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Incorporating The Radio Amateur

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Technical Queries. **We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described.** We regret that queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence **should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.**

Opinions **expressed by contributors are not necessarily those of the Editor or proprietors.**

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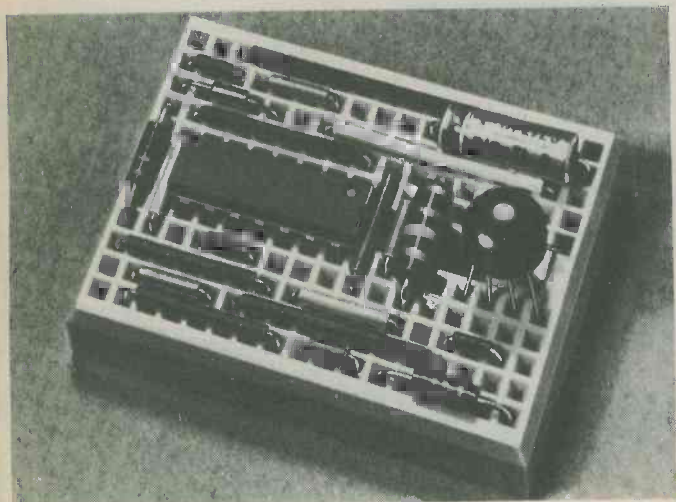
All you want for Christmas

Fast and Easy

Leave this page open where it will do the most good!



You know, almost as well as we know, where to go to get the components a home projects constructor needs to pursue his hobby.

Either your nearest Lektrokit dealer. Or direct from Lektrokit by mail order.

Because Lektrokit offer the most comprehensive range of breadboarding and testing devices on earth.

Trouble is, the nice people who might give you Lektrokit for Christmas probably haven't the faintest idea what we—or even **you**—are on about.

So just tick the items you'd particularly like for Christmas. And then leave this page open in a strategic place!

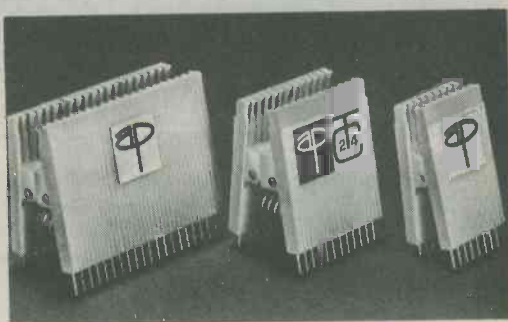
Lektrokit Breadboards

FROM **£3.25,** inc p & p and VAT

Hole for hole, top value! Lektrokit breadboards are modular, so they can be linked together to form any size. With a pitch of 0.1", even the smallest breadboard—217L—can accept 8, 14, 16 or 18 pin Dil sockets. You just take a component, choose a hole, and push it in.

Model No.	Contacts	Price, each
217L	170	£3.25 ☐
234L	340	£5.75 ☐
248L	480	£6.65 ☐
264R	512	£6.65 ☐
264L	640	£8.32 ☐

(All prices include packing, postage and VAT).



Lektrokit IC Test Clips

ONLY **£3.08** inc p & p and VAT

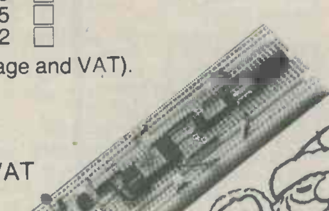
Ten models to fit all DIP sizes. Test clip grips IC's without slipping or shorting between pins—makes testing IC's on boards easier, aids removing and inserting DIP's without damage. Each IC pin can be brought up to a convenient contact post for hooking test leads or probe connections.

Model	Price
TC-8	£4.38 ☐
TC-14	£3.08 ☐
TC-16	£3.25 ☐
TC-24	£9.28 ☐
TC-40	£13.95 ☐

LEKTROKIT COMPLETES THE CIRCUIT—FOR CHRISTMAS!

Lektrokit Super Strip SS2

ONLY **£11.05** inc p & p and VAT



Super Strip accepts **all DIP's—as** many as nine 14-pin at a time—and/or TO-5's and discrete components. With interconnections of any solid wire up to 20 AWG.

Super Strip has 840 contact points, combining a power/signal distribution system with a matrix of 640 contacts in groups of 5. Distribution system has eight bus-bars, each with 25 contact points.

Lektrokit's policy, as you know, is the right product, whatever the project, at the right price. And it's backed by a nationwide network of retailers.

But it could be that, whoever you get to complete your Christmas, doesn't know where the Lektrokit retailers are. So we've included an order coupon to help them—and you out!

All I want for Christmas is what I've marked above.

To Lektrokit Limited, London Road, Reading, Berks, RG6 1AZ.
Telephone Reading (0734) 669116/7.

Please supply the above (tick items required)—IMMEDIATELY.

CUT OUT THE COMPLETE ADVERTISEMENT AND SEND TO LEKTROKIT

(All prices include packing, postage and VAT. All deliveries include name of nearest Lektrokit dealer—plus a FREE catalogue!)

I enclose P.O./cheque for £ ....

Name ....

Address ....

REC3

....

LEKTROKIT

COMPLETES THE CIRCUIT

High quality audio accessories

AL120 50W R.M.S.

AUDIO AMPLIFIER (With Integral heat sink and short-circuit protection)

£11.95
+ 8% VAT p&p 35p

OUTPUT POWER	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 Ohms
TOTAL HARMONIC DISTORTION	.05% Max. (Typically .02%)
FREQUENCY RESPONSE ≡ 1dB	25Hz-20kHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP.	45 deg. C
DIMENSIONS	192 x 89 x 49mm

Introduced to fulfil the demand for a fully protected power amp., capable of driving high quality speaker systems at up to 50w., with distortion levels below .05%. Ideal for domestic use, Discos, PA systems, electronic organs etc. The generously rated component-sensure continuous operation at high output levels.

SPM120 STABILISED POWER SUPPLIES

SPM120/45
SMP120/55
SMP120/65

£5.80
+12½% VAT p&p 35p

NEW

AC INPUTS	—
SPM120/45	40-48v
SPM120/55	50-55v
SPM120/65	60-65v
OUTPUT CURRENT	2.5A
RIPPLE	1A 100mV
	2A 150mV

SPM120 is a fixed voltage stabiliser available with an output voltage of either 45v, 55v, or 65v. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A, operates direct from a mains transformer requiring only the addition of 2 Electrolytic capacitors to complete the s/c protection.

GE100 Mk.2

10 CHANNEL MONOGRAPHIC EQUALISER

£20
+12½% VAT p&p 35p

NEW

CONTROL RANGE	±12db
DYNAMIC RANGE	110db
MAXIMUM OUTPUT	+15db
FREQUENCY RESPONSE	30Hz-20KHz (±1db)
POWER SUPPLY	15-0-15v
VOLTAGE HANDLING INPUT	3v R.M.S.
T.H.D.	.005%

Only 155mm x 65mm x 50mm including the 10 x 10K lin slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20KHz you can cut and boost ±12db with the 10 sliders, each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, PA systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power supply for GE100, o/d SG30 £3.80.

VPS30

REGULATED VARIABLE STABILISED POWER SUPPLY

£7.60
+8% VAT p&p 35p

AC INPUT MAXIMUM	25v
VOLTAGE REGULATION	2-30v
REGULATED CURRENT	0-2A

Incorporating short circuit protection

This NEW versatile Regulated Variable Stabilised Power Supply with short circuit protection and current limiting, is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2v-30v, with a current limiting range of 0-2A. With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 2033), 0-1ma (o/d 1310 or 1305), plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899). It can be used again and again as a self-contained bench, power supply, eliminating the use of batteries and thus saving ££s!

PA200

STEREO PRE-AMPLIFIER

£16.55
+12½% VAT p&p 40p

FREQUENCY RESPONSE	20Hz to 20kHz x 1dB	
TOTAL HARMONIC DISTORTION	Less than .1% (typically .07%)	
SENSITIVITY INPUTS		
1. TAPE	100mV/100K ohms	For an output 500mV
2. RADIO TUNER	100mV/100K ohms	
3. MAGNETIC P.U.	3.5mV/50K ohms	
EQUALISATION	Within ±1 dB from 20 Hz to 20 kHz	
BASS CONTROL RANGE	± 15 dBs at 75 Hz	
TREBLE CONTROL RANGE	+ 10-20 dBs at 15 kHz	
SIGNAL/NOISE RATIO	Better than 65 dBs (all inputs)	
INPUT OVERLOAD	Better than 26 dBs (all inputs)	
SUPPLY	35 to 70V	
DIMENSIONS	300 x 90 x 33mm (less controls)	

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

HEADPHONES

A top quality headphone with cusioned earpads and headband. Separate balance/volume controls. Stereo or Mono switch. Impedance: 8ohms. Frequency: 30-18,000Hz, o/n 884. £8.70 + 12½% VAT. p&p 70p.
A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi-Fi Impedance: 8ohms. Frequency: 30-15,000Hz. o/n BB5 £4.40 + 12½% VAT. p&p 50p.

BIB HI-FI ACCESSORIES

Parallel Tracking GROOV KLEEN
The very latest in automatic record cleaning. Designed to suit all modern single play decks. Simple to fit, it is extremely efficient. Complete with two types of base and three height extensions. o/n B101. £3.68 + 12½% VAT. p&p 35p.

Cassette Tape Editing Kit
Enables cassette tapes to be edited and joined easily, quickly and accurately. Kit comprises: Tape Splicer ⅛ in (3.2mm). 2 Precision Tape Cutters. Tape Piercer 9 Self-adhesive Labels. Reel of Splicing Tape. 3 Winders and removers and instructions, all in a handy wallet. o/n 811. £2.40 + 8% VAT. p&p 35p.

GROOV STAT
The BIB Groov-Stat static reducer neutralises the static charge on records and other plastic surfaces. o/n 8103. £5.45 + 8% VAT. p&p 35p.

Cassette Head Cleaner
Essential for cleaning of tape heads, capstans and rollers. Pack contains Tape Head Applicator and tape head polisher tools. Plus bottle of special formula cleaning fluid and full instructions. o/n 832. £0.56 + 12½% VAT. p&p 35p.

ADAPTORS

AC-DC enables a large range of battery powered radios, recorders, calculators to be run off the mains. (220-240v AC) Switchable for 6, 7.5 or 9 volts. Current rating 2,500MA. Polarity reversing switch. Universal plug Incorporated o/n 137. £3.95 + 12½% VAT. p&p 35p.
DC-DC for use in all cars, boats etc., with pos or neg earth for a regulated output of 6, 2.5 or 9 volts DC at 1a max. For radios, recorders etc. o/n 138. £2.80 +12½% VAT. p&p 32p.

CROSSOVER NETWORKS

2-WAY channels for high and low frequencies to correct speakers — high to tweeters, low to woofers. Complete with instructions. Frequency: 3,000Hz. o/n 1904. £1.10 + 12½% VAT. p&p 35p.
2-WAY for 8ohm speakers up to 30 watts. Frequency: .3kHz. o/n 1905. £1.65 +12½% VAT. p&p 35p.
3-WAY for 8ohm speakers up to 30 watts. Frequency: 800Hz and 4.5 kHz. o/n 1906. £2.95 +12½% VAT. p&p 35p.

CASES

TEAK 30 designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. 32x23x8mm. O/n 139. £5.45 + 12½% VAT. p&p 70p.
TEAK 60 for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve — has no front or back panel. 42x29. x9mm. O/n 140. £7.00 + 12½% VAT. p&p 85p.

METERS

Miniature Balance & Tuning Meter
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity: 100-0-100MA. Dimensions: 23 x 22 x 26mm. o/n 1318. £1.95 +8% VAT. p&p 35p.

Balance and Tuning Meter
Clear view edgewise meter. Centre zero application. Sensitivity: 100-0-100UA. Dimensions: 45 x 22 x 34mm. o/n 1319. £2.00 +8% VAT. p&p 35p.

Miniature Level Meter
Moving coil, for accurate level indication for tape recorders, amplifiers etc. Neat design, rugged construction – will withstand five times rated value. Sensitivity: FSD: 200UA. OdB: 130UA. Dimensions: 23 x 22 x 26mm. o/n 1320. £2.80 +8% VAT. p&p 35p.

Vu Meter
Calibrated – 20 to +3 and 0-100%, making it suitable for use as a recording level meter or as a power output indicator. Sensitivity: 130UA. Dimensions: 40 x 40 x 29mm. o/n 1321. £2.00 +8% VAT. p&p 35p.

MICROPHONES

DYNAMIC CASSETTE
For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick-up pattern is omnidirectional. On/off switch, 1 metre of tough lead with floating 2.5 and 3.5mm plugs. Matching moulded strut. Impedance: 200 ohms. Sensitivity: 90db. Frequency: 90-10,000Hz. Size: 20mm dia x 120mm. o/n 1326. £1.50 + 12½% VAT. p&p 35p.

DYNAMIC MICROPHONE
Superior quality portable cassette recorder mike with built-in remote control switch and lead fitted with 5-pin 240° Din plug (remote switch) and 3-pin Din plug (microphone). Provides a direct replacement for those supplied with rcorders. With detachable stand. Omnidirectional. Impedance: 200 ohms. req. response: 100 to 10,000Hz. Sensitivity: 79db at 1,000Hz. o/n 1327. £2.65 + 12½% VAT. p&p 35p.

RE – 317: DYNAMIC MICROPHONE
Highly sensitive, high-grade desk or hand mike suitable for use with many popular cassette decks. Incorporates On/off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance: 5,000 ohms. Freq. response: 100 at 12,000Hz. Sensitivity: (-7db at 1,000Hz). o/n 1336. £4.10 + 12½% VAT. p&p 35p.

OMNIDIRECTIONAL CARDIOID
Powered by a 1½ volt battery located within the aluminium body. Satin silver finish with front disc protection to the diaphragm housing. On/off switch. Also with 'Busby' type windshield, "U" bracket and stem and extremely supple cable. Consumption: 0.2mA from 1½v battery providing approx. 8-10,000 hours continuous life. Impedance: 600 ohms. Sensitivity: 70db. Frequency: 30-16,000Hz. Size: 23mm dia x 267mm. o/n 1329. £12.80 + 12½% VAT. p&p 35p.

UNIDIRECTIONAL CARTIOID
Dual imp. 600 and 50,000 ohms. Response 50 to 14,000Hz. Sensitivity: 54db at 50K/ohms. Size: 1¼ in. dia x 6¼in. long. Weight approx. 190gm. o/n 1328. £10.95 + 12½% VAT. p&p 35p.

STANDS

GOOSENECK CHROME FLEXIBLE HOLDERS
Length 320mm o/n 1333 £2.40 + 12½% VAT. p&p 35p
Length 515mm o/n 1334 £3.40 + 12½% VAT. p&p 35p

FLOOR STAND Heavy chrome. Stow-away feet with rubber ends for maximum stability. Draws to a height of 5ft maximum. o/n 1335 £9.00 + 12½% VAT. p&p 85p.

BOOM ARM for use with the above stand. Heavy chromed metal. It gives 30in reach from the stand. o/n 1337 £8.00 + 12½% VAT. p&p 70p.

WINDSHIELD COVERS
O/n 1531 Medium per pair £1.20 + 12½% VAT. p&p 35p. O/n 1332. Large per pair £1.80 + 12½% VAT. p&p 35p.

AUDIO LEADS

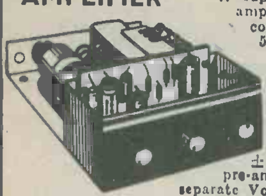
107	FM Indoor Ribbon Aerial	£0·60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0·75*
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0·85*
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0·85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0·68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1·05*
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0·90*
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0·60*
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0·78*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0·78*
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1·30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0·80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1·05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·68*
131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	£0·83*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£0·98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0·75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0·68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0·68*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1·75*
178	AC mains lead for calculators etc.	£0.45*

All above add 8% VAT + 35p p&p.

BI-PAK

DEPT. RC1, P.O. Box 6, Ware, Herts

SUPERSOUND 13 HI-FI MONO AMPLIFIER



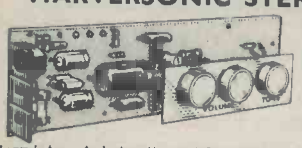
A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz, 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £15.00. P. & P. £1.20.

HARVERSONIC MODEL P.A. TWO ZERO

An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp). Input 1, 15mv into 47k. Input 2, 15mv into 47k. (suitable for use with mic. or guitar etc.) Input 3 200mv into 1 meg. suitable for gram, tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240v. Size approx. 12½"w. x 5"h. x 7½" d.

Special introductory price £28.00 + £2.50 carr & pkg.

HARVERSONIC STEREO 44



A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2⅝" × 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £9·00 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £1·50 plus 40p P. & P. if required. Full connection details supplied.

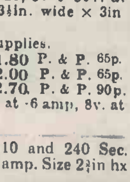
BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240v. Secondary combinations 0-5-10-15-20-25-30-35-40-60v. half wave at 1 amp. or 10-0-10, 20-0-20, 30-0-30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in deep. Price £3.20 P. & P. £1.20.

MAINS TRANSFORMER. For power supplies.
Pri. 200/240v. Sec. 9-0-9 at 500 mA. £1.80 P. & P. 65p.
Pri. 200/240v. Sec. 12-0-12 at 1 amp. £2.00 P. & P. 65p.
Pri. 200/240v. Sec. 10-0-10 at 2 amp. £2.70 P. & P. 90p.
Pri. 200/240v. Sec. 23v. at 1.5 amp, 6v at ·6 amp, 8v. at 50 mA. £2.25 + 65p P. & P.

MAINS TRANSFORMER. Pri. 0.110 and 240 Sec. 28V at 1.8 amps. Also tapped at 12V ·3 amp. Size 2¾in hx 3¼in w x 2½ in d. £2.50 + £1 P. & P.

ALL PURPOSE POWER SUPPLY UNIT 200/240v. A.C. Input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2¾". Ready built and tested. Price £6.75. P. & P. 95p

STEREO-DECODER SIZE 2"×3"×½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6.00 plus 20p P. & P.
Stereo beacon light if required 40p extra.

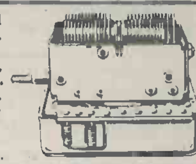
QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £7·00. P. & P. £1.25
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £8·00. P. & P. £1.30.

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER

200/240V Mains operated Solid State A/M F/M Stereo Tuner. Covering M.W. A.M. 540-1605 KHZ, VHF/FM 88-108 MHZ. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp indicator. Built-in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600 m/v RMS into 20K. Simulated teak finish cabinet. Will match almost any amplifier. Size 8½" w. × 4" h. × 9½" d. approx. LIMITED NUMBER ONLY at £28.00 + £1.50 P. & P.

SPECIAL OFFERS

Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¾" × 1¼" × ⅞" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 20p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7-8V + earth. Supplied pre-aligned, with full circuit diagram. Connection details supplied. Beautifully made with precision-geared FM Gang and 323 Pf + 323 Pf AM Tuning Gang only £3·15 + P. & P. 35p.

PRECISION MADE Push Button Switch bank. 8 Buttons giving 16 8/P C/O interlocked switches plus 1 Cancel Button Plus 3 d/p c/o. Overall size 5" × 2½" × 1". Supplied complete with chrome finished switch buttons 2 for £1.80 + 20p, P. & P.

SPECIAL OFFER
Limited number only!

New but very slightly shop soiled transistor radios by well known manufacturer. Very smart and attractive, vinyl covered with carrying handle.
Two models available:
AC mains or battery operated and covering VHF/FM and MW bands. **£10.00 + £1.30 p&p**

Similar to above but battery operation only. Five wavebands, MW, FM, SW and two VHF bands for reception of aircraft and some public service systems. **£11.00 + £1.30 p&p**

Size (either model), 7in.H x 9½in.W x 4in. D approx. Both types have telescopic aerials for VHF/FM reception and internal ferrite aerials for AM bands, also earphone socket for personal listening. Either model uses four HP11 or SP11 batteries (not supplied).

LOUDSPEAKER BARGAINS
5in. 3 ohm £2.20, P. & P. 35p. 7 x 4in. 3 ohm £2.80. P. & P. 48p. 10 x 6in. 3 or 15 ohm £3.85, P. & P. 75p. 8 x 5in. 3 ohm with high flux magnet £3.60, P. & P 60p. Tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £2.20, 30p P. & P.

2" PLASTIC CONE HF TWEETER 4 ohm, £3·50 per matched pair + 50p P. & P.

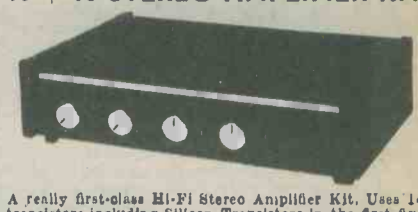
HIGH POWER HI-FI 8 ohm Dome Tweeter. 1" voice coil. Magnet size 3" dia. Suitable for use in up to 50 watt systems. £4·50 each + 60p P. & P.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £2.00 yd. length. P. & P. 50p per yd. (min. 1 yd.). S.A.E. for samples.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER Size 11¾" × 14¾" × 1¾" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, etc. and used with or without bame. Send S.A.E. for details. Only £8·40 each. P. & P. 90p for one, £1.10 for two.
Now available in either 8" round version or 4½" × 8½" rectangular. 10 watts R.M.S. 60Hz-20KHz £5.25 + P. & P. (one 65p, two 75p).

SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78. ONLY £2.50 P. & P. 20p. Also available fitted with twin, Diamond T/O stylus for Stereo LP. £3.00. P. & P. 20p.
LATEST CRYSTAL T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £2.00 P. & P. 20p
LATEST T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £2.00 P. & P. 20p
STEREO MAGNETIC PRE-AMP sens. 3mVin for 100m Vout 15 to 35V neg earth. Equ. ± 1db. From 20 Hz to 20 KHz. Input impedance 47k. Size 1⅝in x 2⅜in x 5⅝H. £2.60 + 20p P. & P.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

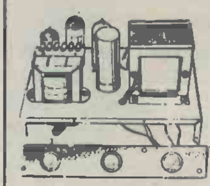


A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ± 3dB 12-15,000 Hz. Bass, boost approx. to ± 12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£13·50	P. & P. 80p
(Magnetic input components 33p extra)		
POWER PACK KIT	£5·50	P. & P. 95p
CABINET	£5·50	P. & P. 95p

Special offer—only £23.75 if all 3 units ordered at one time plus £1.25 P. & P.

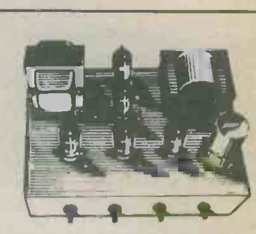
Full after sales service
Also available ready built and tested £31·25. P. & P. £1.50.



3-VALVE AUDIO AMPLIFIER HA34 MK II. Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £8.50. P. & P. £1.40.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £8.00. P. & P. £1.40.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £14.50. P. & P. £1.40. Also available ready built and tested £19.00. P. & P. £1.40.

SPECIAL LINES
OFFERED SUBJECT TO STOCK AVAILABILITY

Limited number of British Manufacturer's Surplus professional 100 watt RMS Slave amplifiers. Special features: 2 separate power modules, 1 for Bass response, and 1 for mid. range/tweeter. 5 stage LED display for power o/p indication. A/c mains i/p switchable for 110 or 240V. Can easily be converted to stereo.

AVAILABLE TO PERSONAL CALLERS ONLY—PLEASE PHONE TO CONFIRM AVAILABILITY.
Brand new and tested only £33·75.

OUR PRICES INCLUDE VAT AT CURRENT RATES

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Prices and specifications correct at time of press. Subject to alteration without notice

HARVERSON SURPLUS CO. LTD.

(Dept. REC) 170 MERTON HIGH ST., MERTON, LONDON, SW.19. Tel: 01-540 3985.
A few minutes from South Wimbledon Tube Station
SEND SAE WITH ALL ENQUIRIES. FOR PERSONAL CALLERS ONLY: WE CAN NOW OFFER A FULL REPAIR SERVICE ON ALL HI-FI EQUIPMENT, DISCO, CASSETTES, CAR RADIO, ETC.

(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

ambit ® international

Production of the new catalogue has been held up for a few weeks - since we have just been appointed as distributors for two of the most exciting ranges of radio components products yet : The Micrometals range of iron dust torroids cores and formers, and the OKI range of VLSI for digital frequency displays for receivers. We apologize for any inconvenience, but these two ranges are really worth the wait, and include some products you will find hard to believe, like the MSM5523 IC, an IC with less than ten external components that gives AM frequency readout to 1kHz from LW to 39.999MHz, FM frequency readout in 100kHz steps - (all usual IF offsets programmable by diodes), a 24 hour format clock with 12 hour display, independent on and off timers, time signals on the hours, stopwatch facility and a sleep timer. This costs £14 with its timebase crystal, and makes all that has gone before an expensive and time wasting excercise. Rather like the way the Intersil ICM7216 has revolutionized the instrument counter market. (See the OSTS ad.) And those of you familiar with Amidon and IG dust torroids, favoured in many new RF designs, will be pleased to know Ambit will be stocking a broad range of the Micrometals types for applications from EMI filters to RF PA stages.

OKI frequency counter ICs: details in cat2

MSM5523	for CA LEDs with RHDP such as FND507	£14 inc xtal
MSM5525	for 3½ digit LCD AM/FM with direct segment drive. no clock or timers	£11 inc xtal

Other types for fluorescent displays etc OA

Other new semiconductor additions:

KB4437	pilot cancel mpx decoder	4.35
KB4438	muting stereo preamp	2.22
HA1370	supercedes TDA2020	2.99
TDA1090	HiFi AM/FM	3.35
TDA1220	low cost AM/FM	1.45

PRICES DOWN ON VMOS: as expected, this new technology in power transistorsis getting cheaper. 120v comp pairs /100W for £10.00

Price reduction on CA3189E ....now £2.20

New varicaps: to add to the biggest range.....

KV1211 2:9v bias to tune MW, like the KV1210, but a double diode £1.75

New pilot tone filters from TOKO...............

2088LR series, individual per channel with a 26/38kHz version for pilot cancel decoder applications. Flat to 15kHz £0.90

New crystal filter for amateur NBFM..........

TOYO 10M4B1 with over 90dB adjacent ch. rejection for 2m NBFM. 10.7MHz £14

New ceramic IF filters for 455kHz..............

CFM455H 6kHz/6dB, 15kHz max /60dB - ideal for MC3357 etc. £10

A brief summary of some of our range of ICs:

TDA1062/1.95; TDA1083/1.95; HA1197/£1.40 CA3123E/£1.40; TBA651/£1.81; CA3089/1.94 HA1137/£2.20; MC1310/£2.20; HA1196/£3.95 KB4424/£2.75; KB4423/£2.53;SD6000/£3.75 KB4412/£2.55; KB4413/£2.75; KB4417/£2.55 MC1495L/£6.86*; MC1496P/£1.25 LM381N/£1.81; LM1303/£0.99; ULN2283B/ £1.00; LM380N/£1; TBA810AS/£1.09 TCA940E/£1.80; TDA2002/£1.95; ICL8038CC/£4.50*; NE566/£2.50*; NE567/ £2.50*; NE560B/£3.50; NE561B/£3.50; NE562B/£3.50*; NE565A/£2.50*

SEE THE OSTS ADVERT FOR CMOS/TTL REGULATORS, OPTO DISPLAYS , and other types of linear devices.

Some transistors for RF specifically:

BF256LB/0.34; 40822/0.43*; 40823/0.51 * 40673/0.55* ; BF900/961/0.80*; BF960/1.60* BF224/0.22; BF274/0.18; BF195/0.18; BF240/0.22; BF241/0.22; BF362/0.70; BF479/0.86; BF679S/0.70; BFY90/0.90*

PIN and other Varicap diodes:

BA102/0.30; BA121/0.30; ITT210/0.30 BB104B/0.40; MVAM2/£1.48; MVAM115/ £1.05; MVAM125/1.05; KV1210/£2.75 BA479/0.35; TDA1061/0.95; BA182/0.21

METER MADE low cost panel meters : 3 x 930 series with blanks and dry transfer sheet of scales and ledgends for £12.5 *

TERMS etc: CWO please, VAT on Ambit Items is generally 12½%, except where marked (*). Catalogue part 1:45p, part 2 50p all inclusive. Postage 25p per order, carriage on tuner kits £3. Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays .

At last, DIY HiFi which looks as if it isn't.

That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb . A small pic here would be an insult, so send an SAE for details on the kit that looks as if isn't. It's something else.............

- ★ Exceptionally high performance - exceptionally straightforward assembly
- ★ Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
- ★ Various options and module line-ups possible to enable an installment approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

- ★ Matching both the style and design concepts of the MkIII HiFi FM tuner
- ★ Hitachi VMOS power fets - characterized especially for HiFi applications
- ★ Power output readily multiplied by the addition of further MOSFETs
- ★ VU meters on the preamp - not simply dancing according to vol level
- ★ Backed with the usual Ambit expertise and technical capacity in audio

The PW Dorchester·LW,MW,SW,& FM stereo tuner

In much the same way as we have swept away the 'old technology' in frequency/timer counters - with the OKI and Intersll single IC counters, we now offer a single IC "All Band" radio tuner. Don't confuse this one chip radio with things like the ZN414 - for this is a genuine superhet receiver with a mechanical AM IF filter, and ceramic IF filters for FM. The AM section employs a balanced input mixer section, covering all broadcast bands - plus a BFO and MOSFET product decetor for SSB/CW - though at this price, the tuner is not intended as a "communications receiver" - although we know of many lesser designs that make that claim. The AM sensitivity is nevertheless better than 5uV, and FM sensitivity is 1.2uV for 30dB S/N. As a multiband broadcast superhet receiver, it is a unique constructor project that fulfills the requests we very frequently get for a general coverage circuit that isn't over complicated. The set has CA3089E FM performance, with mute etc., and a PLL stereo decoder with full pilot tone filtering.

The tuner board - with "on board" PCB mounted switching, all components etc : £33.00

The case/cabinet with PSU, meter and mechanics etc £25.00

An SAE for full details please. See the feature article in Practical Wireless (Dec/Jan)

2 Gresham Road, Brentwood, Essex.

OSTS

Since AMBIT introduced the "One Stop Technology Shop" to our service, we have been pleased to see just how many users of electronic components appreciate our guarantee to supply goods only from BS9000 approved sources. More than ever, professional and amateur electronics engineers cannot afford to waste time on anything less than perfect pedigree products.

SEE THE AMBIT AD TOO!

CD4000 CMOS

4000	17p	4059	563p	4522	149p
4001	17p	4060	115p	4527	157p
4002	17p	4063	109p	4528	102p
4006	109p	4066	53p	4529	141p
4007	18p	4067	400p	4530	90p
4008	80p	4068	25p	4531	141p
4009	58p	4069	20p	4532	125p
4010	58p	4070	20p	4534	614p
4011	17p	4071	20p	4536	380p
4012	17p	4072	20p	4538	150p
4013	55p	4073	20p	4539	110p
4016	52p	4075	20p	4541	141p
4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
4019	60p	4078	20p	4553	440p
4020	93p	4081	20p	4554	153p
4021	82p	4082	20p	4556	77p
4022	90p	4085	82p	4557	386p
4023	17p	4086	82p	4558	117p
4024	76p	4089	150p	4559	388p
4025	17p	4093	50p	4560	218p
4026	180p	4094	190p	4561	65p
4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	281p
4030	58p	4099	122p	4569	303p
4031	250p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	100p
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	69p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	248p		
4044	80p	4510	99p		
4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
4050	55p	4516	125p		
4051	65p	4517	382p		
4052	65p	4518	103p		
4053	65p	4519	57p		
4054	120p	4520	109p		
4055	135p	4521	236p		

Micromarket PRICES SLASHED

6800 series	
6800P	6.50
6820P	£6
6850P	2.75
6810P	£4
6852	3.65
8080 series	
8080	6.30
8212	2.30

8216	1.95
8224	3.50
8228	4.78
8251	6.25
8255	5.40
MEMORIES	
2102	£1.70
2112	£3.40
2513	£7.54
4027	£5.78

2114	£10
2708	£10.55
Development	
MEK6800	£220
TK80	£306

AMI, Signetics, TI, Intersil, Harris etc. OA

Voltage Regs

NEW LOW PRICES

7800 series UC TO220 package 1A	all 95p
7900 series UC TO220 package 1A	all £1
78MUC series TO220 package ½A	all 90p
78LCP series TO92 100mA	all 35p
L200 up to 3A/adjustable V&A	195p
78MGT2C ½amp adjustable volts	175p
79MGT2C ½amp adjustable volts	175p
723C precision controller	65p

MAINS FILTERS FOR NOISE/RFI etc

1 amp in IEC connector	£4.83
5 amp in 'wire in' case	£3.87
NE550A	73p

LINEARS non-consumer

BIMOS			
CA3130E	84p	LM339N	66p
CA3130T	90p	LM348N	186p
CA3140E	35p	LM3900N	60p
CA3140T	72p	709HC to5	64p
CA3160E	90p	709PC dil	36p
CA3160T	99p	710HC to5	65p
Op amps		710PC dil	59p
LM301AH	67p	723CN	65p
LM301AN	30p	741CH to5	66p
LM308H	121p	741CN 8dil	27p
LM308N	97p	747CN	70p
LM318H	279p	748CN	36p
LM318N	224p	NE531T	12Cp
		NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:

5082- 7650	red CA	233p
5082- 7653	red CC	
5082- 7660	yellow CA	
5082- 7663	yellow CC	
5082- 7670	green CA	
5082- 7673	green CC	

0.3" Standard HP

5082- 7730	red CA	147p
5082- 7740	red CC	

0.5" Fairchild

FNO500	red CC	150p
FND507	red CA	150p

TERMS: CWO pse., VAT to be added at 8% (inland), pp 25p per order. When ordering from the OSTS and Ambit - a single combined remittance and pp charge is sufficient. Account details OA.

