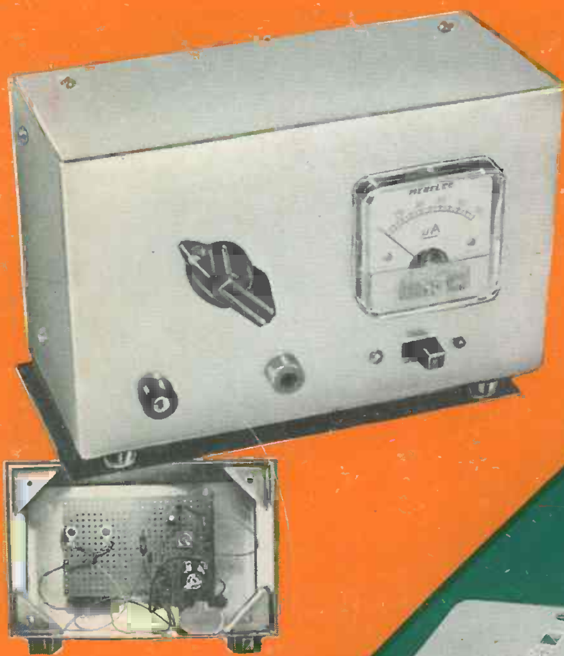
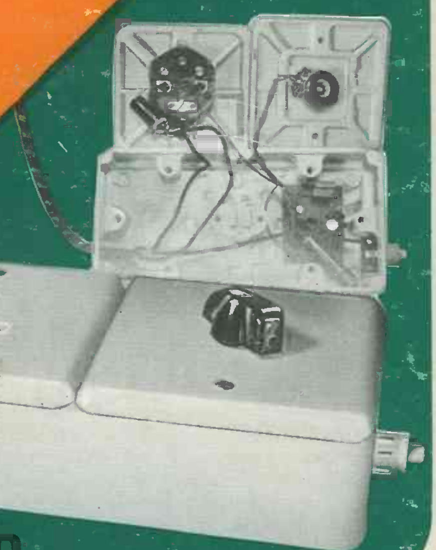
RADIO & ELECTRONICS CONSTRUCTOR

AUGUST 1974

22p



THREE RANGE F.E.T. VOLT-METER



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The largest selection

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Packed with transistors, diodes, capacitors and resistors – COMPONENT VALUE £1.50.
3 for ONLY 55p + p&p 30p

SPECIAL As above PLUS Power Transistors. ONLY 55p each + p&p 15p

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Complete with circuit diagrams etc.
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Coils DRX1 Crystal set 31p; DRR2 Dual range 45p

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SWITCHES

DP/DT Toggle 25p SP/ST Toggle 18p

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1¼" and 20mm. 100mA, 100mA. 250mA. 500mA. 1A. 1.5A. 2A.
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H1012 .. .. £1.87

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K4007 80 ohms Imp. Insertion loss 3dB. £1.21.

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(Angled) £3.85p per pair

BI-PAK CATALOGUE AND LISTS SEND S.A.E. AND 10p

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(In 2 sections. Black Vinyl covered top and sides and bezel).

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BA4	5¼"	x	4"	x	1½"	47p
BA5	4"	x	2½"	x	2"	41p
BA6	3"	x	2"	x	1"	34p
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Ref. 32A	Stylus Balance	£1.36
Ref. J	Tape Head Cleaning Kit ..	51p
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X25 25 watt £1.93 CCN 240 15 watt £2.15
Model G 18 watt £2.15 SK2 Soldering kit £2.86

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ST1 .. .. £1.21 ST2 .. .. 77p

SOLDER
18SWG Multicore 7 oz 82p 22SWG 7 oz. 82p
18SWG 22 ft. .. 28p 22SWG Tube 22p

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102	For model CN240 ⅜"	38p
1100	For model CCN240 ⅜"	38p
1101	For model CCN240 ⅜"	38p
1102	For model CCN240 ¼"	38p
1020	For model G240 ⅜"	38p
1021	For model G240 ⅛"	38p
1022	For model G240 ⅜"	38p
50	For model X25 ⅜"	38p
51	For model X25 ⅛"	38p
52	For model X25 ⅜"	38p

ELEMENTS
ECN 240 .. £1.16 ECCN 140 .. £1.16
EG 240 .. £1.16 EX 25 .. £1.16

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C 3	50	Precision Resistors .1%. .01% mixed values	0.55
C 4	75	⅛th W Resistors mixed preferred values	0.55
C 5	5	Pieces assorted Ferrite Rods	0.55
C 6	2	Tuning Gangs. MW LW VHF	0.55
C 7	1	Pack Wire 50 metres assorted colours	0.55
C 8	10	Reed Switches	0.55
C 9	3	Micro Switches	0.55
C10	15	Assorted Pots and Pre-Sets ..	0.55
C11	5	Jack Sockets 3 × 3.5m 2 × Standard Switch Types ..	0.55
C12	40	Paper Condensers preferred types mixed values ..	0.55
C13	20	Electrolytics Trans. types ..	0.55
C14	1	Pack assorted Hardware – Nuts Bolts, Grommets etc.	0.55
C15	4	Mains Switches.	0.55
C16	20	Assorted Tag Strips & Panels	0.55
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PS37	DIN 5 Pin 180°	0.10
PS38	DIN 5 Pin 240°	0.10
PS39	Jack 2.5mm Switched ..	0.09
PS40	Jack 3.5mm Switched ..	0.10
PS41	Jack ¼" Switched	0.17
PS42	Jack Stereo Switched ..	0.26
PS43	Phono Single	0.06
PS44	Phono Double	0.10
PS45	Car Aerial	0.09
PS46	Co-Axial Surface	0.09
PS47	Co-Axial Flush	0.14

INLINE SOCKETS

PS21	DIN 2 Pin (Speaker)	0.13
PS22	DIN 3 Pin	0.17
PS23	DIN 5 Pin 180°	0.17
PS24	DIN 5 Pin 240	0.17
PS25	Jack 2.5mm Plastic ..	0.10
PS26	Jack 3.5mm Plastic ..	0.12
PS27	Jack ¼" Plastic	0.24
PS28	Jack ¼" Screened	0.28
PS29	Jack Stereo Plastic ..	0.22
PS30	Jack Stereo Screened ..	0.32
PS31	Phono Screened	0.14
PS32	Car Aerial	0.15
PS33	Co-Axial	0.17

PLUGS

PS 1	DIN 2 Pin (Speaker)	0.11
PS 2	DIN 3 Pin	0.12
PS 3	DIN 4 Pin	0.15
PS 4	DIN 5 Pin 180	0.14
PS 5	DIN 5 Pin 240	0.15
PS 6	DIN 6 Pin	0.15
PS 7	DIN 7 Pin	0.15
PS 8	Jack 2.5mm Screened ..	0.10
PS 9	Jack 3.5mm Plastic ..	0.09
PS10	Jack 3.5mm Screened ..	0.12
PS11	Jack ¼" Plastic	0.13
PS12	Jack ¼" Screened	0.18
PS13	Jack Stereo Screened ..	0.29
PS14	Phono	0.06
PS15	Car Aerial	0.15
PS16	Co-Axial	0.10

CABLES

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CP 3	Stereo Screened	0.08
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CP 8	Twin oval mains cable ..	0.06
CP 9	Speaker Cable	0.04
CP10	Low Loss Co-Axial	0.10

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Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC1	Single less Switch	0.14
VC2	Single D.P. Switch	0.26
VC3	Tandem Less Switch ..	0.44
VC4	1K Lin Less Switch ..	0.14
VC5	100K Log anti-log	0.11

HORIZONTAL CARBON PRESETS

0.1 watt 0.06
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M.

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8 Books comprising:
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1 Radio Valve Guide PLUS
3 other Constructional books on Receivers, FM Tuners etc.
Also 1 General Constructional book.

Value £3. Our price £2.

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CARTRIDGES

ACOS	GP91 1SC	200mV at 1.2cms/sec	£1.16
	GP93 1	280mV at 1cm/sec ..	£1.65
	GP96 1	100mV at 1cm/sec.	£2.65
TTC	J-2005	Crystal/Hi Output..	95p
	J-20 10C	Crystal/Hi Output Compatible ..	£1.10
	J-200 CS	Stereo/Hi Output ..	£1.60
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The E12 Range of Carbon Film Resistors, ⅓th watt available in PAKS of 50 pieces, assorted into the following groups:

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R2	50 Mixed 1Kohms – 8.2Kohms ..	40p
R3	50 Mixed 10Kohms – 82Kohms ..	40p
R4	50 Mixed 100Kohms – 1Megohm ..	40p

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C60 32p C90 41p C120 52p

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AL10 AL20 AL30 AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

PARAMETER	CONDITIONS	PERFORMANCE
HARMONIC DISTORTION	Po=3 WATTS f=1 KHz	0.25%
LOAD IMPEDANCE	—	8 – 16Ω
INPUT IMPEDANCE	f=1KHz	100 KΩ
FREQUENCY RESPONSE ±3dB	Po=2 WATTS	50 Hz – 25 KHz
SENSITIVITY for RATED O/P	Vs 25V. Rt. 8ΩF 1KHz	75mV. RMS
DIMENSIONS	—	3" x 2½" x 1"

The above table relates to the AL10, AL20 and AL30 modules.
The following table outlines the differences in their working conditions.

PARAMETER	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL=8Ωf=1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL10	3 Watts	£2.19
AL20	5 Watts	£2.59
AL30	10 Watts	£3.01

PRE-AMPLIFIERS

PA 12 (Use with AL10 & AL20)	£4.35
PA100 (Use with AL30 & AL50)	£13.15

POWER SUPPLIES

PS12 (Use with AL10 and AL20)	88p
SPM80 (Use with AL30 and AL50)	£3.25

TRANSFORMERS

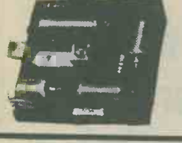
T461 (Use with AL10) p&p 15p	£1.38
T538 (Use with AL20) p&p 15p	£1.93
BMT80 (Use with AL30 & AL50) p&p 25p	£2.15

FRONT PANELS PA12 With knobs £1.00

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL10, AL20 and AL30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84 mm. x 35mm.

Frequency response 20 Hz–50KHz (–3dB)
Bass control ±12dB at 60Hz
Treble control ±14dB at 14 KHz
*Input 1.
Impedance 1 Meg. ohm.
Sensitivity 300 mV
†Input 2.
Impedance 30 K ohms.
Sensitivity 4 mV



EA1000 AUDIO AMP MODULE
Module Tested and Guaranteed.
Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.
SPECIAL OFFER £2

The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Transformer, Power supply and Power Amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interferring with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak. Freq. res. 25Hz–25kHz Harmonic distortion typically 0.25% at 1 watt. Input 1 (er.) 300mV into 1M. Input 2 (Aux.) 4 mV into 30K. Bass control ±12dB at 60 Hz. Treble con. ±14dB at 14 kHz.

£14.45

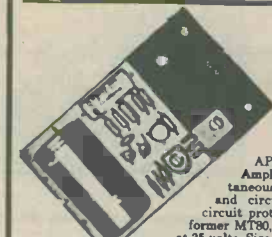
NOW WE GIVE YOU 50w PEAK (25w R.M.S.) *PLUS* THERMAL PROTECTION!

The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95

- Max Heat Sink temp 90°c
- Frequency Response 20Hz to 100KHz
- 0.1% Distortion
- Distortion better than 1% at 1KHz
- Supply voltage 10-35 volts
- Thermal Feedback
- Latest Design Improvements
- Load - 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm x 105mm x 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F., enthusiast.

