiring as well separated as possible. With a bridge amplifier the input is in-phase with one of the output lines, and a significant amount of stray feedback is likely to result in instability.

TESTING, TESTING

If a multimeter is available, this should be used to monitor the current consumption of the unit when it is first switched on. After an initial surge as the capacitors charge up, the quiescent supply current should only be about 5 or 6 milliamps.

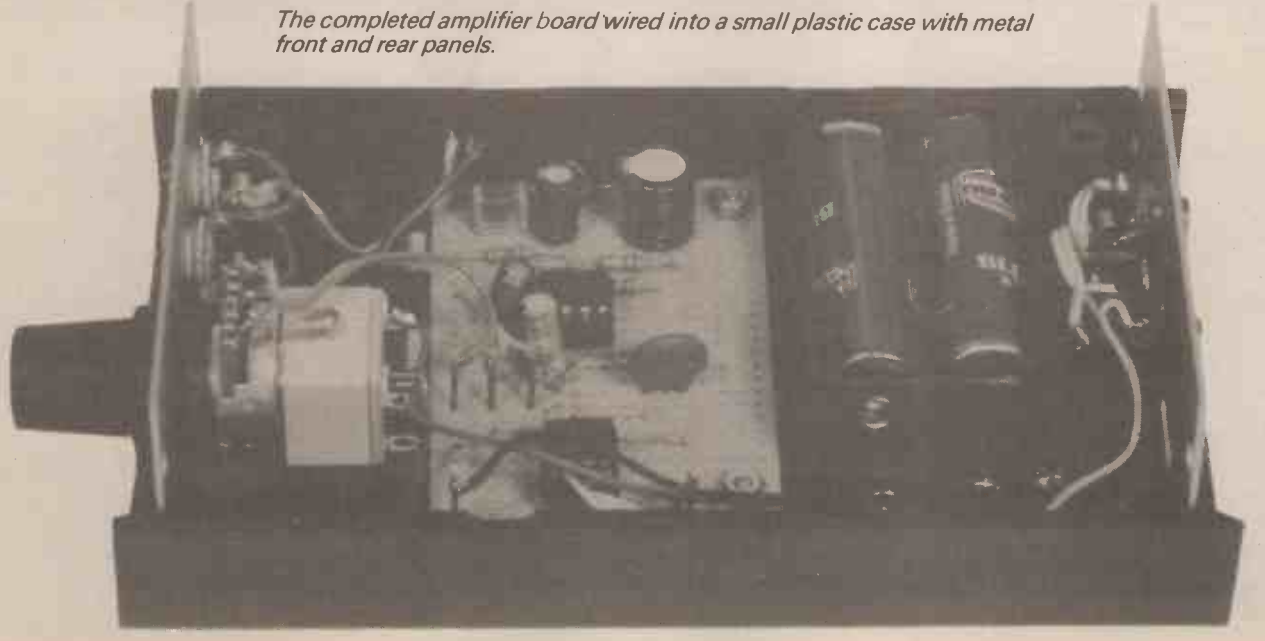
Do not worry if there is no switch-on "click" from the loudspeaker – the bridge circuit virtually eliminates switch-on and switch-off "clicks". Do worry if the current consumption is far removed from the expected level. In fact you should switch off immediately and recheck the wiring.

If all is well, remove the multimeter, reconnect the supply, and try connecting a suitable signal source to one of the inputs. Although the output power of the unit is only about 1.2 watts r.m.s., with any reasonably efficient loudspeaker this is sufficient to give quite high volume (comparable to a large radio or medium size television.)

Socket SK1 is the input that should normally be used. SK2 is only used for very low level inputs that give inadequate volume when coupled to SK1. Using high level inputs with SK2 will make it difficult to control the volume, and will almost cetainly result in severe distortion due to clipping at the output of IC1. The input connecting leads should be of the screened variety so that significant pick up of mains "hum" etc. is avoided.

The amplifier i.c. (IC2) has short circuit protection, but it does not have thermal shutdown circuitry. Do not use a supply voltage of more than 6 volts, or a loudspeaker having an impedance of less than 8 ohms. Either of these could result in IC2 overheating and being destroyed. □

The completed amplifier board wired into a small plastic case with metal front and rear panels.



ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

IN THIS months instalment of *"On Spec"* we shall be introducing the Spectrum Music Group, taking a look at MGT's SAM Coupé "Communications Interface", and telling you how you can win a substantial prize for your programming efforts. We have also included another version of our Big Print program so hopefully there is something for everyone in this month's instalment!

Spectrum Music Group

Sean Sanderson has sent me a fascinating letter introducing the *Spectrum Music Group*. This organisation is a user group concerned primarily with the Music Machine Interface from Ram (now distributed by Datel). Sean writes:

"The Spectrum Music Group aims to help members grapple with the technicalities of MIDI and music and getting across as much information as possible in a clear and simple fashion.

The group is concerned with music in general and MIDI in particular. The area I am interested in is simulating "real" instrument sounds. It should/might be possible to generate different waveforms by fast machine code writing to the volume and pitch registers.

I would particularly like to get a Bass Drum and Snare simulation. Also, I wonder if the "timbre" of an instrument could be achieved by setting the "fundamental" note with one register and using the other five to add the harmonic pitches at the right volumes to give a simple but richer timbre?

I am also working closely with Joseph Karthouser and Keith Turner who are developing MIDI sequencing packages for the SAM Coupé. Unfortunately, I have not worked with music chips before, though I know that some interesting effects have been achieved with the Commodore SID chip and the 128k Spectrum chip".