TTL :Standard AND LP Schottky

	'N'	'LSN'
7400	13	20
7401	13	20
7402	14	20
7403	14	20
7404	14	24
7405	18	26
7406	38	
7407	38	
7408	17	24
7409	17	24
7410	15	24
7411	20	24
7412	17	24
7413	30	52
7414	51	130
7415		24
7416	30	
7417	30	
7420	16	24
7421	29	24
7422	24	24
7423	27	
7425	27	
7426	36	27
7427	27	29
7428	35	32
7430	17	24
7432	25	24
7433	40	32
7437	40	24
7438	33	24
7440	17	24
7441	74	
7442	70	99
7443	115	
7444	112	
7445	94	
7446	94	
7447	82	
7448	56	99
7449		99
7450	17	
7451	17	24
7453	17	
7454	17	24

	'N'	'LSN'
7455	35	24
7460	17	
7463		
7470	28	
7472	28	
7473	32	
7474	27	38
7475	38	40
7476	37	
7478		
7480	48	
7481	86	
7482	69	
7483A		
7484	97	
7485	104	99
7486		40
7489	205	
7490	33	90
7491	76	110
7492	38	78
7493	32	99
7494	78	
7495A	65	99
7496	58	120
7497	185	
74100	119	
74104	63	
74105	62	
74107	32	38
74109	63	38
74110	54	
74111	68	
74112	88	
74113		38
74114		38
74116	198	
74118	83	
74119	119	
74120	115	
74121	25	
74122	46	
74123	48	
74124		
74125	38	44

	'N'	'LSN'
74126	57	44
74128	74	
74132	73	78
74133		29
74136		40
74138		60
74139		60
74141	56	
74142	265	
74143	312	
74144	312	
74145	65	
74147	175	
74148	109	
74150	99	
74151	64	84
74153	64	54
74154	96	
74155	54	110
74156	80	110
74157	67	55
74158		60
74159	210	
74160	82	130
74161	92	78
74162	92	130
74163	92	78
74164	104	
74165	105	
74166		
74167	20	
74168		
74169		200
74170	230	200
74172	625	
74173	170	
74174	87	120
74175	87	110
74176	75	
74177	78	
74180	85	
74181	165	350
74182	160	
74183		210
74184	135	

	'N'	'LSN'
74185	134	
74188	275	
74190	115	92
74191		
74192	105	180
74193	105	180
74194	105	187
74195	95	137
74196	99	110
74197	85	110
74198	150	
74199	160	
74248		90
74249		93
74251		90
74253		105
74257		108
74258		153
74259		420
74260		153
74261		353
74266		40
74273		124
74275		312
74279		52
74283		120
74290		90
74293		95
74295		120
74298		100
74324		157
74325		242
74326		247
74327		237
74352		100
74353		100
74362		715
74365		49
74366		49
74367		43
74368		49
74373		77
74374		77
74375		60

	LSN
74377	124
74378	93
74379	130
74386	37
74390	140
74395	139
74396	133
74398	180
74399	150
74445	92
74447	90
74490	140
74668	110
74670	249

MISCELLENY

NE555 30p
NE556 78p
NE558 180p
ICM7217 950p
ICM7208 1495p
ICL7106CP - LCD DVM IC 955p
LCD DVM KIT 2480p
3½ digit LCD display 1150p
ICL7107 LED DVM kit 2065p
ICM7216 - 8 digit 10MHz DFM/ timer £19.82 (for LED C.Cath)

SCALAR ICs
8629 150MHz divide by 100 420p
95H90DC 780p
11C90DC 1400p
8618 -new-divide by 100 or 10 for 120/60MHz 450p

The ICL7216BIPI is still the cheapest way to make a full 8 digit/ 10MHz frequency counter/timer, and with 10 external components + display - it is also one of the simplest. For £19.82, it takes a lot of beating. The mains filters have been extended now to include a 6amp IEC version at £5.10, and with the amount of electronic noise on the average supply (next door's fridge, for instance) it is a really worthwhile addition to any sensitive equipment. LPSN TTL now includes many more of latest types, all - of course - are absolutely prime first quality types. And don t forget our range of OPTO displays includes Hewlett Package high efficiency 0.43" types in all colours - renowned as the finest quality in the market. For other types of component - discrete LEDs, radio and audio devices, tuner modules, kits etc., see our other advertisement for more details - or send for the AMBIT catalogue system. Part one (45p) includes details of our background 'standard' items, and the new part two includes all the latest introductions and developments, plus a rundown on OSTS.

2 Gresham Road, Brentwood, Essex.

TRADE COMPONENTS

NO LISTS: TOO MANY ITEMS. PAY A VISIT — THOUSANDS MORE ITEMS BELOW WHOLESALE PRICE. CALLERS PAY LESS AS PRICES INCLUDE POSTAGE AND VAT AND ADDITIONAL DISCOUNT IN LIEU OF GUARANTEE. GOODS SENT AT CUSTOMERS RISKS UNLESS SUFFICIENT ADDED FOR REGISTRATION OR COMPENSATION FEE POST.

OFFERS CORRECT AT 20/11/78 APPLICABLE TO ORDERS RECEIVED DURING DECEMBER

VALVE BASES

Printed circuit B7G ... 7p
Chassis B7-B7G ... 11p
Shrouded Chassis B7G-B8A ... 13p
B12A tube. Chassis B9A ... 13p

Speaker 6" x 4" 5 ohm ideal for car radio £1.55
4¾" diam. 30 Ω ... £1.75
2½" diam. 32 or 8Ω ... £1.07

TAG STRIP–6 way 4p
9 way 6p Single 1½p

5 x 50pF or 1000 x 300pF trimmers 35p

Car type panel lock and key 65p

Transformer 9V 4A £3.78

Aluminium Knobs for ¼" shaft. Approx. ⅝" x ⅞" with indicator Pack of 5 **95p**

BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **57p** clear perspex sliding lid, 46 x 39 x 24 mm **15p**.

ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **65p**; 80 x 150 x 50mm black **97p**; 109 x 185 x 60mm black **£1.52**.

DIECAST ALI superior heavy gauge with sealing gasket, approx 6½" x 2⅜" x 1⅜" **£1.50**; 3¾" x 2⅜" x 1⅜" **£1.25**.

VARIABLE CAMM PROGRAMMER 10, 12 or 15 pole 2 way, 50VAC motor — series with 1mfd, or 3k 10W or 15W pygmy bulb for mains operation. Ex equipment **£4.32**

SWITCHES

Pole	Way	Type	
1	2	Slide	15p
6	2	Slide	24p
2	1	Rotary Mains	28p
2	Alternating	Micro with roller	30p
2	3	Miniature Slide	20p
2	1	Toggle	32p
1	2	Sub-Min Toggle	75p
2	Alternating	2A Mains Push (¾" hole)	43p
2	Alternating	Slide	15p

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **38p**; 1 pole 2 way 10 amp oblong clip in mains rocker appliance switch ... **38p**
Standard thumb-wheel switch 0-9 in 1248N or B or Comp. 1242 also 2p co........ **£1.20**
Standard Lever Key Switch D.P.D.T. locking plus D.P.D.T. and S.P.S.T. Heavy Duty non latching ... **82p**

AUDIO LEADS

3 pin din to open end, 1½yd, twin screened 45p
3 pole jack both ends 4ft ... £1
3 pole jack plug to tag ends, 4ft ... 45p

COMPUTER & AUDIO BOARDS/ASSEMBLIES
VARYING CONTENTS INCLUDE ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.
3lb for **£2** 7lb for **£3.70**

1k horizontal preset with knob 10 for **40p**

3" Tape Spools 5p
1" Terry Clips ... 5p
12 Volt Solenoid 40p

ENM Ltd. cased 7-digit counter 2¼ x 1¾ x 1¼" approx. 12V d.c. (48 a.c.) or mains **£1.10**

Auto charger for 12v Nicads, ex-new equipment ... £5.19

RESISTORS

⅛-¼-½ watt ... 1½p
1 watt ... 3p
Up to 15w w/wound 10p
1 or 2% 4 times price

Cinch 8 way std 0.15 pitch edge connector 25p

RELAYS

RS/Alma reed relay, 3k Ω 18-30v d.c. coil, normally open ... 60p
12v d.p.c.o. heavy duty octal ... £1
700 ohm 11-31 volt miniature sealed d.p.c.o. ... £1

POTS

Wirewound 38p. Log. or Lin., carbon rotary or slide. Single 30p With switch 40p Dual 45p Dual switch 55p 1.5m Edgetype 10 for 40p

Skeleton Presets
Slider, horizontal or vertical standard or submin 8p

THERMISTORS and V.D.R's

CZ1/2/6/11/14, KR22, KT150, VA1005/6/8/1010/1033/4/7/8/9 1040/1053/5 /1066/7/1074/6/7 / 1082/6/1091/6/7/8 / 1100/3/8/8602. Rod with spot blue/fawn/green. E299DDP120 / 218 / 224 / 338 / 340 / 350 / 352 · VF020 · E220ZZ002 · KR150 ... All 22p
E23 glass bead 85p
YG150-S534 bead, KB13, E299 DHP230, 116-121 401 (TH7. VA1104, OD10) 35p

JAP 4 gang min. sealed tuning condensers 40p

ELECTROLYTICS Many others in stock

MFD	Up to 10V	25V	50V	63–75V	100V	200–250V	300–350 V	450–500V
10	6p	7p	7p	10p	13p	15p	26p	32p
25	6p	7p	7p	10p	13p	18p	32p	37p
50	6p	7p	7p	12p	16p	23p	32p	37p
100	7p	8p	13p	15p	24p	26p	–	–
250	12p	13p	15p	22p	36p	–	£1.10	£1.30
500	13p	15p	22p	30p	55p	–	–	£1.60
1000	16p	27p	50p	60p	–	£1.05	–	–
2000	28p	47p	55p	93p	–	–	–	–

As total values are too numerous to list, use this price guide to work out your actual requirements 8/20, 10/20, 12/20, 22/50, 47/25. Tub. Tant **24p each** 16-32/275V, 100/150V, 100-100/275V **40p** 50-50/385V, 2+2/200V non polar, 32-32-50/300V, 20-20-20/350V 0.1+0.1/500V AC **80p** 200V, 100-200-60/300V **£1.30** 100-300-100-16/300V **£1.85**

RS 100-0-100 micro amp null indicator Approx. 2" x ¾" x ¾"........£1.85

INDICATORS

Bulgin D676 red, takes M.E.S. bulb........**38p**
12 volt, or Mains neon, red pushfit........**23p**
R.S. Scale Print, pressure transfer sheet........**12p**

CAPACITOR GUIDE — maximum 500V

Up to .01 ceramic **4½p.** Up to .01 poly **6p** .013 up to .1 poly etc. **7p.** .12 up to .68 poly etc. **8p.** Silver mica up to 360pF **10p,** then to 2,200pF **13p;** then to .01 mfd **21p.**
.1/750 **13p.** .01/1000, 8/20, .1/900, .22/900, 4/16, 25/250 AC (600v/DC). **15p.** 5/150, 10/150, 40/150 **50p.**
Many others and high voltage in stock.

SONNENSCHEIN/POWERSONIC DRI-FIT RECHARGEABLE SEALED GEL (Lead Antimony) BATTERY, 6V 1 amp.hr. (3⅞" x 2" x ⅞") **£3.70.** 6 amp. hr. (4½" x 2" x 3") **£7.60**
Ex-equipment, little used.

CONNECTOR STRIP
Belling Lee L1469, 4 way polythene. **9p each**

1¼ glass fuses 250 m/a or 3 amp (box of 12) 20p
Bulgin 5mm Jack plug and switched socket (pair) 40p

Reed Switch 28mm, body length 11p

Aluminium circuit tape, ⅛ x 36 yards—self adhesive. For window alarms, circuits, etc. **95p**

TV MAINS DROPPERS
5 assorted multiple units for........**75p**

100pF air-spaced tuning capacitor........**£1.30**
5¼" x 2¼" Speaker, ex-equipment 3 ohm 65p
2 Amp Suppression Choke........10p
3 x 2½ x 1⁄16" } **PAXOLINE** 5 for 35p
4⅝ x ½ x ⅛" } 10 for 15p
PVC or metal clip on MES bulb Holder 5 for 30p
VALVE RETAINER CLIP, adjustable 5 for 15p

Sub-miniature Transistor Transformer **35p**
Valve type output transformer **90p**

POT CORES with adjuster
LA2508-LA2519 **43p per pair**

16 Watt Power Amp. Module
35v 1A power required, giving 16 watt RMS into 8 Ω **£3.45**

GRUNDIG REGULATED TAPE MOTOR
6V nominal approx. 3 x 1½". Incl. shock absorbing carrier **£1.05**

3.5mm metal stereo plug **30p**
Fane 8 ohm 3" sq. heavy duty communications speaker **£1.60**
RS neg. volt regulator 103, 306-099 (equiv. MPC900) 10A, 100 watt 4-30 volt. Adjustable short circuit protection. Normally £12.50+. **£6.65**

Miniature 0 to 5mA d.c. meter approx ⅞" diameter ... **£1.25**
RS Yellow Wander Plug Box of 12 ... **40p**
18 SWG multicore solder ... **3½p foot**
SAPHIRE STYLII. 15 different, dual and single point, current and hard to get types. My mix **£2.**

Digital count unit. Counts in steps of 1, 2, 5 or 10 with total limit switch (2 x D.I.L BCD), reed relay remote output. Mains power supply, relay and delay unit. UNUSED Displays on 2 Minitron. 7 segments sold separately. £5.40

Burglar alarm, cord-powered for windows, doors, luggage and personal attack. Battery powered 86p

DEAC rechargeable NICAD 450K. Capacity 6V 450 m.a.h. at 10 hour rate. Ex-new equipment £4.11

Crouzet 30-minute timer-programmer, multi-variable contacts £7.56

ACOS DUST JOCKEY Automatic record cleaner £1.30

Mail Order
Over £50 deduct 10%
Over £100 deduct 20%

McMurdo 4 or 8 way plug and socket ex-equipment 50p

"Makaswitch" 1p 10-way wafer 15p
Wood cased 8-12V buzzer £2.50

2.5A r.f. thermo-couple and meter 2¼" square £3.80

BRIAN J. REED

161 ST. JOHNS HILL, BATTERSEA, LONDON SW11 1TQ
Open 10 a.m. till 7 p.m. Tuesday to Saturday. VAT receipts on request.
Terms: Payment with order Telephone: 01-223 5016

100 Capacitors £2.50
100 Resistors up to ¾W £1.00
100 Resistors 2-5W £3.00
100 1% & 2% Resistors £3.50

100 Electrolytics £3.00
100 Resistors 1W £2.00
100 Wirewound Resistors £4.50
Well mixed valves and voltages

Mullard 12-0-12V, 1.4A stabilized, regulated, power supply. Approx. 8½" x 4¾" x 3½" with handbook £14.50

27V 5A Double section bobbin transformer £4.32

UK & EIRE — Postal Orders for same day service. Cheques require 8 days from a Tuesday banking to ensure clearance: export — banker's draft (sterling) same day service. Foreign currency money orders etc. can lose value and take 4-6 weeks to clear.

C90 Cassette Tape 62p

50 ohm BNC plug, through connector or round or flanged chassis socket. TNC plug or N plug or through connector 65p each

250 Ω 50 watt + Resistor 40p

SEMICONDUCTORS Full spec. by Mullard etc. Many others in stock

AC128/176	17p
ACY29	22p
AD161/2 match pr.	85p
AF116	20p
AF124/6/7	28p
AF139	23p
AF178/80/81	35p
AF239	35p
ASY27/73	35p
AU110/113	£2.50
BC107/8/9 + A/B/C	8p
BC147/8/9 + A/B/C	8p
BC157/8/9 + A/B/C	8p
BC178A/B 179B	14p
BC184C/LC	11p
BC186/7	23p
BC213L/214B	13p*
BC261B	10p
BC327/8 337/8	10p
BC547/8+A/B/C	13p
BC556/7/7B/8/9	11p
BCX32/36	15p
BCY31	90p
BCY70/1/2	14p
BCZ11	32p
BD113	57p
BD115	35p
BD116(BRC116T)	£1.15
BD130Y	£1.50
BD131/2/3	40p
BD135/6/7/8/9	35p
BD137/138 match pr	82p
BD140/142	35p
BD201/2/3/4	92p
BD232/3/4/5/8	55p
BDX77	£1.15
BD437	58p
BF/115/167/173	18p
BF178/9	23p
BF180/1/2/3/4/5	18p
BF194/5/6/7	8p
BF194A, 195C	8p
BF200 258 324	23p
BF262/3	35p
BF336	31p
BFS28 Dual Mosfet	£1.15
BFW10/11 F.E.T	46p
BFW30	£1.15
BFW57/58	21p
BFX12/29/30	23p
BFX84/88.89	20p
BFY51	16p
BFY90	57p
BR101	34p
BRY39/56	29p
BSV64	36p
BSV79/80 F.E.T.s	90p
BSV81 Mosfet	£1.00
BSX20/21	16p
BSY40	30p
BSY95A	14p
BU204 + Mount Kit	£1.85
BU208	£2.26
CV7042 (OC41/44 ASY63)	12p
GET111	45p
OC45(ME2)	13p
ON222	23p
R2008B/2010B	£2.30
TIP30	50p
TIS43	39p
TIS88A F.E.T.	28p
uA7805	£1.85
ZT1486	£1.15
ZTX300/341	9p
2N393 (MA393)	35p
2N456A	57p
2N706A	18p
2N929	16p
2N987	45p
2N1484	£1.15
2N1507/2219	18p
2N2401	35p
2N2412	80p
2N2483	28p
2N2904/5/6/7/7A	18p
2N3053	16p
2N3055 R.C.A.	60p
2N3133	24p
2N3553	56p
2N4037	39p
2N5484 FET	39p
2SA141/2/360	36p
2SB135/6/457	24p
2SC372/644/735	15p
2SC853	30p
40250(2N3054)	35p

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	34p
1	140	OSH01-200	30p
5	100	Ex Equip	73p
0.6	110	EC433	20p
5	400	Texas	£1.10
2½	100	I.R.	48p
3½	100	B40C 3200	58p

NEW B. V.A. VALVES

EB91	49p
ECL80	67p
PCC84	59p
6SN7/6K7	89p
6AT6	89p
EZ81	59p
OC3	£1.20
KT66	£6.00

TRANSFORMERS

Ferromag C core. Screens 95-105-115-125-200-220-240v input output 17v ¾A x 2 . 24-0 24V 1.04A + 20v 1mA. These current ratings can be safely exceeded by 50%. £4.90

Cassette Dynamic Microphone with switch and twin plug £1.80

Telephone Pickup, sucker with lead and 3.5 plug 70p

OTHER DIODES

1N916	8p
1N4009	9p
1N4148	4p
BA145	17p
Centercel	29p
BZY61/BA148/OA81	12p
BB103/110 Varicap	24p
BB113 Triple Varicap	43p
BA182	15p
OA5/7/10	17p
BZY88 up to 43 volt	10p
BZX61 11 volt	17p
AA133	10p
BZY96C 10V	34p
BZY95C 33V	34p

RS *Irravin* high temperature wire, 19/0.16, minus 55° to 105°C, 600V 3A, white, black or red. Half trade price at 54p 10M coil.

PVC QUALITY TAPE

Lasso 10m x 15mm grey 38p

33m x 33mm green £1.13p

Trimmer: Post stamp type 3-30pF 16p
10-80pF 19p
30-140pF 23p

GARRARD

GCS23T Crystal Stereo Cartridge £1.20
Mono (Stereo compatible) Ceramic or crystal £1

RECTIFIERS

	Amp	Volt	
M1	½	68	5p
1N4005/6	1	6/800	6p
1N4007/BYX94	1	1250	8p
BY103	1	1,500	21p
SR100	1.5	100	9p
SR400	1.5	400	10p
REC53A	1.5	1,250	16p
LT102	2	30	15p
BYX22-200	1½	300	25p
BYX38-300R	2.5	300	48p
BYX38-600	2.5	600	52p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX49-300R	3	300	35p
BYX49-600	3	600	42p
BYX49-900	3	900	47p
BYX49-1200	3	1,200	60p
BYX48-300R	6	300	47p
BYX48-600	6	600	60p
BYX48-900	6	900	70p
BYX48-1200R	6	1,200	92p
BYX72-150R	10	150	42p
BYX72-300R	10	300	52p
BYX72-500R	10	500	65p
BYX42-300	10	300	36p
1N5401	3	100	16p
1N5402	3	200	18p
MR856	3	600	24p
BYX42-900	10	900	92p
BYX42-1200	10	1,200	£1.07
BYX46-300R*	15	300	£1.19
BYX46-400R*	15	400	£1.75
BYX46-500R*	15	500	£2.00
BYX46-600*	15	600	£2.30
BYX20-200	25	200	72p
BYX52-300	40	300	£2.05
BYX52-1200	40	1,200	£2.90
RAS310AF*	1,25	1,250	48p

**Avalanche type*

TRIACS

Amp	Volt		
8	400	Plastic RCA	£1.40
25	900	BTX94-900	£4.50
25	1200	BTX49-1200	£6.75

Transistor equivalents and substitutes ....Book 1 38p Book 2 82p
Chrome Car Radio facia 28p
Rubber Car Radio gasket 10p
DLI Pal Delayline 90p
Relay Socket miniature 2PCO 20p
28 pin d.i.l. socket low profile 38p
Colour EHT Tray 3000/3500 .... £6.50
Nylon self-locking, 3½" tie clips 3p
1.5, 10, 22 or 750 μh choke 12p
0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive 4½" dia. 13p
Mullard Semiconductor, Valve & Component Data Book 1976-78 .... 50p

OPTO ELECTRONICS

Diodes

TIL209 Red	14p
BPX40	57p
BPX42	92p
BPY10	92p
(VOLTIAC) BPY68	
BPY69	92p
BPY77	

Photo transistor

BPX29	92p
OCP71	75p

BIG L.E.D. 0.2" 2v 50m/A max.
RED 16p
Wire end neons 9p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.15

3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v 19m/a segment, common anode 95p
RS 0.6in. green £2.25
Miniltron 0.3in 3015F filament £1.25

CQY11B L.E.D. Infra red transmitter £1.15
One fifth of trade
Plastic Transistor or Diode Holder 1½p
Transistor or Diode Pad 1½p
Holders or pads 65p per 100

THYRISTORS

Amp	Volt		
1	240	BTX18-200	35p
1	400	BTX18-300	41p
1	240	BTX30-200	35p
15	500	BT107	£1.14
6.5	500	BT101-500R	£1.05
6,5	500	BT109-500R/SCR957/BRC4444	£1.14
20	600	BTW92-600RM	£3.40
15	800	BTX95-800R Pulse Modulated	£8.75

PAPER BLOCK CONDENSER

0.25MFD	800 volt	87p
1MFD	250 volt	54p
1MFD	400 volt	65p

TV KNOB

Dark grey plastic for recessed shaft (quarter inch) with free shaft extension 8p

CHASSIS SOCKETS

Car Aerial 11p, Coax 8p, 5 pin 180° 11p, 5 or 6 pin 240° din 8p, speaker din switched 13p, 3.5 mm switched 7p, stereo ¼" jack enclosed 20p.

INTEGRATED CIRCUITS

TBA920	£2.20
TAA700	£2.40
TBA800	£1.24
741 dil. op amp	28p
uA702 op amp	53p
(72) 709	52p
SN76013N/ND	£1.40
SN76228N	£2.03
SN76131N	£1.55
SN74107N	38p
TAD100 AMRF	£1.22
CA3001 R.F. Amp	58p
CA3132	£2.22
CD4013 CMOS	41p
CD4069	24p
TAA300 1 wt Amp	£1.15
TAA550 Y or G	26p
TAA263 Amp	75p
TAA320	£1.15
7400/7401	16p
7402/4/10/20/30	16p
7414	64p
7438/74	27p
7414	64p
7483	79p
7493	41p
LM300 2/20V reg	£1.15
LM1303N	£1.15
74154	£1.02
TBA550Q	£1.80
ZN414 Radio Chip	£1.40

McMurdo PP108 8 way edge plug 12p
Multicore Solder ½kg. 16 or 18 or 20 s.w.g. 60/40 .... £5.00
3 inch 8 Ω speaker £1.15

New unmarked, or marked ample lead ex new equipment

ACY17-20	10p
ASZ20	10p
ASZ21	35p
BC186	13p
BCY30-34	24p
BCY70/1/2	10p
BY126/7	5p
HG1005	12p
HG5009	4p
HG5079	4p
L78/9	4p
M3	12p
OA81	4p
OA47	4p
OA200-2	4p
OC23	27p
OC200-5	24p
TIC44	28p
2G240	£1.17
2G302	6p
2G401	6p
2N711	28p
2N2926	6p
2N598/9	8p
2N1091	10p
2N1302	10p
1N1907	£1.17
Germ. diode	2p
2N3055 Motorola	36p
GET120 (AC128 in 1" sq. heat sink	22p
GET872	15p
2S3230	34p

MINIATURE EDGE METERS

100uA f.s.d., scaled 0.5. 12V Illuminated blue perspex front, 35mm x 14mm £3.45

200uA level meter, clear front. 10 x 18mm £1.20

SPECIAL OFFERS

2500 mfd. 40v 56p
0.1 mfd. 350/500v 10 for 50p
10000 mfd. 15v 3 for £1.16
6800 mfd. 10v 3 for 90p
32+32/275v 3 for 90p
16+32/350v 3 for 90p
8+8 mfd. 375v4 for 90p
1 mfd. non-polar 350v 10 for £1.19
25000 mfd. 25v 66p
12000/12v 3 for £1.16
G.E.C. 5% Hi-stab capacitors 013, 061, 066, 069, 075, 08. 10 for 65p
Philips Head Cleaner Tape 32p
BC548B 500 for £28.50
BC556 500 for £28.50
BCY71 500 for £43.50
BD437 50 for £13.75
BD133 100 for £16.60
2N2906 500 for £43.50
TBA920 10 for £11.50
Vero card handle 10 for 65p
62 Ω ½W Resistor 2,000 for £6.75
ON222 (superior matched BF181) 10 for £1.20

HANDLES

Rigid light blue nylon 6½" with secret fitting screws 11p

Belling Lee white plastic surface coax outlet box 40p

Miniature Axial Lead Ferrite Choke formers 5 for 13p

RS 10 Turn pot 1% 250 500 Ω 1K, 50K £1.70

Copper coated board 10" x 9" approx. 60p

Geared Knob 8-1 ratio. 1¼" diam., black 93p

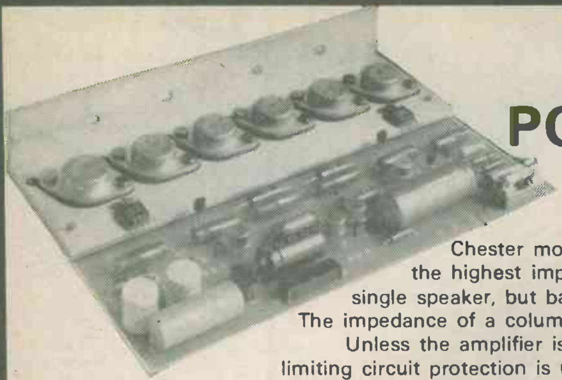
KLIPPON 25A 440v TERMINAL BLOCKS
Professional leaf spring clamp, twin with clip-over cover 11p
Strip of 4, 40A 440V 16p

VAT & POST PAID

MINIMUM ORDER £3 OTHERWISE ADD 50% FOR SMALL ORDER HANDLING COSTS (UNDER £1.00 TOTAL ALSO INCLUDE 9p S.A.E.)

NO MORE TO ADD — Prices INCLUDE UK VAT and Post/Packing

ALL ENQUIRIES, ETC., MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE



450 WATTS
POWER AMPLIFICATION BY CHESTER LABORATORIES

Chester modules are designed for P.A. Disco, and Group amplification. Reliability is of the highest importance in this field, therefore the amplifier has to function into not only a single speaker, but banks of speakers whose impedance varies very considerably with frequency. The impedance of a column of 8 ohm speakers can go down to 2 ohms or less at some frequencies. Unless the amplifier is designed to function into 2 ohms, its reliability will be reduced. If current limiting circuit protection is used, the amp will simply clip the peaks off the signal, with a very audible effect on the music.

Our approach is to use sufficient transistors in the output stage to provide a massive reserve capability for the amplifier to drive into any load down to about 1.5 ohms. Circuit protection is not necessary. If the amp is shorted out the output current rises until the 5 amp fuse blows, without damage to the amp.

OUTPUT POWER

The output is 32 volts into 2.5 ohms 450 Watts
34 volts into 4 ohms 290 Watts
36 volts into 8 ohms 170 Watts

Supply required is 140 volts at 4 amps (nominal)
Signal to noise (unweighted) 130 dB ref 200 watts.
Power bandwidth + or – 1dB 30hz to 25Khz at 200 watts
Input 0db (0.775v)
T.H.D. typically 0.1% at any power at 1Khz
The module features all in one construction, six 20 amp 160 volt output transistors, and 3 amp 100 volt driver transistors. The output capacitor supplied with the amp is too large to mount on a circuit board.

P.A.450 WITH OUTPUT CAP.

£29.00 (includes UK postage + tax etc)

POWER SUPPLY KIT

£18.00 (includes UK postage + tax etc)

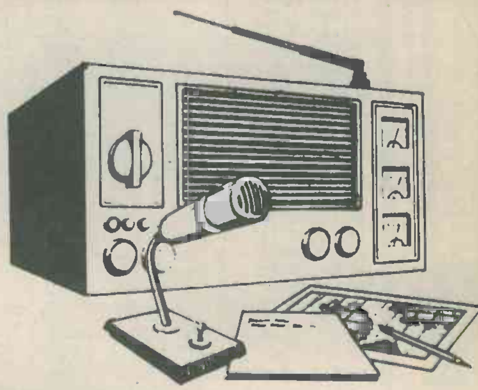
The power supply is over 7 Kilos weight so it is not always possible to send these outside UK.

Callers by arrangement

CHESTER LABORATORIES
96 Glengall Road, London NW6

For more information send cheque or P.O. for 30p.
Our list includes information on preamps, microphone preamps etc.

Electronics. Make a job of it....



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British National Radio & Electronic School
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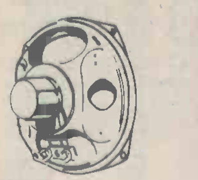
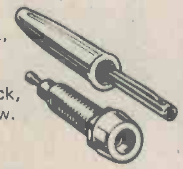
STEVENSON
Electronic Components

LOUDSPEAKERS



56mm dia. 8ohms	70p
64mm dia. 8 ohms	75p
64mm dia. 64 ohms	75p
70mm dia. 8 ohms	100p
70mm dia. 80 ohms	110p

PLUGS AND SOCKETS



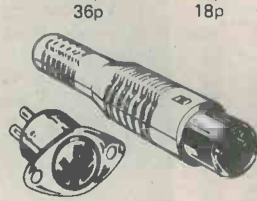
1mm plugs and sockets suitable for low voltage circuits. Available in red or black. Plugs 6p each. Sockets 7p each.

4mm plugs and sockets. Available in black, blue, green, brown, red, white and yellow. Plugs 11p each. Sockets 12p each.

Jack plugs and sockets

	unscreened plug	screened plug	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

Din plugs and sockets



	plug	socket
2 pin speaker	7p	7p
3 pin	11p	9p
5 pin 180°	11p	10p
5 pin 240°	13p	10p

CABLES

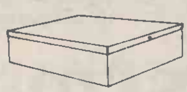
Connecting wire
Available in packs of 8 metres (one metre of each colour) or packs of forty metres (five metres each colour).

	single	standard
Eight Metre pack	16p	16p
Forty Metre pack	76p	70p

Screened Cable
Single screened 8p
twin individually screened 11p

Ribbon cable
10 way 58p metre
20 way 100p metre

ALUMINIUM BOXES



Boxes complete with lid and screws.

	Length	width	height	
AL1	3	2	1	48p
AL2	4	3	1½	58p
AL3	4	3	2	65p
AL4	6	4	2	70p
AL5	6	4	3	85p
AL6	8	6	2	116p

We now have an express telephone order service. We guarantee that all orders received before 5pm. are shipped first class on that day. Contact our Sales Office now! Telephone: 01-464 2951/5770.

ORDERS DESPATCHED BY RETURN POST

Quantity discounts on any mix TTL, CMOS, 74LS and Linear circuits: 25+ 10%. 100+ 15%. Prices VAT inc. Please add 30p for carriage. All prices valid to 30th April 1979. Official orders welcome.

BARCLAYCARD AND ACCESS WELCOME.

TRANSISTORS

AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC158	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214	10p			2N5459	32p
BC477	19p			2N5777	50p
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

1N914	4p	1N4148	3p
1N4001	4p	1N5401	13p
1N4002	4p	1N5402	15p
1N4004	5p	1N5404	16p
1N4006	6p	1N5406	18p

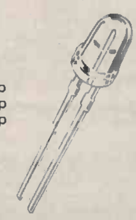
BZY88 series 2V7 to 33V 8p each.