FULLY BUILT - TESTED and GUARANTEED



STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 62mm x 105mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom Units etc. Handbook available 10p.

PRICE £3.25

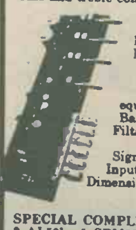
TRANSFORMER BMT80 £2.15 p. & p. 25p.

STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques.

Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz — 20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50KΩ
2. Radio, Tuner	35 mV into 50KΩ
3. Magnetic P.U.	1.5 mV into 50KΩ

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB, from 20Hz to 20KHz.

Base Control	± 15dB @ 20Hz	Treble Control	±15dB @ 20KHz
Filters: Rumble (High Pass)		100Hz	
Scratch (Low Pass)		8KHz	
Signal/Noise Ratio		better than — 65dB	
Input overload	+ 26dB	Supply	+ 35 volts @ 20mA
Dimensions	292mm x 82mm x 35mm		

Price £13.15

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 and 1 PA100 ONLY £25.30 FREE p & p.

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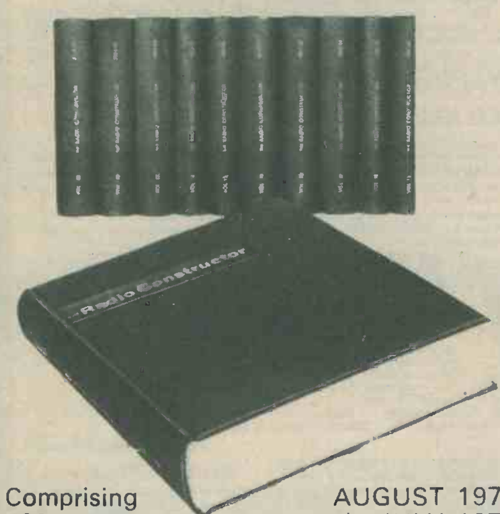
MD 1 Decoder Circuitry for Stereo Reception	..	24p

All post paid, but please enclose S.A.E. with all other requests in the interests of retaining lowest possible prices to actual consumers



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Printed circuit B9A – B7G 3p
Chassis UX7 – UX5 – B9G – B7G .. 3p
Shrouded chassis B7G – B9A 4p
B8A – B9A chassis – B12A tube .. 5p

TAG STRIP

6 way 4p Single 1p

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20p with Needle Lock

TO3 Mica Washer 2p
3″ Standard Tape - Boxed 20p
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GC10/4B Cold Cathode £5.00
Brand New Boxed 6K7G 25p

1¼ glass fuses— 250 m/a or 3 amp (box of 12) 12p
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PVC or metal clip on M.E.S. bulb holder 5p
All metal equipment Phono plug 2p
Bulgin, 5mm Jack plug and switched socket (pair) 30p
12 volt solenoid and plunger 40p
250 RPM 50 c/s locked frequency miniature mains motor .. 50p
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R.S. 12 way standard plug and shell 50p

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	10p
6	2	Slide	15p
4	2	Lever Slide	10p
6	4	Wafer Rotary	20p each
4	3	Wafer Rotary	20p each
3	7	Wafer Rotary	20p each
2	5	Wafer Rotary	20p each
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	20p
1	2	Toggle	10p

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English Numbering Machines LTD.
MODEL 4436-159-989
6–14 volt, 6 digit, illuminated, fully enclosed. £2.50

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⅛–¼–½ watt .. 1p
1 watt 2p
Up to 5 watt wire 10p
10 watt wire wound 12p
15 watt 14p

SKELETON PRESETS

5K or 500K .. 4p
5K wirewound 5p

SAFETY PINS

Standard size, 10 for 4p

WIREWOUND POTS

250, 300 OHM, 1K, 4 watt, 5K, 10K, 11K, 20K, 50K, all at 12p each

Philips transformer, safety fused. In 200-220-240v. Out 240v 60ma + 6.3v 1a approx 2″ x 2¼″ x 2½″ £1.50
5K, 20K, Log Pot 15p
1meg Tandem Pot 25p
2M, 5M, Log Switched pot 25p

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VA1034, VA1040, VA1055, VA1066, VA1077, VA1100 15p
VA1005, VA1026 25p

PARMEKO P480

6000/55, 20 Henry ·12A, potted choke £1

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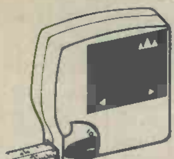

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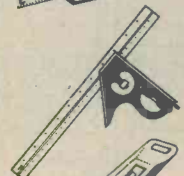

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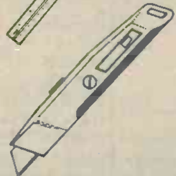

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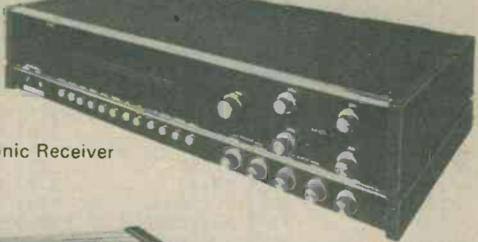

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SEPTEMBER ISSUE WILL BE PUBLISHED ON 1st SEPTEMBER

LAMP

By R. A. Penfold

THE LAMP DIMMER DESCRIBED IN THIS ARTICLE CAN control domestic filament lamps up to 100 watts in power. Few components are required, a factor which makes the design inexpensive and simple to construct. The prototype has been built as a portable unit incorporating a mains socket into which a standard, or table, lamp can be plugged.

The unit can also be employed as a soldering iron temperature controller, but it is not suitable as an electric drill speed controller or for similar applications where a fairly high power rating is required. Neither should it be used with flourescent tubes.

THYRISTOR OPERATION

The power control element in the design is a thyristor. This is a four-layer silicon semiconductor device, and its circuit symbol is shown in Fig. 1(a). Its semiconductor structure is illustrated in Fig. 1(b).

A thyristor is usually considered as basically consisting of two transistors, a p.n.p. type being formed by the upper three layers of the semiconductor material, and an n.p.n. type being formed by the three lower layers. Each of these two transistors will have its base connecting to the collector of the other transistor. This gives us the transistor circuit equivalent shown in Fig. 1(c).

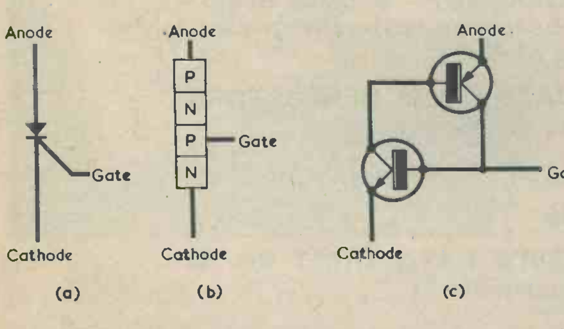


Fig. 1 (a). Circuit symbol for a thyristor
(b). The four-layer structure of a thyristor
(c). A thyristor can be regarded as a p.n.p. and an n.p.n. transistor connected as shown here

In normal operation the cathode of the thyristor is taken to the negative side of a d.c. supply, and the anode is taken, via the load, to the positive side. As the transistors are silicon devices they will have very low leakage currents, and these are the only currents that can flow in the device as neither of the transistors is receiving any appreciable forward base bias. The device is in consequence turned off.

If a current from a voltage source that is positive of the cathode is applied to the base, this will begin to turn on the n.p.n. transistor. As this turns on its collector causes a forward bias current to flow in the base of the p.n.p. transistor. This in turn begins to turn on, and its collector provides an increasing bias current for the base of the n.p.n. transistor. There is therefore a regenerative action between the two transistors and it results in their both very rapidly turning hard on. In this state, the thyristor conducts heavily between its anode and cathode, with very little voltage dropped between these two electrodes.

Only a very brief gate pulse is required to turn the thyristor on. Once it is turned on it will remain in this state even if the gate current is removed, since the internal n.p.n. and p.n.p. transistors continue to bias each other hard on. The only way of turning the thyristor off is to reduce the current flowing between its anode and cathode to virtually zero, whereupon both the internal transistors become non-conductive and, once again, only leakage current flows.

The thyristor operates therefore as an electronic switch, requiring only a brief pulse at its gate to turn it on and the removal of the load current to turn it off again.

THE CIRCUIT

The full circuit diagram of the light dimmer is shown in Fig. 2. Since the thristor can only control direct current and we require it here to control an alternating current, a full-wave bridge rectifier circuit consisting of D1 to D4 is included to ensure that the current in the thyristor flows in one direction only. On a.c. half-cycles where the Live input is positive, current (from positive to negative) passes through D2, through the thyristor and then through D4 to complete the circuit to the output socket. On the alternate half-cycles the current flows through D3, through the thyristor, and then through D1 to the Live input point.

DIMMER

This continuously variable dimmer is suitable for domestic mains lamps having powers up to 100 watts and it is housed in a standard electrical fitting box

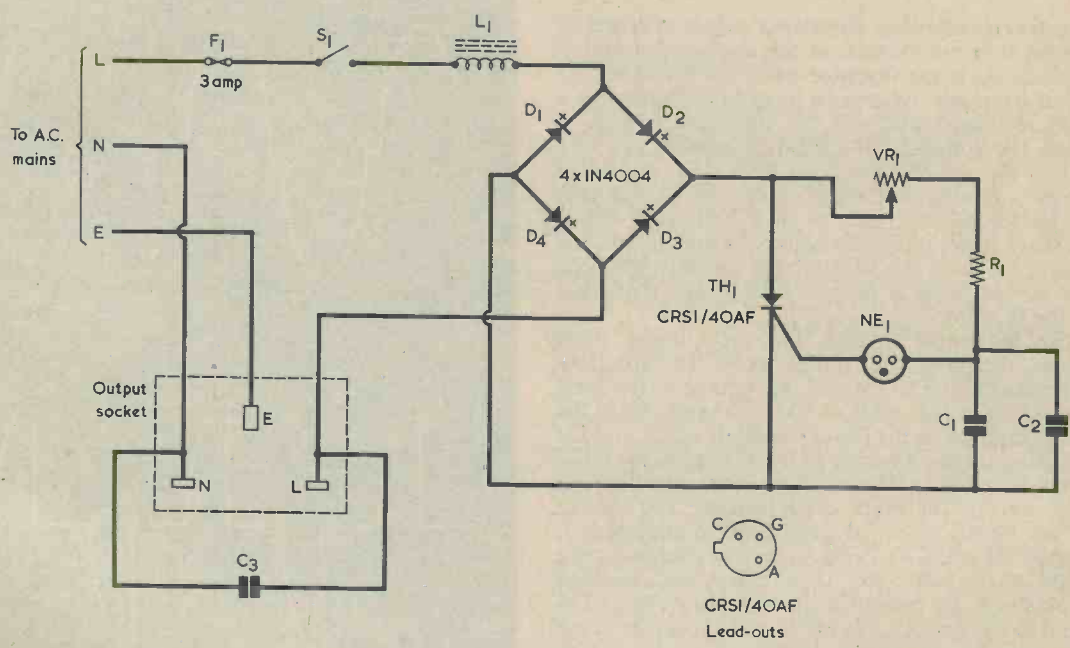


Fig. 2. The circuit of the lamp dimmer unit

Resistors
- R1 — 22kΩ ½ watt 10%
- VR1 — 500kΩ potentiometer, linear

Capacitors
- C1 — 0.15μF plastic foil
- C2 — See text
- C3 — 0.002 or 0.0022μF, 250V A.C. Wkg.