Sean has sent me a most impressive demonstration tape (issue 3 of the Spectrum Music Group club tape). This tape will be of great interest to all Spectrum/SAM music enthusiasts.

Membership of the Spectrum Music Group costs £5 (including postage) for four issues of the (approximately) quarterly tape magazine. The group welcomes new members and details can be had by sending a stamped addressed envelope to *Sean Sanderson* at *"Chesters", Chesters Lane, High Bentham, Lancaster, LA2 7AN.*

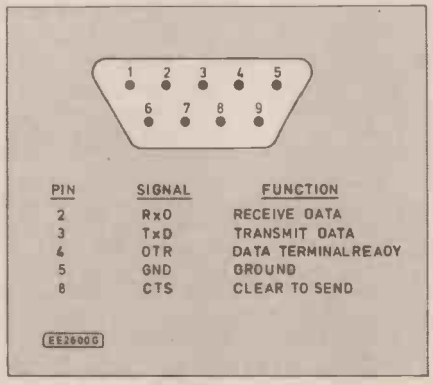


Fig. 1. RS-232 connector pin connections on the Sam Coupé Communications Interface

Big Print Mk2

Sean Sanderson's letter was accompanied by an interesting refinement of the Big Print routine which I described in an earlier *On Spec*. Sean's version (shown in Listing. 1) is well worth the effort of keying in so I make no excuses for including it here.

Competition time!

Miles Gordon Technology (MGT), manufacturers of the SAM Coupé, have recently entered into the world of software marketing. To mark this venture, MGT are launching a £20,000 competition for the best original SAM software published in 1990. The industry magazine *Computer Trade Weekly* will act as an independent judge and jury.

MGT is particularly keen to promote software which exploits the SAM Coupé's powerful capabilities (which rival those of many 16-bit machines).

Prizes are being awarded as follows:

First Prize: £15,000

Interim prizes: Four prizes each of £500 awarded in March/April, May/June, July/August and September/October

In addition to these prizes, MGT will be awarding three further prizes (each of £1000 for the best entries in each of the following categories; aged under 12, aged 12 to 16, and non-games software.

The competition should certainly be a stimulus to new and existing software writers and hopefully will generate a good deal of exciting new software for the SAM Coupé. My own "wish list" would include a software development system to rival that of Ocean's **Laser Genius** (in terms of power and sophistication); a 3-D CAD package to beat Sinclair's **View 3D**; and a SAM **BASIC** compiler to equal HiSoft's **BASIC**.

Let's hope that someone is already working along these lines. I, for one, would rush out and eagerly part with some cash!

Further details, competition rules, and entry forms for MGT's SAM Coupé competition can be obtained from *Miles Gordon Technology plc, Century Park, Valley Way, Swansea, SA6 8QP.*

Communications Interface

Communications adds an extra dimension to any microcomputer system and a very welcome arrival through my letter box just before Easter was the long awaited SAM Communications Interface from MGT. This little unit interfaces with the expansion connector at the rear of the Coupé and provides both parallel (Centronics) and serial (RS-232) interfaces.

The communications interface provides two rear mounted connectors; 9-pin DIN for the serial interface and a 26-way IDC connector for the Centronics output. Both the serial and parallel ports can be in use at the same time but if you wish to connect another external interface (e.g. an external disk drive adaptor) to the Coupé's expansion connector you will have to invest in the SAM Card Cage (due for release later this year).

The SAM Coupé Centronics interface makes use of a standard BBC-type printer cable (as used for the MGT Plus-D interface) whilst the RS-232 connector is IBM PC-AT compatible. For the technophile, Fig. 1. and Fig. 2. show the pin connections for these connectors.

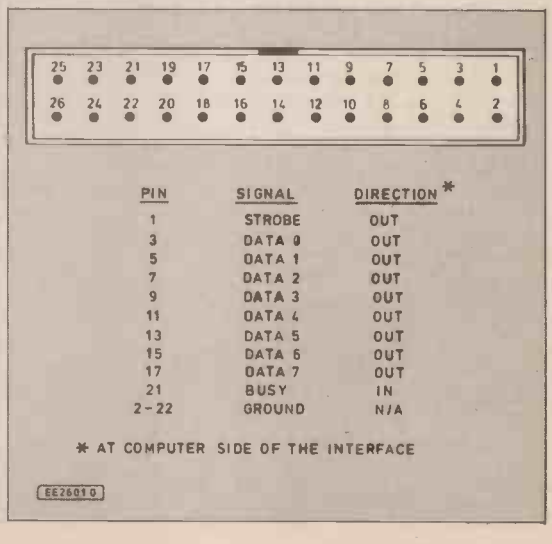


Fig. 2. Centronics connector pin connections on the Sam Coupé Communications Interface

Listing. 1: "Big Print Mk2" from Sean Sanderson

```
5 GO SUB 1000
10 FOR A=64 TO 71: POKE 23681,A: LPRINT "     Big Print Mk2  ": NEXT a
15 LET z=0
20 FOR a=72 TO 79: POKE 23680,z: POKE 23681,a
25 LPRINT a$
30 POKE 23681,89: LPRINT b$
40 NEXT a
45 LET z=z+32: IF z>255 THEN GO TO 15
50 GO TO 20
1000 LET B=USR "A": FOR A=0 TO 7: POKE B+A,120+A: NEXT A
1010 LET b$="■": FOR a=0 TO 5: LET b$=b$+b$: NEXT a
1020 LET a$="      SPECTRUM MUSIC GROUP      "
1030 RETURN
```

(Note that the character marked ■ in line 1010 is a graphic A).