LINEAR

A SELECTION ONLY! DETAILS IN CATALOGUE.

709	25p	LM324	50p	NE556	60p
741	22p	LM339	50p	NE565	120p
747	50p	LM380	75p	NE567	170p
748	30p	LM382	120p	SN76003	200p
CA3046	55p	LM1830	150p	SN76013	140p
CA3080	70p	LM3900	50p	SN76023	140p
CA3130	90p	LM3909	60p	SN76033	200p
CA3140	70p	MC1496	60p	TBA800	70p
LM301AN	28p	MC1458	35p	TDA1022	650p
LM318N	125p	NE555	25p	ZN414	75p

OPTO



LEDs	0.125in.	0.2in.	
Red	TIL209	TIL220	9p
Green	TIL211	TIL221	13p
Yellow	TIL213	TIL223	13p
Clips	3p	3p	

DISPLAYS

DL704	0.3 in CC	130p
DL707	0.3 in CA	130p
FND500	0.5 in CC	100p

RESISTORS

Carbon film resistors. High stability, low noise 5%.

E12 series. 4.7ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res.) 0.5W £7.50. 0.25W £5.70

CAPACITORS

HERE ARE JUST A FEW OF THE CAPACITORS STOCKED

TANTALUM BEAD — each

0.1, 0.15, 0.22, 0.33, 0.47, 0.68,1 & 2.2uF @ 35V	9p
4.7, 6.8, 10uF @ 25V	13p
22 @ 16V, 47 @ 6V, 100 @ 3V	16p

MYLAR FILM

0.001, 0.01, 0.022, 0.033, 0.047	3p
0.068, 0.1	4p

RADIAL LEAD ELECTROLYTIC

63V	0.47	1.0	2.2	4.7	10	5p
			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p
10V		220				5p
				470		9p
	1000					13p
		2200				23p

74LS

		LS95	65p
		LS123	56p
		LS125	40p
		LS126	40p
LS00	16p	LS132	60p
LS01	16p	LS136	36p
LS02	16p	LS138	54p
LS03	16p	LS139	50p
LS04	16p	LS151	50p
LS08	16p	LS153	50p
LS10	16p	LS155	80p
LS13	30p	LS156	80p
LS14	70p	LS157	45p
LS20	16p	LS164	90p
LS30	16p	LS174	60p
LS32	24p	LS175	60p
LS37	26p	LS190	80p
LS40	22p	LS192	70p
LS42	53p	LS193	70p
LS47	70p	LS196	80p
LS48	48p	LS251	60p
LS54	16p	LS257	55p
LS73	29p	LS258	55p
LS74	29p	LS266	40p
LS75	44p	LS283	60p
LS76	35p	LS290	55p
LS78	35p	LS365	45p
LS83	60p	LS366	45p
LS85	70p	LS367	45p
LS86	33p	LS368	45p
LS90	45p	LS386	35p
LS93	45p	LS670	180p

TTL

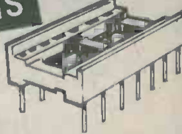
		7493	34p
		7494	52p
		7495	52p
		7496	50p
7400	12p	74121	25p
7401	12p	74122	33p
7402	12p	74123	40p
7404	12p	74125	35p
7408	14p	74126	35p
7410	12p	74132	50p
7413	25p	74141	56p
7414	48p	74148	90p
7420	12p	74150	70p
7427	24p	74151	50p
7430	12p	74156	52p
7442	43p	74157	52p
7447	55p	74164	70p
7448	58p	74165	70p
7454	14p	74170	125p
7473	25p	74174	68p
7474	25p	74177	58p
7475	32p	74180	72p
7476	28p	74191	72p
7485	70p	74192	64p
7489	145p	74193	64p
7490	32p	74196	55p
7492	35p	74197	55p

CMOS

FULL DETAILS IN CATALOGUE

		4029	60p
		4040	68p
4001	15p	4042	54p
4002	15p	4046	100p
4007	15p	4049	28p
4011	15p	4050	28p
4013	35p	4066	40p
4015	60p	4068	20p
4016	35p	4069	16p
4017	55p	4071	16p
4018	65p	4075	16p
4023	15p	4093	48p
4024	45p	4510	70p
4026	95p	4511	70p
4027	35p	4518	70p
4028	52p	4520	65p

SKTS



Low profile by Texas

8 pin	10p	24 pin	24p
14 pin	12p	28 pin	28p
16 pin	13p	40 pin	40p

Soldercon pins: 100: 50p
1000: 370p

AT LAST! OUR NEW 40 PAGE CATALOGUE OF COMPONENTS IS AVAILABLE. SEND S.A.E.

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AC126	18p
AC127	17p
AC128	16p
AC141	24p
AC142	24p
AC151	42p
AC152	53p
AC153	58p
AC176	18p
AC187	23p
AC188	23p
AD149	65p
AD161	38p
AD162	38p
AF114	30p
AF118	30p
AF125	27p
AF126	27p
AF127	27p
AF139	36p
AF186	54p
AF239	40p
ASY53	81p
ASY54	81p
ASY55	69p
BC107	8p
BC108	8p
BC109	8p
BC113	17p
BC117	20p
BC119	29p
BC140	34p
BC142	27p
BC143	27p
BC147	8p
BC149	8p
BC157	9p
BC158	9p
BC159	9p
BC168	8p
BC170	9p
BC171	9p
BC172	9p
BC173	9p
BC182	10p
BC183	10p
BC184	10p
BC186	23p
BC187	26p
BC207	10p
BC212	10p
BC213	10p
BC214	10p
BC237	14p
BC238	14p
BC301	30p
BC303	30p
BC328	15p
BC338	15p
BC547	11p
BC548	10p
BC549	11p
BC557	14p
BCY30	67p
BCY34	74p
BCY59	24p
BCY70	14p
BCY71	14p
BD115	52p
BD121	79p
BD123	79p
BD124	97p
BD131	35p
BD132	35p
BD135	38p
BD136	37p
BD137	38p
BD138	38p
BD139	35p
BD140	35p
BF115	25p
BF167	29p
BF173	27p
BF178	34p
BF179	37p
BF180	37p
BF181	37p
BF182	37p
BF183	37p
BF184	28p
BF185	30p
BF194	13p
BF196	13p
BF197	16p
BF198	16p
BF200	36p
BF224	16p
BF257	37p
BF258	40p
BF259	44p
BFR39	30p
BFR79	30p
BFR40	30p
BFR79	30p
BFR80	30p
BFX29	25p
BFX30	38p
BFX85	29p
BFX86	31p
BFX87	20p
BFY50	15p
BFY51	15p
BFY53	28p
BSX19	25p
BSX20	21p
BU205	140p
BU208	160p
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OC28	108p
OC35	108p
OC71	19p
OC72	34p
OC84	46p
TIP29	40p
TIP30	40p
TIP31	50p
TIP32	55p
TIP33	75p
TIP34	98p
TIP35A	253p
TIP36A	389p
TIP41A	69p
TIP42A	69p
TIP2955	126p
TIP3055	64p
ZTX108	14p
ZTX109	14p
ZTX300	16p
ZTX500	16p
2N706	13p
2N1131	23p
2N1132	23p
2N1302	38p
2N1304	54p
2N1305	25p
2N1306	39p
2N1308	40p
2N1613	22p
2N1711	21p
2N1893	44p
2N2217	27p
2N2219	21p
2N2369	16p
2N2483	26p
2N2484	22p
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2N2906	22p
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2N3703	8p
2N3704	8p
2N3706	9p
2N3707	9p
2N3710	8p
2N3711	8p
2N3772	177p
2N3773	290p
2N3866	54p
2N3904	8p
2N4061	12p
2N4062	20p
2N4123	23p

TTL

7400	12p
7401	12p
7402	12p
7403	12p
7404	12p
7405	13p
7406	24p
7407	24p
7408	14p
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74109	30p
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74165	70p
74166	80p
74167	180p
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74174	70p
74175	65p
74176	60p
74177	60p
74178	80p
74180	80p
74181	145p
74182	60p
74184	110p
74190	72p
74191	72p
74192	65p
74193	64p
74194	60p
74195	55p
74196	55p
74197	55p
74198	110p
74199	110p

CMOS

4000	16p
4001	15p
4002	15p
4006	68p
4007	15p
4008	64p
4009	35p
4010	35p
4011	15p
4012	15p
4013	35p
4014	60p
4015	60p
4016	35p
4017	55p
4018	64p
4019	40p
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4073	16p
4077	25p
4078	16p
4081	16p
4082	16p
4086	59p
4501	19p
4507	40p
4510	70p
4516	64p
4518	70p
4519	60p
4520	65p
4528	55p
4578	27p
4583	82p
4585	105p

LINEARS

710CN	40p
741-8	22p
747C-14	50p
748C-8	30p
CA3011	80p
CA3018	80p
CA3028A	85p
CA3035	140p
CA3036	120p
CA3046	75p
CA3054	110p
CA3080	70p
CA3140E	70p
LM301AN	28p
LM308N	64p
LM380N	76p
LM381N	120p
NE555	25p
NE556	80p
TBA641	240p
TBA800	70p
TBA810	100p

VOLTAGE REGULATORS

7805	60p
7812	60p
7815	60p
7818	60p
7824	60p
7905	79p
7912	79p
7915	79p
7918	79p
7924	79p

THYRISTORS

1A/50V	28p
1A/100V	30p
1A/200V	38p
1A/400V	40p
3A/100V	36p
3A/200V	38p
3A/400V	51p

DIODES

BY127	16p
OA47	10p
OA91	15p
OA200	6p
OA202	9p
1N4148	4p
1N916	5p
1N4001	4p
1N4002	4p
1N4003	5p
1N4004	6p
1N4005	7p
1N4006	8p
1N4007	9p
1N5400	13p
1N5401	14p
1N5402	15p
1N5403	20

BRIDGE RECTIFIERS

1A/50V	22p
1A/100V	24p
1A/200V	27p
1A/400V	30
2A/50V	34
2A/100V	36
2A/200V	38
2A/400V	40

OPTO/ DISPLAY

2N5777	50p
OCP71	70p
ORP12	70p
DL704	115p
DL707	115p

.125" & .2" LEDS

Red	9p
Green	13p
Yellow	14p
Clip	3p

DIL SOCKETS

8 pin	10p
14 pin	12p
16 pin	13p

ZENER DIODES

400mW

2.7V to 33V 8p

VERO BOARDS

0.1" copper

2.5"x5"	51p
3.75"x5"	60p

CERAMIC CAP 50V

22pF to 50,000pF 2p

POLYESTER CAP 250V

.01, .015, .022, .033, .047, .068 & .1µF at 5p
.15, .22, .33µF at 7p
.47 & .68µF at 13p
1µF at 17p
2.2µF at 28p

ELECTROLYTIC CAP 25V

1µF to 47µF	7p
68µF & 100µF	8p
150µF	9p
220µF	10p
330µF	12p
470µF	15p

RESISTORS

4.7 ohms to 1 Mohms 1p

POTENTIOMETERS

1 Kohm to 2 Mohm Linear and Log 25p
5 Kohm to 1 Mohm Log with switch 58p

PRESETS

horizontal

100 ohm to 1 Mohm 5p

TRANSFORMERS

240V primary

6-0-6V 100mA 96p. 0-6V x 2 1 amp x 2 360p. 9-0-9V 100mA 250p. 9-0-9V 1 amp 290p. 9-0-9V 2 amp 400p. 0-12V 2 amp 370p. 0-15V x 2 200mA x 2 240p.

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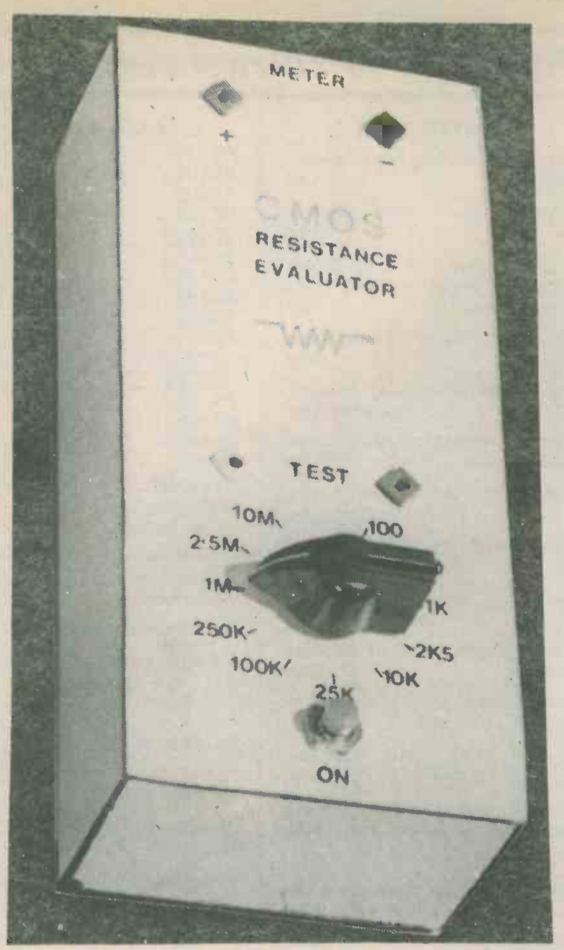


The prototype resistance evaluator is housed in a home constructed case, with Formica covering the front panel and the sides. An external meter, which can be a multimeter switched to a suitable range, is plugged into the meter sockets when required

CMOS

* * *

RESISTANCE

* * *

EVALUATOR

By

Bruce Woodland

Linear read-out from less than 5Ω to 10MΩ.

●

Eleven overlapping ranges.

●

Simple low-cost "plug-in" circuitry.

●

An ohmmeter is an important item of equipment for both amateur and professional workers in the electronics field, its uses varying from the simple continuity tester to the selection of close tolerance resistors for specialised uses. The basic type incorporated in most commercial multimeters has a non-linear scale, and can only give accurate results when the value assessed lies around mid-range.

The unit described here is suitable for evaluating resistance values from less than 5Ω to 10MΩ with eleven overlapping ranges. The circuit is designed around two CMOS operational amplifiers, resulting in a low component count and ease of initial setting up without the drawback of a dual rail power supply.

A combination of constant current generator and high input impedance voltmeter provides linear meter scale readings., The meter movement itself is plugged in to the ohmmeter only when required, thereby ensuring that the meter is not solely committed to use with the ohmmeter. Indeed, a multimeter switched to a low current range will give excellent results.

The eleven ranges provided are listed in the accompanying table.

Table

RANGES	
1	0-100Ω
2	0-250Ω
3	0-1kΩ
4	0-2.5 Ω
5	0-10kΩ
6	0-25kΩ
7	0-100kΩ
8	0-250kΩ
9	0-1MΩ
10	0-2.5MΩ
11	0-10MΩ

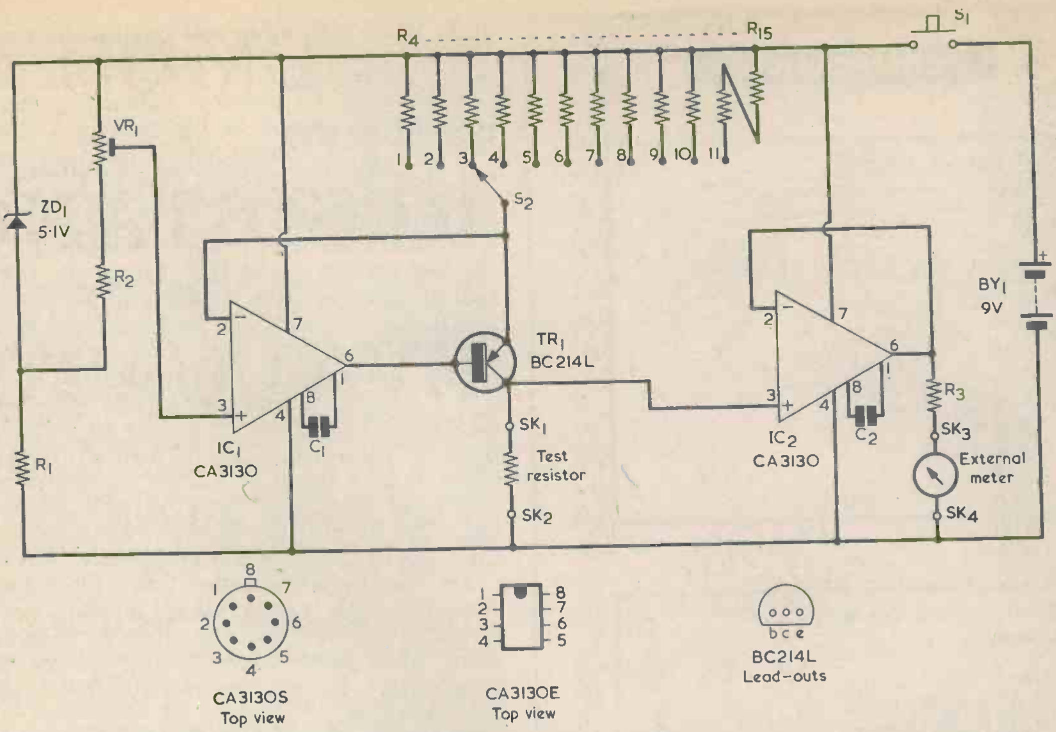


Fig. 1. The circuit diagram of the CMOS resistance evaluator. S2 selects the ranges shown in the table

PRINCIPLE OF OPERATION

IC1, TR1 and the associated components in Fig. 1 form a very accurate constant current generator. The reference voltage applied to the non-inverting input of ICI is nominally 2.4 volts referred to the positive rail. ICI compares this with the voltage at TR1 emitter, at which the same voltage appears. The base-emitter voltage drop (which can vary for different emitter currents) is eliminated as a factor by the overall negative feedback in the transistor and operational amplifier circuit, whereupon the emitter voltage remains constant for all emitter currents selected. The maximum current which can be drawn from the transistor collector is therefore dependent only on the reference voltage from VR1 slider and the value of the emitter resistor selected by the range switch, S2.

The constant current generator develops a voltage across the test resistor which is directly related to the constant current and the test resistance. The range resistors R4 to R15 are chosen to produce sufficient current to develop a nominal 2 volts across the highest test resistance in the particular range selected. This voltage is applied to the non-inverting input of the voltage follower IC2, the input impedance of which is more than sufficiently high to give no significant loading on even a 10M Ω test resistance.

The output of IC2 drives the meter via the current limiting resistor R3, this resistor having a value which gives full-scale deflection at the nominal 2 volts from IC2. Any meter with an f.s.d. requirement of 2mA or less will be suitable.

The value of R3 has to be calculated to suit the particular meter to be employed, and its value is equal to (2 minus Vm) divided by the meter f.s.d. current. Vm is the voltage dropped across the meter at f.s.d. As an example, the meter may be a 0-1mA panel-mounting type having a coil resistance of 150Ω whereupon Vm is equal to 150Ω multiplied by 0.001 amp, or 0.15 volt. R3 then calculates as 2 minus 0.15 volt, or 1.85 volt, divided by 0.001 amp, giving a resistance of 1,850Ω. It is not necessary for R3 to have precisely this resistance, and the nearest preferred value of 1,800Ω can be employed instead. The small error introduced is then cancelled out during setting up by adjusting VR1 for a maximum voltage across the test resistor which is slightly removed from the nominal figure of 2 volts.

A modified approach is required if the meter to be used is a multimeter switched to a low current range. This is because, due to their universal shunt current selection circuits, many multimeters offer quite high voltage drops at f.s.d. current readings, such voltage drops being in some cases as high as 1 volt. It is necessary to determine the voltage dropped across the multimeter with the aid of the circuit shown in Fig. 2. Here, the fixed current

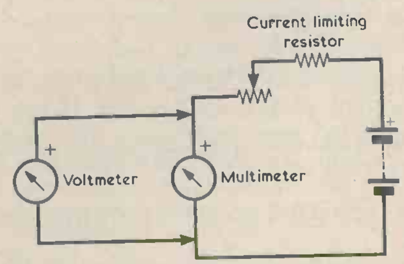


Fig. 2. When a multimeter switched to a low current range is used as the external meter the voltage dropped across it at full-scale deflection may be found with this test circuit. The value of the current limiting resistor must be such that an excessive current cannot pass through the multimeter

COMPONENTS

Resistors
(All fixed values ¼ watt)
R1 1.8kΩ
R2 1.8kΩ
R3 see text
R4 120Ω
R5 300Ω
R6 1.2kΩ
R7 3kΩ
R8 12kΩ
R9 30kΩ
R10 120kΩ
R11 300kΩ
R12 1.2MΩ
R13 3MΩ
R14 2MΩ
R15 10MΩ
VR1 2.2kΩ Miniature pre-set potentiometer, 0.1 watt, horizontal

Capacitors
C1 220pF polystyrene
C2 220pF polystyrene

Semiconductors
IC1 CA3130E or CA3130S
IC2 CA3130E or CA3130S
TR1 BC214L
ZD1 BZY88C5V1

Switches
S1 push-button, miniature, press to make
S2 1-pole 12-way rotary, miniature with adjustable end stop

Sockets
SK1-SK4 2mm. insulated sockets

Battery
BY1 9-volt battery type PP3 (Every Ready)

Miscellaneous
Battery connector
4-off 2mm. plugs
2 crocodile clips
2-off 8-way d.i.l. sockets
Pointer knob
Materials for case and printed board
External meter (see text)
Nuts, bolts, etc.

limiting resistor has a value which would cause a slight overload in the multimeter if the variable resistor inserted zero resistance into circuit. The variable resistor is then adjusted for an f.s.d. reading in the multimeter, and the separate voltmeter connected across it indicates the voltage dropped.

To take a further example, say that the multimeter drops 0.75 volt at f.s.d., the f.s.d. current again being 1mA. The voltage to be dropped by R3 is therefore 2 minus 0.75, or 1.25 volt, with the result that the value of R3 calculates as 1.25 divided by 0.001, or 1,250Ω. R3 may in practice be one of the two preferred values, 1,200Ω or 1,300Ω.

A minor point is that it will be helpful if the meter employed has an f.s.d. marking on its scale of 1, 10 or 100. This will enable the ranges of 0-100Ω, 0-1kΩ, etc., to be read more easily from the meter calibration.

COMPONENTS

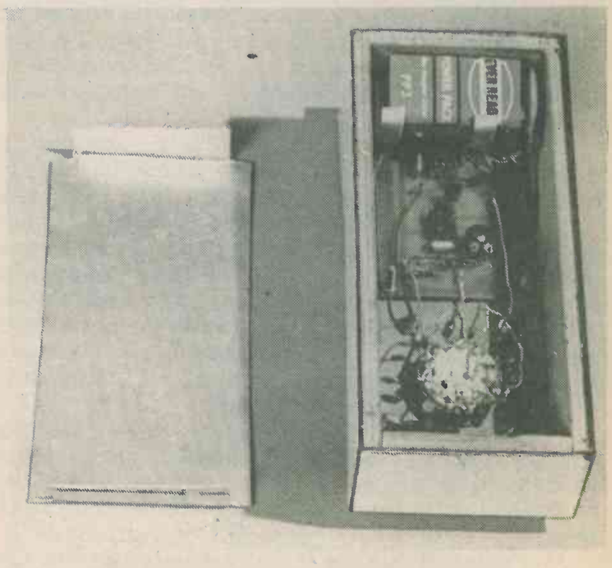
The CA3130 operational amplifier, a CMOS device, has a very high input impedance of around 1.5 million megohms. This is necessary to prevent loading of the current range resistors at IC1, and of the test resistances at IC2. Moreover, the negative output swing of this device can be considered to reach, for all practical purposes, the potential of the negative supply rail. Thus a dual rail power supply is avoided in this application.

A CA3130E is nowadays obtainable, this being an 8 pin d.i.l. version of the op-amp. There is also the CA3130S, which has its lead-out pins preformed to fit an 8 pin d.i.l. holder. Either type may be employed here, and the CA3130E is available at the time of writing from A. Marshall (London) Ltd., 40-42 Cricklewood Broadway, NW2 3ET.

TR1 has been specially chosen for the resistance evaluator since it must satisfy a number of criteria. It has a very low leakage current, high minimum gain, and good current and power handling capabilities. Its substitution by other types is thus not advisable.

Of the fixed resistors R1, R2 and R3 (after its value has been calculated) may be 5% components. The accuracy of the finished instrument depends upon the quality of the range setting resistors R4 to R15. Metal oxide 2% tolerance types are recommended, but if 1% types are available they will give even better results, albeit at increased cost. Since 12MΩ resistors cannot be easily obtained, the highest value range setting resistor consists of R14 and R15 in series.

An ever-present problem with home-constructed instruments of this type is that close tolerance resistors above 1MΩ are not normally available from the large mail order suppliers. The writer has been able to locate a few close tolerance resistors higher than 1MΩ (from bankrupt clearance stocks



The components inside the case. Also to be seen is the case back, which simply consists of an aluminium sheet with flanges bent in the ends to provide a push fit and the like) by shopping around various component stores, but supplies of such resistors are limited and continuity cannot be guaranteed. Readers who are prepared to accept a lower accurancy on the top three ranges may use 5% resistors for R12 to R15. R12 could, however, be close tolerance 1MΩ and 200kΩ resistors in series, whereupon only the top two ranges have reduced accurancy.

An alternative approach, which has been used satisfactorily by the author and can be carried out after the instrument has been set up, is to connect a known close tolerance resistor in the test position, and then try a number of 5% resistors in the R12 to R15 positions for maximum accuracy of readings. This does, of course, again necessitate close tolerance resistances above 1MΩ for Ranges 10 and 11, but these could consist of two close tolerance 1MΩ resistors in series as the test resistance for Range 10, and seven or more close tolerance 1MΩ resistors in series as the test resistance for Range 11.

The range switch, S2, is a miniature 1-pole 12-way rotary component with an adjustable end stop set up for 11 positions.

The unit is powered by a 9 volt battery and, since push-button operation is utilised, current is only drawn when a test is actually carried out. Thus the battery will have quite a long life. However, it should be replaced when its on-load voltage drops below some 8 volts, otherwise the accuracy of the two lowest resistance ranges may be compromised.

CONSTRUCTION

The actual layout of the instrument is not critical, but the following points should be borne in mind if alternative forms of construction are contemplated. Flying leads from the component board should be kept short, and the leads to SK1 and SK2 should not be twisted together, or pressed against other leads. If Veroboard is used, all traces of flux must be removed between adjacent copper strips. Integrated circuit sockets should be used for IC1 and IC2, and the latter only inserted after all wiring has been completed and checked. Fig. 3 shows the printed circuit layout used by the author. R4 to R15 can be mounted direct to the tags of S2, as shown in Fig 4.

The prototype unit is housed in a plywood case having internal dimensions of 5$\frac{3}{4}$in. long by 2$\frac{1}{4}$in. wide by 1$\frac{1}{2}$in. deep, the front and sides being covered by Formica. The back consists of a sheet of aluminium with flanges bent down at the ends to allow a push fit. The circuit board is mounted behind the front panel, secured by four 6BA countersunk bolts and nuts, but spaced from the front panel by an extra nut on each bolt. The bolt heads are covered by the Formica. The sockets and switches are also mounted on the front panel. An aluminium clamp secures the battery. The layout is clarified by the photograph and Fig. 5. The test probes consist of two short flexible leads, terminating in 2mm. plugs at one end and in miniature crocodile clips at the other.

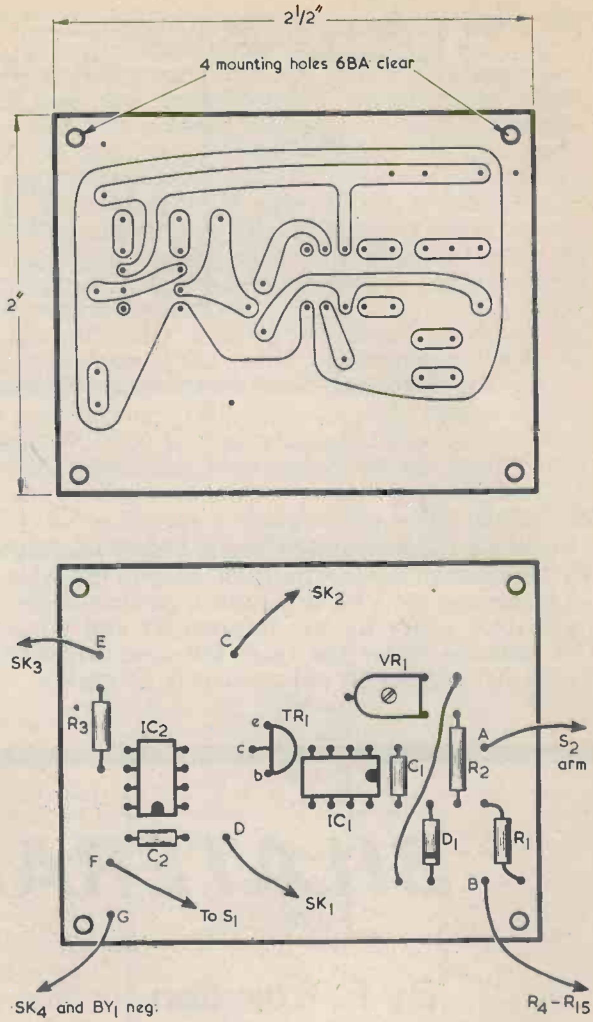


Fig. 3. The copper and component sides of the printed board, which is reproduced full size. The letter references "A" to "G" apply to corresponding references in Figs. 4 and 5

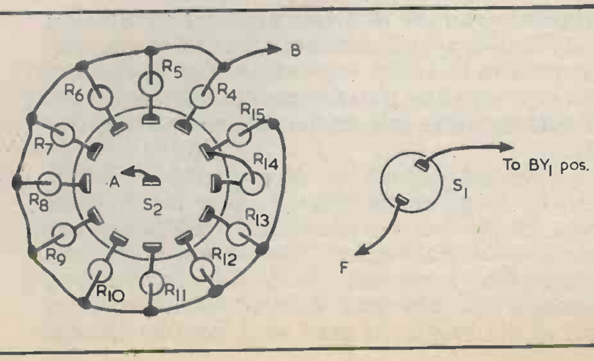


Fig. 4. Details of the switch wiring. The twelfth outer tag of S2 (not reached by the switch arm because of its end stop) is used as an anchor tag for the junction of R14 and R15. Outer tags may be located with a continuity tester

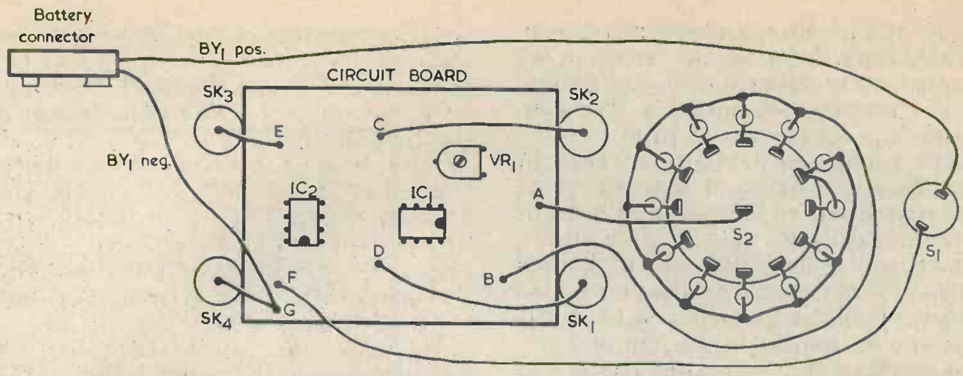


Fig. 5. Wiring between the printed circuit board and the other components in the resistance evaluator

SETTING UP

To set up the instrument, insert a close tolerance 10kΩ resistor in the test position. Plug in the external meter and set VR1 to a central position. Select the 0-10kΩ range by S2. Depress S1 and adjust VR1 until the meter just reads full-scale deflection. No further setting up adjustment is necessary.

If S1 is pressed with the test sockets open-circuit or with a test resistance much higher than the range selected, a voltage of up to some 6.5 volts may be applied across R3 and the meter. This will cause the meter needle to swing over to its end-stop but, with any normal robust meter movement, should not cause any damage. ■

BILATERAL SWITCH

By F. Bowden

Lateral switching of signal voltages

One of the more interesting and useful devices in the CMOS armoury, and yet one which the writer has hardly ever seen employed in home-constructor projects, is the bilateral switch. This has a control terminal which, when taken positive up to VDD, allows both digital and analogue signals to pass from an input terminal to an output terminal. If the control terminal is taken negative, to VSS, the switch turns off and prevents the flow of signals between the input and output terminals.

F.E.T. OPERATION

A typical example of a bilateral switch is found in the CD4016, which contains four of them. The pinout for the CD4016 is given in Fig. 1. Each of the four switches is quite separate although they all, of course, share the same positive and negative supply.