Inductor
- L1 — Home-wound with 24 s.w.g. enamelled copper wire on 2 in. by ¼ in. ferrite rod

Semiconductors
- TH1 — CRS1/40AF
- D1–D4 — IN4004

Neon
- NE1 — Small wire-ended neon bulb (see text)

Switch
- S1 — s.p.s.t., push-on push-off

Fuse
- F1 — 3 amp fuse (fitted in input plug)

Miscellaneous
- Mains plug, mains socket and parts for case (see text)
- 3-core flexible mains load
- Heat sink (for TH1)
- Plastic control knob
- Printed circuit board

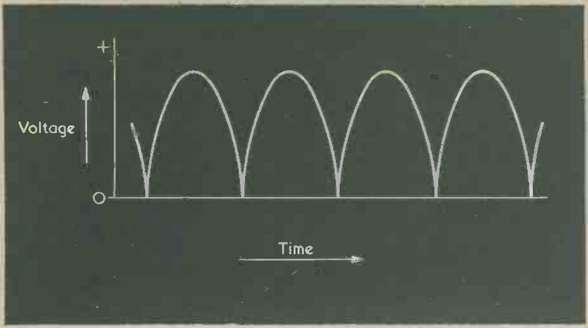


Fig. 3. If the thyristor did not become conductive, the voltage at its anode could consist of rectified half-cycles, as here

When VR1 is set to insert maximum resistance into circuit the time constant is increased still further, and a relatively long time elapses after the start of each half-cycle before the voltage across C1 and C2 reaches a sufficiently high level to trigger the circuit. Triggering, in fact, only occurs just before the end of each half-cycle, giving the output waveform shown in Fig. 4(c). This provides very little power for the output load, and represents the minimum available power output.

Thus, it is possible, by a switching action, for the unit to provide a continuously variable control of the output power. Since the thyristor is either turned fully on or fully off for the major part of the time it dissipates very little power and there is in consequence very little heat generated. The thyristor is, in practice, fitted with a small TO5 heat sink.

The power available at the output socket is varied by having the thyristor turned on for a controlled part of each half-cycle. If the thyristor were not turned on, the voltage at its anode, relative to its cathode, would be a series of rectified half-cycles, as illustrated in Fig. 3. However, the voltage at the anode is passed, via VR1 and R1 to C1, C2 and the neon bulb NE1, and these components ensure that the thyristor is, in practice, turned on for at least part of each half-cycle. When VR1 is set to insert minimum resistance into circuit, the capacitors C1 and C2 charge very quickly and the voltage across these is only a little lower than that across the thyristor.

At the beginning of each half-cycle under these conditions, therefore, the voltage across the capacitors will very quickly rise to the striking voltage of the neon bulb, which is of the order of 70 to 80 volts. Since the neon bulb couples to the lower terminals of C1 and C2 via the gate-cathode junction of the thyristor, the pulse of current in the neon will also flow in the gate-cathode junction, causing the thyristor to turn on. The voltage across the thyristor will at once drop to almost zero, whereupon C1 and C2 receive no further charge for the remainder of the half-cycle. At the end of each rectified half-cycle the anode current in the thyristor is reduced to zero, and so the device turns off ready to function in the same manner during the next half-cycle.

Even when VR1 is set for maximum power, where it inserts minimum resistance into circuit, there is still, of course, some loss of power. This is because the thyristor is not triggered on at the very beginning of each half-cycle. However, as can be seen from the waveform of Fig. 4(a), which shows the voltage appearing across the lamp load under these conditions, the power lost is negligible. There is also a very small loss of power in the rectifier diodes and the thyristor, and this again is negligibly low.

If we now consider the circuit with VR1 slider set about mid-way along its track, we will find that the voltage across C1 and C2 takes longer, after the start of each half-cycle, to reach the level at which the neon strikes and the thyristor is triggered on. This is due to the increased time constant of the circuit. In consequence, the thyristor does not turn on until the mains voltage is at about its peak level, whereupon the waveform shown in Fig. 4(b) is produced, indicating that current flows in the lamp load over the latter half of each half-cycle. Thus, only half power is developed across the load.

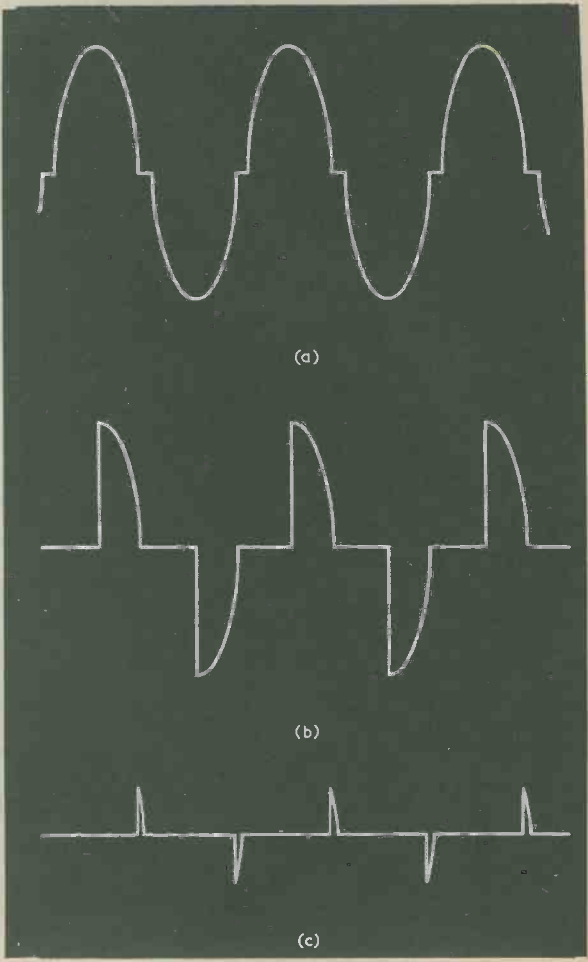
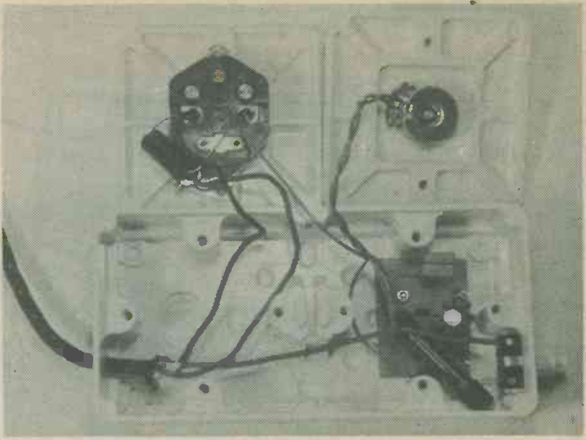


Fig. 4 (a). Voltage waveform across the lamp load when the dimmer unit is set to give maximum power output
(b). The waveform given at half output power
(c). The waveform for minimum output power



A view looking directly down at the inside of the unit

Due to the rapid speed at which the thyristor turns on the output waveform is rich in harmonics and can cause interference with a.m. radio receivers. L1 and C3 are suppression components which remove the harmonics at radio frequencies. S1 is the on-off switch. When the unit is assembled, there is little space for this switch, and it has to be a small type. The author used a push-on push-off mains switch obtained from the local Woolworth's store.

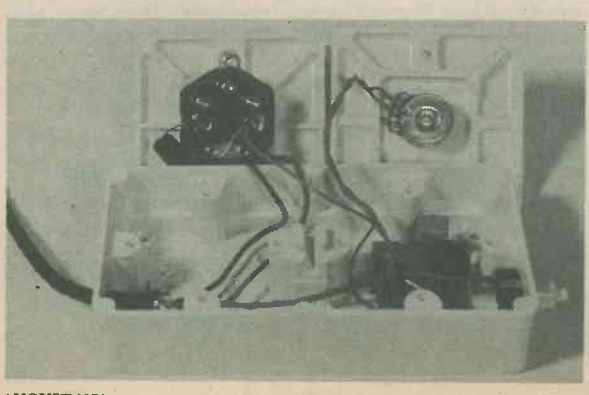
The neon bulb is a small wire-ended type. The bulb retailed by Home Radio under Cat. No. PL32A is suitable. Capacitor C3 must be rated at 250 volts a.c., and a 0.0022μF capacitor with this rating is listed bv Home Radio under Cat. No. 2EL01. Capacitors C1 and C2 should have a d.c. working voltage of at least 100 volts, and the value of C2 is found experimentally, after the unit has been completed, in a manner which is described later. The potentiometer, VR1, is a standard component with a carbon track. It should have a plastic and not a metal spindle. Choke L1 is home-wound on a 2 in. length of $\frac{1}{4}$ in. diameter ferrite rod. This can be taken from a longer length of $\frac{1}{4}$ in. rod by carefully filing a groove in the rod at the point where the break is required and then tapping the rod with a small hammer. Ferrite rods with a diameter of $\frac{1}{4}$ in. and a length of $3\frac{1}{2}$ in. are available from Henry's Radio Ltd. The thyristor specified is rated at 400 p.i.v. and 1 amp, and is encapsulated in a TO5 can.

CONSTRUCTION

The prototype dimmer is housed in an MK Electric Limited double-size plastic wall-mounting switch or socket block. This has a mains socket on the left hand side and a plastic blanking panel on the right hand side. These parts can all be obtained from local electrical shops, and are supplied complete with the necessary mounting screws. The particular parts required can be readily identified from the accompanying photographs.

A $\frac{3}{8}$ in. hole is drilled in the centre of the blanking plate and VR1 is mounted on this. It should be fitted with a plastic knob. A hole is drilled in the left hand side of the box and a three-core flexible mains input lead passes through this, being suitably anchored by a cable clamp on the inside. The other end of the mains input cable, which can be of any convenient length, is terminated in a 3-way mains plug fitted with a 3 amp fuse. Switch S1 is mounted on the right hand side of the case, exactly opposite the mains input cable entrance.

Most of the components are wired up on a small printed circuit board measuring 2 by $1\frac{1}{2}$ in. Details of this are given in Figs. 5(a) and (b). To enable the copper pattern to be easily traced, this is reproduced actual size in Fig. 5(b). The two mounting holes are drilled 6BA clear. After all wiring has been completed and the required value for C2 has been found, the board is mounted on the bottom of the case underneath VR1 by



Another view of the internal construction of the dimmer

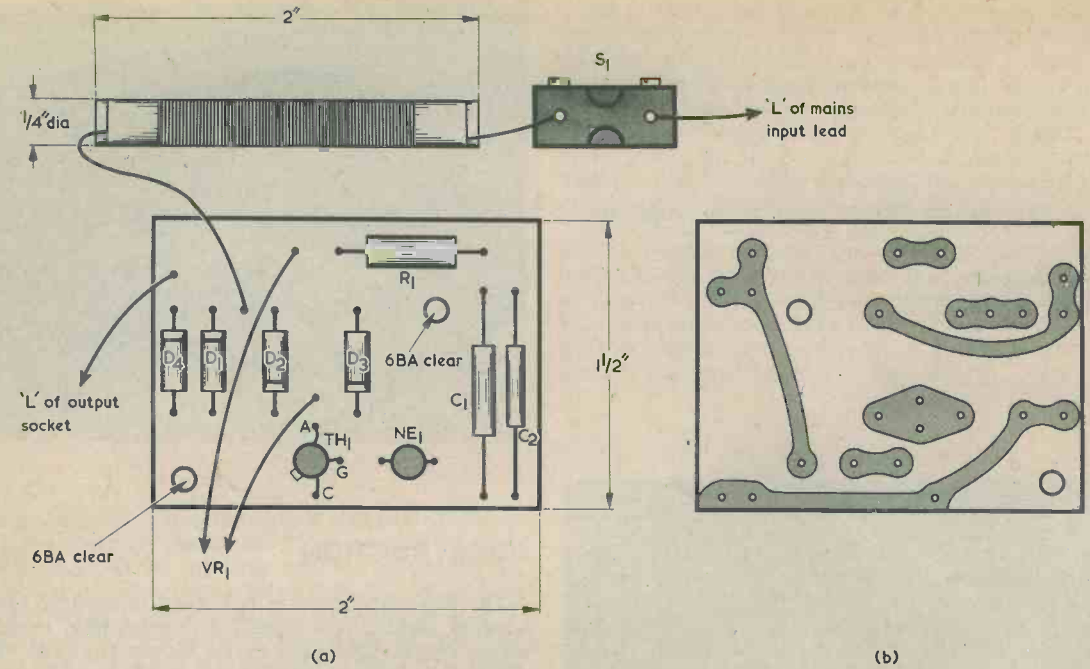


Fig. 5 (a). Wiring on the component side of the printed board. The two 6BA clear holes are for mounting purposes
(b). The copper side of the board. This is reproduced full size and the diagram may be traced

means of two ½ in. countersunk 6BA bolts and nuts. VR1 is wired so that the resistance it inserts into circuit decreases as its knob is turned clockwise.