The Communications Interface is supplied with a simple instruction sheet which provides details of using both the serial and parallel ports. An RS-232 configuration program is supplied on tape and this allows users to define the baud rate and data format for serial communications. Various options are included within the configuration program which allows users to save communications drivers which include different setting for different applications.

The serial interface can be used very easily from SAM BASIC using commands such as **OPEN #**, **INPUT #**, **PRINT #** and **CLOSE #**. A simple example is provided which shows how input characters from a modem (via the RS-232 port) can be directed to a parallel printer (via the Centronics port).

The parallel interface is very easy to use as it requires no configuration. The interface responds to the usual **LLIST** and **LPRINT** commands and is available immediately from power-up whenever the Communications Interface is attached.

Next Month: We shall present the first of a series of interface projects for the SAM Coupé. This will take the form of an 8-Channel Analogue to Digital Converter.

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.**

SHOP TALK

with David Barrington

New Premises

Coming just too late for constructors of the *Amstrad CPC Speech Synthesiser* project (last month's issue) was the news that *Greenweld Electronics* had moved to new premises. They inform us that they have purchased a further 6,000 square feet of storage and office space.

They expect to be carrying many new lines and have opened a "trade counter" offering very competitive prices on bulk purchases. For further information their new trading address is: **Greenweld Electronics Ltd., 27D Park Road, Southampton, Hants SO1 3TB.** ☎ *0703 236363; Fax 0703 236307.*

Catalogues Received

This month we should like to take the opportunity to catch up on some of the excellent components catalogues that have arrived in the office recently. We always look forward to receiving any catalogues, and ask advertisers to keep them flowing as it helps us in our search for "hard-to-find" items.

Available either by post or from their shops, the latest catalogue from **Henry's Audio Electronics** contains over 250 pages in full colour.

Although their reputation is built on excellent high quality audio equipment, they also stock such items as meters, aerials and intercoms. Needless to say, the range of audio accessories, ranging from microphones to full disco set-ups, is second to none. The catalogue also carries sections on components, security equipment and test gear.

Copies of the Henry's catalogue cost £1 to callers and £2, with a s.a.e., for mail orders. It is available with one of two price lists, retail or trade/education, and contains redeemable vouchers with a claimed total value of £90. **Henry's Audio Electronics, Dept EE, 301 Edgware Road, London W2 1BN.**

The latest "summer" edition of the **Cirkit** Electronic Constructors Catalogue contains over 180 fully illustrated pages, many packed with new lines, and costs £1.60 from larger newsagents or direct from Cirkit. It also contains £10 worth of discount vouchers.

Once again they are running an easy to enter competition; closing date for entries 1 October 1990. This year the prizes are: 1st prize – Bearcat scanning receiver; 2nd and 3rd prizes – TM5375 Digital Multimeter, with 20Mhz frequency counter facility; 4th and 5th prizes – 25W soldering iron. They ought to give an additional prize for spotting the "deliberate" mistake!

Cirkit Distribution Ltd., Dept EE, Park Lane, Broxbourne, Herts EN10 7NQ.

Finally, we should like to mention the latest No. 15 edition of the **Cricklewood Electronics** components catalogue. The 1990 copy contains over 150 pages and costs £1.50, inclusive of postage. They have added, it is claimed, around 2,400 items to their stocks, partially due to having taken over the entire stocks of USD Ltd and to natural additions to their stock range during the last 12 months. Having diversified into such areas as hobby kits, loudspeakers, headphones, aerials and even video heads has also helped to swell their stocks. Amongst their kits is an "apple radio" and a gas/alcohol sensor.

The semiconductor section contains well over 60 pages, most with pin outlines and technical information. **Cricklewood Electronics Ltd, Dept EE, 40 Cricklewood Broadway, London NW2 3ET.**

Mains Appliance Remote Control

As the series on the *Mains Appliance Remote Control (MARC)* unfolds during the next few months, some of the components used will require special mention. These items will be highlighted as each project is published. As some of the models are connected to the mains, it is most important that only new high quality components are used.

The SL490 remote controller encoder i.c. used in the *Handheld Infra-Red Transmitter was obtained from* **Maplin** and carries the order code YH66W(SL490). They also stock an equivalent infra-red emitter diode to the TIL38.

The twelve printed circuit board keyswitches used to form the "keypad" were purchased from **Cirkit**, code KHC10901 (stock no. 53-10901). They are fitted with transparent tops type KT5 (stock No. 53-19080). If a different type of switch is used check that it will fit on the board and also that the pinouts are identical.

The case is the Cirkit moulded type, with integral battery compartment, stock code 21-06030.

The two printed circuit boards for the transmitter have been produced as one item, to save on cost, and will have to be carefully separated with a small saw. These board(s) are available from the *EE PCB Service*, codes EE692/693.

80Metre Direct Conversion Receiver

There are one or two components called for in the *80Metre Direct conversion Receiver* that will most certainly cause local purchasing problems.

The double-balanced mixer i.c., type SL1640C, caused quite a lot of tracking down problems and the only source of supply we have been able to locate is from **Cirkit**. When ordering quote stock code 61-01640.

All the Toko inductor coils were purchased from the above company. They claim to be the main UK distributors.