The internal circuit of one of the switches, Switch A, is given in Fig. 2. The other three switches in the i.c. are identical. The switch has two p-channel field-effect transistors, TR1 and TR4, and two n-channel field-effect transistors, TR2 and TR3. The long line at each transistor symbol is the insulated gate, and the two outside

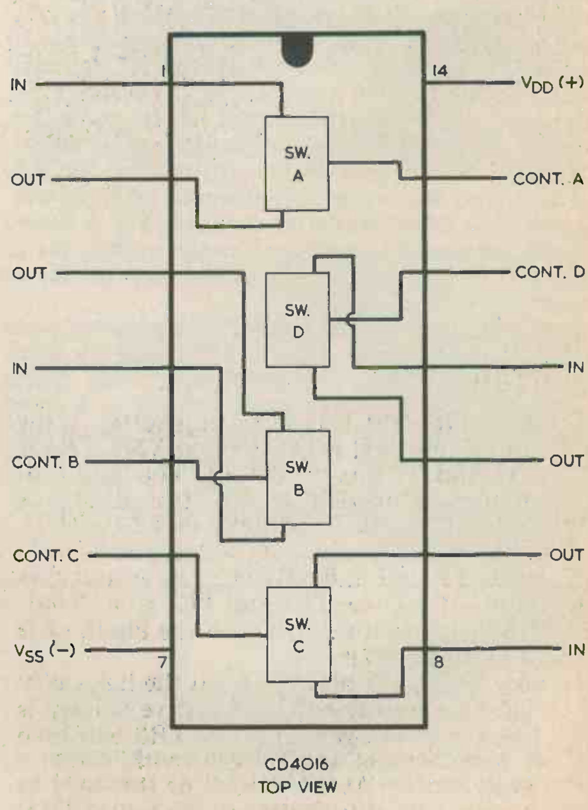


Fig. 1. Pin allocations for the quad bilateral switch type CD4016. The more recent CD4066 has the same pin connections

bars alongside it are the source and drain. The central bar is the substrate. Although not shown in the diagram, the substrate of TR3 connects to VSS and the substrate of TR4 connects to VDD. The substrates have no effect on circuit operation.

If the gate of a p-channel field-effect transistor of the type used here is at the same potential as its source, or if it is positive of the source, the transistor is cut off and exhibits a very high resistance between its source and drain. When the p-channel gate is taken negative of its source current is allowed to flow along the channel, and a low resistance is set up between the source and the drain.

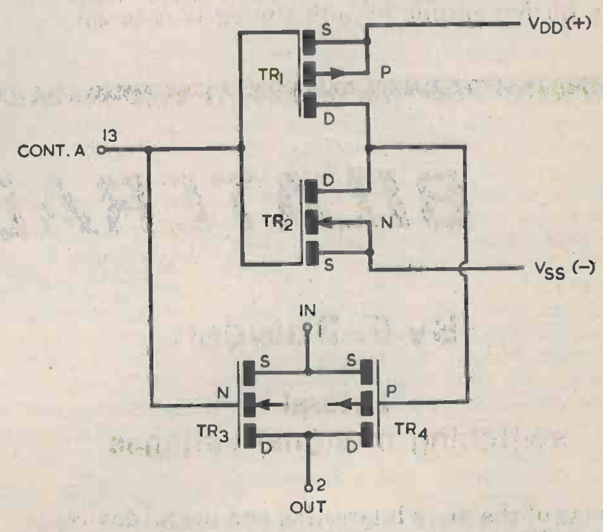
The n-channel field-effect transistor has an exactly opposite performance so far as polarities are concerned. It exhibits a very high resistance between source and drain when its gate is at the same potential as its source or when the gate is negative of the source. The source-to-drain channel offers a low resistance only when the gate is positive of the source.

VDD or negative of VSS. Any signal voltage at the input is prevented from appearing at the output terminal because of the two turned off transistors.

When the control input terminal is taken positive, this positive voltage is applied to the gate of TR3, turning this transistor on when the source is negative at VSS. Similarly, the inverter applies a negative voltage to the gate of TR4, which turns on when its source is at VDD. Signals at the input terminal equal to VSS or VDD are therefore passed through TR3 or TR4 as applicable and appear at the output terminal.

If, with the control terminal positive, the signal voltage at the switch input terminal is taken gradually from VSS to VDD, the signal will initially pass through TR3, then through TR3 and TR4 together and, finally, through TR4 on its own. With a reasonably high supply voltage, say 10 volts or so, the input to output voltage graph from VSS to VDD is almost a straight line when the switch output is loaded by 100kΩ, exhibits slight cur-

Fig. 2. The internal circuitry for one of the CD4016 bilateral switches



INVERTER

In Fig. 2, TR1 and TR2 form an inverter. If the input control terminal is negative, at VSS, TR1 is conductive and TR2 is turned off. The output at the common connection to the two drains is therefore positive and is virtually equal to VDD. Taking the input control terminal positive, to VDD, turns TR1 off and TR2 on. The output goes negative, to VSS. Thus, TR1 and TR2 give an output which has opposite polarity to the input, as is required of an inverter.

Consider next what happens when the input control terminal is negative. This negative voltage is applied direct to the gate of TR3. TR3 will then turn off regardless of the voltage (within device limits) at its source. At the same time the inverter output applies a positive voltage to the gate of TR4, whereupon this transistor is also turned off for all voltages at its source. The two sources are connected to the switch input terminal which, to keep within the CD4016 ratings, must not go positive of

vature for a load of 10kΩ and marked curvature for a load of 1kΩ. The curvature is much more marked for the three loads when a low supply voltage, at around 5 volts, is used. So, if a CD4016 is to be employed to switch an alternating voltage signal it is advisable to use a supply voltage of around 10 volts and to avoid excessive loading of the switch output.

With a supply voltage of 10 volts, the "on" resistance of the CD4016 is typically 250Ω. A more recent bilateral switch, the CD4066, has the same pin allocations as the CD4016, but it has a lower "on" resistance of around 100Ω typical with a 10 volt supply.

Before concluding, it may be mentioned that the section of the circuit comprising TR3 and TR4 is sometimes described as a "transmission gate". Also, the two transistors may be considered as being symmetrical. In Fig. 2 this would allow an input signal to be applied to pin 2 and an output taken from pin 1. ■

NEWS . . . AND

75 YEARS OF THE 'MEGGER' TRADE MARK

Evershed & Vignoles Ltd. this year celebrate 75 years of the MEGGER trade mark, a name which has become synonymous with electrical insulation testing.

The name MEGGER was first coined by E. B. Vignoles and registered in 1903 and was derived from Megohm. The first MEGGER Tester was marketed in 1904 and at that time was the only high resistance measuring instrument which tested at or above the working voltage of the circuit and yet was self-contained in a single portable case. The d.c. test voltage was produced by a hand-wound generator and the resistance value indicated by a pointer travelling across an analogue scale, calibrated directly in Megohms. The pointer was controlled by the unique cross-coils movement invented by Sydney Evershed, which is still the basis of today's Major MEGGER and Wee MEGGER testers as well as the Battery MEGGER tester BM6. The great advantage of the cross-coils movement is that the accuracy of resistance reading is not affected by variations in generator winding speed.

Thus the MEGGER tester was just the instrument which the young electrical trade needed to ensure safety in the rapid spread of domestic use of electricity for lighting and heating. It was portable, simple to use, direct reading (no calculations) and independent of any power source.

A 1978 MEGGER Model SL2, Series 1 insulation tester alongside one of the self-contained 500V resistance testers of 1904 design. Both use the Evershed cross-coils movement

Today the full range of MEGGER insulation testers comprises 23 different models, some of which generate their test voltage by battery-driven solid-state oscillators, while others retain the total independence of hand cranked generators. In addition there are low resistance ohmmeters, earth resistance testers and a line-earth loop tester.

In 1972 Evershed & Vignoles moved their production of MEGGER testers from Chiswick to the site at Dover, which is shared with their associate companies, Avo and H. W. Sullivan. Production is at a higher level than ever before and the proportion of export sales is around 60%

To mark the 75th anniversary, commemorative ashtrays are being distributed. These carry the 75-year emblem consisting of an inverted omega to form the figure 75.

LEKTROKIT APPOINT NEW MANAGING DIRECTOR AND WIN NEW FRANCHISE

Lektrokit Ltd., of Sutton Industrial Park, London Road, Earley, Reading, Berks., the Unitech company that specialises in breadboarding and prototype packaging equipment, has been in an expansion minded mood during the past few months. In addition to appointing new Managing Director, Geoff Bigg, formerly marketing manager with ITT, they have also acquired several new franchises and split their operations into two distinct but related fields.

Mr. Geoff Bigg can be seen on the right in our accompanying photograph shaking hands with Mr. Horst Moll of AP Products.

Geoff Bigg's philosophy for the new style Lektrokit is summed up in two phrases: 'Two Stop Shopping for the Professional' and 'Fast and Easy for the Student and Hobbyist'.

With this activity, Lektrokit have extended their home-constructor/hobbyist business to include, under a new franchise deal, AP Products' comprehensive range of 'fast and easy' products. These simple-to-use solderless breadboards, terminal and distribution strips, connectors, pins, sockets, jumpers, i.c. test clips, heat sinks, cabling, etc. are all now available ex-stock either individually or in kit form from Lektrokit's Reading headquarters or their appointed agents/distributors.

COMMENT

TUNE-IN TO PROGRAMS

Next month we commence the publication of our exclusive new series on Programmable Calculators.

Written by the well known technical author, Ian Sinclair, the series will enable readers to get to grips with programming in an easy fashion.

The purpose of the series is to show in what ways a calculator can be used, and what is involved, in writing and using programs.

With the growing use of microprocessors the skills of programming are now a necessary part of the electronic engineer's equipment. Programming languages vary, but it is true to say that when you have learned how to program one device, you can very quickly adapt to another.

Therefore this series of nine articles is a 'must' for those who wish to be able to use calculators for programming.

MICROCOMPUTERS WITH A VOICE

In an age when it has appeared that microcomputers can do almost anything, General Instrument Microelectronics Ltd. has announced two new peripheral microcircuits which under microprocessor control emit a broad range of complex sounds.

Designated the AY-3-8910 (40 pin DIP) and AY-3-8912 (28 pin) DIP) these two Programmable Sound Generators (PSG's), emit various familiar or exotic sounds for applications in entertainment, education, security and control. Sounds ranging from musical notes for musical instruments, complex sound-effects for electronic games and broadcasting, jarring warning signals for security applications, ultrasonic signals for remote control, etc., are all easily generated.

GIM are so impressed with the performance and versatility of the PSG's that they are offering automatic demonstrations over the telephone to all callers. **To hear a demonstration of the device simply call the special number in London: 01-439 7052.**

FREE CHRISTMAS GIFT

Include a Christmas card with orders to Messrs. Brian J. Reed, their advertisement appears on pages 272 & 273, and you will receive, in addition to your order, a surprise packet of components to the value of approximately 20% of the original order. This offer to our readers will apply to all orders received by Messrs. Brian J. Reed during December.

CHESS CHALLENGER 10 PLAYS LIKE A HUMAN

A major advance in "intelligent" computerised board games for the leisure market is being introduced by Spectrum Marketing of 12 The Shrubberies, George Lane, South Woodford, London E18. It is little more than a year since the company pioneered a totally new market with Chess Challenger — a single-level-of-play computerised chessboard which, allowed a person to play chess without a partner.

The game cost £200 but, despite this, and the fact that all but the complete novice quickly learned to beat the then somewhat unsophisticated computer most of the time, it sold extremely well, so that the third generation can now also be purchased for £200.

It comprises a gold metal playing surface and a keyboard, similar to that of a calculator, with large LED display windows to show moves, all contained in a solid wood case and complemented with magnetised French style chess pieces. It features no less than 10 levels of play.

A new feature of this advanced version is its random response capability. If the computer foresees an important move sequence it will select the move which best protects its pieces while endeavouring to checkmate the player's King.

Computer technology is growing so fast that the microprocessor "brain" in Chess Challenger 10, capable of analysing a few dozen moves only a year ago, has been evolved to a point where it can now analyse up to 3,024,000 board positions before making its move.

Chess Challenger 10 is an excellent "state of the art" example of the space-age technology and almost human capabilities that can be built into computerised board games.

SUGGESTED CIRCUIT

ELECTRONIC "HANGMAN"

By G. A. French

Nearly all readers will be aware of the game of "Hangman". This is a simple word guessing game in which one contestant draws out a row of dashes on a piece of paper, each dash representing a letter in a word or phrase. The remaining person or persons then submit letters in turn which may form part of the word or phrase. When a letter is correct it is entered at the appropriate point or points along the dashes. If incorrect, the "Hangman" picture of Fig. 1 is drawn out, each line corresponding to an incorrect letter. The first line to be drawn is the upright of the gallows, the second is the horizontal beam and the third is the sloping strut. These are followed by a line for the rope, a circle for the victim's head, an oval for the body, two lines for the arms and two lines for the legs. If the "Hangman" picture can be completed, the person presenting the unknown word or phrase has won.

The number of steps needed to make up the "Hangman" picture is 10, whereupon the possibility arises that simple electronic logic may be used to provide added amusement to the game. Each incorrect letter step could be indicated by the lighting up of an l.e.d. by pressing a button, the l.e.d.'s appearing at the appropriate points in the "Hangman" picture. The first incorrect letter can cause one l.e.d. to be lit, the second another l.e.d. until, after 10 incorrect letters, 10 l.e.d.'s are illuminated and the "Hangman" picture is effectively complete.

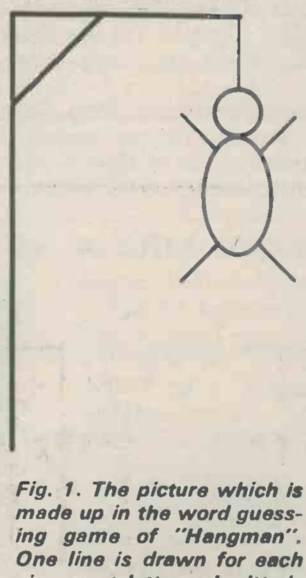


Fig. 1. The picture which is made up in the word guessing game of "Hangman". One line is drawn for each incorrect letter submitted

CMOS CIRCUIT

Since there is a total count of 10, it is appropriate to think in terms of a decade counter i.c. to light up the l.e.d.'s, and a particularly suitable choice here would be the CMOS CD4017. This device has been described in earlier issues of this magazine and need only be referred to briefly here. As is shown in Fig. 2, the device has a clock input at pin 14 and 10 decimal outputs at the pins indicated. Succeeding decimal output pins go positive at each positive-going input pulse edge at the clock input. The clock input is enabled if pin 13 is low and is inhibited when this pin is high. The counter is cleared to 0 by taking pin 15 high.

For the present application it is required that each of 10 l.e.d.'s lights up in turn, with the important proviso that, once lit, an l.e.d. remains lit until the whole circuit is reset. Continued illumination of an l.e.d. could be achieved by having each decimal output trip a bistable circuit, but this is not very attractive since each bistable would typically require two transistors or two inverters. The decimal outputs could alternatively trigger silicon controlled switches, such as the BRY39. However, 10 silicon controlled switches would be required and these would be expensive.

The method adopted by the author for maintaining illumination in the l.e.d.'s is rather novel, and requires only 10 additional diodes to be incorporated in a conventional transistor switching circuit. The idea could, incidentally, be employed for similar applications in which it is desired to have l.e.d.'s maintained in the illuminated state as subsequent l.e.d.'s in a chain become lit.

Fig. 3(a) shows a standard l.e.d. switching circuit for operation from a CD4017. At the start of a count, pin 3 of the CD4017, representing 0, is high, whereupon TR1 is turned on by the base current flowing from pin 3 through the current limiting resistor in the base circuit. LED1 lights up. At the next count, pin 2 of the CD4017 goes high, causing LED2 to become alight. LED1 extinguishes, however, because pin 3 of the CD4017 goes low when pin 2 goes high. At the next count, LED3 will light up on its own, and LED2 will extinguish.

Two diodes are added in Fig. 3(b). When pin 3 is high, TR1 is turned on as before and LED1 lights up. Pin 2 next goes high, turning on TR2 which not only lights up LED2 but also keeps LED1 alight by way of diode D1. At the following count pin 4 is high, and TR3 keeps all three l.e.d.'s lit up, current for LED2 flowing through D2, and current for LED1 flowing through D1 and D2. The system can be extended to any number of transistors and diodes, the only limiting factor being forward voltage drop in the diodes. This causes early l.e.d.'s in the chain to have a lower voltage applied across them and their series current

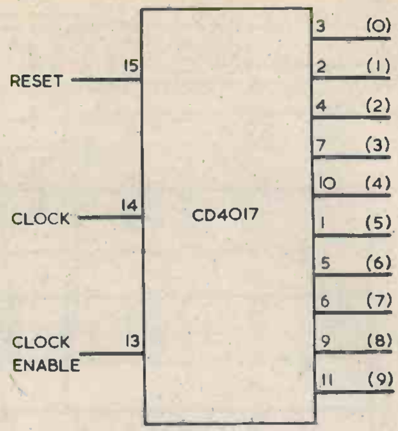
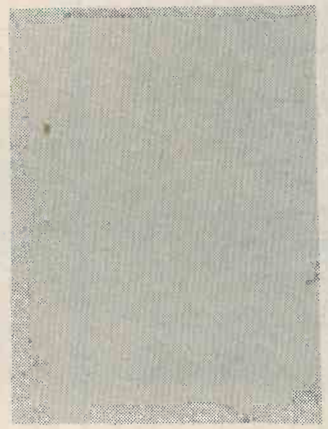


Fig. 2. The CD4017 pins which are employed in the "Hangman" project

limiting resistors than have l.e.d.'s which are later in the chain.



FULL CIRCUIT

The full circuit of the "Hangman" project appears in Fig. 4. A CD4011 quad NAND gate is used in addition to the CD4017, two of the NAND gates being employed in a conventional anti-switch bounce circuit in conjunction with the single-pole double-throw push-button S1. When S1 is not depressed, the output at pin 3 of the two gates is low; pressing S1 causes the pin 3 output to go high. This output is applied to the clock input of the CD4017.

S2(a)(b) is the reset switch. When it is put to "Reset" S2(a) allows pin 15 of the CD4017 to go high via R3, thus clearing the i.c. output to 0, whilst S2(b) breaks the base input circuit to TR1. The clock enable input at pin 13 is connected to the output of a NAND gate at pin 11 of the CD4011. This gate, appearing at the right hand end of the circuit, is connected as an inverter. When TR10 is turned off, as it is until the last count of the decade, the inverter input is taken high by way of R24 and its output is low. S3(a)(b) is the on-off switch for the circuit.

The count is started by changing S2(a)(b) from "Reset" to "Start". The 0 ouput of the CD4017 is high and S2(b) allows base current to flow into TR1 via R4. LED1 lights up. Pressing S1 causes the 1 output at pin 2 of the CD4017 to go high. The upper

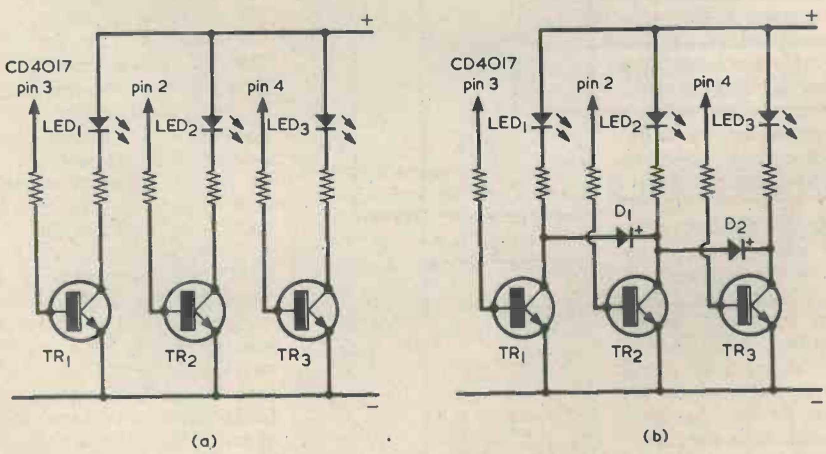


Fig. 3(a). A standard transistor circuit which enables l.e.d.'s to be lit when the decimal output pins of the CD4017 go high (b). If diodes are added, as here, l.e.d.'s which have already been lit remain illuminated as the count proceeds

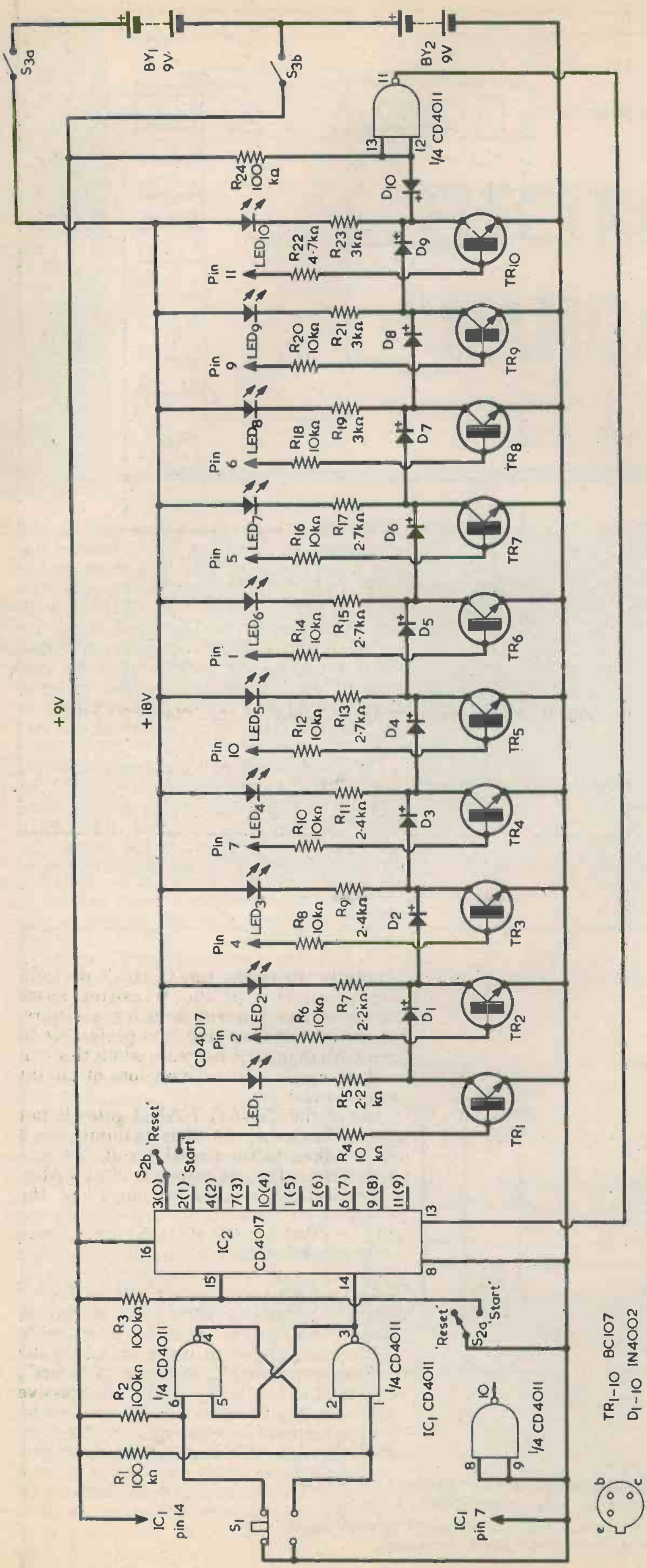


Fig. 4. The full "Hangman" circuit

end of R6 is connected to this pin and TR2 turns on. Both LED1 and LED2 are now alight. Successive operations of S1 cause the number of lit l.e.d.'s to increase, until, when TR9 is turned on, LED1 to LED9 are illuminated. All the current for these l.e.d.'s is passed by TR9 and is carried, to the left, by way of diodes D8 to D1.

Pressing S1 once more causes TR10 to turn on, with the result that all the l.e.d.'s are alight. At the same time the input to the NAND gate inverter at the right goes low via D10. Its output goes high and takes pin 13 of the CD4017 to the clock inhibit state. Pressing S1 then has no further effect on the circuit. Without the clock inhibit feature the circuit would have taken the count back to 0 at the next operation of S1.

The CMOS circuitry is powered by a 9 volt supply, whilst the l.e.d.'s are fed by an 18 volt supply. This higher voltage is necessary because of the forward voltage drop in the diodes; when TR10 is turned on the voltage at the lower end of R5 is about 5.5 volts positive of the voltage at the lower end of R23. This quite large difference in voltage is masked when the l.e.d. supply is as high as 18 volts. As will be noted, the l.e.d. series current limiting resistors have values which increase gradually along the chain from LED1 to LED10. These enable all lit l.e.d.'s to have the same brightness regardless of which transistor is turned on. It will be apparent that, as successive transistors become conductive, the brightness of, say, LED1 reduces because the voltage across it and R5 decreases. However, the effect is gradual and is not easy to discern even when it is being especially looked for.

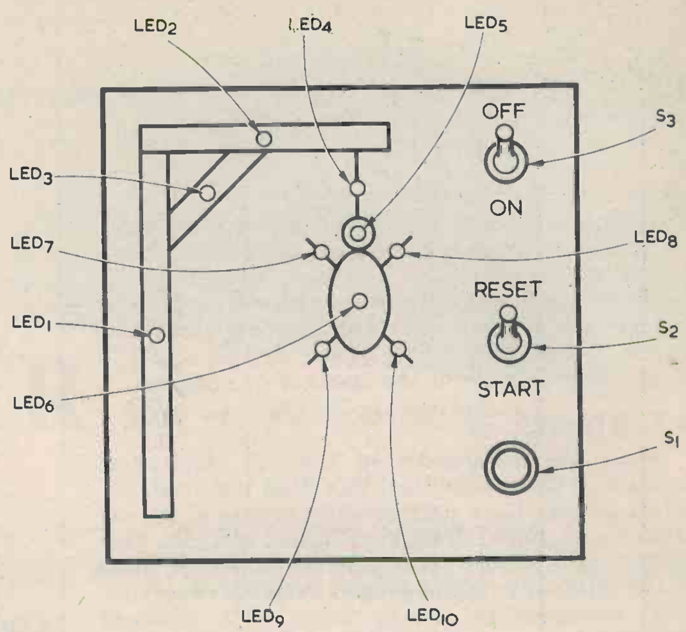


Fig. 5. A suitable front panel layout for the "Hangman" unit

SUPPLY VOLTAGES

The use of two supply voltages means that care has to be taken to ensure that 18 volts is not accidentally applied to the CMOS circuitry during wiring up or when connecting the batteries. Diode D10 isolates the input of the right hand NAND gate inverter from the 18 volts supply, this input being returned to the 9 volt supply via R24.

The current drawn from the two 9 volt batteries rises as more l.e.d.'s light up, being about 45mA with all l.e.d.'s turned on. Fairly large batteries, such as the PP9, are advisable. The current drawn from BY2 by the CMOS circuitry is only about 1mA. If the voltage from BY1 falls with age the only effect is that the brightness of the l.e.d.'s reduces. The same is true for a fall in voltage from BY2 down to around 5 volts. At lower voltages it will be found that the clock input is not inhibited after a count of 10, this being due to the fact that TR10 does not turn on sufficiently hard to cause changeover in the right hand NAND gate inverter. R22 is given a lower value than the other series transistor base resistors to reduce this effect but in practice the improvement this gives is of a very marginal nature only. In any event, a 9 volt battery whose voltage has fallen to a level as low as 5 volts can be considered as being well past its useful life. With new 9 volt batteries the voltage across TR10 when it is turned on is only 0.25 volt despite the fact that it is passing current for all the l.e.d.'s. This voltage rises to about 0.5 volt when BY2 has fallen to 6 volts. (It would be in order, incidentally, to apply the CD4017 decimal outputs directly to the transistor bases without series current limiting resistors, but the author feels that it is preferable to limit CMOS output currents when this can be done easily and without loss of circuit performance).

One of the CD4011 NAND gates is not used in the circuit. This has its input pins, 8 and 9, taken to the negative rail. No connection is made to its output at pin 10. Also, no connection is made to pin 12 of the CD4017.

A suitable front panel layout for the project is shown in Fig. 5. This has the "Hangman" picture drawn out on it with l.e.d.'s positioned at the various significant points. To start a game, S2 is put to "Reset" and S3, if not already closed, set to "On". The game then commences. At the first incorrect letter S2 is moved to "Start", causing LED1 to light up. Successive l.e.d.'s are then lit up in turn by pressing S1 for each further incorrect letter. If the game ends with all l.e.d.'s alight, the person putting forward the unknown word or phrase has won. The l.e.d.'s can be any small types, having whatever colour is favoured by the constructor.

■

CAR RADIO TRIM

By R. D. Smith

Keep your car radio in good trim

Medium and long wave car radios differ quite considerably from the average battery operated transistor portable. For instance, since there is plenty of low voltage power available from the car battery, the a.f. output stage of a car radio can employ large transistors which deliver quite a respectable wattage to the speaker or speakers.

R.F. STAGE

There are differences in the r.f. stage, too. Because of the mechanical vibration involved, car radios usually have permeability tuning of the oscillator and signal frequency tuned circuits, this being a more robust arrangement than is provided by the relatively fragile ganged variable capacitor. With permeability tuning there is a constant capacitance across each coil, and the resonant frequency is varied by moving an iron dust core in and out of the coil. The resonant frequency reduces as the core enters the coil.

Another advantage of permeability tuning is that the capacitance across the coil can be made low, whereupon the LC ratio, i.e. the ratio of inductance to capacitance, is always large. This is of particular benefit in signal frequency tuned circuits, because a high LC ratio tends to confer greater selectivity.

Some car radio aerial input tuned circuits are complicated, but in general they can be reduced to the very simple basic circuit shown in Fig. 1. Here, the car aerial connects via a large value d.c. blocking capacitor to a high impedance point in the tuned circuit (shown in the diagram as a tap close to the non-earthy end of the coil) by way of a length of low capacitance screened cable. A low value fixed capacitor is connected across the coil. There is also a trimmer capacitor in the receiver between the aerial input and the radio chassis. At radio frequencies the latter will be common with the metal body of the car.

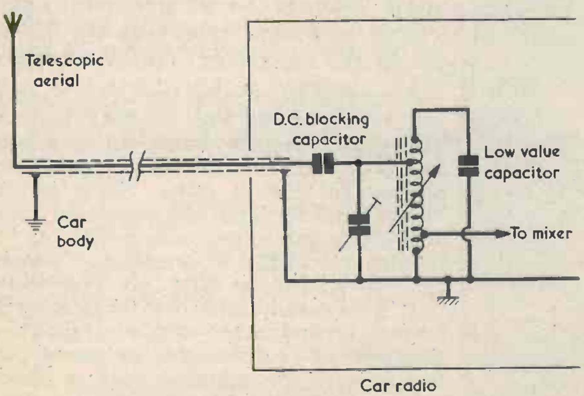


Fig. 1. Simplified version of the input tuned circuit of an a.m. car radio. The arrow through the coil indicates that it is permeability tuned.

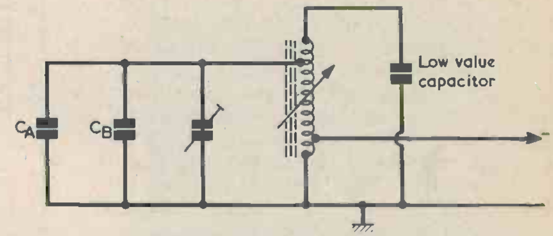


Fig. 2. Equivalent circuit in which CA is the capacitance between aerial and car body and CB the self-capacitance of the screened cable

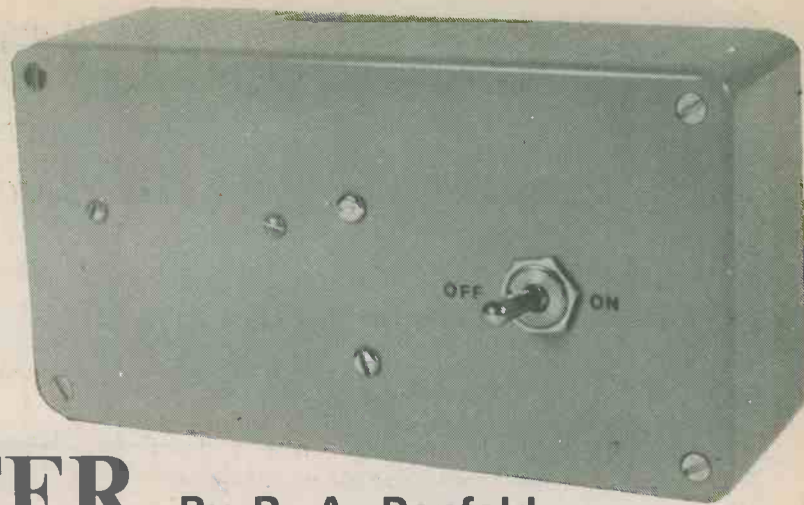
EQUIVALENT CIRCUIT

Fig. 1 breaks down into the equivalent circuit given in Fig. 2, where CA is the capacitance between the aerial and the car body and CB is the capacitance between the braiding and the centre conductor of the screened cable. The ordinary telescopic car aerial gives a very low level of signal pick-up at medium and long waves, and so it must be coupled very tightly into the signal frequency tuned circuit in the radio. In practice, it is coupled so tightly that CA and CB form a significant part of the capacitance tuning the coil. The purpose of the trimmer is to ensure that the total tuning capacitance, *including* CA and CB, is exactly right.

In many car radios the aerial trimmer is not accurately set up, with the result that the receiver does not have the full sensitivity of which it is capable and is more likely to be subject to second channel whistles from interfering stations. A fairly useful test is to fully extend the aerial, tune in a weak station near the high frequency end of the medium wave band and, whilst standing outside the car on dry ground, touch the aerial. If signal strength goes down, the car radio input tuned circuit is probably in pretty good trim, because the added capacitance to the car metalwork of your body is detuning it. Should signal strength go up the input circuit is probably incorrectly trimmed: the added capacitance of your body is not making the trimming situation noticeably worse and you are improving signal strength by acting as an additional aerial. Unfortunately, this very simple test is not 100% reliable, but it can often give you a good idea of the state of the aerial input tuned circuit.