As already stated, choke L1 is home-wound. It consists of approximately 60 turns of 24 s.w.g. enamelled copper wire close-wound on the 2 in. by ¼ in. diameter ferrite rod mentioned earlier. The exact number of turns is not critical, but they should not be significantly less than 60. The ends of the winding are secured to the rod with insulating tape. Although 24 s.w.g. is a rather thin wire for the current it is called upon to carry, it copes with it quite adequately. The author has not been able to detect any noticeable heat generated in the choke even when the unit has been run at maximum output power.

Most of the wiring is illustrated in Fig. 5(a). C3 is not shown, and this is mounted on the output socket between the Live and Neutral terminals. The only other connections are to the Neutral and Earth terminals of the output socket. These connect to the wires from the Neutral and Earth terminals, respectively, of the input plug at the other end of the 3-core mains lead. Care must be taken to see that all mains wiring is correctly and reliably carried out.

SETTING UP

When initially testing the unit, no capacitor should be connected in the C2 position. Firstly, it should be ensured that the wiring to VR2 is correct and that rotating its spindle in a clockwise direction gives an increase in lamp brightness.

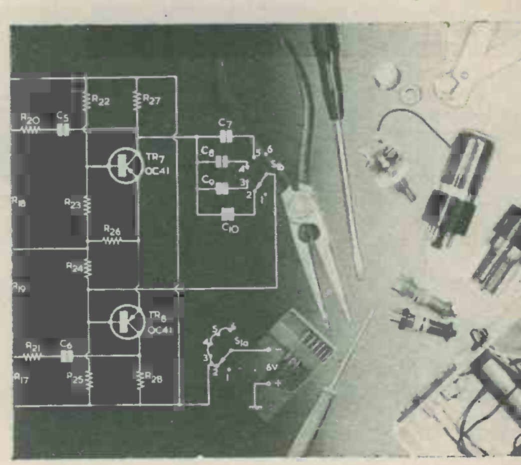
If, with VR1 set fully anticlockwise the lamp connected to the output is still fairly bright, connecting a capacitor in the C2 position with a value between about 0.005μF and 0.022μF should enable a dimmer minimum setting to be obtained. The best value is found by trial and error. *The unit input plug must be removed from its mains socket whilst adding or removing different capacitors in the C2 position or whilst carrying out any other work on the internal wiring of the unit.* Otherwise, there is a risk of dangerous shock from the mains.

The reason why a precise value for C2 cannot be specified is that different thyristors require varying values of gate current to be turned on. There may also be a small variance in striking voltage between different neon bulbs.

Sometimes, it is found that a neon bulb does not ionise and strike reliably if it is in complete darkness. There was no evidence in the present unit of erratic operation when the socket and blanking plates were screwed down to the box on which they are fitted.

If the unit is used very close to an a.m. radio receiver it may be found that radiation from L1 causes a certain amount of interference. This can be virtually eliminated by orienting the dimmer unit relative to the radio so as to obtain the minimum amount of interference. Alternatively the unit could be built in a metal case, which would screen L1. If such a case is used it must be reliably connected to the mains earth. ■

TRANSISTOR GAIN METER



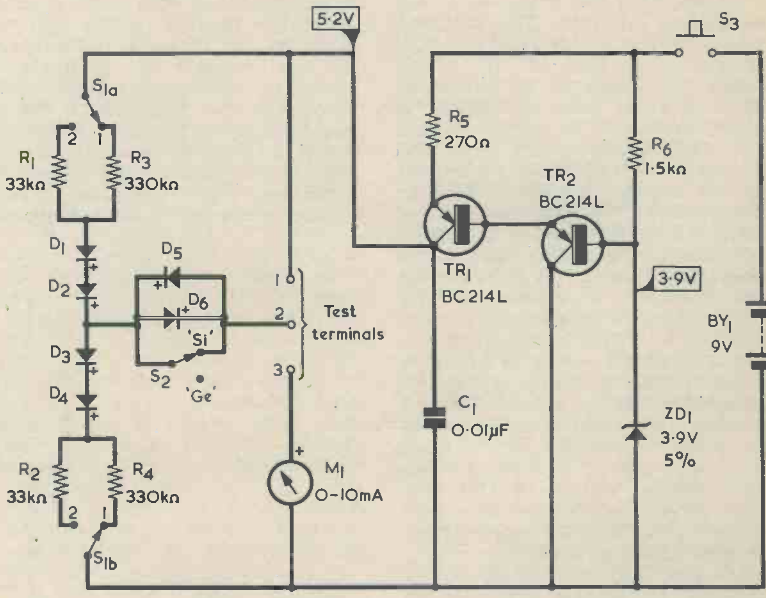
By G. A. French

TEST INSTRUMENTS INTENDED TO measure the current gain of transistors have been described in the home-constructor press from time to time. In some instances the instruments have been quite complex in design, whereas in others the main design aim has been simplicity and low cost.

The gain meter to be described in this article falls into the second category and it also has two unusual features. Firstly, the gain of the transistor being checked is indicated directly on the scale of a moving-coil meter and, secondly, no switching is required to change circuit popularities for p.n.p. and n.p.n. transistors. The accuracy of the readings obtained is sufficiently high for most general work with transistors, and the instrument is capable of selecting matched pairs of transistors to a close tolerance. Current gain measurements are taken at collector currents between 1 and 10mA according to the gain of the particular transistor being checked.

THE CIRCUIT

The circuit diagram of the instrument is shown in Fig. 1. At the right of the diagram TR1 and TR2 appear in a stabilizing and current limiting supply circuit, and this has primarily to be discussed. The circuit is based on a design described in 'Suggested Circuit' No. 283, which was published in the June issue of this journal. A full description of circuit operation appeared in the earlier article, and so only a brief account will be given here.



BC214L Lead-outs

S1 positions: 1 - 0 to 1,000; 2 - 0 to 100

D1-D6	1N4002	
R1-R5	1/4 watt 5%	
R6	1/4 watt 10%	

Test terminals	N.P.N.	P.N.P.
1	C	E
2	B	B
3	E	C

Fig. 1. The complete circuit of the transistor gain meter. This caters for both p.n.p. and n.p.n. transistors without a polarity reversing switch

When the 9 volt supply from the battery is applied by closing push-button S3, a stabilized voltage of 3.9 volts appears across zener diode ZD1. If no current is drawn from the collector of TR1, its base-emitter junction functions as a simple diode, and conventional current (from positive to negative) flows from the 9 volt positive supply rail via R5, the base-emitter junction of TR1 and then via TR2 to the negative supply rail. TR2 functions here as an emitter follower, with its base coupling to the stabilized voltage on the upper terminal of the zener diode, and its emitter coupling to the base of TR2. Both transistors are silicon types, and the voltage drops in their base-emitter junctions cause the emitter of TR1 to be about 5.3 volts positive of the negative supply rail. If a new 9 volt battery is employed, its terminal voltage on a light load, will be of the order of 9.4 volts, whereupon a voltage of 9.4 minus 5.3 volts, or 4.1 volts, appears across R5. This corresponds to a current flow in R5 of 15mA. When the battery voltage drops after use to 8 volts, the voltage across R5 then becomes 8 minus 5.3, or 2.7 volts, whereupon the current in R5 is 10mA.

The voltage at the collector of TR1 is 5.2 volts positive of the negative supply rail. If a small current is drawn from this collector, it still remains at 5.2 volts. The unaltered voltage is due to the relatively high current in the base of TR1, which causes this transistor to be turned hard on. TR1 collector current is drawn by way of its emitter through R5, and since the voltage across this resistor remains unaltered, the current flowing through it is shared between the collector of TR1 and the emitter of TR2. When TR1 collector current is very close to the limiting value (15mA with a new 9 volt battery) the current available from TR1 base for TR2 emitter becomes insufficient to maintain TR1 in the fully conductive state, and the collector voltage of TR1 goes negative. The overall effect is that TR1 collector is held at around 5.2 volts positive of the negative supply rail for all collector currents up to those which are close to the limiting value. The collector voltage of TR1 then falls rapidly, becoming zero with respect to the negative supply rail at the limiting current itself.

To sum up, the voltage at the collector of TR1 is approximately 5.2 volts positive of the lower supply rail for load currents up to a limiting value, with a new 9 volt battery, of 15mA, and up to a limiting value of 10mA with a battery whose voltage has dropped to 8 volts. Intermediate battery voltages give intermediate values of limiting current. It is impossible to draw a current from TR1 collector which is in excess of the limiting value.

We may now turn our attention to the remainder of the circuit, and we can at once see the necessity for having a current limiting power supply. The transistor whose gain is to be measured is connected to the three test terminals, of which Terminal 1 couples to the 5.2 volt stabilized rail whilst Terminal 3 couples to the negative supply rail via a 0-10mA meter. With normal usage of the instrument it would be quite possible for Terminals 1 and 3 to be short-circuited together, whereupon the current limiting supply circuit ensures that, under worst conditions, the current flowing in the meter cannot exceed 15mA. The current flowing in the transistor being tested is also limited to the same value.

P.N.P. AND N.P.N. TRANSISTORS

As is indicated in Fig. 1, p.n.p. transistors are connected to the test terminals in a different manner than are n.p.n. transistors. The two different methods of connection enable the usual polarity reversing switch to be dispensed with.

A p.n.p. transistor is connected with its emitter to Terminal 1, its base to Terminal 2 and its collector to Terminal 3. If it is a silicon transistor switch S2 is set to 'Si', whereupon the circuit around the test transistor is as shown in Fig. 2. The range switch, S1(a), (b), is initially at position 1, whereupon a bias feed circuit is set up from the negative supply rail via S1(b), R4, D4, D3 and S2 to the base of the test transistor. All the diodes in the circuit are silicon types, and at the low currents involved here it can be assumed that the forward voltage drop across a silicon diode and across the base-emitter junction of a silicon transistor is 0.6 volt. The forward voltage drops across the base-emitter junction of the test [illegible] nd across D3 and D4 add u[illegible] re to 1.8 volts, leaving 5.2 minus 1.8, or 3.4 volts, to be dropped across R4. When S1(a) (b) is in position 1, full-scale deflection in the meter indicates an h_{FE} in the test transistor of 1,000. Since meter f.s.d. corresponds to a collector current of 10mA, the base current to the test transistor then needs to be 0.01mA. R4, across which there is a voltage drop of 3.4 volts, will pass such a current if it has a value of 340kΩ. In practice, the nearest preferred value of 330kΩ proves to be satisfactory.