The Jackson type variable tuning capacitors are stocked by a number of our advertisers and should be readily available. Our experience shows that the prices for these items varies quite considerably, as much as £2 each, and it is probably wise to check around before buying.

The printed circuit board for this amateur band radio is available through the *EE PCB Service*, code EE691.

Telephone Alert

Some readers may experience difficulty in obtaining the ICL7611 micropower op.amp i.c. used in the *Telephone Alert*. This device is currently listed by **Cricklewood Electronics** (☎ *081 452 0161).*

The British Telecom approved plug-in "ringer" should be available from telephone shops. However, in case of difficulty, it is available from **Maplin**, code FV96E (Tele Ringer) £5.45.

Mini Bridge Amplifier

The semiconductor devices called for in the *Mini Bridge Amplifier* are fairly common devices and should not cause any purchasing problems. Remember to quote a "log" type potentiometer.

This amplifier has a maximum output power of about 1.2W which will most likely be too high for the popular, inexpensive miniature loudspeakers of about 50mm to 80mm diameter. This means that you will probably require a speaker of at least 100mm in diameter and above.

Micropower Stabilised Voltage Regulator

We do not expect any local component buying problems for constructors undertaking the *Micropower Stabilised Voltage Regulator*. The 18-turn cermet presets are now stocked by most of our advertisers.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Too Much Fizz

Next time someone shows me an electronic test facility, equipped with all the best gear available, I shall ask them for a glass of Perrier.

In February 1990 traces of Benzene were found in bottles of Perrier water, and the company had to withdraw stocks all round the work, at a short term cost of millions. Even when the bottles re-appeared again, in April, confidence had been so badly shaken that the long term loss is incalculable.

Although benzene is a known carcinogen (cancer trigger) the levels found were probably quite safe. But Perrier sells on the image of purity.

At first no-one knew how the benzene had got into the water. One theory was sabotage, another that the bottles had been cleaned with chemicals. Or perhaps someone had used an oily rag. Or impurities had leached from the soil to the spring.

It took British scientists hired by Perrier's headquarters at Vergeze (pronounced with a soft "g") near Nimes in Southern France to come up with the answer. Hydrotechnica of Shropshire, a group of independent analysts who specialise in petroleum geology, confirmed that when the French Ministry of Health, and Gustave Leven, President of the Source Perrier, pronounced thee spring water source to be "100 per cent pure", they were absolutely right. What the French had not known or said was that the gas which makes Perrier fizz was contaminated with hydrocarbons, including benzene.

The benzene was not a cleaning fluid, accidentally, or deliberately, introduced at the surface. Nor did it seep down into the source from contaminated soil. It was generated naturally, in the bowels of the earth. Perrier's staff at the bottling plant in Vergeze knew it was there but fell down on their routine of filtering it off.

It so happens that I had visited Vergeze a year before the incident, and had seen the technology for myself. I had also seen the laboratory which is supposed to guard against such eventualities.

For the first half of the century the gas and water were pumped together from the ground. Then, in 1956, Perrier persuaded the French government to authorise pumping through separate pipes. Since then the gas and water have only come together at the bottling machines.

The water source at Vergeze is a natural spring which was once an open lake several hundred square metres in area. The mineral-rich spring water comes from the neighbouring limestone hills and is contained by clay.

The carbon dioxide gas is generated by deep limestone which is continually being decomposed by heat from the earth's magma. The CO2 rises to the surface through volcanic fractures in the rock.

Prior to 1956 the gas dissolved naturally in the spring water under pressure. Perrier than capped the area with a massive slab of concrete, drilled one pipe to 30 metres to collect still water and another 200 metres to collect the gas, quite separately.

Gas Mask

Perrier has always made much of the fact that its gas is natural, and only 99.7 per cent pure, which contributes to the taste. As the 0.3 per cent impurity is mainly inert nitrogen, helium, argon and neon, all tasteless gasses, this may sound a nice idea but it does not hold water. The characteristic taste comes from the extraordinary mix of chemicals in the water, including traces of cyanide, selenium, cadmium, chromium and arsenic!

What Perrier has never previously admitted, is that the gas also contains hydrocarbon impurities, including benzene an toluene. These are produced by reaction of hot CO2 on vegetable and animal organic matter trapped far beneath the surface.

To get rid of these potentially dangerous chemicals Perrier passes the gas through activated charcoal filters, which work like a gas mask or odour-eating shoe insert. The carbon lets the inert impurities through but traps the benzene and toluene. But, as with gas masks and shoe inserts, the carbon loses activity over a period of time, or if there is a burst of more impurity than usual.

The carbon filters must thus be regularly checked and replaced. To Perrier's considerable cost, this was not done, letting traces of benzene and toluene get through to the bottling machines.

Quite simply, an employee did not change a filter that needed changing. He, or she, is presumably now an ex-employee.

Check Out

In my book, the far more serious issue is how Perrier's laboratory came to miss the problem. At Vergeze there is a two storey building which employs a staff of 20 to check the bottled water every hour with equipment for spectrophotometry, gas chromatography, atomic absorption and plasma torch analysis.

The moral of this true story is that there is no point in having the best-equipped laboratory in the world if the people running it don't use the technology available to them. And that goes for any industry. Managers ingore this at their peril.

Dynamic Sounds

A disc jockey recently told me how he and his engineers discovered by accident, back in the seventies, how to make a live disco system sound extra punchy. They were experimenting with compressors, which squash the dynamic range by making quiet sounds louder and loud sounds quieter, and with expanders, which expand the dynamic range by making quiet sounds quieter and loud sounds louder.