The aerial trimmer of a car radio should be set up when the radio is initially installed, or if the aerial or screened cable is altered. Find out from the instructions or the service manual for the radio where the aerial trimmer is situated and then adjust it as recommended by the set manufacturer. Do *not* attempt the adjustment without following the set-maker's advice or you may end up with a car radio having a worse performance than when you started! ■

RADIO 4 CONVERTER



By R. A. Penfold

Converts 1500 metres to medium waves
Inductive coupling - no connections to medium wave radio

Many a.m. sound receivers, both home constructed and commercially manufactured, do not have a long wave band. The result, now that Radio 4 has been moved to the long wave band on 1,500 metres (200kHz), is that they cannot receive the Radio 4 signal on this channel at all.

This article describes a simple and inexpensive converter which enables a medium wave receiver to pick up the long wave transmission on 1,500 metres. The converter is self-contained, with its own internal battery and ferrite aerial. There is no need to make a direct connection between the converter and the medium wave radio as the converter radiates a local signal which is picked up inductively by the receiver on its own ferrite aerial.

BLOCK DIAGRAM

The basic way in which the converter operates is extremely simple, and the block diagram provided in Fig. 1 shows the general arrangement. The superheterodyne principle is used to mix the 200kHz output from a ferrite aerial with a nominal 500kHz oscillator signal to produce a sum signal at about 700kHz (200kHz plus 500kHz equals 700kHz). This 700kHz signal is fed to a tuned circuit which is resonant at this frequency, and the tuned circuit produces a local r.f. field which can be picked up by a medium wave receiver tuned to 700kHz and placed near the converter. The mixer circuit provides a certain amount of gain and so the final signal will be quite strong, provided a reasonably good coupling between the converter and the radio is obtained. The signal level from the converter is insignificant more than a few feet away from it, and there is thus no radiation which is likely to interfere with other receivers.

The heterodyning of the 200kHz input signal with the 500kHz oscillator signal also produces a difference signal at 300kHz (500kHz minus 200kHz equals 300kHz), but this will not be radiated to any significant extent by the 700kHz tuned circuit in the converter. The converter oscillator is made tunable so that the output signal can be adjusted to any convenient quiet spot on the medium wave band at a frequency in the region of 700kHz.

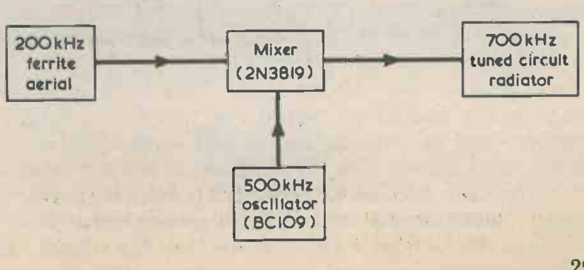
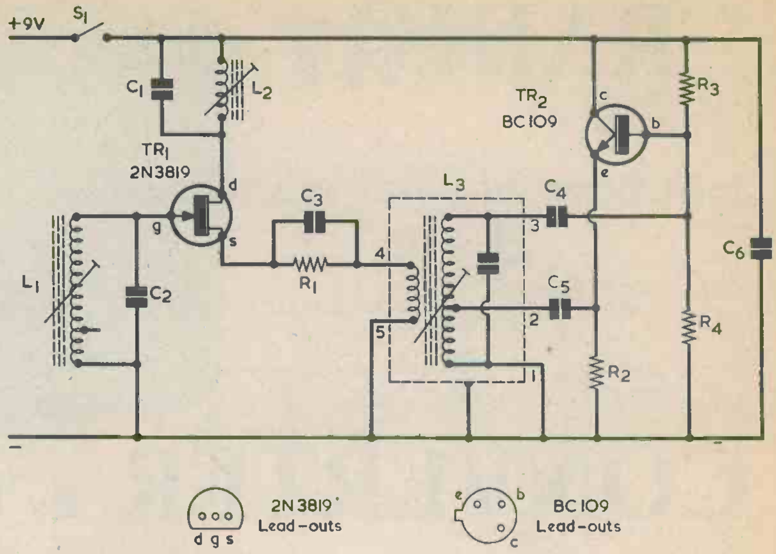


Fig. 1. Block diagrams illustrating the manner in which the converter functions. The 700kHz output signal is picked up on the ferrite aerial of a medium wave receiver

Fig. 2. The circuit of the Radio 4 converter. L1 picks up the 200kHz signal and this is heterodyned in TR1 with a 500kHz oscillator signal from L3. The resultant 700kHz sum signal is radiated by L2



THE CIRCUIT

The complete circuit diagram of the Radio 4 converter is shown in Fig. 2 and, as will be seen from this, the unit is based on just two transistors. TR1 is a Jugfet transistor and is employed as the mixer, with L1 providing gate bias. L1 is also the tuned winding of the 200kHz ferrite aerial and is brought to resonance at this frequency by fixed capacitor C2. Tuning the circuit to precisely 200kHz is achieved by varying the inductance of L1, this being done by simply sliding the coil along the ferrite rod. The expense of a trimmer capacitor to provide tuning of the aerial circuit is thereby avoided. R1 is the source bias resistor for TR1 and C3 and its bypass capacitor, but these components are not returned direct to the negative supply line; instead they connect to the negative supply by way of the secondary winding of the oscillator transformer, L3. The oscillator signal across the secondary causes variations in the gate-to-source potential of TR1, and this in turn causes variations in the gain of this device. The oscillator signal therefore modulates the input signal and produces the required heterodyne action.

L2 and C1 are the drain load for TR1, and these form a tuned circuit which is resonant at 700kHz nominal and selects the desired output signal. L2 is actually a medium wave ferrite aerial and is tuned by the same means as L1. An r.f. choke of suitable inductance with a parallel capacitor could be used as the drain load for TR1 to provide a simple form of inductive coupling to the receiver, but in practice it gives markedly inferior results to the method finally adopted here. It is important to obtain a strong output from the unit so that any weak medium wave signals that might otherwise cause interference are completely swamped.

TR2 appears in the oscillator circuit, which is of the emitter follower Colpitts type. TR2 is biased by R3 and R4, and R2 is its emitter load resistor. An emitter follower has slightly less than unity voltage gain, and so the output from TR2 is coupled to a tap in the oscillator tuned coil via C5, whilst the upper end of the oscillator coil is coupled to the base of TR2 by C4. This gives a voltage step-up through the oscillator coil and produces sufficient positive feedback to maintain oscillation.

The unmarked capacitor across the main winding of L3 is an internal fixed capacitor in the coil assembly. L3 is a 470kHz i.f. transformer, but by unscrewing its adjustable tuning core it will readily tune to frequencies of around 500kHz and even higher.

C6 is a supply decoupling capacitor and S1 is the on-off switch. The converter has a current consumption of only about 2 to 3mA, and the 9 volt battery type PP3 used to power it has a long life.

COMPONENTS

Resistors
(All $\frac{1}{4}$ watt 5%)
- R1 3.3k Ω
- R2 3.3k Ω
- R3 22k Ω
- R4 22k Ω

Capacitors
- C1 150pF ceramic plate
- C2 180pF ceramic plate
- C30 0.047μF ceramic plate or type C280
- C4 2,200pF ceramic plate
- C5 560pF ceramic plate
- C6 0.47μF type C280

Inductors
- L1 Ferrite aerial type MW/LW5FR (Denco) with medium wave winding removed
- L2 Medium wave winding of above on ferrite rod (see text)
- L3 I.F. transformer type IFT14/470kHz (Denco)

Semiconductors
- TR1 2N3819
- TR2 BC109

Switch
- S1 S.P.S.T. toggle

Miscellaneous
- Plastic case (see text)
- 9 volt battery type PP3 (Ever Ready)
- Battery connector
- Veroboard, 0.1in. matrix
- Veroboard pins, single ended, 0.04in. diameter
- Wire, solder, etc.

CONSTRUCTION

An inexpensive plastic case measuring approximately 150 by 80 by 50mm. is used as the housing for the prototype converter. The case must be all plastic to allow input and output signal coupling, and it must be large enough to take the components including, in particular, the two ferrite rods. The author mounted the ferrite aerials, the on-off switch and the component panel on the lid of the case, so that no components were secured to the actual case body.

The upper part of Fig. 3 shows the general layout of the rear of the front panel, and this should be studied in conjunction with the photographs.

The 200kHz ferrite aerial, L1, is a Denco MW/LW5FR medium and long wave ferrite rod assembly with the medium wave coil removed. L1 is mounted above the component panel (as shown in Fig. 3) using a suitable mounting clip. This can be a ferrite aerial clip taken from a defunct transistor radio, an insulated cable clip of suitable diameter or a clip devised from fairly thick flexible plastic. A metal clip must not be used as it would form a shorted turn around the ferrite rod. With the author's case, the rod had to be mounted a little way in from the edge of the front panel as it was too long to fit between the two mounting pillars moulded into the case body. A lead-out wire from the long

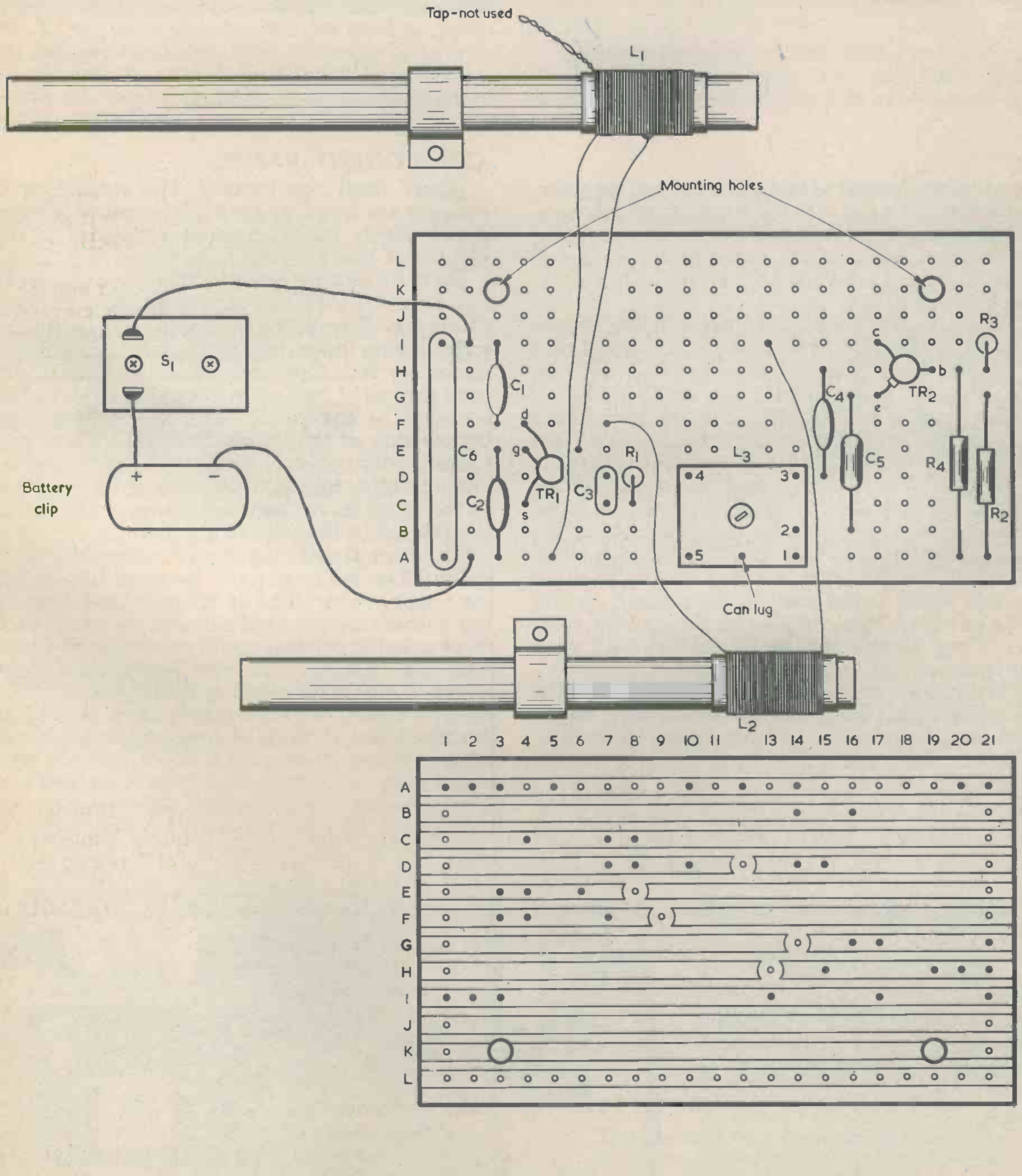
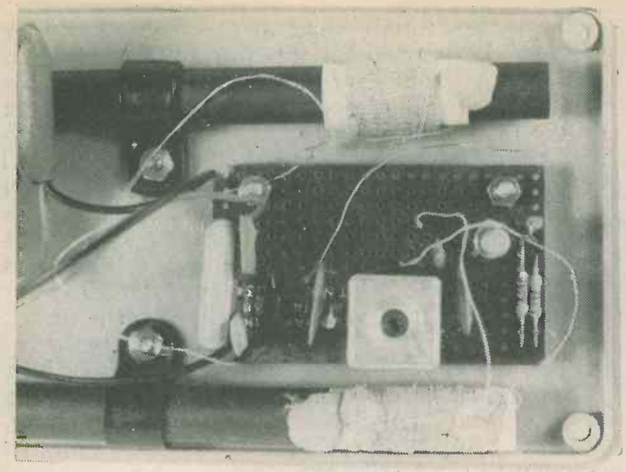


Fig. 3. Details of wiring on the component board together with the connections to L1, L2, S1 and the battery clip



The Veroboard panel and the two ferrite rods are secured to the lid of the case

wave winding consists of two leads twisted together. This lead-out is a tap into the winding, and no connection is made to it. It should be glued to the front panel to keep it out of the way and to prevent it coming into contact with any of the other components or wires.

L2 consists of the medium wave winding removed from the MW/LW5FR assembly mounted on a second ferrite rod. This rod should have a diameter of $\frac{3}{8}$in. (9.5mm.) and can have any length between 2 and $4\frac{1}{2}$in. If necessary, the rod can be cut down from a longer rod, the procedure being to file a sharp V-cut around the rod at the point where it is to be broken and then rapping it lightly against the edge of the bench. L2 is mounted below the component panel (again as shown in Fig. 3) using a clip meeting the same requirements as that for L1. There is a small low impedance coupling winding on the medium wave coil which is not used in the present cicruit, and its two lead-outs can also be glued to the front panel. They should not be in contact with each other.

S1 is mounted in the position shown between the two ferrite rods. This can be a standard toggle switch requiring a $\frac{1}{2}$in. (12.7mm.) diameter mounting hole.

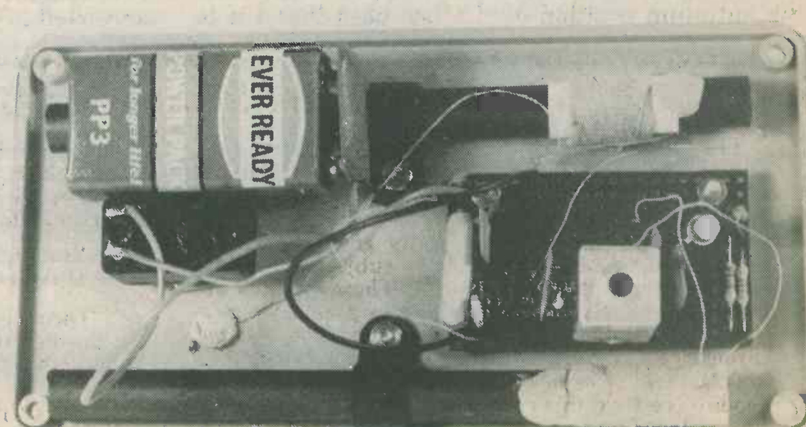
COMPONENT PANEL

Apart from the battery, the remaining components are wired up on a 0.1in. matrix Veroboard panel which has 12 copper strips by 21 holes. Details of this are also provided in Fig. 3.

Start by cutting out a panel of the required size and then drill the two mounting holes 6BA or M3 clearance. Then make the five breaks in the copper strips before mounting the various components and soldering them into circuit. L3 will not fit direct onto the panel and so single ended solder pins are soldered to the panel, with their heads on the copper side, at the six places where L3 is to be connected to the panel. Note that one connection is to a can mounting lug. After the pins of L3 and the pins in the panel have been well tinned with solder, L3 is soldered to the pins in the panel.

The completed Veroboard assembly is then mounted on the front panel between L1 and L2 using a pair of short 6BA or M3 bolts and nuts. Spacing washers are required between the board and the front panel to prevent strain on the board when the nuts are tightened. Before finally mounting the board it should be wired up to L1, L2, S1 and the battery clip. The last connection is to solder the positive battery clip lead to the appropriate tag of S1.

Internal layout of parts inside the case. The PP3 battery can be held against the case bottom with plastic foam



ADJUSTMENT

Initially the core of L3 should be unscrewed somewhat, so that its upper end protrudes slightly above the top of the coil can. It is advisable to use a proper trimming tool, such as the Denco TT5, for this adjustment as a screwdriver or a similar tool can easily damage the core. L2 should only be partially pushed onto its ferrite rod, and L1 should be pushed a little way down its own rod.

When first testing the converter it is advisable to position it so that L2 is as close to the medium wave winding of the ferrite aerial of the receiver as is reasonably possible, so that there is a good signal transfer from converter to receiver. The relative orientation of the transmitting and receiving rods and coils is not too important provided that they are not at right angles to one another. The ferrite aerial, L1 of the converter has the normal directional properties of this type of aerial, of course, and maximum pick up of the 200kHz signal will occur with the rod at right angles to the direction of the transmitter.

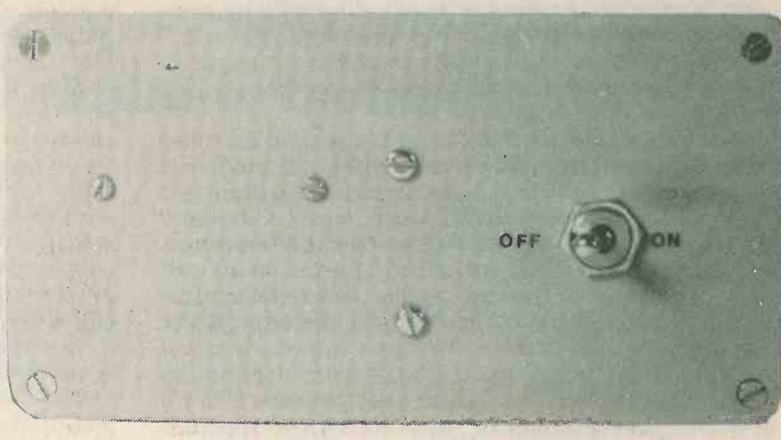
glued to the ferrite road at this setting. Bostik "Blue-Tak" is ideal for this purpose.

Next the converter is switched off and the receiver tuning is adjusted to search for a quiet spot on the medium wave band close to where the output from the converter was received. This should be done after dark, as what is a quiet spot during daylight hours can produce quite strong signals from distant stations once darkness has fallen. The converter is then switched on again, and the core of L3 is adjusted to bring the output of the converter onto the frequency to which the receiver is tuned. Unscrewing L3 core will raise the output frequency whilst screwing it inwards has the opposite effect.

Finally, L2 is slid along its ferrite rod to find the position which provides the best signal transfer. When this optimum setting has been found the coil is glued to the ferrite rod.

Although the author does not live in a particularly good reception area for the BBC 200kHz transmission, no difficulty was experienced in ob-

The only panel control is the on-off switch. The converter couples inductively to the medium wave radio without any direct connections



Switch on the converter and the receiver. By tuning the receiver to around 700kHz (429 metres) it should be possible to locate the 200kHz converted signal from the converter. L1 is then slid along its ferrite rod to provide the strongest possible signal. If the receiver has an a.g.c. circuit the peak setting may not be readily apparent, whereupon moving the converter away from the receiver to provide a weaker signal should overcome this problem. When the optimum position for L1 has been found it is

taining a strong output from the converter, and good results are obtained merely by placing the converter alongside the radio. It has not been found necessary to have L2 particularly close to the ferrite aerial of the receiver, and medium wave interference does not seem to be a significant problem. The author's unit even provides quite good reception of some foreign stations on the long wave band if the receiver is tuned either side of the converted 200kHz output signal! ■

PHAS
A.M.
Part 1 (2 p

A phase locked loop is used here for a.m. detection very successfully in this practical medium wave receiver

The use of phase locked loop circuits as f.m. detectors is quite a well known technique which will be familiar to many readers. It is probably less well known that certain phase locked loop integrated circuits have the ability to demodulate a.m. signals as well as f.m. ones.

This article describes a fairly simple medium wave superhet receiver which employs the NE567 phase locked loop (p.l.l.) i.c. to provide the second i.f. amplifier and detector functions. The receiver is powered from a PP6 9 volt battery and can provide a good quality audio output of a few hundred milliwatts to an internal loudspeaker. The prototype has been constructed as a bedside or small table radio, but obviously the physical construction of the set can be altered to suit individual requirements, if desired.

The receiver was primarily designed and constructed for its interest value and will probably be of greatest attraction to those who are experimentally minded, although it is a perfectly viable alternative to more conventional designs.

P.L.L. DETECTOR

Most p.l.l. systems are fairly complicated pieces of electronics and the NE567 device is no exception to this. Therefore, the operation of the device will only be considered in fairly broad terms here. Fig. 1 gives details of the internal arrangement of the NE567 in block diagram form, together with basic details of the external discrete components needed to enable it to function. The device is contained in a standard 8 pin d.i.l. package and pinout details are provided in Fig. 1.

The main function of a p.l.l. circuit is to lock an internal oscillator onto the same frequency as a signal applied at the input. It also maintains the internal oscillator in phase with the input signal.

In common with virtually all p.l.l. designs, the internal oscillator of the NE567 is a C-R relaxation type and no L-C tuned circuits are used. The "centre frequency" of the internal oscillator is determined by the values of discrete resistor RA and discrete capacitor CA, and this is the frequency at which the oscillator runs in the absence of an input signal.

The internal oscillators of p.l.l. devices are usually voltage controlled and can be modulated slightly either side of the centre frequency by the application of a control voltage. The oscillator of the NE567 is a little unusual in that it is a current rather than a voltage controlled oscillator, but this does not alter the basic operating method.

The control input of the oscillator is fed from the output of an internal amplifier, which in turn has its input fed from the output of a phase detector (or

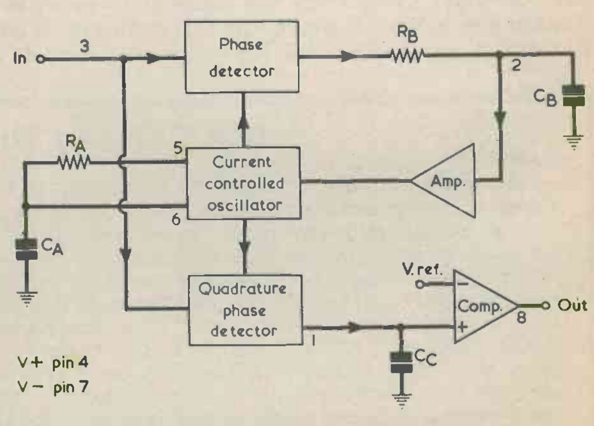


Fig. 1. Block diagram illustrating the functioning of the NE567 integrated circuit

SE LOCKED RECEIVER

parts) By M. V. Hastings

phase comparator, as it is sometimes alternatively termed). The phase detector compares the phase and frequency of the input signal and the output from the internal oscillator.

If the output from the internal oscillator lags behind the input signal in frequency, or even just slightly in phase, the output from the phase detector swings positive. This signal is amplified and fed to the control terminal of the oscillator, where it has the effect of increasing the oscillator frequency so as to bring it not only to the same frequency as the input signal but also to produce an identical phase relationship.

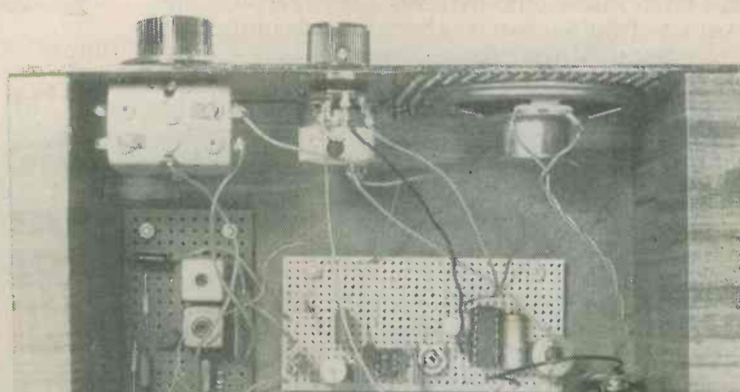
If, on the other hand, the internal oscillator signal is ahead of the input signal in phase or frequency, the output of the phase detector goes negative. An amplified signal is applied to the control terminal of the oscillator, reducing its frequency and once again causing it to have the same frequency and to be in phase with the input signal.

Thus, when the input signal is within what is termed the "capture range" of the p.l.l., the internal oscillator becomes locked onto the input signal and will remain so provided that the input signal does not stray outside the capture range or vary in frequency at a rate which is too fast for the p.l.l. to keep track with. The highest rate of frequency change which a p.l.l. can handle is known as the "maximum tracking rate", and is largely determined by a low pass filter connected between the phase detector output and the control input of the oscillator. In Fig. 1 the filter is formed by RB and CB. The filter is necessary because the output from the phase detector is actually a series of pulses, and these must be integrated to produce a d.c. control voltage.

When a p.l.l. is used as an f.m. demodulator it is the output from the low pass filter which constitutes the audio output, since this voltage rises and falls with changes in input frequency. P.L.L. devices usually make excellent f.m. detectors as they are normally designed to have good linearity between input frequency and output voltage. They also have high immunity to input noise.

As a.m. detectors p.l.l's have little advantage over more conventional types of circuit. However, they can provide lower distortion than an ordinary diode detector and they certainly make a very in-

Modular design considerably eases construction of the receiver. A PP3 battery appears in this photograph, but the larger PP6 battery is recommended for normal usage



teresting alternative form of approach for the electronics experimenter.

A basic p.l.l. circuit is not suitable for a.m. detection and requires some additional circuitry. The necessary circuitry is included in the NE567 and consists of a quadrature phase detector which provides what is known as synchronous a.m. detection. Looking at this in a somewhat oversimplified manner, the output of the oscillator is used to operate a switching circuit which opens with half-cycles of one polarity and closes for half-cycles of the opposite polarity. In this way the input signal is rectified. Filter capacitor CC removes the r.f. signal content on the output, thereby giving the required a.f. signal in more or less conventional manner.

The comparator which is incorporated in the device and which has its non-inverting input fed from the demodulated a.m. signal plays no part in the present application. It is only used when the NE567 is employed as a tone detector, which is what the device is primarily designed for. In the decoder application the open collector output transistor of the comparator is turned on when the p.l.l. circuitry is locked onto an input signal. In the a.m. detector circuit no connection is made to the comparator output at pin 8.

THE CIRCUIT

The complete circuit of the receiver is shown in Fig. 2. TR1 is used in a conventional mixer-oscillator stage. L2 is the oscillator coil and the tuned winding of this is tuned over the appropriate frequency range by VC2. C4 is a padder capacitor. The tuned winding of the ferrite aerial, L1, is tunable over the medium wave band by means of VC1. The latter is ganged with VC2, and the alignment trimmers, TC1 and TC2, are part of the tuning capacitor. The signal picked up by the ferrite aerial is coupled into the mixer input via the low impedance coupling winding of L1 and d.c. blocking capacitor C2. The 470kHz i.f. output is selected by IFT1 and fed to the i.f. amplifier stage.

An untuned i.f. amplifier is used, and this provides more than ample gain. It incorporates TR2, connected as a straightforward common emitter amplifier of the stype commonly encountered in audio applications. There is very little selectivity before the detector since there are only two tuned circuits to provide this selectivity (L1 and VC1, and the primary circuit of IFT1) but a p.l.l. a.m. detector seems to work well under these conditions. Indeed, a high degree of selectivity only makes tuning more critical, and provides no beneficial effect.

IC2 is the NE567 p.1.1. detector, and reference to Fig. 1 will show the functions of the discrete components associated with it. R7 enables the current controlled oscillator centre frequency to be tuned to the intermediate frequency of 470kHz. The oscillator centre frequency, in Hz, is approximately equal to 1 divided by CR, where C is the tuning capacitance in microfarads and R is the tuning resistance in megohms. The NE567 will work well at frequencies up to 500kHz, and so is suitable for use at 470kHz.

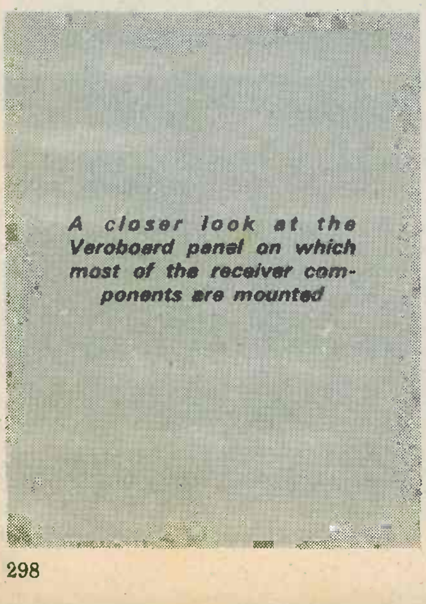
The operating frequency of the p.l.l. is affected significantly by variations in supply voltage, and so it must be fed from a stabilized supply rail to obtain satisfactory results. It must also be fed from an extremely well decoupled supply as the overall stability of the circuit will otherwise be very poor. The detector and i.f. amplifier stages are therefore powered from the main 9 volt supply by way of a small 5 volt monolithic regulator, IC1. The result is excellent p.l.l. frequency and overall stability.

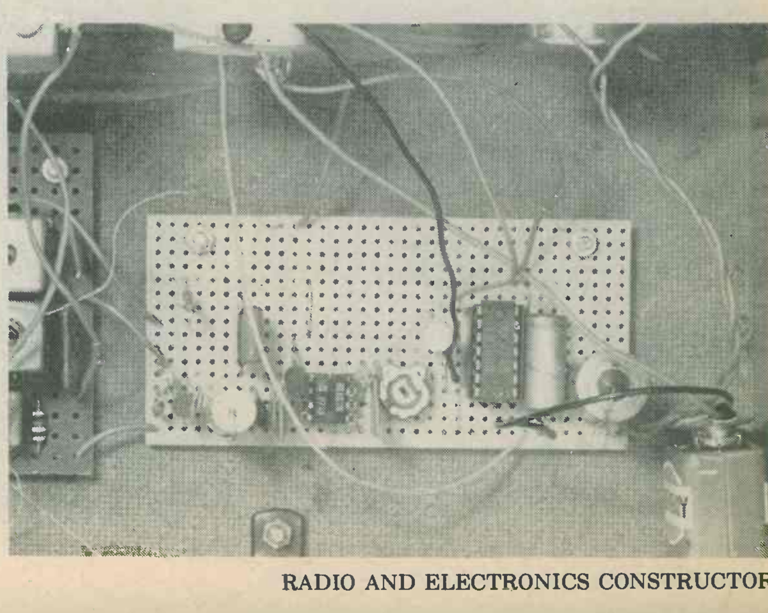
The output from the detector is fed to volume control VR1 and thence to the inverting input of an LM 380 audio output stage, IC3. No d.c. blocking capacitor is needed between the input of the LM380 and VR1, but the r.f. filter capacitor C13 is needed to preserve stability. For the same reason the non-inverting input of IC3 is connected direct to the negative supply rail. C14 is a supply decoupling capacitor for the internal input stage of IC3.

S1 is the on-off switch and is ganged with VR1. The quiescent current consumption of the receiver is about 15mA, but as the LM380 has a Class B output stage this naturally rises considerably at high output volume levels.