Setting S1(a) (b) to position 2 selects the '0-100' range, with the result that base current to the test transistor needs to be 10 times greater, at 0.1mA, than is given on the '0-1,000' range. This current flows through R2, whose value is one-tenth that of R4.

Under the conditions illustrated in Fig. 2, no current can flow in the upper bias resistors R1 or R3. The base of the test transistor is held at 0.6 volt negative of the 5.2 volt rail, whereupon diodes D1 and D2 cannot pass forward current. If the test transistor is a germanium type, switch S2 is set to 'Ge', thereby inserting D5 in series with the transistor base. The forward voltage drop across the base-emitter junction of a germanium transistor is much lower than that across the base-emitter junction of a silicon transistor and is, typically 0.15 volt. Inserting D5 in series with D3 and D4 ensures that the total voltage drop across the diodes and the base-emitter junction of the transistor is just a little higher than the 1.8 volt figure given with a silicon test transistor; whereupon the base bias current is still approximately 0.01mA with S1(a) (b) in position

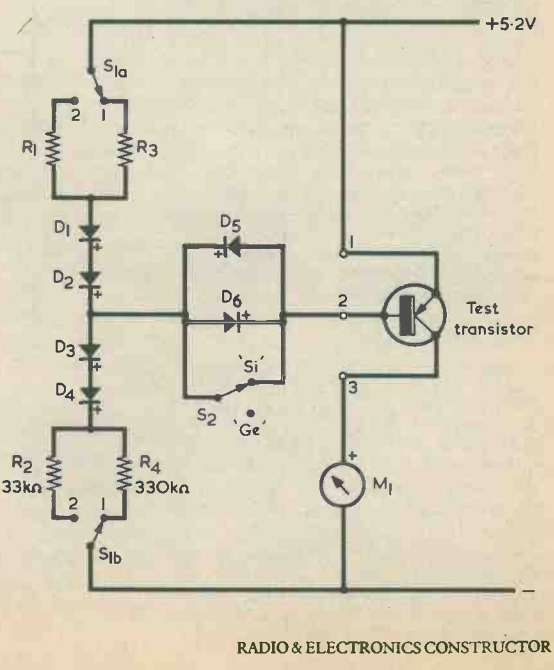


Fig. 2. Circuit conditions when a p.n.p. transistor is checked

1 and 0.1mA with S1(a) (b) in position 2. The voltage at the junction of D2 and D3 still ensures that D1 and D2 cannot pass forward current.

The hFE gain figure for the test transistor may be read directly from the scale of meter M1, multiplying by the requisite factor according to the setting of S1(a) (b). Should the meter indicate 6mA with S1(a) (b) in position 1, then the hFE of the transistor under the circuit conditions given by the instrument is 600. Again, should the meter read, say, 4.5mA with S1(a) (b) in position 2, then the hFE of the transistor is 45. Test readings are taken by pressing S3 after S1(a) (b) has been set to position 1. If the hFE is less than 100 (indicated by a reading of less than 1mA in the meter), S3 is released, S1(a) (b) is set to position 2, and S3 is then pressed again.

An n.p.n. test transistor is connected with its collector to Terminal 1, its base to Terminal 2 and its emitter to Terminal 3, as shown in Fig. 3. If it is a silicon transistor, S2 is again set to 'Si'. This time a base bias supply is taken from the 5.2 volt positive rail via R3 or R1, D1 and D2, and this again takes into account the forward voltage drop across the base-emitter junction of the test transistor and across two silicon diodes. The latter are now D1 and D2. In consequence, R1 and R3 have the same values respectively as have R2 and R4. The voltage drop across meter M1 has also to be considered, but this can be expected to be negligibly low. The meter employed by the author had an internal resistance of 6Ω, which means that, at f.s.d., the voltage dropped across it is only 0.06 volt. Most other standard moving-coil 0-10mA meters have similarly low internal resistances.

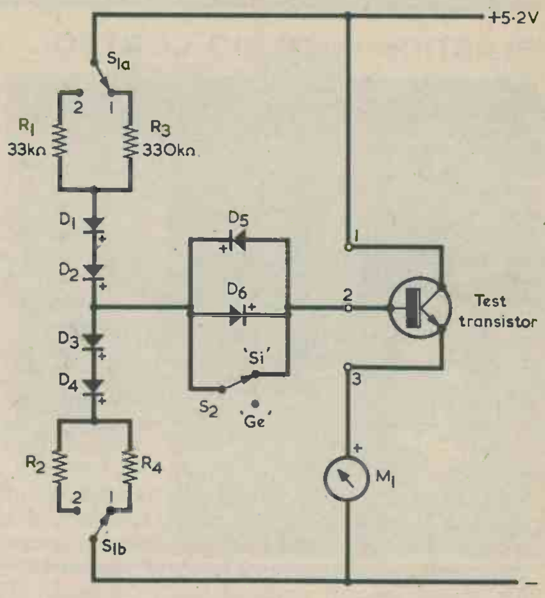


Fig. 3. An n.p.n. transistor is connected in the manner shown here

If the test transistor is a germanium device, S2 is set to 'Ge', thereby bringing D6 into circuit to provide the requisite extra forward voltage drop. No current flows in R2 or R4 because the voltage at the junction of D2 and D3 is sufficiently low to prevent D3 and D4 passing forward current.

When an n.p.n. transistor is checked it functions as an emitter follower, and the current flowing in meter M1 is equal to the base current multiplied by hFE + 1. The slight inaccuracy introduced by the '+ 1' term is not of importance in a simple instrument of the present type.

COMPONENTS

The components are all readily available types. There are rather a large number of silicon diodes, and the author employed rectifiers type 1N4002 for these. However, the current flowing in the diodes is low and any other silicon diodes, rectifier or signal, could be employed in the D1 to D6 positions. The use of the four diodes D1 to D4 has the advantage of removing the necessity for a polarity reversing switch. The zener diode, ZD1, may have a dissipation rating between 200 and 400mW. S1(a) (b) is a d.p.d.t. toggle switch, and S3 is a push-button which closes when pressed.

Capacitor C1 is included to reduce the possibility of r.f. instability. When p.n.p. transistors are being checked, there is a long amplifier chain given by TR2, TR1 and the test transistor, and r.f. instability can occur if C1 is not included in the circuit. R.F. instability is indicated if the meter reading changes when one of the test terminals is touched with a finger. There was no evidence of instability with the prototype circuit despite the fact that no attempt was made to keep wiring particularly short. Meter readings will very probably change, incidentally, if *two* of the test terminals are bridged by a finger or fingers. This effect is merely due to the added resistance between the two terminals being touched and should not be confused with r.f. instability.

As has already been mentioned, test readings are taken with S1(a) (b) initially set to position 1. Most modern transistors have current gains in excess of 100 whereupon starting a measurement with S1(a) (b) in position 2 will nearly always cause the meter to pass the power supply limiting current. Whilst, at worst, this cannot exceed some 15mA, there is no point in needlessly subjecting the meter to currents in excess of the full-scale deflection value. With normal use occasional excursions of the meter beyond f.s.d. are, nevertheless, bound to occur from time to time. If desired, an electrolytic capacitor can be connected across the meter to damp its movement so that, in the event of its passing the limiting current, its needle is stopped less abruptly by the end-stop. The value of the capacitor will depend upon the meter used and may be found by experiment. The author did not use such a capacitor in the prototype circuit as this incorporated a normal robust meter movement. When it is found that the limiting current is less than 10mA, this is an indication that the battery voltage has fallen below 8 volts and that a replacement is needed. The current drawn from a 9 volt battery is approximately 17mA when S3 is pressed.

It will probably be found that there is not an exact correlation between the readings given on the '0-1,000' and '0-100' ranges with test transistors having hFE values close to 100. This is mainly due to slightly different transistor characteristics at the different base bias currents. As a final point, the readings given by small germanium transistors will probably increase by a small amount from their initial values if S3 is pressed for an extended period. This is particularly liable to happen if the transistors produce meter deflections of 5mA or more. The effect is due to warm-up in the transistor and can be ignored if the meter reading remains steady at the slightly increased value.

■

PLASTICS IN RADIO CONTROL

Cases fabricated from 'Bondene' PVC-clad aluminium supplied by BIP Sheet and Film Division (Turner & Newall Limited), Manningtree, Essex, protect and enhance the appearance of a range of transmitters made for model aircraft enthusiasts by Skyleader Radio Control Limited of Croydon, Surrey.

Originally anodised aluminium cases were used but since this material was easily scratched during assembly of the transmitters, and was also liable to become scuffed and dirty in service, the firm changed to type E180 'Bondene' sheet, gold in colour.

As a result damage to cases during assembly has been virtually eliminated and they now have greatly improved wear-resistance. Furthermore they are less cold to the touch than bare aluminium, and dirty marks are easily wiped off the PVC surface.

There are three transmitters in the Skyleader series – the SLX, Clubman and Clubmate. Frequencies can be adjusted by fitting various plug-in crystals. The SLX and Clubman also have a pupil training facility, which prevents 'learner' modellers crashing their aircraft whilst acquiring the art of radio control. The two transmitters are coupled by a special lead, enabling an experienced flyer to take control if his pupil sets the model on a course to disaster.

Switches and other fittings on the fascias are in black nylon and plated ABS.

VAT REDUCTION

As copy for magazines is set well in advance of publication, changes in prices due to budget action cannot be immediately reflected.

Therefore, where appropriate, either an enquiry should be made, or the amount due calculated on the following formula.

Where price is inclusive of VAT – divide the total by 11 and deduct one-fifth of the resulting figure. When VAT is charged separately, the rate is 8%.

Short Wave Regenerative Receiver

In this article, which appeared in our May 1974 issue, the position of the valveholder for coil L1 is such that the coil fouls VC4. The L1 valveholder holes should be omitted when making the chassis and front panel. after which a suitable position for the valveholder is found with the front panel temporarily assembled to the chassis and VC4 mounted. The valveholder will be to the right and rear of the position indicated in Fig. 2 of the article.

SKIL JIG SAW WITH ADJUSTABLE SPEED

Since SKIL of 1B Thames Avenue, Windsor, Berkshire, introduced their electronic speed control of diy-drills several years ago, this feature has proven of great value in practice. In the meantime various industrial drills and drivers have been equipped with the Variable Trigger Speed system.

After quite some research and tests, SKIL now launch the 'VTS jig saw', which offers more application possibilities than conventional 1- or 2-speed saws. As a matter of fact, the speed can be adapted to any material: synthetics, such as plexiglass, plastic, fibreglass; ferrous and non-ferrous metals; all sorts of lumber; composition materials; in short practically all modern building materials. It's just a matter of selecting the right saw blade and the appropriate speed. The cutting speed is simply controlled by adjusting the finger pressure on the trigger. More pressure . . . faster, less pressure . . . slower. And every speed between zero and maximum can be locked with the adjusting screw.

Other technical data: saw foot adjustable for bevel cuts, for splinter-free cuts and for intricate precision jobs; input 300 Watts; depth capacity in wood up to 45 mm, in aluminium up to 6 mm, in ferrous metals up to 3 mm.

SKIL 497H

. . . COMMENT

TREASURE HUNTING TODAY

Treasure hunting, either the hard way or with modern equipment, has become one of Britain's fastest growing hobbies. Already an estimated 80,000 people are looking where the eye cannot see.

Using a metal detector combines electronic expertise with the desire to look into the past.