Normally you use a compressor on some music and an expander on other music; but never the two together because it's a pointless exercise to compress music and then expand it again. Or is it?

On one occasion the disco crew made the mistake of connecting the output of the compressor to the input of the expander. The sound they got was meaty and punchy and cut through the crowd noise like a knife.

Doubtless many professional disco DJ's are now playing the trick. But anyone who isn't might like to try it.

Sharp Research

You may have read that Sharp is spending £10 million (pounds) on a research and development centre at the new science park being built near Oxford by Magdalen College. Canon has already opened a small research centre at the University of Surrey Research Park in Guildford. This puts heavy pressure on Matsushita/Panasonic, which has for five years been promising to open an R & D centre in Europe but so far failed to deliver the goods.

Sharp's move looks likely to embarrass the government. The Japanese have employed a British civil servant to run their centre. Dr Charles Bradley will leave the Cabinet Office, where he is head of the Secretariat of the Advisory Council on Science and Technology, to lead a team of 30 British scientists and engineers. They will work for Sharp on opto electronics, information technology and high definition television.

Bradley admits he now faces a tricky political decision on HDTV. Sharp is heavily committed to the Japanese system, called *Hi Vision* against which Europe's *Eureka* system, HD-MAC, is competing. Sharp will not want Bradley to spend Japanese money on a European system, but the British Government has already invested £5 million in the Eureka project and will not like to see an ex-ACOST man help the competition.

The British Government has no strings to pull. Although industry minister Eric Forth "welcomed" Sharp's investment, the DTI is not putting in any money.

Says Anthony Smith, ex-British Film Institute and now President of Magdalen College, *"All our funding for the Park comes from whatever we can raise on the money markets. These days, the idea of the government putting money into universities sounds faintly ridiculous".*

DOWN TO EARTH

BY GEORGE HYLTON

WHY BUILD BRIDGES?

THE measuring bridge (Fig. 1) used to be an essential laboratory tool. It was the only readily available means of measuring resistance and capacitance accurately.

Nowadays, even the lower-priced digital multimeters can do this and they do it more conveniently. So is the bridge obsolete? Let's think about it.

HOW BRIDGES WORK

First, a quick run-through on bridge operation. Suppose the input (V_1) is d.c. and S and X are resistances. Taking C as a common (or "earth") connection, a voltage V_2 appears between A and C, and V_3 between B and C.

By moving the slider of VR1, V_2 can be set to any voltage between V_1 and zero. V_3 also has a value which can be anywhere in the same range, but depends on the relative values of S and X. For example, if $S = X$, $V_3 = V_1/2$. In practice, S is a standard; i.e. a close tolerance component, and X is what we are trying to measure.

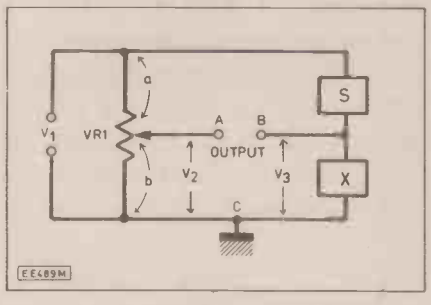


Fig. 1. Simple bridge.

By adjusting VR1 it is possible to find a setting where $V_2 = V_3$. This is the "balanced" condition. The output is the difference between V_2 and V_3 and is zero at balance.

By monitoring the output, the bridge can be set to balance. It turns out that X can then be defined in terms of the values of the other "arms" of the bridge: $X = S(b/a)$ where a and b are the resistances of the two parts of VR1. Since b/a is a ratio, the arms a and b are called ratio arms.

In practice, a number of standards S are provided. In use, a standard is selected which enables balance to be achieved with the slider as close to the half-way setting as possible, because this gives best accuracy and sensitivity.

For everyday use VR1 may be calibrated to show ratios from 0.1 to 10. A standard of 1k then enables values of X from 100 ohms to 10k to be measured. Accuracy is good when X is about the same as S.

A.C. BRIDGES

If the bridge is driven by a.c. it becomes an impedance bridge and can be used to measure capacitance and inductance as well as resistance. In this case the standard S must have an impedance of the same kind as X. If X is a capacitance then S must be a capacitance, and so on, otherwise balance cannot be obtained.

There are other types of bridge where this is not true, but they are not usually general-purpose test-bench instruments. Practical inductors never give purely inductive impedance, because their inductance is always accompanied by the resistance of the wire (and core losses if they have magnetic cores).

This may blur the balance point and also make it vary with frequency. It helps to drive the bridge from a source of a.c. which delivers a pure sine wave.

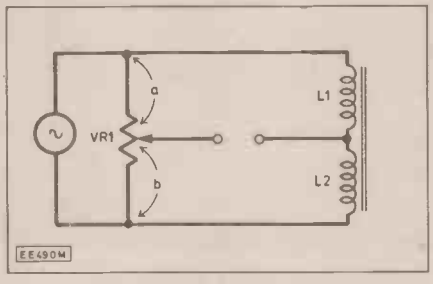


Fig. 2. Measuring turns ratio.

STILL USEFUL?

It seems likely that bridges will continue to be used where measurements of the highest possible precision are needed. This isn't the case in a typical service workshop, because components found in domestic equipment seldom have tolerances closer than one per cent.

So why use bridges? One reason is that at present few digital multimeters measure inductance, so a bridge could be useful for that.