SPEAKER

Ideally a speaker having an impedance of about 16 to 25 Ω should be used, and the unit will then have a maximum r.m.s. output power of about 300mW. Unfortunately, speakers of around this impedance are sometimes difficult to obtain. An





A closer look at the Veroboard panel on which most of the receiver components are mounted

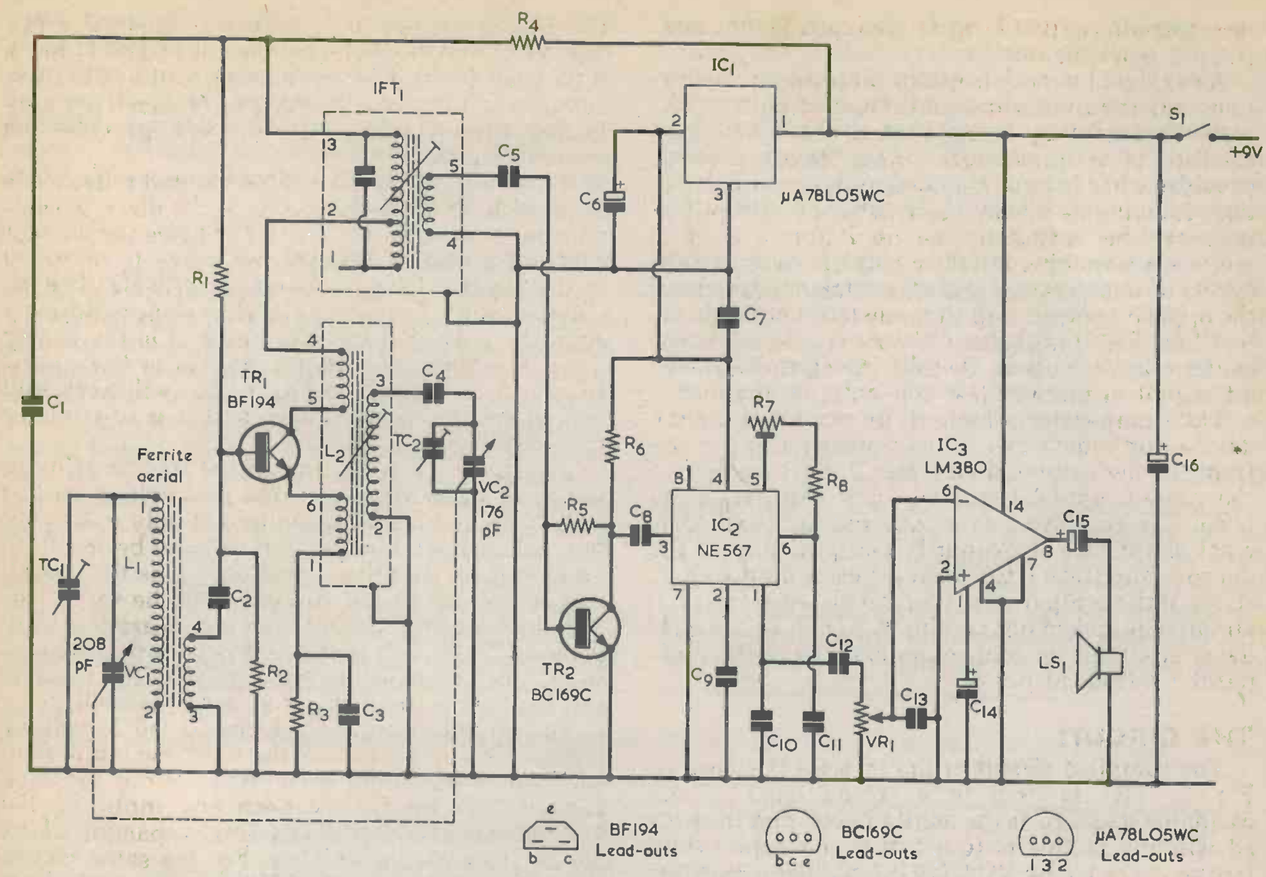


Fig. 2. The circuit of the phased lock loop a.m. medium wave receiver

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
- R1 18k Ω
- R2 15k Ω
- R3 3.9k Ω
- R4 33k Ω
- R5 1.8M Ω
- R6 2.2k Ω
- R7 2.2k Ω pre-set potentiometer, 0.1 watt, horizontal
- R8 2.7k Ω
- VR1 10k Ω potentiometer, log, with switch S1

Capacitors
- C1 0.1μF type C280 (Mullard)
- C2 0.01μF type C280 (Mullard)
- C3 0.01μF type C280 (Mullard)
- C4 180pF silvered mica or ceramic plate
- C5 0.01μF ceramic plate
- C6 100μF electrolytic, 10 v. Wkg.
- C7 0.01μF ceramic plate
- C8 2,200pF ceramic plate
- C9 4,700pF ceramic plate
- C10 0.022μF ceramic plate
- C11 470pF ceramic plate
- C12 0.1μF type C280 (Mullard)
- C13 4,700pF ceramic plate
- C14 10μF electrolytic, 10 V. Wkg.
- C15 330μF electrolytic, 10 V. Wkg.
- C16 220μF electrolytic, 10 V. Wkg.
- VC1,2 208 + 176 pF 2-gang variable with trimmers, type "00" (Jackson)

Inductors
- L1 Ferrite aerial type MW/5FR (Denco)
- L2 Oscillator coil type TOC1 (Denco)
- IFT1 I.F. transformer type IFT13/470kHz (Denco)

Semiconductors
- IC1 μA78LO5WC
- IC2 NE567
- IC3 LM380
- TR1 BF194
- TR2 BC169C

Switch
- S1 s.p.s.t. toggle, part of VR1

Speaker
- LS1 2½ to 3in. diameter speaker (see text)

Miscellaneous
- Veroboard, 0.1 in. matrix
- Perforatd board, 0.15 in. matrix
- 9-volt battery type PP6
- Battery connector
- 2 control knobs
- Materials for case (see text)
- 14-way i.c. holder
- 8-way i.c. holder
- Wire, bolts, nuts, etc.

8 Ω speaker is used with the prototype and provides perfectly satisfactory results although it gives less than optimum battery life. Also, in theory at any rate, the output stage is capable of severely overloading a miniature speaker of 8 Ω impedance and could possibly damage it if the volume control were advanced too far. However, this is unlikely to happen in practice even if the speaker is severely overloaded for long periods.

Constructors who prefer to employ components within rating may use a higher impedance speaker, and a 35Ω speaker will give an output power of about 200mW. Higher impedance speakers can also be employed, and an 80Ω speaker offers an output power of around 100mW only. In many circumstances, however, this will be quite adequate.

CASE

A home-constructed case is used as the housing for the prototype. The front panel is an 8 by 3½in. piece of 16 s.w.g. aluminium sheet, and drilling details for this are given in Fig. 3. The cut-out for the speaker can be made using a fretsaw. Three 4BA clearance mounting holes are required for the tuning capacitor. The two small holes at each end

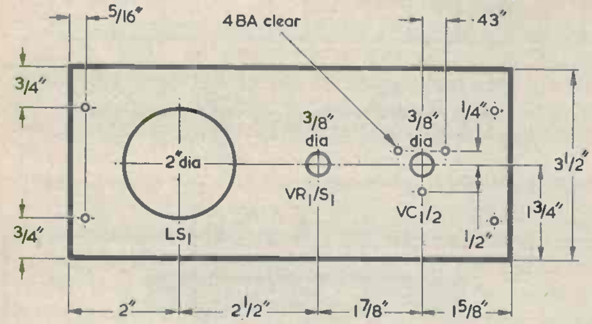


Fig. 3. Drilling details for the aluminium front panel of the receiver

of the panel take four small woodscrews which secure the panel to the rest of the case. The size of these holes must be chosen to suit the mounting screws used.

Two pieces of ⅜in. chipboard measuring 5¾ by 3¼in. form the sides of the case, and an 8 by 3½in. hardboard back with a thickness of ⅛in. is joined to these by means of panel pins. The front and back panels protrude ⅛in. above and below the side pieces. The base panel is an 8 by 5¾in. piece of hardboard which is also pinned to the sides of the case. The assembly of sides, back and base panels is covered with a self-adhesive plastic material to produce a neat appearance. After this, the front panel is screwed into position.

Another piece of ⅛in. hardboard measuring 8 by 5¾in. is covered with the plastic material and forms the case lid. On the prototype this has been made a tight push fit so that it simply slots into position. However, it can be screwed to the sides of the case if necessary or preferred.

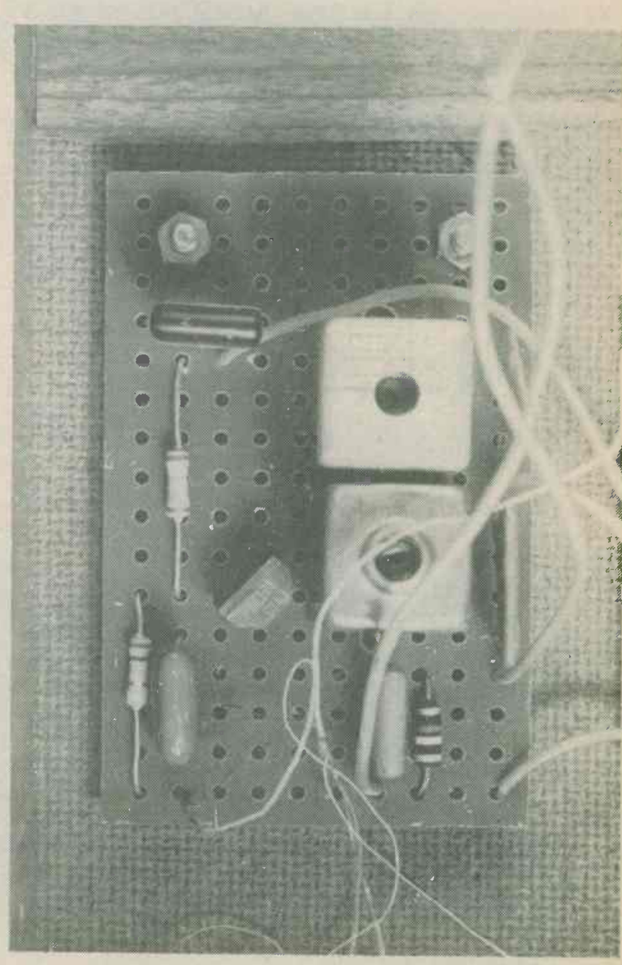
A piece of speaker fret or cloth is glued over the rear of the speaker cut-out and then the speaker is glued into place onto this, care being taken not to get any adhesive on the diaphragm of the speaker.

The tuning capacitor is mounted by three short 4BA countersunk screws pasing into threaded holes in its front plate. The screws should not penetrate more than very slightly beyond the front plate of the capacitor, as they could then damage the fixed or moving vanes. It will be found helpful to fit spacing washers over the 4BA screws between the front panel and the capacitor.

COMPONENT PANELS

Most of the circuitry is assembled on a 0.1in. matrix Veroboard panel having 16 copper strips by 35 holes, and full details of this panel are provided in Fig. 4. It will be noted that only two of the copper strips are cut between the two rows of holes for the LM380. This is quite in order: pins 9 and 13 are both "NC" pins, and pins 3, 4, 5, 10, 11 and 12 are internally connected "ground" pins. In the prototype both IC2 and IC3 were fitted in i.c. holders; these are not essential and the i.c's can be soldered directly into circuit, if desired.

The mixer circuitry is constructed on a plain 0.15in. matrix board, as this has better compatibility with the pins of the Denco oscillator coil and i.f. transformer which are used in the design. The board has 10 by 16 holes and uses the compnent layout shown in Fig. 5. Certain of the holes in the board must be enlarged with a ⅛in. diameter



The mixer stage and i.f. transformer are wired up on a separate perforated board

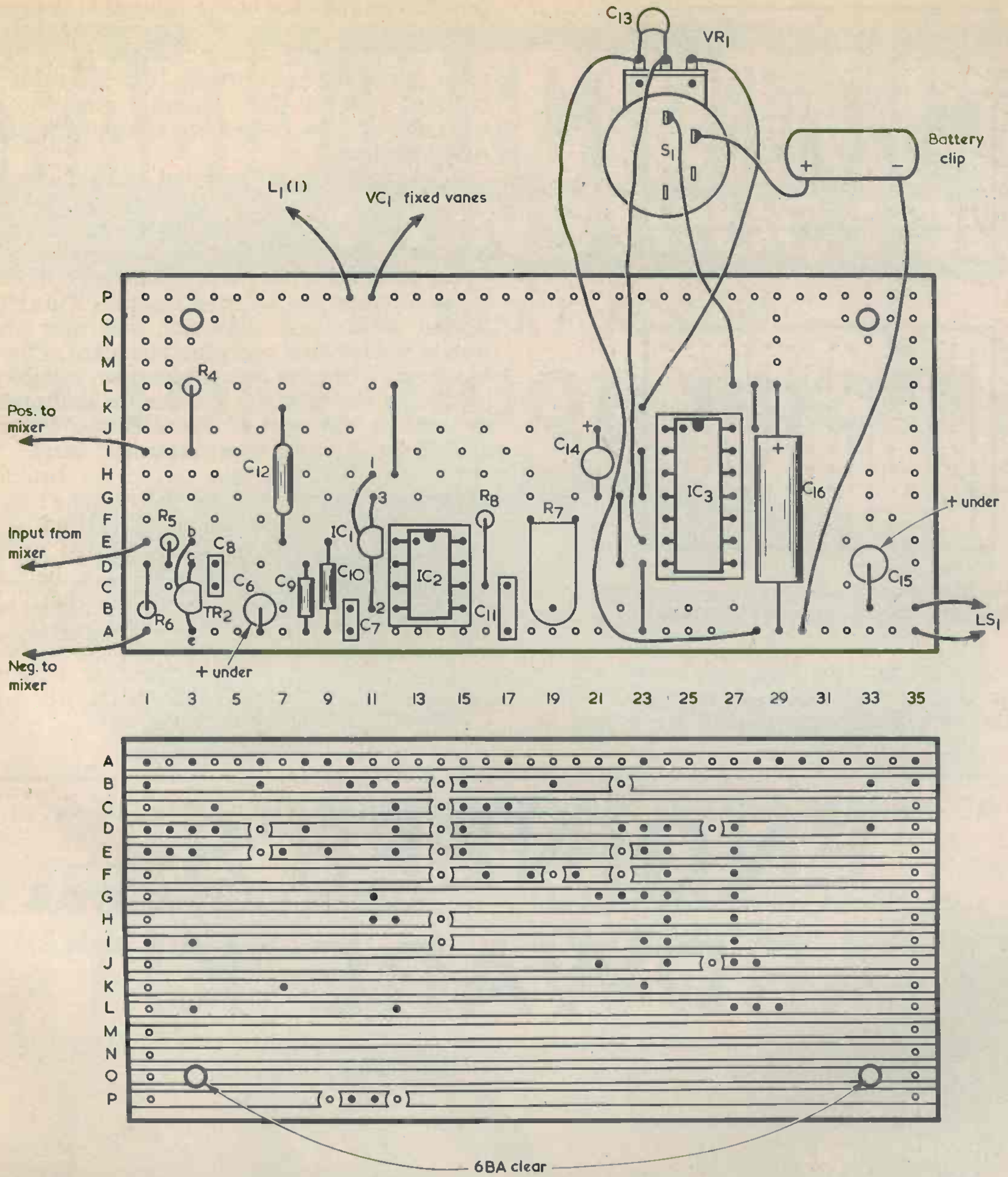
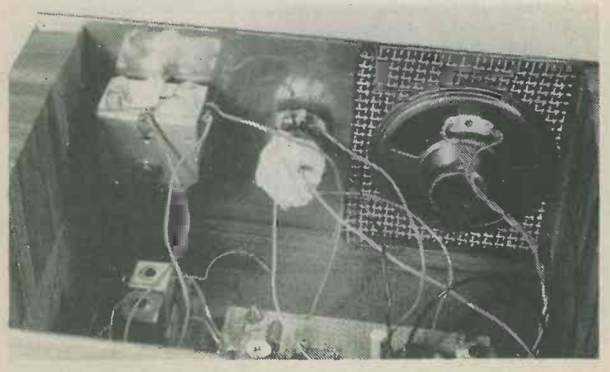


Fig. 4. The untuned i.f. amplifier, phase locked loop detector and a.f. amplifier stages are assembled on a Veroboard panel of 0.1 in. matrix

drill to enable L2 and IFT1 to be fitted in place. Note that some of the negative rail circuit is carried by way of the can mounting lugs. It should perhaps be explained that TR1 does not have the usual lead-out wires, but has pins which can be passed through the holes in the board.

The method of construction used by the author was to first complete both panels in the normal way, next wire them together and then wire the ferrite aerial to the mixer panel. It may be a little difficult to identify the individual lead-out wires from the ferrite aerial, but a visual inspection and the aid of a continuity tester should clear up any problems here. The phasing of the low impedance coupling winding is unimportant.

Next, the component panels are wired up to the components mounted on the front panel. C13 is not



Rear view showing the wiring to the components on the front panel

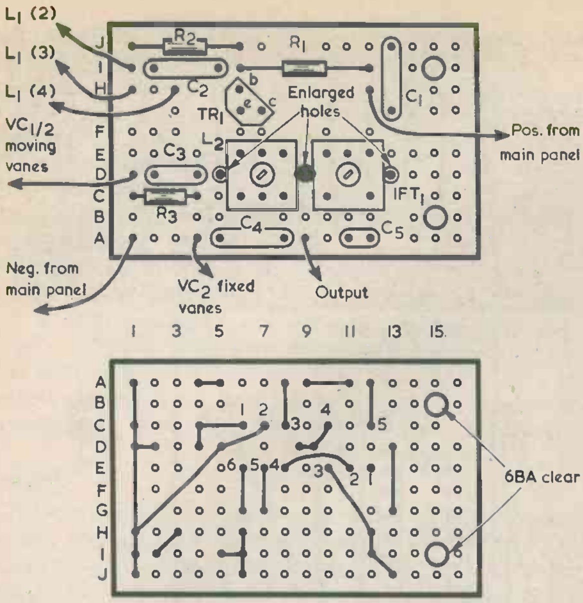


Fig. 5. A plain perforated board accommodates the components in the mixer stage

mounted on the detector and a.f. board but is soldered in place on the appropriate tags of VR1. Finally, the two component panels are bolted in position on the base of the cabinet to the rear of the speaker and controls, spacing washers being fitted over the mounting bolts to hold the panel undersides clear of the cabinet bottom. It is advisable to mark out and drill the 6BA clearance mounting holes in the cabinet base before the component panels are wired together.

The ferrite rod is mounted on the bottom of the case behind the component panels, and then the aerial coil is fitted onto one end of it. In the prototype the ferrite rod was mounted using a clip obtained from an old transistor radio, but a small block of wood can be used instead. This should be drilled with a $\frac{3}{8}$in. diameter hole into which the ferrite rod is fitted and glued in place. The wooden block can then be either glued or screwed to the bottom of the cabinet. The ferrite rod must not be secured by any sort of metal clamp which would act effectively as a short-circuited turn.

NEXT MONTH

In next month's concluding article, details of receiver alignment will be given. At the present stage, the only relevant comment to be given here is that the cores of L2 and IFT1 must not be touched, and that they should be left at the factory settings they have when purchased.

(To be concluded)

ENGINEER'S HARDWARE KIT

There are more than one and a half thousand items in the mouth-watering Engineer's Hardware Kit now made available by Home Radio (Components) Ltd. at £21 plus lower rate VAT and postage. Listed under Cat. No. Z304, the kit comprises virtually all the nuts, bolts, washers and solder tags that the constructor and electronics engineer is likely to require during normal work.

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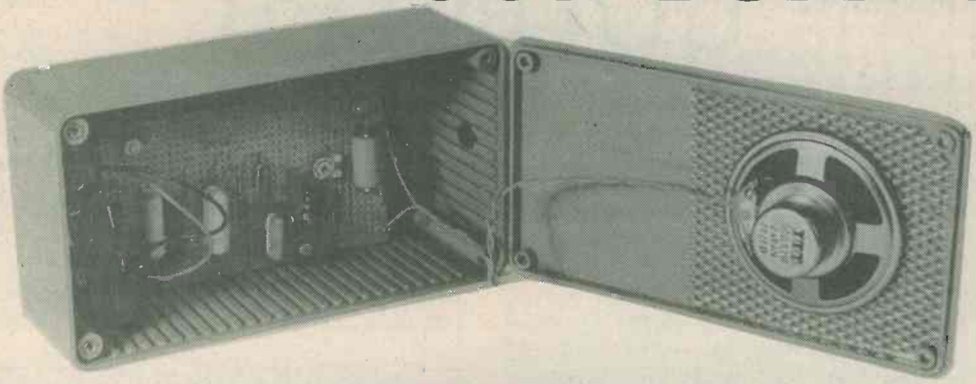

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By Ian Sinclair

SCALE-OF-TWO COUNTER

Binary counter with steering diodes and l.e.d. monitors.

The simple one-stage bistable is a popular circuit for a single S-Dec layout, and is a useful introduction to bistables and flip-flops generally. The simple circuit suffers from two problems, however. One is that the count is only to binary 1, which does not teach the user very much binary arithmetic, and the other is that simple on-off switches, when used to provide the input pulse, do not give a reliable trigger pulse because of contact bounce.

CONTACT BOUNCE

Contact bounce is a problem that afflicts all mechanical switch contacts whether hand

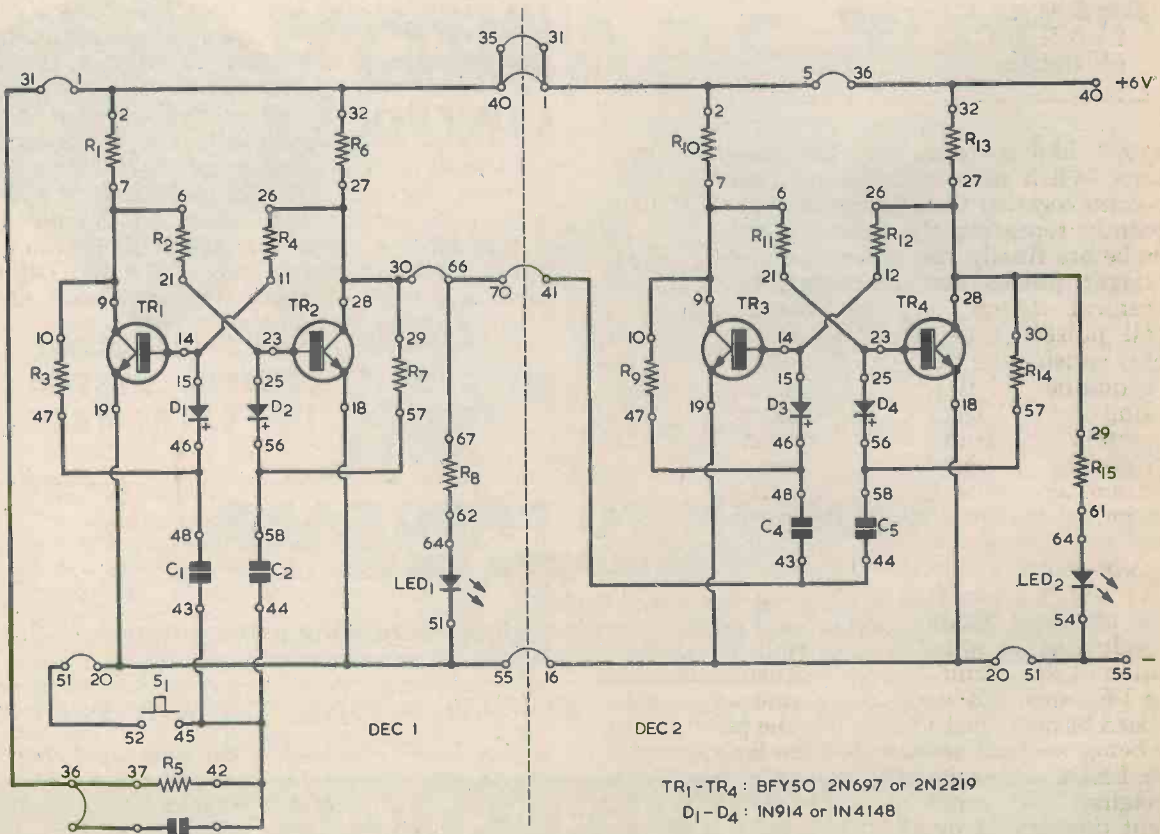


Fig. 1. The circuit of the scale-of-two counter. The numbers in the circuit indicate S-DeC connection points

COMPONENTS

Resistors
(All ¼ watt 5%)

R1 1.8kΩ
R2 22kΩ
R3 150kΩ
R4 22kΩ
R5 56kΩ
R6 1.8kΩ
R7 150kΩ
R8 1KΩ
R9 150kΩ
R10 1.8kΩ
R11 22kΩ
R12 22kΩ
R13 1.8kΩ
R14 150kΩ
R15 1kΩ

Capacitors
C1 0.001μF polyester or mylar
C2 0.001μF polyester or mylar
C3 0.1μF polyester
C4 0.001μF polyester or mylar
C5 0.001μF polyester or mylar

Semiconductors
TR1-TR4 BFY50 or 2N697 or 2N2219
D1-D4 1N914 or 1N4148
LED1, LED2 light-emitting diodes

Switch
S1 push-button, press to make

Miscellaneous
2-off S-DeC
6V battery

operated, like switches, or otherwise, like thermostats. When such switches are closed the contacts come together then briefly bounce open again, frequently repeating the bouncing action several times before finally remaining continually closed. If trigger pulses are generated by closing a mechanical switch, contact bounce can allow several pulses to be produced at each closure, thereby causing the triggered circuit to operate the same number of times, once for each bounce. Working on two S-Decs gives us enough room to incorporate a simple anti-bounce circuit that makes the triggering of a bistable much more reliable than it would otherwise be. Despite the name it's not the bouncing of the contacts that is stopped but the multiple trigger pulses that the bouncing would normally cause.

TR1 and TR2 in Fig. 1 form the first of two almost identical bistables. As either transistor can be conducting at switch-on, we shall imagine the situation in the circuit as each transistor conducts. Since TR3 and TR4 work in the same way, the action need be described only for the one pair. For the time being we shall assume that the light-emitting diode, LED1, and resistor R8 are not in the circuit.

Imagine TR1 conducting. In this state, the current through R1 produces a large voltage drop across this resistor, so that point 9 of DeC 1 is almost at earth potential (assumed to be the potential of the negative supply rail).

Because of the low voltage, no current flows through R2 into the base of TR2, which is cut off. Current through R6 flows through R4 into the base of TR1, keeping TR1 switched on. To reverse this stable state we need either a negative pulse at the base of TR1 or a positive pulse at the base of TR2.

The pulsing circuit is composed of S1, R5 and C3. With S1 open, the connection of R5 to the positive supply ensures that point 45 of DeC 1 is at 6 volts positive. Closing S1 will make the voltage at point 45 equal to zero, so generating a negative-going pulse of 6 volts amplitude, and will also charge C3 very rapidly If the switch points open momentarily the charge in C3 cannot change rapidly enough, due to discharge through R5, for the voltage at point 45 to alter to any significant effect. The time constant of C3 and R5 is 5.6 milliseconds whereas the overall bounce time period of the switch is probably only about 1 millisecond, so that only one large negative pulse is produced when the switch is closed.

The negative pulse that is generated each time S1 is closed will be present at points 43 and 44 of DeC 1, and it is passed through capacitors C1 and C2 to points 48 and 58 respectively. We must take the trigger pulse to both transistor bases, as we must be able to change either of them over in turn. If we simply applied the pulse directly to both bases, however, the bistable would not change over, or would change irregularly, since the action would be the same at both bases. Steering diodes D1 and D2 are incorporated into the circuit to ensure that each pulse is correctly routed.

Now remember that we imagined TR1 conducting and TR2 shut off, so that the bistable could be changed over by a negative pulse on the base of TR1. The base of TR1 will be about 0.6 volt positive of earth, the voltage of a conducting silicon junction, so that the anode of D1 at point 15 will be at the same voltage. The cathode of D1 at point 46 will be at about 0.2 volt positive of earth because this will be, roughly, the voltage at the collector of the turned on TR1, and point 46 connects to this collector through R3. The potentials across D1 cause it to be forward biased but by not quite enough for it to pass current; a silicon diode requires a forward bias of about 0.5 volt before it starts to conduct. A negative pulse at point 46 will, however, cause D1 to conduct easily.

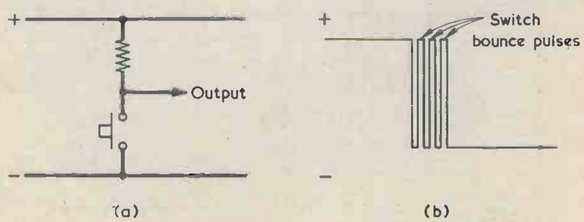


Fig. 2(a). What may, at first sight, seem to be a satisfactory method of obtaining a negative-going pulse edge

(b). In practice, switch contact bounce causes the appearance of several further pulses (shown in exaggerated form) after the initial pulse at contact closure

Now look at D2. TR2 is cut off, so that its base voltage is low, probably around 0.2 volt positive of earth because it is coupled to the collector of TR1 through R2. The collector of TR2 will be at a high voltage which (assuming that R8 and LED1 are omitted) will be close to the 6 volt positive supply rail. R7 will then cause D2 to be reverse biased by nearly the full supply voltage, so that it will need a negative pulse of rather more than 6 volts at its cathode if it is to conduct.

When S1 is closed, then, the negative pulse at points 48 and 58 affects only the base of TR1, because the pulse cannot pass through D2. The bistable then changes over. TR1 cuts off, so that its collector voltage rises, causing current to flow through R2 into the base of TR2. The collector voltage of TR2, in turn, falls so that no current flows through R4 into the base of TR1. This is the second stable state of the bistable and it consists of TR2 conducting and TR1 turned off.

With the transistor voltages reversed, the voltages on the diodes are also reversed, so that it is D2 which is now slightly forward biased and D1 which is highly reverse biased. As a result, the next negative pulse given by closing S1 passes easily through D2 but not through D1, and it will cut off TR2 and cause the bistable to switch back to its original state. Two successive pulses from the switch are needed to make the bistable return to its original setting so that the output from one collector of the bistable forms one complete pulse. Hence the alternative name of "scale-of-two".

LIGHT-EMITTING DIODE

To monitor the state of the bistable we now introduce LED1 and R8. This light-emitting diode lights up when TR2 is off, as current then flows to it through R6 and R8. When the bistable is used for counting in the scale of two, LED1 extinguished indicates a count of 0, and LED1 alight indicates a count of 1. The presence of LED1 and R8 modifies circuit operation from the "ideal" condition assumed up to now when we said that, in the off state, the collector of TR2 rises nearly to the voltage of the positive rail. What happens now is that TR2 collector rises to a relatively high voltage, dictated by the values of R6, R8 and the forward voltage drop in LED1, which is lower than the positive rail. In practice, this circumstance does not alter the functioning of the bistable. Although it reduces the reverse voltage across D2 when TR2 is off, the voltages across the two steering diodes are still different enough for D1 to turn off TR1 at the next negative pulse from S1.

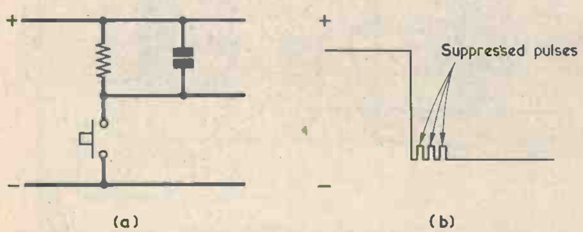


Fig. 3(a). Here, as in the scale-of-two counter, a capacitor is added across the resistor

(b). The capacitor supresses the contact bounce pulses, limiting them to a low amplitude

Fig. 4(a). Some light-emitting diodes, such as the TIL209, identify the cathode lead-out by a flat on the l.e.d. case

(b). Lead-out identification for the transistors specified for the scale-of-two counter. The lead-outs point towards you

We make use of the second DeC to build another stage of the counter. TR3 and TR4 have exactly the same action as TR1 and TR2, though the triggering is simplified by the fact that there is no need for circuitry to suppress switch bounce, since the trigger pulse comes from TR2 rather than from a switch. Note the use of a wire link between points 70 of DeC 1 and 41 of DeC 2 to carry the trigger pulse to C4 and C5.

Each time TR2 switches on its collector voltage drops abruptly, so that a negative trigger pulse is delivered to diodes D3 and D4, only one of which conducts the pulse through to a transistor base. The second bistable will therefore be switched over each time TR2 conducts, which is on each second switch contact closure. When TR4 collector voltage is high, LED2 indicates. This time the lit l.e.d. indicates a count of 2. When the l.e.d. is off the count is 0.

We should now be able to go through a complete counting sequence. If we press the switch repeatedly until both l.e.d.'s are out, we have reset the counter to a count of 0. The first switch operation will then cause LED1 to glow, a count of 1. The second operation of the switch will extinguish LED1 and light LED2, so that the count is 2. The third pressing of the switch will light LED1 again, so that the count is 1+2=3. The fourth operation of the switch will reset the counter to 0, with both the l.e.d.'s extinguished again.

S-DEC CONSTRUCTION

Start by clipping the S-DeCs together at their ends to form one long DeC. Now plug in the ten wire links, not forgetting the link between points 70 of DeC 1 and 41 of DeC 2 which is needed to carry the trigger pulse. A front panel can be used to carry the l.e.d.'s and the push-button switch if desired, or the l.e.d.'s can be plugged directly into the circuit and the switch operated remotely. Whichever method is used, connect these components into place next.

Now plug in the four transistors and four diodes. Note the correct connections in each case, particularly for the diodes. The capacitors can be plugged in next; all are non-polarised so that they can be connected either way round. Finally, the resistors are added to complete the circuit.