Britain may not be everybody's idea of a treasure island, but with electronic metal detectors, a remarkable number of good finds have been unearthed, including at least three major hoards. One at Reigate, was most spectacular and consisted of nearly one thousand gold and silver 15th century coins, tentatively valued at £250,000.

The C-Scope Metal Detector Company Ltd., 82 Castle Street, Canterbury, Kent, one of the most successful manufacturers of treasure hunting metal detection machines in Britain, have been concerned with their design development and unique advanced construction over the last few years.

At the lower end of the C-Scope price range are the two induction Balance machines, the 100 and the 300. Priced at £47.74 and £62.26 respectively, they both combine regular C-Scope features of fine weight distribution, lightweight rugged construction, the ability to be used in water to a depth of two feet, and are equipped with headphones.

'PANEL SIGNS' AND PRINTED CIRCUITS

We are indebted to T. E. Millsom for pointing out to us that the adhesive on our current Strip-Fix Plastic 'Panel Signs' is such as to make them suitable as a masking material in the production of printed circuit boards. The required shapes for the copper pattern are cut out from a 'Panel Sign' sheet and are then pressed on to the copper side of the laminate. The etchant fluid then removes the copper which is not protected by the 'Panel Sign' material.

We are pleased to pass on Mr. Millsom's idea to readers, but we have to stress that we cannot guarantee success with 'Panel Sign' material for all printed circuit etching applications. This is due to the fact that the material is being employed for a purpose other than that for which it was designed and because we have no control over the etching process. Nevertheless, experimentally minded readers may care to try for themselves the effect of using scrap from 'Panel Signs' in the production of small printed boards.

HELPING HANDS

After twelve years of outstanding service to the Radio Amateur Invalid and Bedfast Club, Frances and Joe Woolley have retired from their respective positions as Honorary Secretary and Honorary Treasurer respectively. Mrs. Woolley is also giving up the editorship of *Radial*, the news letter of the Club, although she will continue to handle the supply of QSL cards for members. Evelyn and Sid Boakes have taken over the responsibilities of Honorary Secretary and Treasurer.

Many of our readers will be aware of the voluntary work of the R.A.I.B.C., which assists radio amateurs and SWL's who are physically handicapped to follow their hobby.

The new HQ address is RAIBC, Bristol Road, Cambridge, Glos. GL2 7BQ.

Torbay Amateur Radio Society are holding a Radio Mobile Rally on Sunday, 11th August, at the All Whites Rugby Football Ground, Newton Abbot.

Part of the proceeds will be towards an extension to the Douglas House Cheshire Home at Brixham. The extension has became necessary because the room designated for the radio station only, installed by the Society, has now to be largely used for the storing of therapeutic equipment.

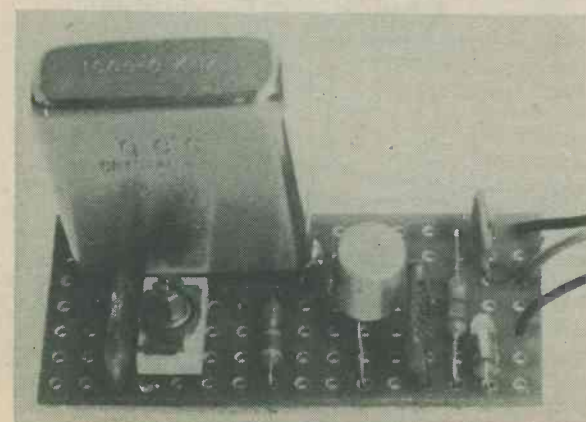
"The TV Repair Man can't come but suggests you call the R.S.P.C.A.!"

1 MHz CRYSTAL MARKER

A neat little unit which provides calibration markers from 1MHz to higher than 30MHz.

★ ★ ★

By
F. G. Rayer, Assoc. I.E.R.E., G30GR



The crystal marker components make up a tidy assembly on the board

IF YOU HAVE NOT YET USED THE VEROBOARD PANEL GIVEN away with the October 1973 issue of *Radio and Electronics Constructor*, it can be employed for the construction of this crystal marker. Alternatively, of course, a panel of the required size can be cut out from a larger piece of 0.15 in. Veroboard. The panel has 7 by 16 holes, with the strips running in the longer dimension.

CRYSTAL MARKER

A crystal marker is a device which provides extremely accurate frequency calibration points for a receiver or other equipment. The marker described here has a 1MHz crystal, and will provide calibration points from 1MHz to above 30MHz. The 1MHz point is the fundamental frequency of the crystal itself. The calibration points which are obtained at higher frequencies are harmonics, or multiples, of this. They thus arise at 2MHz, 3MHz, 4MHz, and so on, right up to 30MHz and beyond. The way in which these points can be used to calibrate a receiver or other equipment is explained later.

COMPONENTS

Resistors
(All ¼ watt 10%)

R1	470kΩ
R2	2.7kΩ

Capacitors

C1	150pF silvered mica or polystyrene
C2	47pF silvered mica or polystyrene
C3	470pF silvered mica or polystyrene
C4	33pF silvered mica or polystyrene
C5	0.047 or 0.05μF disc ceramic
TC1	30pF mica trimmer

Transistor

TR1	OC170

Crystal

X1	1MHz crystal, HC6/U (see text)

Miscellaneous

Veroboard, 0.15 in. matrix, 7 strips x 16 holes
9 volt battery
Flexible wire
Battery clips
Crystal holder.

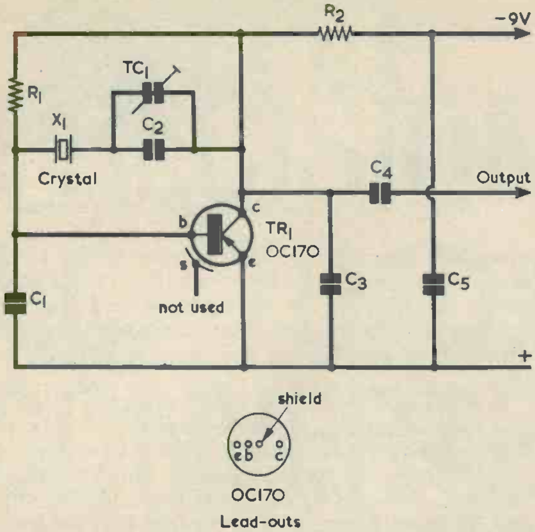


Fig. 1. The circuit of the 1MHz crystal marker

The circuit of the unit to be described is shown here and it will be seen that it employs a single transistor type OC170. The capacitor values, and particularly those for C1 and C3, are chosen to suit the crystal frequency and would have in some cases to be modified if a different frequency were used.

Trimmer TC1, in parallel with C2, allows some adjustment of the series capacitance for critical setting of the crystal frequency. This can be carried out with the aid of one of the standard frequency transmissions, such as that available on 5MHz. If this adjustment is made, an accuracy of a few Hertz, or cycles per second, is easily obtained. On the other hand, if an accuracy of the order of 0.01% is sufficient TC1 and C2 may be omitted, a single 68pF capacitor being substituted in their place.

Output is taken from the capacitor C4, and is at a high enough level for any receiver of ordinary sensitivity. In fact, with a receiver of good sensitivity, a reading of over S9 may be anticipated at 30MHz.

The current required is about 3mA at 9 volts. This may be taken from a separate battery, or from the existing supply if the unit is to be installed permanently in a receiver and the latter has a suitable supply voltage available.

The components are quite standard types. The crystal is in an HC6/U encapsulation and may be obtained direct from its manufacturer, The Quartz Crystal Co. Ltd., Wellington Crescent, New Malden, Surrey. The crystal holder may be any type intended to take an HC6/U crystal, such as that available from Henry's Radio. The trimmer TC1 is a small 30pF component. The trimmer employed by the author is made by Cyldon (Home Radio Cat. No. VC29D) and fits comfortably into the Veroboard layout. However, any other small mica trimmer of the same value and having tags which can be fitted to Veroboard holes spaced by 0.45 in. would be equally suitable.

VEROBOARD ASSEMBLY

Both sides of the board are shown in Fig. 2. Some crystal holders can be mounted on top of the board, with sockets projecting through holes drilled in the board. The holder employed by the author required a rectangular aperture measuring 9 by 20 mm. This was cut out by drilling sufficient holes to allow a file to be inserted and then carefully filing out to the required size. The board should be supported to ensure that it does not crack whilst being filed. Care should also be taken to ensure that the filing does not turn up fragments of copper so that a short-circuit could arise between adjacent copper strips.

The centre strip is cut at hole 6D, using either a twist drill or the special Vero spot face cutter. Components are then inserted and soldered into circuit in the following manner,

1. Fit R1 between holes 8A and 8D.
2. Fit R2 between holes 14A and 14G.
3. Fit C1 between holes 10D and 10E. This capacitor is fitted vertically if a polystyrene component is used.
4. Fit C2 between holes 3A and 3D.
5. Fit C3 between holes 13A and 13E.
6. Fit C4 between holes 15A and 15C.
7. Fit C5 between holes 15E and 15G.
8. Fit TC1 between holes 5A and 5D. The Veroboard holes have to be elongated with a very small file to take the tags of this trimmer. Also, it may be necessary, with some trimmers, to reduce the width of the tags by careful snipping.
9. On the copper side of the board fit a wire between hole 2D and the nearer tag of the crystal holder.
10. Fit a second wire between hole 7D and the remaining tag of the crystal holder.
11. Take up the transistor and identify its lead-outs. The shield lead (S) is not used and is cut off fairly close to the transistor body. Shape the other leads so that, with the transistor on the component side of the board, the collector lead (C) passes through hole 11A, the base lead (B) through hole 11D, and the emitter lead (E) through hole 11E. Position the transistor so that the underside of its body is about $\frac{3}{8}$ in. above the board surface, then solder its leads. Cut off excess wire after soldering.

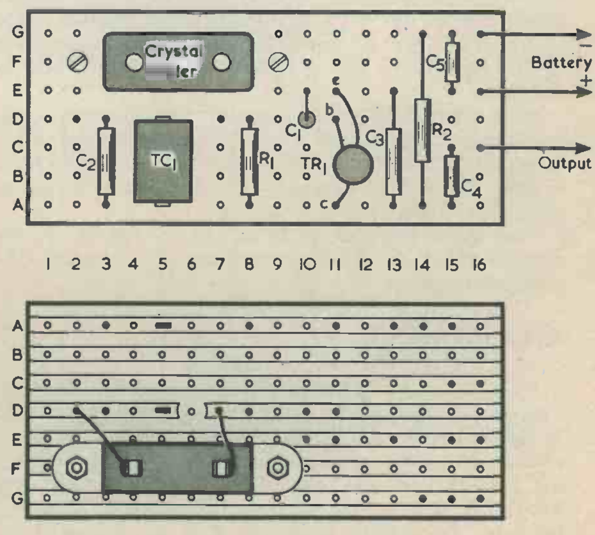
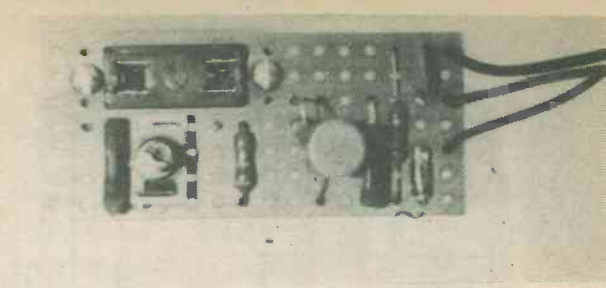


Fig. 2. Component and copper sides of the Veroboard assembly

12. Connect a piece of red flexible wire to hole 16E for battery positive.

13. Connect a piece of black flexible wire to hole 16G for battery negative.

14. Connect a piece of flexible wire of some other colour to hole 16C. This wire carries the output.



A view looking directly down on the Veroboard

BATTERY OUTPUT

If the unit is to be used as it stands, the red and black leads can be simply clipped to a battery when it is required. If desired, an on-off switch can be inserted in either battery lead. The unit could also be fitted in a case, complete with a small 9 volt battery and on-off switch.