Bridges can be used to measure transformer turns-ratios. To make the measurement (Fig. 2) the two windings whose ratio is needed are connected as shown (L1,L2). At balance, the turns ratio N is given by b/a. (If balance is not obtained, reverse the connections to one winding and try again).

It's sometimes necessary to select a pair of components which have the same value. This can be done easily be connecting one component as S and the other as X and setting VR1 to give $b/a = 1$. Other specimens are tried at X until a good match is obtained.

Note that for this job a bridge is needed which gives access to the S terminals. Some commercial bridges have an "external standard" setting on the range switch which connects to a spare pair of terminals.

Note that a bridge can be used to match complex impedances such as networks with R and C in series, and so on.

SKELETON BRIDGE

For workbench use it may not be necessary to go to the trouble of constructing a complete working bridge. If you already have an audio oscillator it may be usable to drive a bridge. A crystal earphone may serve as balance indicator (or better, a vintage pair of high impedance magnetic phones of the crystal set type). The audio frequency can be chosen to suit the earphone.

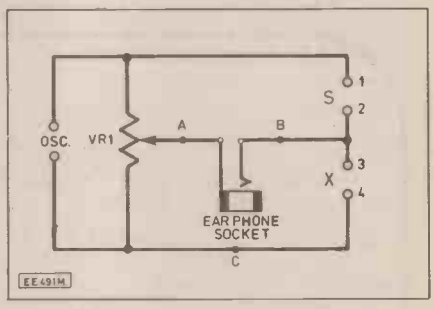


Fig. 3. Skeleton bridge.

A skeleton bridge (Fig. 3) consisting of a calibrated ratio pot and terminals for oscillator input, S, X and headphones — occupies little space and can be got out and set up easily on the odd occasions when it's needed for some job that the multimeter can't do.

The value of VR1 should not be so low that it overloads the oscillator or so high that it reduces sensitivity by seriously restricting the output current. In practice, a value of around 5k is often suitable.

Use a linear potentiometer. Wirewound pots are best, but carbon will do. Fit a knob with a pointer and provide a scale panel.

CALIBRATION

For calibration you need a selection of close tolerance resistors. Suppose you connect 1k to points 1 and 2 and another 1k to points 3 and 4. Balance the bridge and mark the scale "1".

Leaving the first 1k in place, connect 2k to points 3 and 4. This gives the "2" mark, and so on.

By connecting the 1k to 3 and 4 and 2k to 1 and 2, the 0.5 point is found, and so on for other fractional markings. In theory, minor scale divisions can also be marked, by using a wider selection of standards.

You can also use the first few markings to enable a variable resistance to be set to a convenient value and then used to fill out the scale. However, this work rapidly becomes tedious.

If the ratio pot VR1 has good linearity it is often good enough, once the major scale markings have been made, to subdivide by eye. (Note however that the scale is non-linear. It becomes cramped towards each end, and in this area it's not possible to subdivide by eye with any accuracy.)

The scale for capacitance is the reciprocal of the resistance scale: i.e. "2" becomes "0.5"; "3", "0.33" and so on. However, it is possible to use the resistance scale for capacitance by using the X terminal for the standard capacitance and S for the unknown.

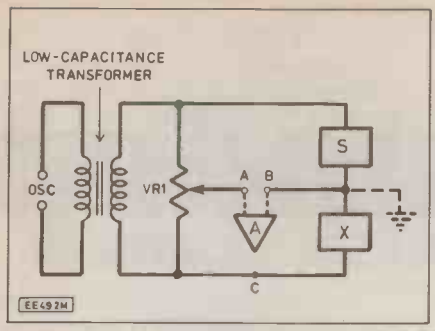


Fig. 4. Floating input.

IMPROVEMENTS

For some measurements the bridge output is so small that one feels the need for amplification. This isn't easy. The output terminals "float"; i.e. neither is common to the input. If you connect them to an amplifier with a terminal at *C*, then one arm of the bridge is shorted. Most indirect ways of connecting an amplifier, while they don't actually short a bridge arm do place some stray capacitance across it and this, too, spoils accuracy.

One expedient which helps is to use an isolation transformer to provide a floating input (Fig 4). You can then earth *A* or *B*. However, the inter-winding capacitance of the transformer makes isolation imperfect so it isn't a complete answer. A low-capacitance booster transformer of the sort once used to pep up fading TV tubes is a possible component.

Robot Roundup

NIGEL CLARK

TWIN LEGO

The developments in education during the last few years by Lego have had a spin-off for its retail side. The Lego Technic Control Center (correct) is due to be launched in the shops by September this year.

It will be the first kit on general sale to contain two motors. The Universal Buggy and the school control kits, which have at least two motors, are only available through educational suppliers. The major innovation, however, will be the specially-developed, battery powered control board. It can control up to three motors, two simultaneously by way of a spherical pad and the other by two switches for forward and reverse.

The pad allows movement in any direction and to change through any angle by activating two motors at the same time. A colour coded system allows the model builder to decide which motors should be controlled by which switches. The motors plugged into the blue and red terminals are controlled by the spherical pad, the yellow terminal is for the simple forward/reverse switches. None of the switches have distance or time inputs so each instruction continues until it is countermanded.

A memory has been included on the board allowing a maximum of 50 commands to be stored which can last a total of 200 seconds. The memory has been split into two areas with each area being able to accept a maximum of 40 commands, leaving at least ten available for the other area. This allows for the total 50 commands to be split between the two areas on the basis of anything between 25 each to 40 for one and ten for the other. Users have to be careful they are in the correct memory for the device being controlled or it will not work.