It should be noted that some of the link connection point numbers are positioned in Fig.1 away from the other circuit point numbers in the S-DeC strip with which they are common. This is done merely to ease circuit presentation. ■

9-VOLT ELIMINATOR SPEAKER UNIT

Part 1 (2 parts)

By R. A. Penfold

STABILIZED 9 VOLT OUTPUT • CURRENT LIMIT AT 100mA

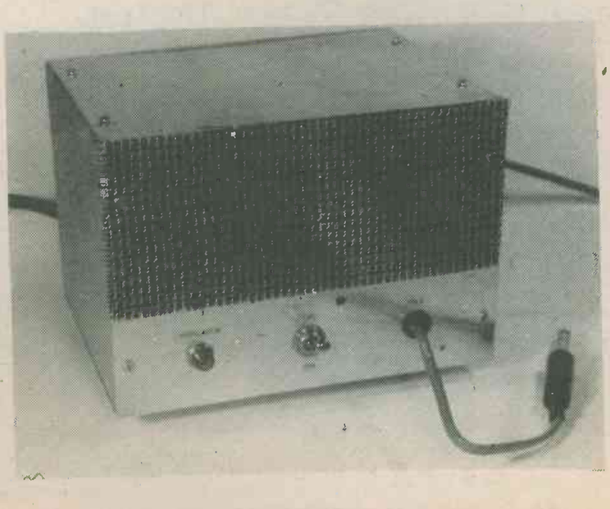
Although this unit was primarily designed and built for use with the "3 Band Short Wave Superhet" described in the last four issues it may also be employed with other short wave receivers requiring a 9-volt supply and an external speaker. Several have been described in earlier issues.

This power supply contains a stabilized circuit offering 9 volts output at currents up to 100mA. Current limiting is incorporated, and this prevents the output current rising more than marginally above the 100mA figure. Also fitted in the same case is a 5 by 3in. 8Ω speaker.

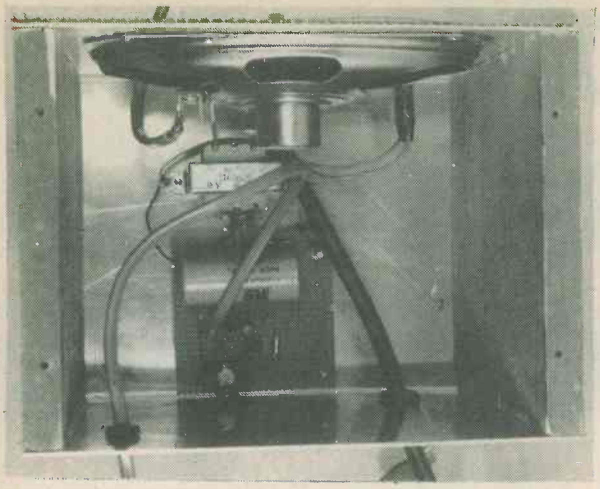
It should be explained that there are two important advantages given by using a separate power supply and speaker unit which is not integral with the short wave receiver. The first is the considerable reduction of possible hum links with the receiver circuitry. Such links are possible by way of stray capacitive coupling between the mains transformer wiring and the input wiring of the receiver audio stages, and it is even possible to have inductive coupling between the mains transformer and the receiver r.f. coils. All these problems are overcome by using an external supply. When the receiver is completely screened by its own all-metal case, as is the "3 Band Short wave Superhet", there is complete isolation between the receiver and the supply unit so far as hum pick-up is concerned. Indeed, no hum whatsoever can be heard on the output of the superhet when it is used with this power supply.

The second advantage is that the speaker is also isolated from the receiver. If the speaker is housed in the same case as the receiver it can couple mechanically to the receiver oscillator wiring and, in particular, to the vanes of the oscillator section of the tuning capacitor, the consequent microphony resulting in accoustic feedback. Small alterations in oscillator frequency and, hence, intermediate frequency are converted to amplitude modulation when the i.f. is applied to the skirts of the i.f. amplifier response; the amplitude modulation is then detected and re-applied to the speaker, producing an acoustic feedback loop. The effect is, of course, made worse when the i.f. amplifier has a very narrow bandwidth, as occurs in the "3 Band Short Wave Superhet" when this is set up for s.s.b. and c.w. signals. As with hum pick-up, acoustic feedback difficulties are completely resolved by the use of the external unit.

The power supply circuit will also be of interest to readers who require a 9 volt battery supply for a general purpose receiver. In this instance the speaker is not required, and the power supply, on its own, may be assembled in a smaller case than that employed for the unit to be described. The constructional details given in this article will, however, apply only to the speaker and supply unit and to its use with the particular receiver for which it was designed. It is assumed that experienced constructors will be quite capable of making any simple adaptations that may be required for alternative uses.



The case of the eliminator-speaker unit is made up with aluminium and timber panels



Inside the unit the mains transformer is fitted immediately behind the on-off switch. The component board then appears between the transformer and the rear panel of the case

THE CIRCUIT

The complete circuit of the unit appears in Fig. 1. S1 is the on-off switch and NE1 is a mains neon indicator having its own integral series resistor. This must be a type intended for 240 volts a.c. operation.

T1 is the mains transformer with a 12-0-12 volt secondary winding which feeds the full-wave rectifier circuit given by D1 and D2. C1 is the reservoir and smoothing capacitor.

IC1 is a 723C regulator i.c. in a 14 pin d.i.l. package, and the lead-out functions are shown in Fig. 2. The heart of the i.c. is an operational amplifier employed as a voltage comparator, its output being fed to the output of the i.c. by way of a buffer amplifier. The op-amp non-inverting input is connected to an internal zener diode voltage reference at pin 6 which offers a nominal stabilized voltage of 7.15 volts. The inverting input is coupled to the junction of the potential divider given by R1 and R2.

COMPONENTS

Resistors
(All ¼ watt)
R1 1kΩ 2%
R2 3.3kΩ 2%
R3 6.8Ω 5%

Capacitors
C1 2,200μF electrolytic, 25V. Wkg.
C2 150pF polystyrene
C3 2,200μF electrolytic, 12V. Wkg.

Transformer
T1 Miniature mains transformer, secondary 12-0-12V at 100mA

Semiconductors
IC1 723C in 14-pin d.i.l.
TR1 BFY51
D1 1N4001
D2 1N4001

Indicator
NE1 Panel mounting neon indicator with integral series resistor, 240V. A.C.

Speaker
LS1 5 x 3in., 8Ω

Switch
S1(a) (b) D.P.S.T. toggle

Miscellaneous
Red wander plug
Black wander plug
Red socket
Black socket
¼in. jack plug
TO5 clip-on heatsink
Plain perforated s.r.b.p. board, 0.1in. matrix
Materials for case (see text)
4 rubber feet
wire, screws, grommets, etc.

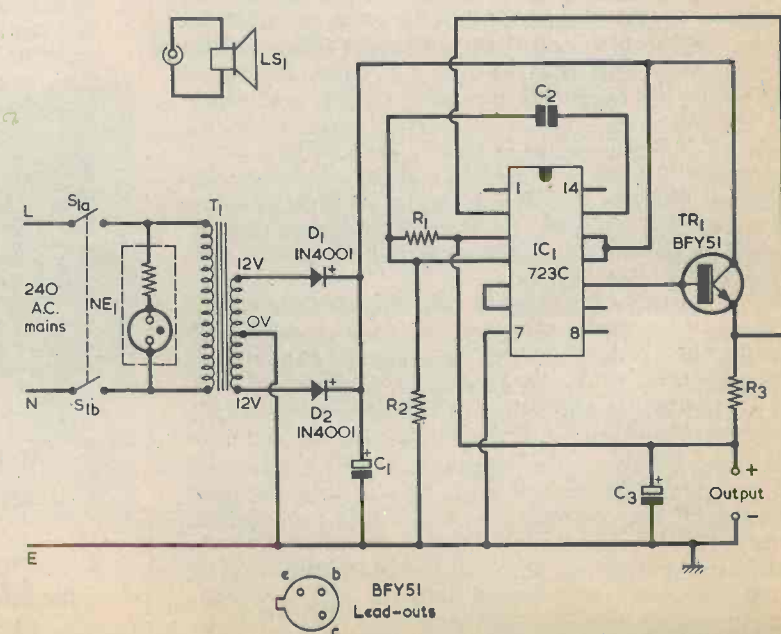


Fig. 1. The circuit of the 9 volt eliminator-speaker unit. The speaker is in no way connected to the eliminator circuitry and may be omitted if it is desired to use the circuit as a simple 9 volt power supply unit

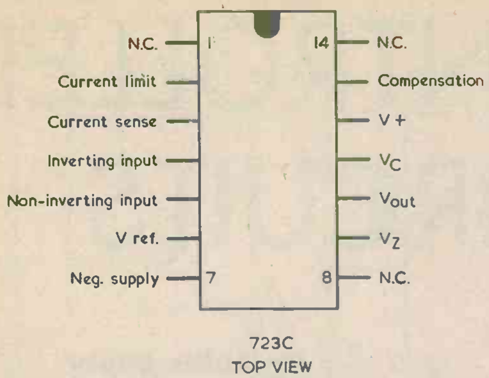


Fig. 2. Pin allocations for the 723C in its 14-pin d.i.l. package

The output voltage of the unit is stabilized at a voltage equal to 7.15 volts multiplied by the sum of R1 and R2, and then divided by R2, which calculates at 9.32 volts with the component values specified. In practice, tolerances on the zener reference voltage and, to a lesser extent, on the values of R1 and R2, could result in the stabilized output voltage being up to as much as 0.5 volt higher or smaller than the calculated figure, but this does not incur any disadvantages. During its life-span, a PP9 battery provides maximum and minimum voltages of the order of 9.6 volts and 7.5 volts respectively! The voltage stabilization is due to the high level of negative feedback between the 723C op-amp comparator input and the power supply output.

R3, in series with the output, is part of the current limiting circuit. It is connected across the base and emitter of an internal transistor in the i.c., so that when about 0.65 volt is developed across R3 the transistor turns on. It then reduces the output voltage of the internal operational amplifier and, hence, the output voltage of the power supply. With R3 at the specified value of 6.8Ω the output current is theoretically limited to about 96mA, but in practice the actual value is subject to a small amount of variation due to component tolerances.

C2 is the compensation capacitor for the operational amplifier. TR1 is a discrete emitter follower output stage. This is needed to increase the power handling capability of the circuit since the 800mW absolute maximum dissipation of the 723C could otherwise be exceeded at high volume levels in the superhet or if the output were short-circuited.

C3 provides additional smoothing at the output and it enables brief current peaks of more than 100mA to be provided by the unit. Such peaks are drawn by the Class B output stage of the receiver when it is used at high volume levels.

The loudspeaker, LS1, is kept separate from the power supply circuitry. It has an impedance of 8Ω when it is used with the "3 Band Short Wave Superhet" but, of course, other impedances may be required with other short wave receivers. Its dimensions of 5 by 3in. are nominal and it is advisable to obtain it before starting work on the cabinet, just in case the cabinet dimensions need to be modified slightly to suit the particular component chosen.

T1 is specified as having a secondary rating of 12-0-12 volts at 100mA. Miniature mains transformers having a secondary with this rating are available from a number of suppliers, including Home Radio (Components) Ltd and Bi-Pak Semiconductors.

CABINET

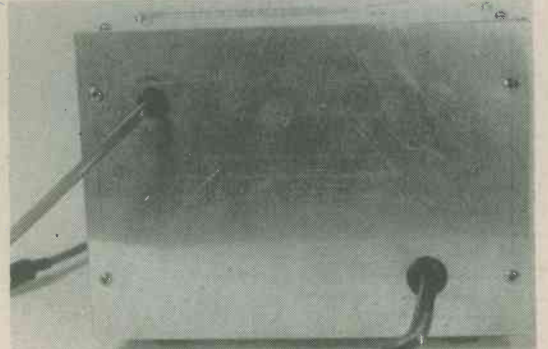
The prototype is housed in a cabinet which measures 180 by 130 by 144mm., and this is home constructed from 18 s.w.g. aluminium for the top, base, front and rear panels. The two sides are timber approximately 12.5mm. thick, the aluminium panels being simply affixed to the edges by two small woodscrews at each edge. The front and rear panels each measure 180 by 130mm, and the top and bottom panels are each 180 by 142mm. The wooden side panels are each 142 by 128mm.

The accompanying photographs show the general layout of the unit and the manner in which the cabinet is assembled. Three holes are drilled symmetrically on a horizontal line along the lower part of the front panel to take S1 at the centre, NE1 to the left and a hole for the speaker lead to its right. The hole for the speaker lead is fitted with a grommet.

A hole for the mains lead is drilled towards the lower right hand corner of the rear panel (as viewed from the rear) and another for the power supply output lead near the upper left-hand corner. Both these holes are fitted with grommets. The top, front and rear panels also each require a 6BA or M3 clear hole which will be used to fit a solder tag internally for earthing purposes. These holes may be drilled at any convenient points.

A rectangular cut-out for the speaker is made in the upper part of the front panel. This can be made with either a fretsaw or a small round file. The speaker may be mounted either by four countersunk bolts whose heads are reasonably flush with the front surface of the front panel or by means of a strong adhesive such as an epoxy resin. In the latter case, take care that none of the adhesive is allowed to get onto the speaker cone or its surround. The upper part of the front panel is completely covered with a piece of speaker fabric. The best approach here is to cut out a piece of material which is slightly too large and then glue it in place with a general purpose adhesive such as Bostik No. 1. When this has set, the excess fabric can be trimmed off the panel edges with a pair of scissors.

Finally, four small rubber feet are fixed near the corners of the base panel by means of adhesive or nuts and bolts.



The rear of the unit. The mains input and 9 volt output leads pass through grommets in the rear panel.

(Constructional details will be given next month)

SILICON CONTROLLED SWITCH CIRCUITS

Part 2 (Conclusion)

by John Baker

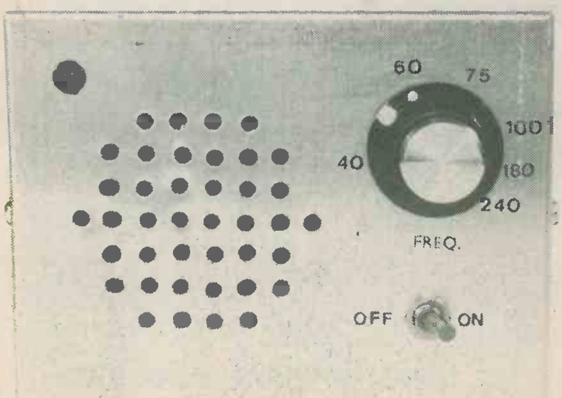
● Metronome ● True CR Latching Timer

● Motor Speed Control ● Temperature Sensor

P.U.T. METRONOME

Unijunction transistors are popular in electronic metronome circuits, where they are employed as relaxation oscillators. The pulse output they produce is ideal when amplified and fed to a loudspeaker. One drawback to u.j.t. circuits of this type is that in order to obtain the low pulse repetition frequency required the timing capacitor has to be electrolytic. A potentiometer is also necessary in order to obtain a control of the beat rate.

Unfortunately, neither potentiometers nor electrolytic capacitors have particularly close tolerances on value; just the opposite in fact. Potentiometers usually have a tolerance of 20 per cent whilst that of electrolytic capacitors is normally - 10 per cent to +50 per cent or even worse! As was mentioned last month, unijunction transistors have varying characteristics so far as triggering voltage is concerned and this fact combined with the wide tolerances in the timing resistor and capacitor make it impossible to obtain good repeatability with regard to beat rate range between one metronome unit and another. To overcome this difficulty it is common for u.j.t. metronomes to cover a much wider range of beat rates than is really required, and even then it is sometimes necessary to select certain component values by empirical means.



Front panel layout of the s.c.s. metronome. The light-emitting diode is upper left of the speaker grille

On the other hand, a programmable unijunction transistor relaxation oscillator has its triggering voltage set by an external potential divider, and it is not then subject to the variations in triggering voltage which occur between one u.j.t. and another. The external reference voltage is, indeed, the reason why the device is called a *programmable* unijunction transistor. Good repeatability can be obtained from a p.u.t. circuit by employing close tolerance components in the potential divider, but this still does not overcome the effects of wide tolerance components in the timing network.

However if, for example, R3 and R4 of Fig. 5 (published last month) were to be replaced by a potentiometer, the latter could be adjusted to vary the frequency of oscillation and thus compensate for variations in the timing network values. When the actual values of C2 and R2 in Fig. 5 are greater than the nominal figures, the potentiometer could be adjusted so that more than half the supply rail potential was applied to the gate cathode of the s.c.s. This would compensate for the excess values since it would decrease the time taken for the charge on C2 to reach the triggering voltage. Similarly, adjusting the potentiometer for decreased gate cathode voltage would raise the triggering voltage and lower the frequency of oscillation, and such an adjustment would correct any deficiency in the timing component values which would otherwise cause too high an operating frequency.

METRONOME CIRCUIT

A working circuit diagram in which a silicon controlled switch functions as a p.u.t. metronome is given in Fig. 8. VR1, R7 and C2 are the timing components and these provide a range of about 40 to 250 beats per minute. Pre-set potentiometer R4

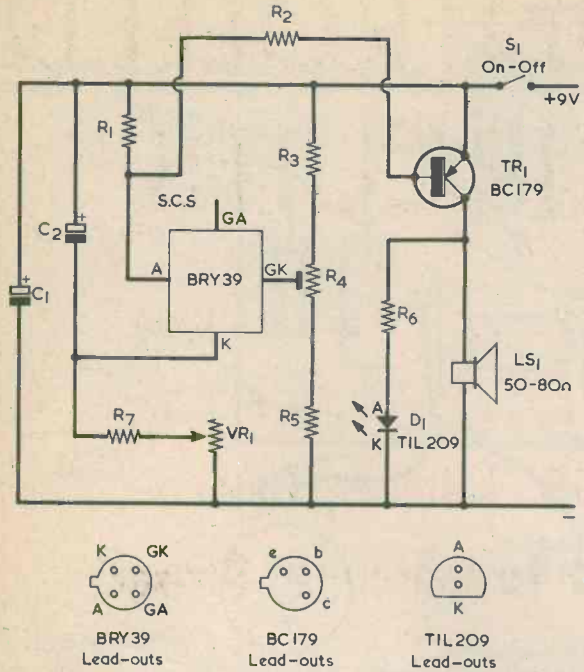


Fig. 8. A metronome circuit incorporating a silicon controlled switch. Both audible and visual outputs are given. Despite variations in value in C2 and VR1 due to wide tolerances, very nearly the same frequency range can be given in all practical versions of the circuit by adjustment of R4

METRONOME COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
- R1 680 Ω
- R2 1.2k Ω
- R3 2.7k Ω
- R4 4.7k Ω pre-set potentiometer, 0.1 watt, horizontal
- R5 2.7k Ω
- R6 560 Ω
- R7 82k Ω
- VR1 470k Ω potentionmeter, linear

Capacitors
- C1 100µF electrolytic, 16V. Wkg.
- C2 4.7µF electrolytic, 16V. Wkg.

Semiconductors
- S.C.S. BRY39
- TR1 BC179
- D1 TIL209 or similar

Speaker
- LS1 50-80 Ω miniature

Switch
- S1 s.p.s.t. miniature toggle

Miscellaneous
- Aluminium case (see text)
- L.E.D. panel holder
- Veroboard. 0.1in. matrix
- 9-volt battery type PP3 (EveryReady)
- Battery connector
- Control knob

can be adjusted to compensate for discrepancies in the timing network component values.

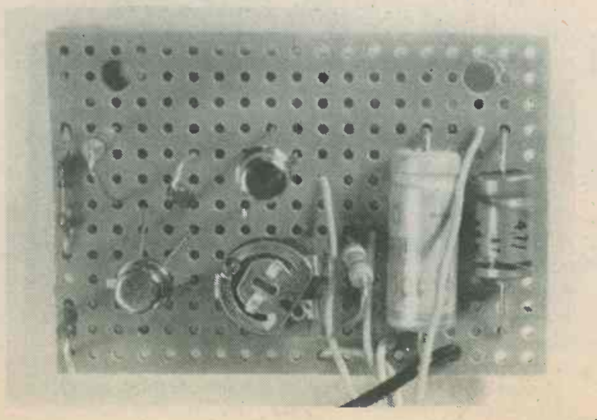
A negative-going pulse is developed across R1 each time C2 discharges and this is fed to the base of TR1 by way of R2. The pulse turns on TR1 and feeds a brief surge of current to the loudspeaker, thereby producing the required clicking sound.

The volume available from units of this kind is rather limited, and they can be rendered inaudible by loud playing of the musical instrument concerned. The volume could be increased slightly by decreasing the value of R2, but this is not likely to make a vast improvement as the main limiting factor to volume is the miniature loudspeaker employed, the diaphragm of which is of small size and has a small available movement.

Obviously, a larger speaker could be used, but a more satisfactory alternative is to augment the clicking sound by a simultaneous flashing from a visual indicator. The latter overcomes the problem because it is, of course, totally unaffected by the volume of the music. In this circuit the visual signal is provided by the light-emitting diode, D1, for which the series resistor R6 provides current limiting.

In the Components List, C2 is specified as having a working voltage of 16 volts. It will be quite in order to employ a capacitor having a higher working voltage here and this may be 63 volts or even higher.

The metronome uses a simple Veroboard module for most of the components



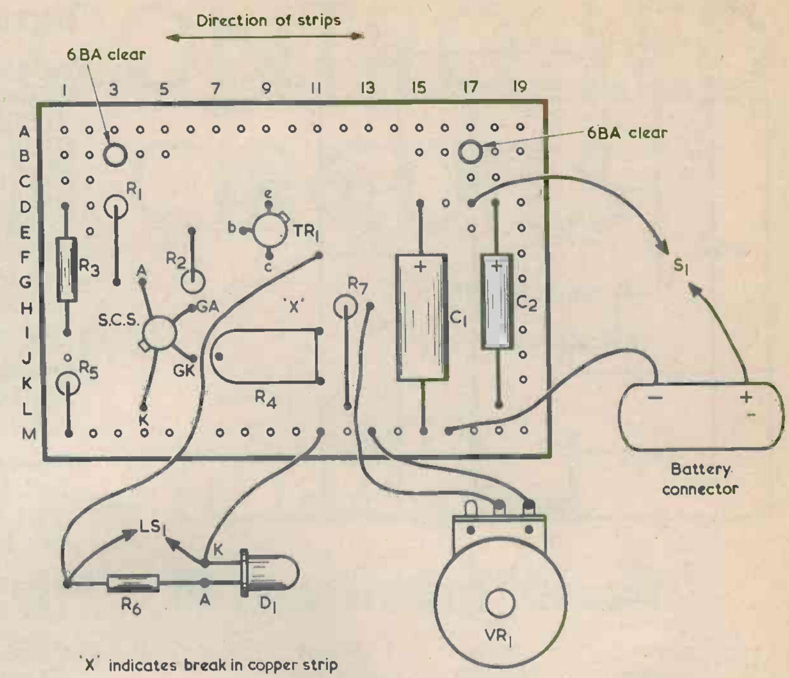


Fig. 9. The majority of components for the metronome may be assembled on a Veroboard panel having the layout shown here

CONSTRUCTION

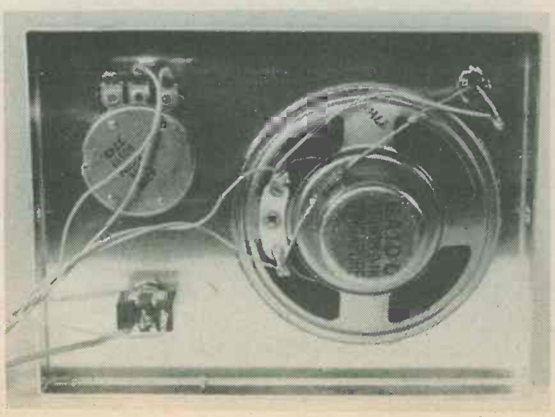
Most of the components are assembled on a Veroboard panel of 0.1in. matrix having 19 holes by 13 copper strips. Details are given in Fig. 9. There is only one break in the copper strips, this being indicated by the cross at hole H10. R6 is not mounted on the panel but is wired between the anode lead-out of the l.e.d. and the appropriate tag of the loudspeaker.

The prototype metronome is housed in an aluminium box which has approximate dimensions of 102 by 76 by 38mm. (4 by 3 by 1½in.). Any aluminium box of around the same, or having slightly larger dimensions may be used provided it can accomodate the particular speaker used, together with the other components. A plastic case would also be suitable.

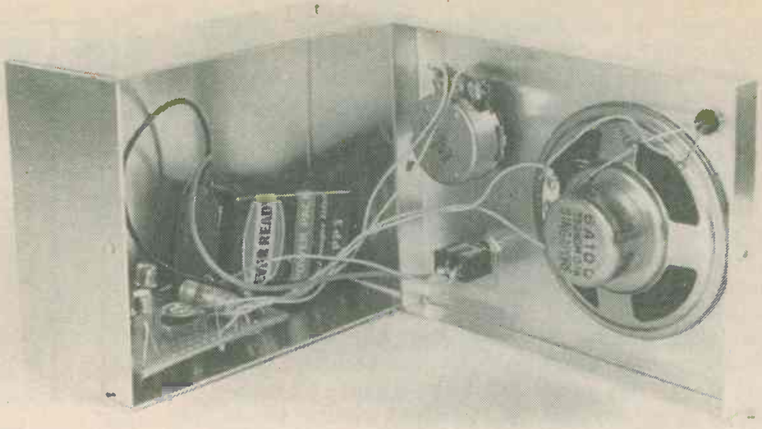
The general layout of the prototype unit can be seen from the photographs. As these show, the speaker grille is made by drilling a matrix of holes in a regular symetrical pattern. These are about 3mm. in diameter and are spaced about 6.5mm. apart. The number of holes required depends upon the size of the speaker. The speaker is carefully glued in place behind the grille using a high quality adhesive such as an epoxy resin type. Care must be taken to see that none of the adhesive gets on to the speaker cone or surround. The component panel is mounted on the bottom of the case at the left below the speaker, using 6BA bolts and nuts. Spacing washers must be passed over the bolts to space the board underside away from the inside surface of the case. This prevents strain on the board and, with an aluminium case, ensures that there are no short-circuits to the underside soldering.

As viewed from the front, the light-emitting diode, which is fitted in a panel-mounting holder, is upper left of the speaker grille. On the right is frequency control VR1 and, below it, the on-off switch. There is sufficient space inside the case for a PP3 battery behind the on-off switch.

The average current consumption from the PP3 battery is only about 1mA, although a brief high current surge occurs each time a click is produced from the speaker.



Rear view of the front panel

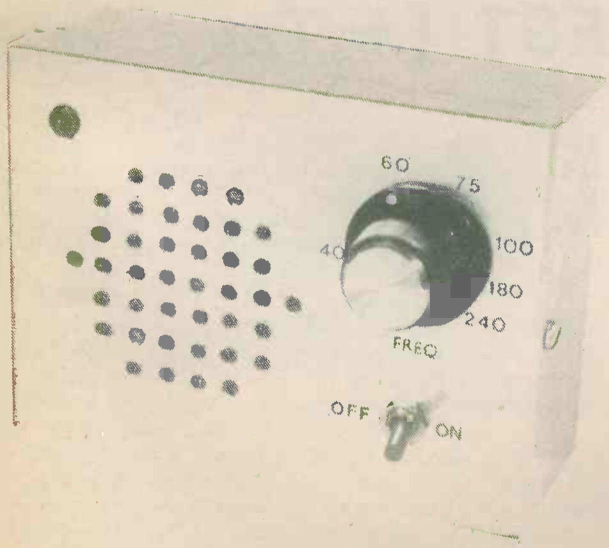


The front panel components wired up to the Veroboard panel. Interconnecting leads consist of thin flexible p.v.c. covered wires

CALIBRATION

At the outset R4 should be adjusted so that its slider is at the centre of its track. It is then necessary to establish whether or not the range of beat rates covered by VR1 is suitable. It is an easy matter to determine the beat rate, this being done by counting the number of beats produced in a certain length of time. The number of beats in, for instance, a 15 second period can be counted, and the result multiplied by 4 to obtain the number of beats per minute. To increase the beat rates provided by VR1 adjust R4 in a clockwise direction. Alternatively, adjust R4 in the anti-clockwise direction if the opposite effect is required.

When a suitable range has been obtained, a simple scale can be made up around the control knob of VR1, the individual calibration points being found by trial and error.



Three-quarter shot of the metronome in its aluminium case

OTHER USES

It is of course impossible, in the limited space available here, to give details of all the various types of circuit in which a silicon controlled switch can be used. In the p.u.t. mode the device can be employed in the applications generally associated with ordinary unijunction transistors, such as tone generators, waveform generators, timers, frequency dividers and simple analogue to digital converters.

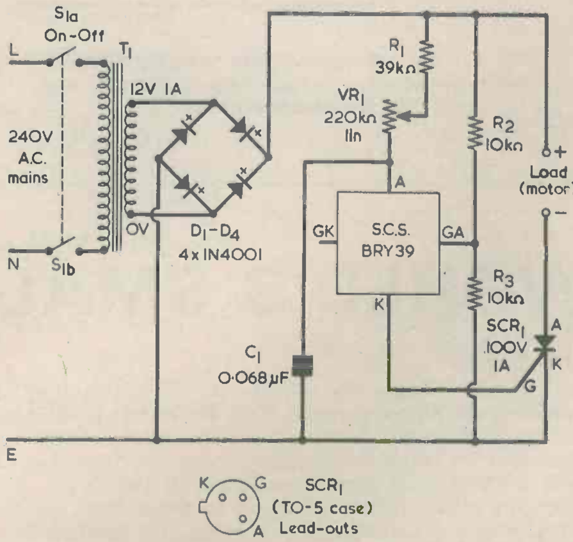


Fig. 10. A circuit in which a silicon controlled switch is used as a speed control for a small 12 volt d.c. motor. Maximum load current is 1 amp

As an example, an s.c.s. can be used as the trigger device for a simple 12 volt motor speed controller, as shown in Fig. 10. Maximum load current is 1 amp and, if the thyristor employed is in a TO-5 encapsulation, as is for instance the TAG1/100, it has the lead-out layout shown in the inset.

When used as a switch, the s.c.s. can be employed in such applications as rain alarms, burglar alarms, temperature alarms, etc. Fig. 11 shows the circuit for an over-temperature alarm in which the s.c.s. is used both as the sensor and as the switching device. This works by virtue of the fact that the voltage at what is effectively the n.p.n. transistor integral in the s.c.s. begins to turn on falls, like any silicon transistor, with increasing temperature. If VR1 is adjusted so that there is just sufficient gate cathode voltage to switch the s.c.s. on when it is at the alarm temperature, the s.c.s. will remain in the "off" state at temperatures below this level. When, subsequently, the s.c.s. reaches the alarm temperature it will turn on and latch in that state. The relay can have a coil resistance of 200 Ω or more, and an excellent choice would be the type with a 410 Ω coil which was referred to in Part 1.

The fact that the device latches in the "on" state can often be put to good use, and the simple timer

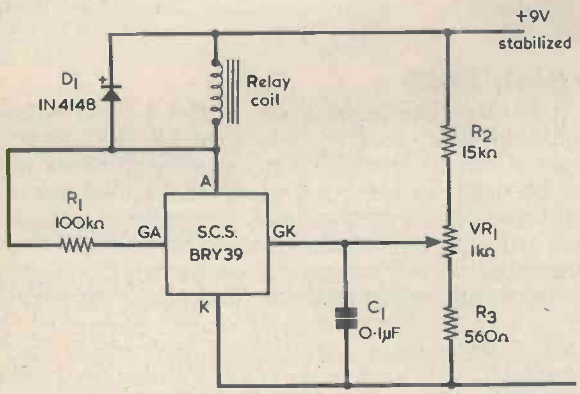


Fig. 11. An over-temperature warning circuit. The s.c.s. acts both as latching switch and as the temperature sensor

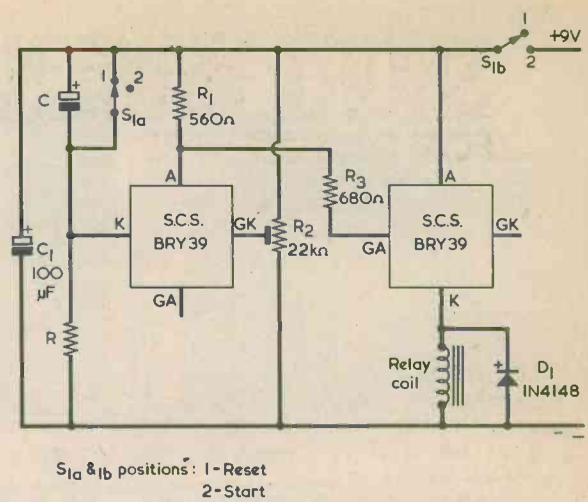


Fig. 12. A timer incorporating two silicon controlled switches. The s.c.s. on the left functions as a p.u.t. and passes a negative-going pulse to the second s.c.s. This latches on and energises the relay. The timing period is governed by the values of C and R

circuit of Fig. 12 illustrates this point. Here an working as a p.u.t. produces an output pulse at the end of the timing period, and this operates a second s.c.s. which acts as a combined latch and relay driver. The timing period can, if desired, be made equal to the time constant of C and R by appropriate adjustment of R2. The value of R should lie between about 15kΩ and 1MΩ. Relay details are the same as for Fig. 11.

The silicon controlled switch is one of the most useful and versatile devices available at present and should be of great interest to the electronics experimenter. It certainly deserves wider use in home-constructor designs.