When the marker is to be installed inside a receiver the method of mounting depends on whether it obtains its power from its own battery or from the receiver supply. In the former case, the unit should be mounted in such a manner that both its positive and negative supply rails are isolated from the receiver chassis. If, later, it is found that performance is improved by having the positive or negative rail common with the receiver chassis, the requisite connection can then be made. A suitable 9 volt supply may already be available in the receiver, particularly if this employs transistors. In this instance, either the positive or negative rail of the marker may be made common with the receiver chassis according to the polarity of the receiver supply.

An isolated fixing to a metal chassis is easily arranged by cutting the copper strip at hole 14C. Strips B and C are then isolated from holes 1 to holes 14, and holes for two 6BA mounting screws can be drilled between these strips in the vicinity of holes 1 and 10. These screws, with extra nuts for spacing, must raise the board so that the crystal holder tags do not touch the receiver chassist

COUPLING TO RECEIVER

The lower order harmonics are strong, and it is only necessary to place the output lead near the receiver aerial lead. Higher order harmonics are weaker. With these, it may be necessary to twist the insulated output lead a few times round the aerial lead, or even to make a direct connection from this lead to the receiver aerial socket. The effect of connecting the positive supply line of the marker to the receiver chassis should also be checked.

With many receivers it is possible to arrive at a degree of coupling which will be satisfactory for the whole range, from 1MHz to 30MHz. In order to avoid other signals, it may be necessary to disconnect the actual aerial lead from the receiver.

The marker signal is heard by switching on the receiver b.f.o., in the usual way for the reception of a c.w. transmission.

ADJUSTMENT

If adjustment of the crystal frequency is felt necessary, tune in the standard frequency transmission from MSF at Rugby on 5MHz, and set up the marker coupling, as already described, so that the received transmission and the marker harmonic are of roughly similar strength. The b.f.o. is switched off. Any difference in frequency between the marker harmonic and the standard frequency transmission will be heard as a low-pitched tone. Adjust TC1 so that this falls in frequency; the error will eventually become a matter of only a few Hertz or cycles per second, heard as a rise and fall in background noise, or observed as an upwards and downwards movement of the S-meter. There is normally no purpose whatever in securing an accuracy better than a few Hertz.

It should be mentioned that the signals from MSF are transmitted on alternate periods of about five minutes each during the hour. The transmission consists of carrier and second pulses for 0 to 5 minutes past the hour, followed by no signal from 5 to 9½ minutes past the hour. From 9½ to 10 minutes past the hour the transmission consists of the call-sign and frequency off-set in slow Morse, followed by carrier and second pulses from 10 to 15 minutes past the hour. This cycle of transmission continues throughout the hour.

RECEIVER CALIBRATION

Receiver calibration can be checked at 1MHz intervals throughout the short wave bands. Appropriate harmonic 'pips' will also allow the exact low frequency ends of the 7MHz, 14MHz, 21MHz and 28MHz amateur bands to be located.

With a home-built or uncalibrated receiver, establish the frequency of any one 'pip' by its relationship to an amateur band, or any other known frequency. The 1MHz points can then be counted up and down from this, and marked up on the tuning scale.

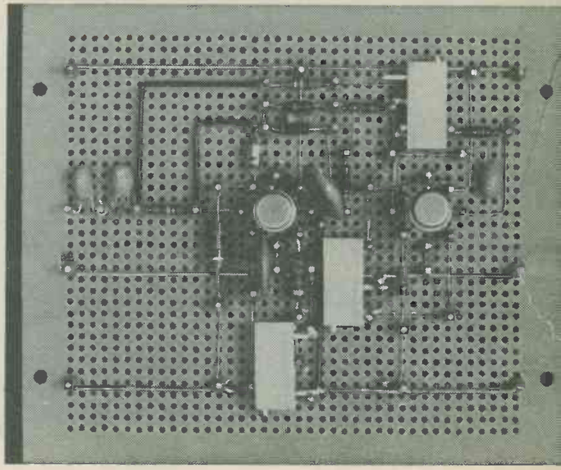
SIGNAL GENERATOR CALIBRATION

To check the calibration of a signal generator, couple it and the marker to a receiver. Tune in any required 1MHz harmonic from the marker on the receiver, then tune the generator to zero beat with this.

A signal generator can be checked or calibrated through the lower frequency bands by beating its harmonics against the 1MHz fundamental or a 1MHz harmonic from the crystal marker. As an example, tune the receiver to 1MHz with the aid of the marker. If the signal generator is now tuned to half this frequency,the second harmonic of its 500kHz output will beat with the crystal marker signal, thus allowing the 500kHz tuning point of the generator to be established. Some signal generator frequencies giving harmonics at 1MHz will not be convenient, a typical instance being 333.3kHz. Others, where the fundamental is a round figure, will be more useful; for example, the fourth harmonic of 250kHz is 1,000kHz or 1MHz, as is the fifth harmonic of 200kHz. So by this means a check of signal generator outputs can be made at frequencies lower than that of the 1MHz crystal.

Similar methods can be employed to calibrate a grid dip oscillator. But for general use the marker is most likely to be employed to determine accurately the frequencies to which a receiver is tuned. ■

PRECISION A.C. TO D.C. CONVERTER



By A. Foord

The circuit described here functions as a precision rectifier and allows a moving-coil meter to directly indicate a.c. r.m.s. voltages up to 1 volt

A.C. TO D.C. CONVERTERS ARE USED IN MANY INSTRUMENTATION applications; for example, in average reading r.m.s. calibrated a.c. voltmeters. Although semiconductor diodes have excellent forward to reverse impedance ratios, they have severe limitations in low level circuits. A silicon diode will have a 0.7 volt threshold which must be exceeded before appreciable conduction occurs. If the diode is placed within the feedback loop of an amplifier then this threshold voltage is divided by the open loop gain of the amplifier, and is effectively eliminated.

BASIC RECTIFIER CIRCUITS

One basic full-wave rectifier circuit often used in a.c. voltmeters is shown in Fig. 1. Here a full-wave bridge rectifier is placed in the feedback path of a high gain amplifier. The meter measures the *average value* of the a.c. input, but the overall gain is chosen so that the scale reading is appropriate for the r.m.s. value of the sinusoidal input. This circuit has several disadvantages for general instrumentation applications because an a.c. signal passes through the meter, and a ground referenced output level is not available.

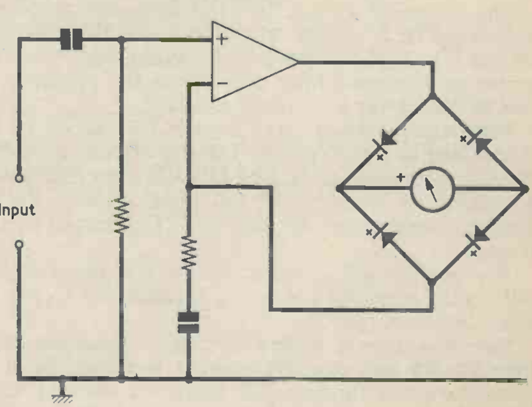


Fig. 1. Basic full-wave rectifier circuit

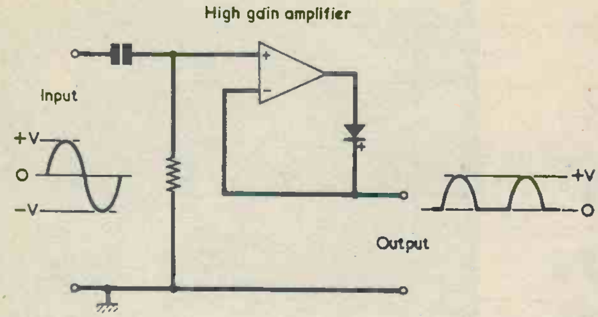


Fig. 2. Basic half-wave rectifier circuit

The simplest half-wave rectifier circuit for eliminating the diode threshold voltage is shown in Fig. 2. If the voltage at the non-inverting amplifier input is positive, the amplifier output swings positive. As soon as the amplifier output becomes 0.7 volts positive the diode becomes forward biased. Negative feedback through the diode forces the inverting input to follow the non-inverting input. This gives a unity gain for positive signals. However when the output swings negative the diode is cut off and the amplifier saturates negatively.

This circuit will be relatively slow for two reasons. Firstly, because since there is 100% feedback for positive-going signals a unity gain frequency compensation must be used for the amplifier. Secondly, because when the diode is reverse biased the feedback loop is opened and the amplifier saturates. These effects limit the frequency response to about 2kHz.

Although this half-wave circuit can be considerably improved, adding an extra amplifier enables a precision full-wave rectifier to be produced.

PRECISION FULL-WAVE RECTIFIER

The complete circuit for the full-wave rectifier is shown in Fig. 3, and its operation is slightly different to that of Fig. 2. IC1 forms a half-wave rectifier while IC2 forms an averaging filter and allows the complete circuit to function as a full-wave rectifier.

For negative-going input signals the output of IC1 is clamped to +0.7 volts by D2 and disconnected from the summing point of IC2 by D1. IC2 then functions as a unity gain inverter with an input resistor R6 and feedback components R7 and VR3. This gives a positive output.

For positive-going input signals IC1 operates as a unity gain amplifier connected through R3 to the IC2 summing point (pin 2).

Positive current enters the IC2 summing point through R6 and negative current is drawn from the summing point through R3. Since the voltages across R3 and R6 are equal and opposite, and R3 is half the value of R6, then the circuit becomes a full-wave rectifier giving a positive output. When C5 is connected across VR3 and R7 the output is averaged provided this time constant is much larger than the maximum period of the input signal.

FREQUENCY COMPENSATION

IC2 has to be compensated for unity gain, and the 741 has its compensation built-in. A 301A integrated circuit has been used for IC1 so that feedforward compensation can be used. This form of compensation increases the slew rate of the integrated circuit to 10 volts per microsecond and reduces the error at high frequencies. This is achieved by C3 which bypasses a lateral p.n.p. transistor inside the integrated circuit at high frequencies to increase the unity gain bandwidth to 10MHz. This arrangement can only be used with the inverting configuration shown, and not with a non-inverting arrangement.