The saved commands will stay in the memory until they are programmed over or the batteries run out. Lego say it might be possible to save the programs if the batteries are changed quickly but they do not offer any guarantee. The memory is accessed by go, stop and pause buttons. There is no display panel or computer link so it is advisable to keep a written copy of the commands entered as a reminder of what is in the controller.

CONTROL

A spokeswoman for Lego UK said that it had been decided not to go for computer control as not everyone would have a computer and even if they had, they might not want to tie it down to controlling models. To go with the more sophisticated control that is available are plans and Lego pieces for the most complex models which the company has offered on general sale. They include an X-Y plotter (see photo) and a mobile crane which can twist and lift under the control of the board, but the whole crane has to be moved manually on its wheels.

There is also a small turtle which can hold a pen with which to draw a tracing of its movements and a two-axis pick and place arm with a gripper which comes complete with small bricks and baskets in which they have to be placed.

The spokeswoman said that it had been decided to market the retail Control Center kits after lego had been working on the series of kits for schools. The school kits start with simple mechanics and by degrees work up to complex models controlled by computers. The Control Center kits will cost about £110.

For less complex control Lego is also introducing to its retail catalogue a motor set including a motor, and a battery box with forward and reverse switches. It will be put on sale at the same time as the Control Center.

There is also a pneumatic system using compressed air generated by airpumps and controlled by special valves. It can be used on models of cranes, JCB excavators and forklift trucks.

FEEDBACK FOURTH

As part of Feedback Instruments' decision to concentrate on their two Scara robots, discontinuing the two revolute arms, they are working on new software. A version of Forth is being prepared for the PW801 to help bring the arm up to industry standard and expand its market in education – at which it is aimed at the moment. The Forth version will be usable on IBM PC and IBM clones. Feedback is trying to move away from its dependence on education where it sees limited sales potential.

The PW801 is the bigger of its two Scara arms with a maximum reach of 380mm and a load capacity of 2kg. The IVAX 901 can lift 500gms and has a reach of 280mm. In other respects they are very similar, both having four axes and a gripper, with an on-board controller allowing instructions to be entered by way of a teach pendant and interfaces available for micros like the BBC B and Master and IBM PC. The 801 has a workcell with a conveyor, hopper and workpieces while the 901 workcell has conveyors and gauging devices.

ATARI

Silica Systems, the computer systems distributor, is keen to make clear that it is still offering the Atari Robokit system. The company had been concerned that following last year's demise of Personal Robotics, possible customers may think the control system was no longer available. Personal Robotics developed the Atari version from its own much more complex robotics development and teaching system, called simply Robokit.

A spokesman for Silica, which is the major distributor of the Atari Robokit, said that interest had fallen off following the closure of Personal Robots. However there had been an increase recently which Atari was attempting to boost by making a special offer package of an Atari ST 1040 plus the kit for about £350 plus VAT.

The package includes an interface to drive d.c. motors, lights and solenoids with eight inputs for sensors and two for Lego shaft encoders. A manual contains instructions for building five robotic projects from Lego Technic parts. On its own the Atari Robokit sells for about £70 to educational users and about £90 retail.

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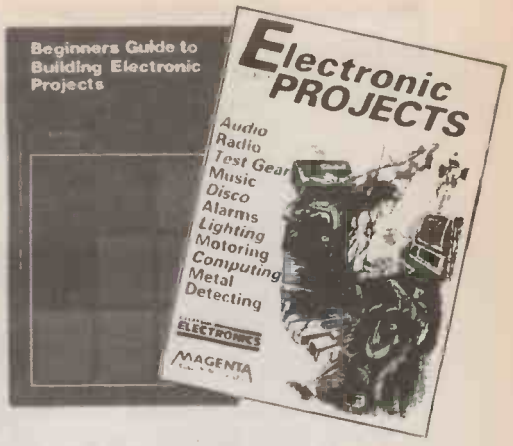

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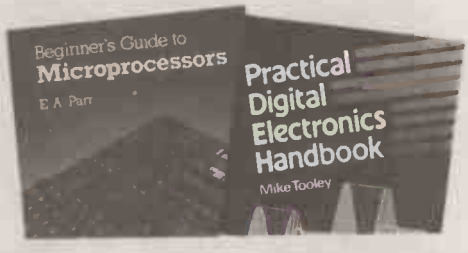

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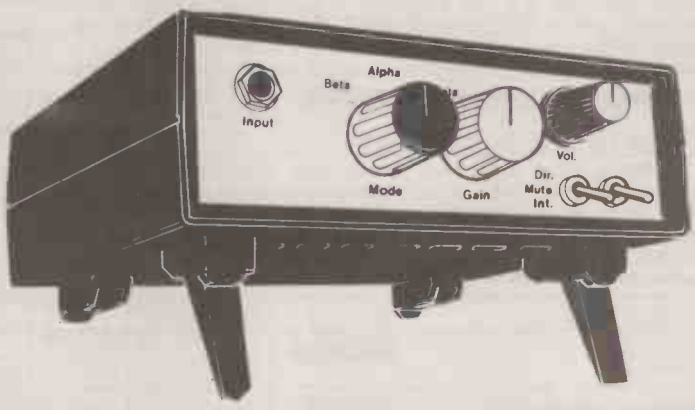