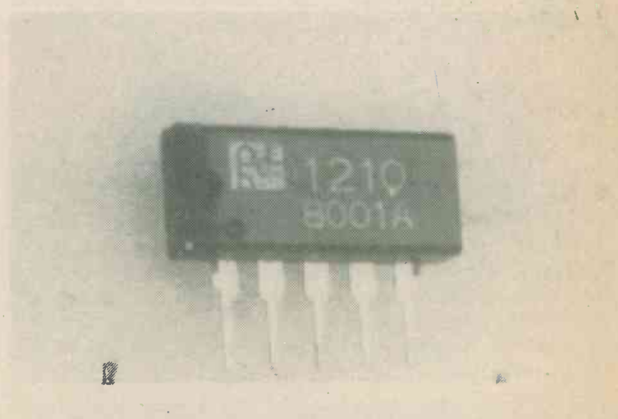
(Concluded)

WORLD'S SMALLEST I.F.Ts

The new Toko 5S series of fully tunable i.f. transformers for frequencies from 100kHz to 15MHz are currently featured by Ambit International, and are described as being the smallest mass produced i.f./r.f. coils with in-built capacitor tuning in the world. The screening cans measure 5.5 by 5.5 by 6mm. high, and the transformers are available in a range of 2-winding combinations which include capacitor tuning of one winding together with different tapping options.

In conjunction with the Ambit International triple varicap tuning diode type KV1210, the 5S coils could be employed in a complete a.m./f.m. radio which is only 10mm. thick. The KV1210 is supplied in a "5-in-line" package (i.e. 5 pins in a single row) and is capable of tuning the medium wave band with a bias control range of only 2 to 9 volts d.c. This makes the tuning diode particularly suitable for car radios, since there is no necessity for an inverter to produce a bias voltage higher than the supply.

Further details are available from Ambit International, 2 Gresham Road, Brentwood, Essex, CM14 4RH.



The Ambit International triple tuning varicap diode type KV1210

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT   Frequencies = kHz

● **SRI LANKA**
Colombo on a measured **4902** at 1740, Buddhist monks with religious chants on a full-moon evening. This is the Home Service 1 which operates from 0015 to 0230 and from 1030 to 1715 in Sinhala. Additionally on full-moon days from 1600 to 2400. The power is 10kW.

● **PAKISTAN**
Radio Pakistan on **4790** (unlisted channel) at 0015, local songs and music until 0043 when the Azad Kashmir Anthem was heard. At 0045, identification as "Radio Pakistan". All in parallel with **4736.5** (measured). All logged on three separate occasions.

● **SINGAPORE**
Radio Singapore on **5010** at 2331, OM with a newscast in English. This is the English Service, scheduled from 1030 to 1630 and from 2230 to 2400. Also to be heard in parallel on **5052**. The power is 10kW.

● **NEPAL**
Radio Nepal, Jawalakhal, on **5005** at 1547, YL with songs, local-style music in the Home Service, scheduled here from 1150 to 1720 and from 0020 to 0350 (the English programme is from 1440 to 1520) and the power is 100kW.

● **MALAYSIA**
Kuala Lumpur on **4845** at 2202, Indian-type music, YL with songs in the Tamil Service scheduled here from 0545 to 1530 and from 2130 to 0130 Monday to Friday (Saturday from 0545 to 1530 and from 2130 to 0330; Sunday from 2130 through to 1530). The power is 50kW.

● **BOTSWANA**
Gaberones on **4845** at 1822, OM's with a discussion about African affairs in English. The schedule is from 0400 to 0630, 1500 to 2100 Sunday to Wednesday and from 0400 to 0600, 1435 to 2100 Thursday to Saturday. The power is 10kW.

● **KENYA**
Nairobi on **4804** at 1812, YL with a newscast of local affairs in English. This is the Home Service in English and is scheduled from 0255 (Sunday from 0330) to 0630 and from 1300 to 2010 (Saturday until 2110). The power is 1kW.

Nairobi on a measured **4934** at 1829, OM with a talk about Kenya after Jomo Kenyatta. This is the National Service, scheduled here from 0300 to 0630 and from 1310 to 2115. The power is 100kW.

● **BENIN**
Cotonou on **4870** at 1829, OM in vernacular, African drums and chants. The schedule is mostly on a 24 hour basis and is the Home Service in French and vernaculars. The power is 30kW.

● **TOGO**
Radio Lama-Kara on a measured **3222** at 1901, OM with announcements in French. The schedule of this one is from 0530 to 0830 and from 1630 to 2230, the power is 10kW but it is not an easy station to receive owing to the surrounding commercial interference.

● **SAO TOME**
Radio Nacional de Sao Tome on a measured **4807** at 2110, YL with songs, local-type music, OM with announcements in Portuguese. The schedule is from 0530 to 2300 and the power is 10kW.

● **CAMEROON**
Radio Garoua on **5010** at 1834, OM with a newscast in English, this being a feature of the daily schedule from 1830 to 1845. The full schedule is from 0500 to 0700 and from 1700 to 2200. The power is 30kW.

● **TANZANIA**
Dar-es-Salaam on **5050** at 1738, OM with Moslem chants in the Commercial Service, scheduled here from 1300 to 2015. The National Service in Swahili is scheduled from 0300 to 0500. The power is 10kW.

● **MOZAMBIQUE**
Radio Mozambique on **4865** at 1754, OM with a talk in Portuguese in the 'A' Programme, scheduled from 0255 to 0815 and from 1600 to 2210 (there is a programme in English from 1800 to 1815 daily). The power is 25kW.

Radio Mozambique on a measured **4896** at 1747, light music on records, OM announcer in Swahili. The schedule is from 0400 to 0700 and from 1430 to 2000. The power is 100kW.

● **UPPER VOLTA**
Ouagadougou on **4815** at 1805, OM's with a discussion in vernacular. The schedule is from 0530 (Saturday and Sunday from 0700) to 0900 and from 1600 to 2400. The power is 20kW.

● **SWAZILAND**
Trans World Radio (TWR) Mpangela on a measured **4759** at 1813, light music followed by hymns in vernacular at 1815. The schedule is from 0315 to 0600 in Afrikaans and from 1600 to 1800 in German, Portuguese and vernaculars. The power is 30kW.

Continued on page 321

In your work-shop

SIMPLE COMBINATION LOCKS

"This," said Smithy incredulously, as he put a tremulous hand to his brow, "is Christmas Eve. Why on earth am I in the Workshop answering your questions on Christmas Eve?"

"So far as I can remember," stated Dick, "you've always been in the workshop answering my questions on Christmas Eve."

"But I shouldn't be doing that this year," protested Smithy. "Dash it all, we finished work *yesterday*. I just popped in this morning a few minutes ago to pick up a record which should fit in nicely with our Christmas festivities at my club, and I now find myself answering a whole load of questions for you. Look, let's get back to the moment when I came in. And for goodness' sake take things gently when you get to the bit about the missing Father Christmasses."

Dick threw a sympathetic glance at the Serviceman.

"It sounds," he remarked compassionately, "as though you've already started your own Christmas festivities. I bumped into my uncle earlier on today and he said that things were really heaving at your club last night."

Smithy sighed. One of the banes of his life was the fact that Dick's uncle was also the steward of his club.

"Forget about last night," he said shortly. "Let's recap on this morning."

COMBINATION LOCK

"Okeydoke," said Dick obligingly. "Well, as you say, you came in for your record a couple of minutes ago. I was already in here trying to work out a little private job for Joe down at the Caff, and it was then that I told you he'd had nearly all his Father Christmasses pinched."

"Father Christmasses," repeated Smithy hollowly.

"They're only *little* Father Christmasses," explained Dick soothingly. "They're made in Taiwan."

"Father Christmasses from Taiwan," moaned Smithy. "The mind boggles."

"Old Joe," continued Dick cheerfully, "got a whole lot of them cheap and he put them out on display at his Caff. Well, you know what the blokes are like down there, and it ended up with nearly all of them getting nicked."

"At least *that* bit figures."

"As a result, Joe's decided to put all the future odds and ends he flogs in a glass case with a locked front. But with his clientele an ordinary key type lock would be asking for trouble and so he's asked me to dream up a combination electronic lock for him."

Smithy visibly brightened.

"Ah," he said, "things are beginning to get a bit more straightforward now. So far as combination locks are concerned, there's hardly any problems at all in making up one which works on electronic, or even electrical principles. The simplest way of providing a lock of the type you want is to have a combination switching circuit. Something like this."

Smithy spied his note-pad on his bench and, taking out a ball point pen, sketched out a circuit. (Fig. 1).

"That's all there is to it," he continued. "Each switch can be a single-pole single-throw panel mounting toggle type. To open the case, or whatever the lock is fitted to, all the switches have to be in the closed position. You then press the push-button, the solenoid becomes energised, and it withdraws a bolt securing the case."

"Humph," commented Dick critically. "I don't think much of that. Anybody can turn a series of toggle switches on."

"Not if the switch bodies are hidden behind a panel they can't,"

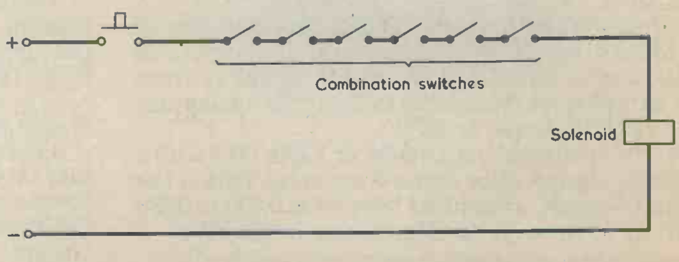


Fig. 1. A very simple but quite effective combination lock incorporating six s.p.s.t. toggle switches. All the switches have to be closed to operate the solenoid and open the lock

retorted Smithy. "You mount the switches so that some are turned on when the operating dolly is up and some are turned on when the operating dolly is down. To open the lock from the outside you have to know which switch dollies should be up and which should be down." (Fig. 2).

"To my mind," grunted Dick, "it still seems to be too easy for anyone to open the lock. You've put six switches in your circuit. How many combinations will that give?"

"Let me think a minute."

Smithy scribbled a few figures on the note-pad.

"The six switches," he said in a satisfied tone, "will give you 64 combinations, of which only one will open the lock. If you added another switch in series you'd get 128 combinations and if you added yet another switch there'd be 256 combinations."

"Blimey," said Dick, impressed, "that toggle switch idea doesn't sound so bad after all. Hey, Smithy, you seem to be quite clued-up on this combination lock business."

SECURITY

Smithy gave a mysterious smile.

"Ah," he said darkly, "that's a result of the experience I picked up during the last war. Now that all these years have gone by I suppose that it's safe for me to mention a few of my secret activities at that time."

"Go on."

"To begin with," said Smithy modestly, "I originated not a few new technical ideas so far as security was concerned. Indeed, I was commended for some of my designs."

"Come off it," snorted Dick scornfully. "The only security designs you've ever had are designs on *Social* Security!"

Smithy turned a pained eye on his assistant.

"That's typical of present-day reactions," he stated disgustedly. "Well, if that's the sort of comment you're going to make about my wartime activities I'll pick up my record and press on home."

Dick gazed dispassionately at Smithy.

"You're miffed, aren't you?"

"Too true I'm miffed. I'm cheesed off with blokes like you taking the mickey out of my wartime service."

"All right then, I won't do it any more. Besides, it *is* Christmas and the season of goodwill and all that schmaltz. So how about hanging on a bit longer and giving me some more gen on this combination lock business?"

"Oh, all right," conceded Smithy reluctantly. "What do you want to know next?"

"How do you work out the number of combinations those switches of yours will give? You said, for instance, that six toggle switches give you 64 combinations, seven switches give 128 combinations, and so on. How do you calculate that?"

"You can," said Smithy, "work it out with mathematics. But I find that the easiest way of finding the number of switch combinations is by thinking in terms of binary notation, assuming that a switch turned in one direction is equal to 0 and that a switch turned in the other direction is equal to 1. Imagine you've got three switches. All the combinations you can then get are from binary 000 to binary 111, going through the series 001, 010 and so on till you get to 111. Now, 111 in binary is 7 in decimal, so that 001 to 111 gives 7 combinations. Add the combination 000 and you then find that the three switches give 8 combinations. Do the binary business for four switches and you find there are 16 combinations. Five switches take you up to 32 combinations, and so on."

"How would it be," asked Dick, "if we used rotary switches instead? Say we had three 10-way rotary switches wired up like this."

Dick picked up Smithy's pen and drew out a circuit. (Fig. 3).

"Rotary switches," said Smithy, "will obviously give you more combinations than the same number of toggle switches. In that circuit of yours the lock will only open when the first switch is set to 6, the second to 1 and the third to 4."

"Yes, but how many combinations are there?"

"We can calculate it very easily. Since the switches are 10-way instead of 2-way we work in terms of decimal instead of binary. In the three figure decimal group from 001 to 999 there are obviously 999 combinations. Add one for 000 and you

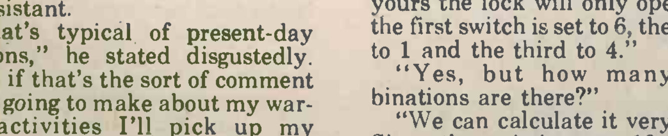


Fig. 2. The combination switches may be orientated in random fashion so that the closed dolly positions cannot be judged from the front of the panel on which they are mounted

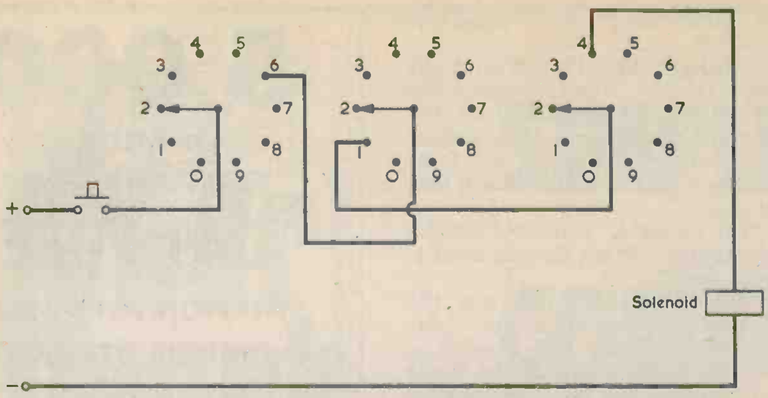


Fig. 3. More combinations are possible if rotary switches are employed. Here, the combination required to open the lock is 614

can see at once that the three switches give 1,000 combinations. If you had six rotary switches you'd get a million combinations!"

"Stap me," said Dick, awed at this prospect. "I think I'll use rotary switches instead of toggle swtches for this lock of mine, then."

"As you wish," responded Smithy. "You can't normally get 10-way rotary switches but 12-way switches are quite easy to obtain. Two 12-way swtiches would give you 144 combinations, and three would give you 1,728 combinations. Each time you add a switch the number of combinations is multiplied by 12."

"You really are on the ball with these switch combinations," said Dick. "Was this wartime work of yours concerned entirely with security systems?'

Smithy looked round cautiously.

"There's nobody else in here, is there?"

"Of course there isn't. Blow me, Smithy, who the heck would want to hide in here?"

Smithy drew himself closer to his assistant.

"We were always trained," he said in a hushed voice, "never to take chances. To start off with, did you bring anything into the Workshop this morning?"

Dick indicated a brown paper parcel on his bench.

"Only that."

"Open it."

Resignedly, Dick picked up the parcel and tore off the brown paper. He revealed a small figurine coloured in bright red and white.

"Why, oh why," fumed Smithy, roused to a sudden fury at the sight of the figure, "do you always contrive to change the atmosphere in here from a state of solemnity to one of utter lunacy?"

"Hey, take it easy, Smithy. It's only one of Joe's Father Christmasses."

"I can *see* it's one of his Father flaming Christmasses. Why bring the darned thing here?"

An expression of obduracy passed over Dick's face.

"If," he said firmly, "I'm going to dream up a lock to guard Father Christmasses and things like that, I might as well have a sample of what is going to be guarded while I'm doing it."

Smithy looked at his assistant, then let his hands fall helplessly to his sides.

"I give up," he said hopelessly. "There is a random logic behind some of your thought processes which has me completely baffled. What were we talking about?"

"Your wartime exploits."

"And before that?"

ALARM CIRCUIT

"We were talking about these combination locks. Which reminds me about something else."

"What's that?"

"Well, the circuits we've talked about up to now simply have the combination switches in series between a battery and a solenoid. Couldn't we have some form of alarm circuit, so that an alarm was given if the push-button was pressed when an incorrect combination was selected?"

"That could be done quite easily," replied Smithy. "One way would consist of wiring all the unused switch contacts together and passing them to an alarm circuit." (Fig. 4).

"But that would mean a lot of wiring up," objected Dick, "particularly if the system employs rotary switches, as I now intend to use."

'True, true," agreed Smithy. "An easier method would consist of having an electronic circuit which could sense that the circuit through the switches wasn't complete when the button was pressed. Let's see what I can think of along those lines."

Smithy settled himself at his bench and jotted down a few experimental circuits. Suddenly his brow cleared. With a decisive gesture, he tore off the top sheet of his note-pad and drew out a new circuit. (Fig. 5).

"This will give you an alarm facility," he said, "and all you need are a few extra components and a relay with two normally open con-

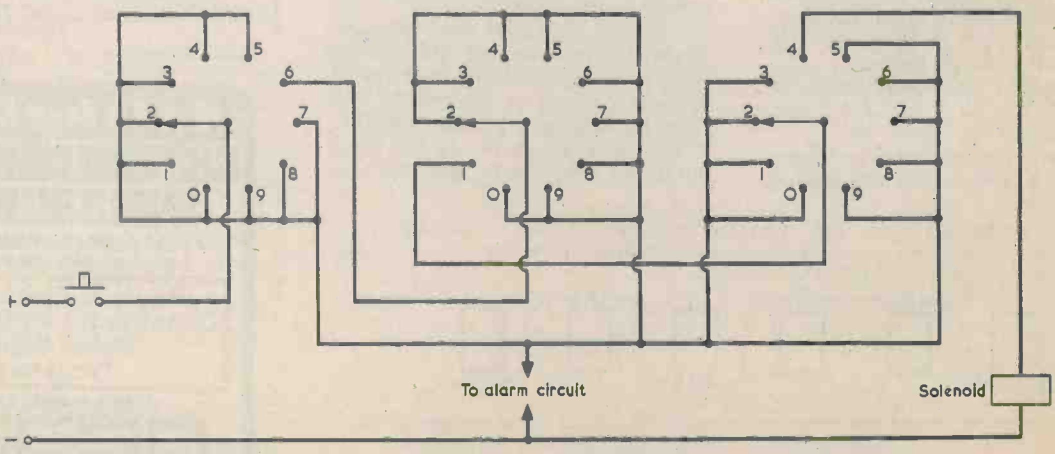


Fig. 4. An alarm facility to indicate incorrect combination switch selection can be provided by connecting all the unused contacts to an alarm circuit. This is the circuit of Fig. 3 so modified

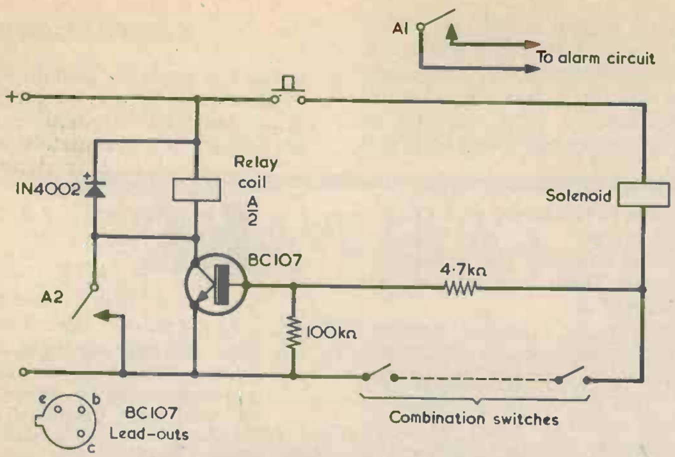


Fig. 5. An alternative circuit which gives warning that an incorrect combination has been selected. The combination switches can consist of any number of toggle or rotary switches. The relay contacts are shown in the de-energised position

tact sets. I've marked these contacts A1 and A2."

"How does the circuit work?"

"To start off," replied Smithy, "let's assume that the switches are all set to the correct combination. They will then cause the base and emitter of the transistor to be short-circuited together. When the push-button is pressed the solenoid will then energise and open the lock. The transistor won't have any effect and the relay will be de-energised. Okay?"

"Yes," said Dick, squinting down at Smithy's circuit.

"Next," went on Smithy, "we'll see what happens if we press the button with the switches set to an incorrect combination, so that there's no circuit from the negative supply through to the solenoid. When we now press the button, current from the positive supply will pass through the solenoid and then through the 4.7kΩ resistor to the base of the transistor. The coil resistance of the solenoid will be much lower than 4.7kΩ and so it won't have any significant effect on the transistor base current. At the same time, the relatively small current passing through the solenoid and the 4.7kΩ resistor won't be enough to operate the solenoid."

"I can see all that," broke in Dick impatiently. "Does the transistor now turn on?"

"The transistor turns on. It energises the relay whose coil is in its collector circuit and the two contact sets close. Contact set A1 causes an alarm to be sounded, whilst contact set A2 connects the lower side of the relay coil to the negative supply. The result is that the relay remains energised even if the push-button is released again. The only way of de-energising the relay is by disconnecting the supply."

"That's neat," commented Dick enthusiastically. "I suppose that the diode across the relay coil is the usual diode to stop the formation of a high back-e.m.f. when the relay is eventually de-energised."

"That's right," confirmed Smithy. "The diode protects the transistor."

"It looks," stated Dick, "as though I've got the basis now for making up a really effective electronic lock for old Joe."

At the mention of the name, Smithy's eyes automatically flickered towards the gaily coloured Father Christmas on his assistant's bench. Frowning suspiciously, he walked over to it and examined it carefully.

"Come on, Smithy," called out Dick. "The darned thing isn't bugged, if that's what you're worried about."

Smithy put the little Father Christmas back on Dick's bench.

"Back in '43," he observed, "I was nearly trapped by something like this Father Christmas of yours."

"Were you? What happened?"

"I was engaged in an undercover operation in Occupied France. In fact, I was setting up a clandestine radio in the attic of an *estaminet* near the Seine, when I observed a peculiar intermittent interference on the band we were using, which was around 50MHz."

"Gosh."

"I traced it in the end to a wire recorder hidden down below in the bedroom of *le patron.*"

"Golly."

Smithy warmed to his tale.

"The recorder was very cunningly secreted in the stomach of a stuffed alligator with wires going to a small microphone fitted under the tail. The commutator and brushes of the wire recorder motor were sparking a little, and the leads to the microphone were just the right length to form a quarter-wave aerial at 50MHz and radiate the interference!"

"Blimey. Who were you working for then? MI5?"

"Oh no," said Smithy, so quietly that Dick could just catch the words. "I was seconded to the CIA."

"But," protested Dick, "there wasn't a CIA in those day, was there?"

"It was just starting," replied Smithy hastily. "Some of us were with it right at the beginning."

FURTHER SECURITY

Smithy moved back from his assistant and turned a stern eye on him.

"It is when I recall moments like that," he said, reverting to his normal tone of voice, "that I get angry at people who mock these wartime exploits."

"I won't do it again," said Dick contritely. "Fancy you being mixed up in all that underground business! You've certainly kept quiet about it over the years."

"There are some tales," pronounced Smithy heavily, "that are best left untold."

"Perhaps so," agreed Dick. "Anyway, thanks to you, I've got my combination lock circuit sorted out."

He glanced down at the circuit Smithy had drawn, then his brow furrowed.

"What's wrong?"

"This circuit doesn't seem to cover all possibilities."

"In what way?"

"Well," said Dick, "if the push-button is pressed for an incorrect switch combination the alarm circuit goes off all right. But this still doesn't prevent anyone who is trying to open the lock from continuing to try different switch combinations, even though the alarm has been activated."

Smithy took the circuit from his assistant and studied it.

"That's a good point," he stated approvingly. "What we want in this circuit is something which not only sounds the alarm but also disables the combination lock switches as well. Let's see what I can do about that."

Smithy sat down and, after a little thought, produced a new circuit. (Fig. 6).

"You've changed the contacts," commented Dick, looking over his shoulder.

"That's right," agreed Smithy. "I've altered contact set A2 from a normally open to a changeover set. If, with this new circuit, the button is pressed when the switches are at the correct combination, the solenoid operates as before and the transistor remains cut off. If, however, the switches are at an incorrect combination, pressing the button causes current to flow into the transistor base via the solenoid coil and the 4.7kΩ resistor once more, and the relay energises. The contact set A2 changes over and connects the lower side of the relay coil to the negative supply so that the relay remains latched in the same way as it was in the previous circuit. The important change now is that contact set A2 also breaks the negative supply connection to the switches, so that they cannot possibly cause the solenoid to be operated."

"That's the best circuit of the lot," said Dick appreciatively. "What sort of relay should I use?"

"Pretty well any relay which has the requisite contact sets will do," said Smithy, "and it's advisable to choose one which doesn't draw an excessive energising current. When the transistor is a BC107 the energising current must not exceed 100mA. In practice you should be able to find a relay with a much lower energising current. The supply can have any voltage between 6 and 12 volts or so which suits the relay and the solenoid. The current drawn from the supply when the push-button is not pressed is only

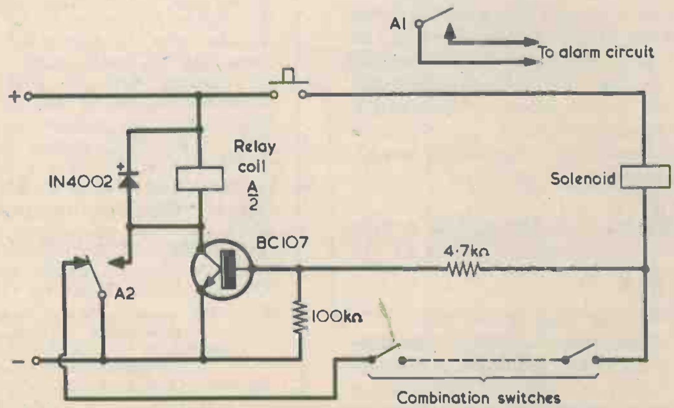


Fig. 6. An improved version which not only sounds an alarm for an incorrect combination selection but also disables the combination switches

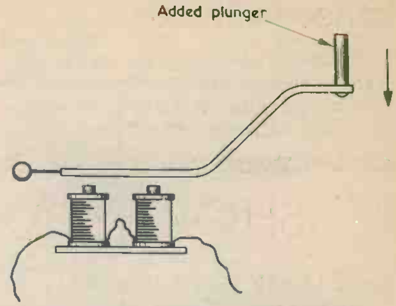


Fig. 7. For mechanically light applications, the locking device may consist of an electric bell modified as shown here. Connection is made direct to the coil of the bell

leakage current in the transistor and this will be negligibly low."

"How do I get hold of a suitable solenoid?"

"You have to use a bit of ingenuity so far as that is concerned. Solenoids are advertised from time to time by dealers of job lot components. Alternatively, you could try to make one up yourself. At a pinch you could even adapt an old electric bell by removing the gong and making a connection to the bell coil only. A small plunger could then be attached to the bit which strikes the gong. Provided there was no mechanical strain on the plunger this could function as a bolt securing a small box or case." (Fig. 7).

"That seems to button *that* up, then," said Dick happily. "This Christmas Eve has certainly opened my eyes for me. Not only have I now got a combination lock circuit to work with but I've also been able to hear about your secret war work. That's quite a coincidence, too, because I happened to be talking to my uncle about you and the war when I met him this morning."

A shadow crossed Smithy's face.

"Were you?" he asked anxiously.

"Yes," replied Dick. "He told me that you spent all the war working for NAAFI!"

"Zounds," muttered Smithy. "my cover is blown!"

"I'm not too sure, though," continued Dick artlessly, "what the letters NAAFI stand for."

Smithy seized his chance.

"One of the best kept secrets of the last war," he said quickly, "was the fact that there were two NAAFI organisations. One of these served out tea and cakes and things like that and, as everyone in the Services knew, the letters stood for No Ambition And Fleeting Interest. It was the second, covert, NAAFI that I worked for."

"And what did the letters stand for there?"

"Navy, Army and Air Force Intelligence!"

SEASONAL SPIRIT

Dick turned a gaze of newly formed respect on the Serviceman.

"I'm certainly looking forward to working with you in the future," he said admiringly. "Blimey, I keep forgetting that it's Christmas. So, a Merry Christmas to you, Smithy."

"And the same to you, Dick," returned Smithy warmly. "This is just the right time, too for us to wish a truly Merry Christmas and a really prosperous New Year to all the readers who've put up with our capers over the last twelve months."

'God bless us," concluded Dick. "God bless us, everyone!" ■

SHORT WAVE NEWS continued from page 315

● **MAURETANIA**

Nouakchott on **4845** at 2355, OM with Moslem chants, announcements and off at 2400 with the National Anthem. The weekday schedule is from 0600 to 0900 and from 1800 to 2310 (Friday and Saturday until 2400); Sunday from 0600 to 0900 and from 1700 to 2400. The power is 100kW and there is an English programme from 1900 to 1930.

● **CONGO**

RTV Congolaise, Brazzaville, on **4765** at 0434, OM with a talk in French. The schedule is from 0400 to 0700 and from 1700 to 2300 but the closing time can vary up to 0100. There is an English programme at 2130 and the power is 50kW.

● **GUINEA**

Conakry on **4910** at 0118, Arabic-type music. The schedule is from 1230 to 0730 and the power is 18kW.

● **LEBANON**

Radio Lebanon, Beirut, on **11965** at 0240, YL with a newscast in English in the programme directed to North America, scheduled from 0230 to 0300.

● **COLOMBIA**

Emisora Nuevo Mundo, Bogata, on **4755** at 0428, OM with a talk about Colombian affairs in Spanish. This one has a power of 1kW and radiates around the clock.

Radio Bucaramanga on **4845** at 0335, OM with a love song (heart-rendering at that!) in Spanish. The schedule is from 1000 to 0400 and the power is 1kW.

Radio Surcolombiana, Neiva, on **5010** at 0346, OM with pop song in Spanish. The schedule is around the clock and the power is 2.5kW.

● **PERU**

Radio Chinchaycocha, Junin, on **4860** at 0455, local folk music, OM with 'noticias', identification at 0501. The schedule is from 1100 to 0730 but sometimes around the clock and the power is 0.5kW.

Radio Atlantida, Iquitos, on **4790** at 0425, OM with a love song in Spanish. The schedule is from 0400 to 0600 and the power is 1kW.

● **ECUADOR**

Radio Nacional Espejo, Quito, on a measured **4679** at 0117, OM with a sports commentary in Spanish. The schedule is around the clock but it has been reported sometimes closing at 1600. The power is 5kW.

Radio Quito on **4920** at 0342, OM with news of Latin America — especially Colombia — in Spanish. The schedule is from 1030 to 0500 and the power is 10kW.

● **BRASIL**

Radio Nacional, Boa Vista, on **4835** at 0357, OM with a ballad in Portuguese, identification at 0400 followed by choral National Anthem — all four minutes of it!

Radio Jornal do Brasil, Rio de Janeiro, on **4875** at 0352, OM with announcements about 'futebol' (football) followed by a programme of typical Latin American music.

● **NETHERLANDS ANTILLES**

Bonaire on **11710** at 0459, OM with identification at the close of the English transmission to Europe.

● **CHINA**

Urumchi on **5060,** at 2340, OM with physical exercises to music in the Mongolian Service.

Radio Peking on **9860** at 1432, YL with the English programme to South Asia, scheduled from 1400 to 1500.

Radio Peking on **9440** at 1505, YL with the programme in Standard Chinese to South Asia and South East Africa, scheduled here from 1500 to 1600.

Radio Peking on **9880** at 1444, YL with the Sinhalese programme, scheduled from 1430 to 1500.

Radio Peking on **11445** at 1500, OM opening the Nepalese programme, scheduled from 1500 to 1530.

● **YEMEN**

San'a on a measured **4853** at 1825, drama in Arabic in the Domestic Service, scheduled here from 0300 to 0700 and from 1000 to 2105 except Friday when times are from 0300 through to 2105. Also to be heard in parallel on **9780.**

● **AFGHANISTAN**

Kabul on **4775** at 0135, YL with announcements, local music in the Home Service 1 programme, scheduled from 0100 to 0330 and from 1230 to 1740 (except from 1300 to 1530 when the Foreign Service operates on this channel — the English programme is from 1400 to 1430). The power is 100kW.

NOW HEAR THESE

Radio del Pacifico, Lima, Peru, on **4975** at 0331, OM with identification, announcements in Spanish, plaintive flute music, acoustic echo on announcements.

Radio Loreto, Iquitos, on **5050** at 0439, trumpet fanfare, OM identification in Spanish, OM love song, full identification at 0500.
0500.

TRANSFORMERS

Primary 240V

6-0-6V	100mA	£0.75
9-0-9V	75mA	£0.75
12-0-12V	50mA	£0.85
12-0-12V	100mA	£1.05
Post on above transformers		30p
9-0-9V	1A	£1.80
12-0-12V	1A	£2.15
15-0-15V	1A	£2.36
6·3V	1½A	£1.80
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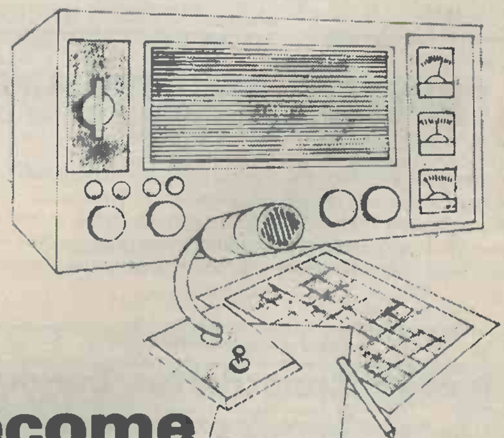

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