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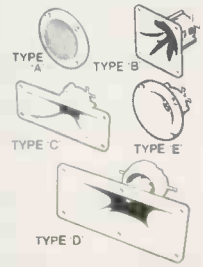

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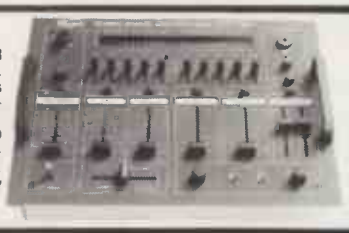

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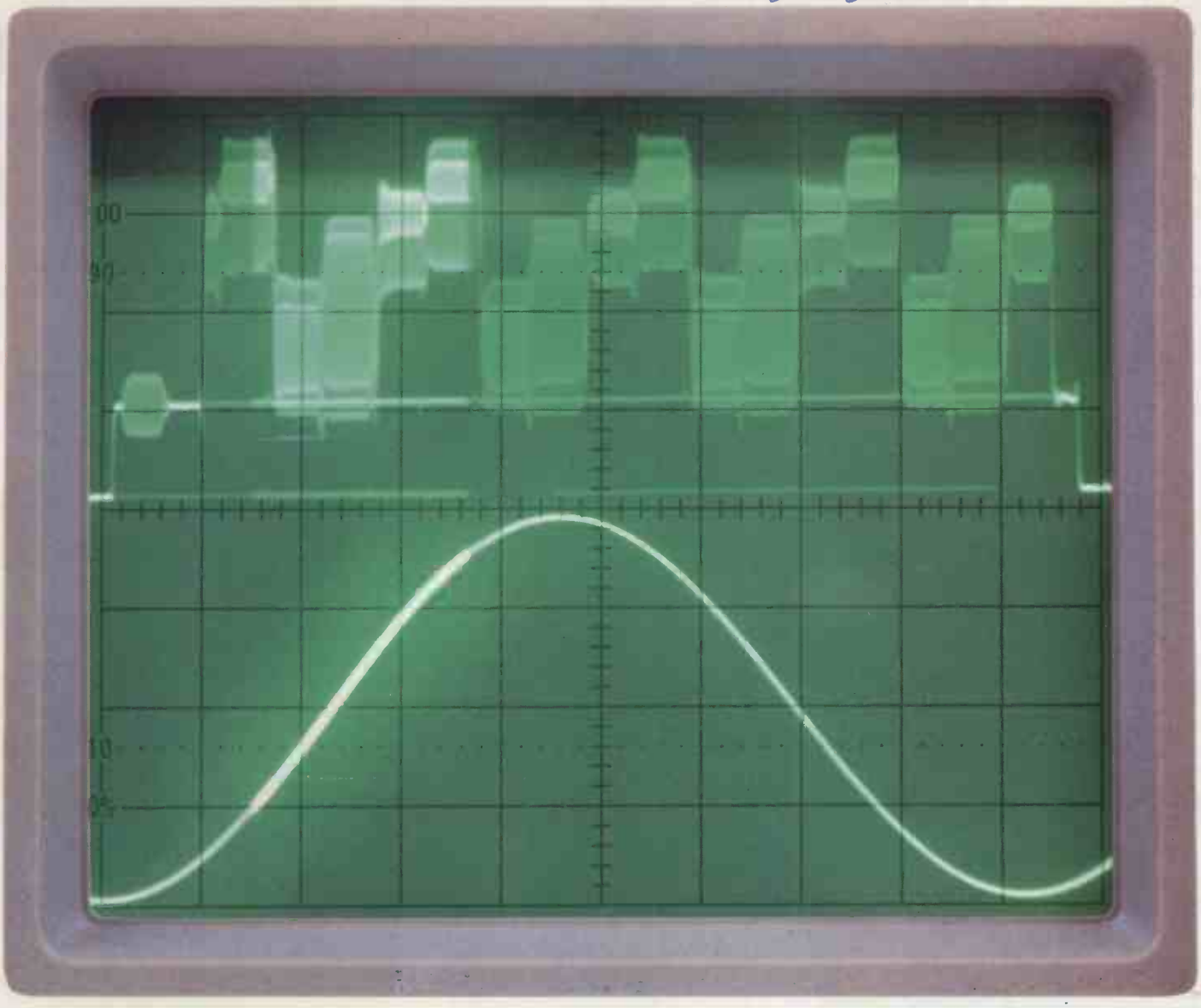

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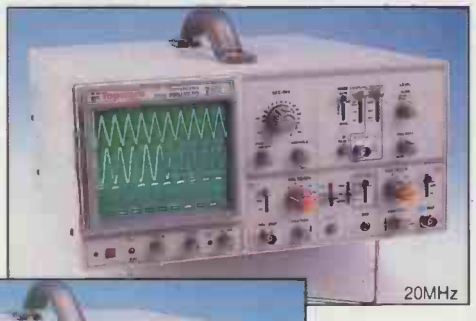

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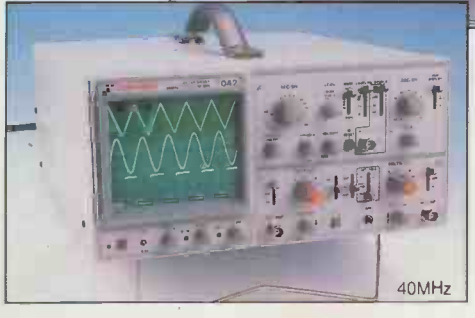

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