The Components List gives full National Semiconductor and Texas Instruments part numbers for the two integrated circuits in the round T099 case. Readers who purchase components through home-constructor retail sources can obtain IC1 as type 301A and IC2 as type 741C. Both are available in the round T099 case (sometimes described as T05), in 8 pin d.i.l. or in 14 pin d.i.l. The inset in Fig. 3 gives pin details for all three versions, but the pin numbering in the circuit itself corresponds to the T099 or 8 pin d.i.l. cases. The 741C i.c. is widely available, whilst the 301A can be obtained from Trannies, 4 Bush House, Bush Fair, Harlow, Essex. The Components List also specifies C1, C2 and C5 as tantalum bead. Tantalum bead capacitors with

COMPONENTS

Resistors
(All fixed values ¼ watt)

R1	20kΩ 1%
R2	20kΩ 1%
R3	10kΩ 1%
R4	10kΩ 5%
R5	5.6kΩ 5%
R6	20kΩ 1%
R7	18kΩ 5%
R8	5.6MΩ 10%
R9	10MΩ 10%
VR1	50kΩ potentiometer, multi-turn
VR2	10kΩ potentiometer, multi-turn
VR3	10kΩ potentiometer, multi-turn

Capacitors

C1	22μF tantalum bead, 16 V.Wkg.
C2	22μF tantalum bead, 16 V.Wkg.
C3	150pF ceramic 10%
C4	10pF ceramic 10%
C5	22μF tantalum bead, 16 V.Wkg.
C6	0.047μF ceramic
C7	0.047μF ceramic

Integrated Circuits

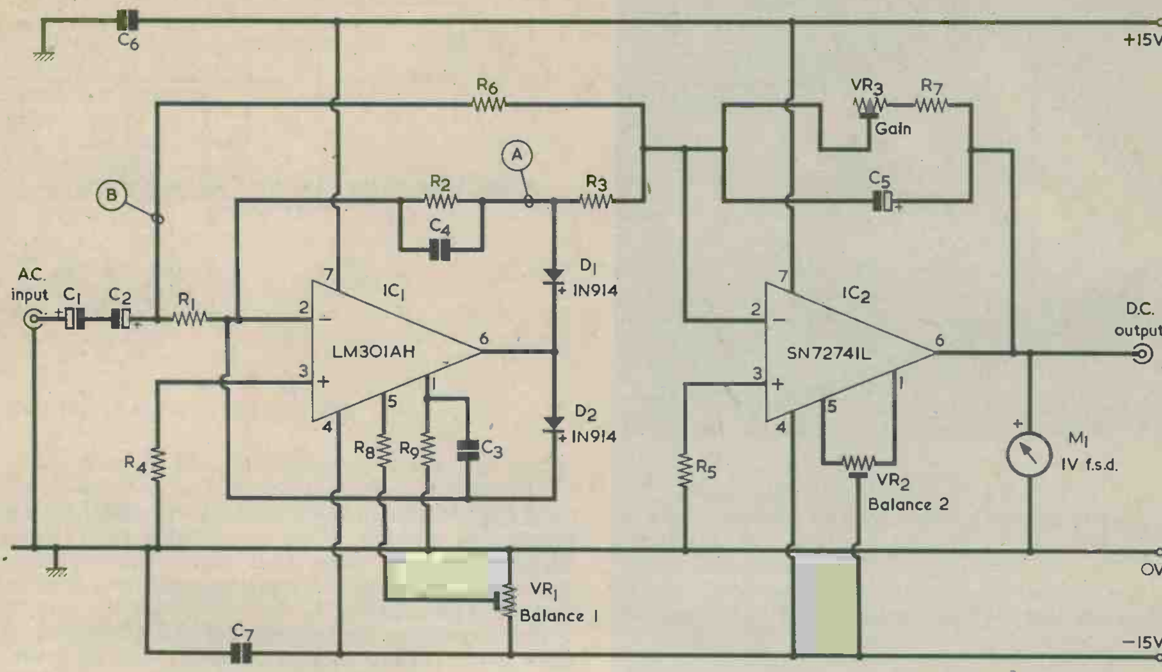
IC1	LM301AH, SN72301AL, or similar, T099 case (see text)
IC2	LM741CH, SN72741L, or similar, T099 case (see text)

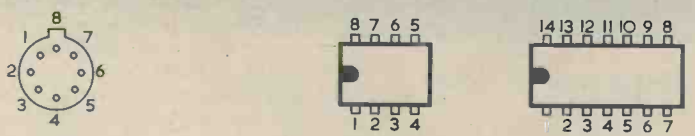
Diodes

D1	1N914
D2	1N914

Meter

M1	Moving-coil meter, 1 volt f.s.d. (f.s.d. current 100μA to 1mA)





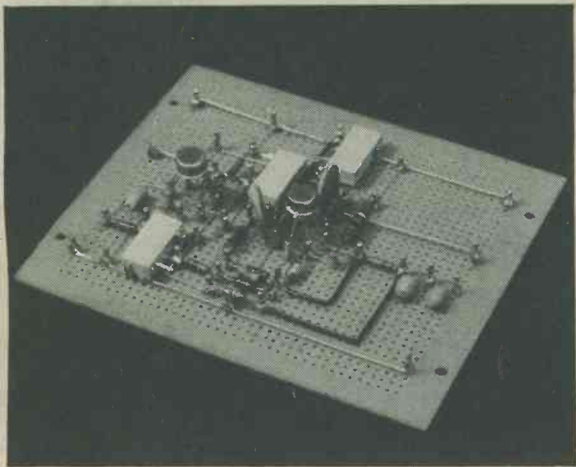
301 PINNING

	TO99 and 8-pin D.I.L.	14-pin D.I.L.
Offset null/comp N1	1	3
Inv. I/P	2	4
Non-inv. I/P	3	5
Vcc −	4	6
Offset null N2	5	9
O/P	6	10
Vcc +	7	11
Comp	8	12
N.C.	−	1,2,7,8,13,14

741 PINNING

	TO99 and 8-pin D.I.L.	14-pin D.I.L.
Offset null N1	1	3
Inv. I/P	2	4
Non-inv. I/P	3	5
Vcc −	4	6
Offset null N2	5	9
O/P	6	10
Vcc +	7	11
N.C.	8	1,2,7,8,12,13,14

Fig. 3. Complete circuit for the precision rectifier, or a.c. to d.c. converter



A side view of the completed a.c. to d.c. converter

the values quoted are available from Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey. Multi-turn potentiometers with the same general construction as those used by the author can be purchased from Henry's Radio, Ltd.

CONSTRUCTION

The construction is straightforward and any of the conventional techniques may be used. The author employed the T099 versions of the i.c.'s, wiring these up on a Lektrokit plain perforated 0.1 in. matrix s.r.b.p. board type LK-141. (This is available from Home Radio under the same Cat. No.). The prototype assembly can be seen in the photographs, and a wiring diagram is given in Fig. 4.

The decoupling components C6 and C7 should be close to IC1 because of its wide bandwidth. VR1, VR2 and VR3 are multi-turn potentiometers to ease the process of setting up. The meter can be almost any instrument with an f.s.d. of 1 volt, since several milliamps current can be drawn from IC2 if required.

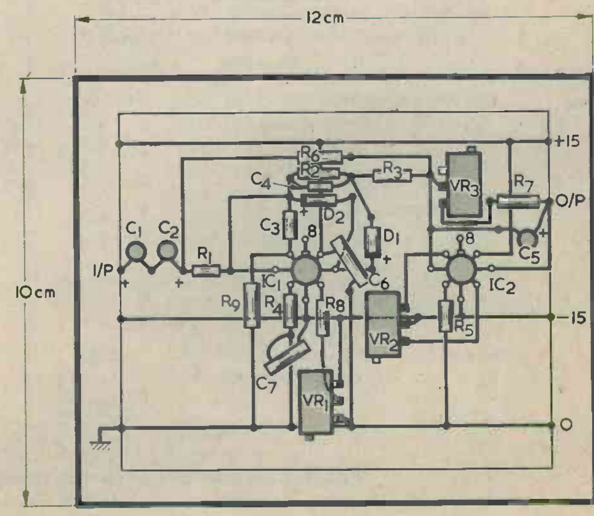


Fig. 4. Component layout employed in the author's prototype

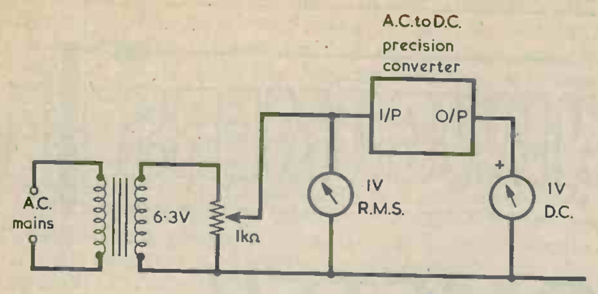


Fig. 5. One possible arrangement for gain calibration

SETTING UP PROCEDURE

To obtain the best possible accuracy from the circuit, the offsets due to IC1 and IC2 must be removed. If points A and B in Fig. 3 are short-circuited directly to earth then any unbalance due to IC2 may be removed by adjusting VR2 until the d.c. output is zero. If points A and B are now returned to normal, then with no input signal (or with the input short-circuited) VR1 may be adjusted to restore the d.c. output to zero, thus removing any offset errors due to IC1. Since these errors are of the order of millivolts the adjustments must be carefully performed.

The overall gain can now be adjusted. The circuit values are so chosen that an input of 1 volt r.m.s. gives a d.c. output of 1 volt. The gain adjustment may be carried out at any frequency between 50Hz and 50kHz. If no other equipment is available, a 1 volt r.m.s. signal may be derived from a low voltage mains transformer and applied to the input, as shown in Fig. 5. Then VR3 should be adjusted for exactly a 1 volt d.c. output level.

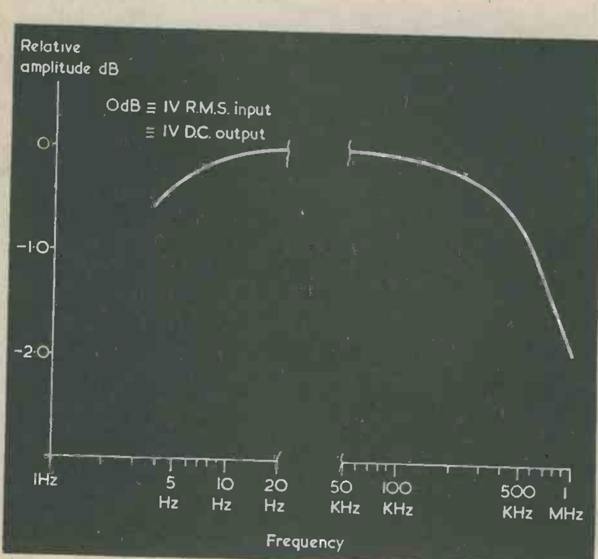


Fig. 6. The frequency response of the a.c. to d.c. converter

PERFORMANCE

The typical performance after setting up is shown in Figs. 6 and 7. For a 1 volt signal the frequency response is 0.1dB down (1%) at 10Hz and 140kHz. The reading will be in error at low and high voltages, as shown in Fig. 7. Here the reading is 1dB down (10%) at 20mV and 1.8V.

For all practical purposes the readings can be regarded as correct over the range of 50 millivolts to 1 volt and from 20Hz to 100kHz.

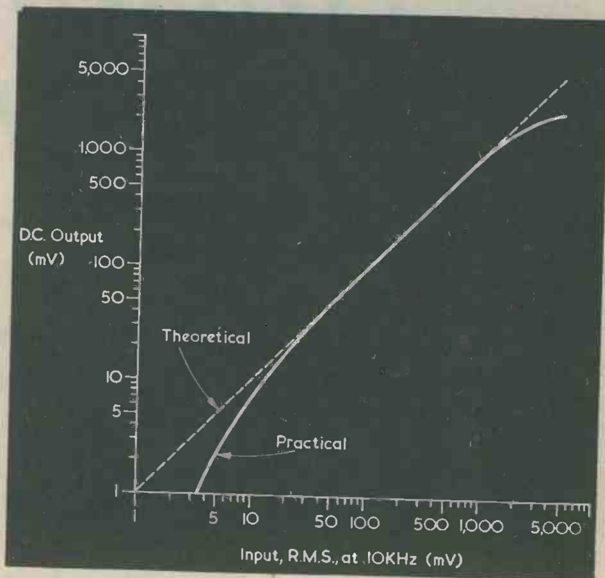


Fig. 7. The input-output linearity curve

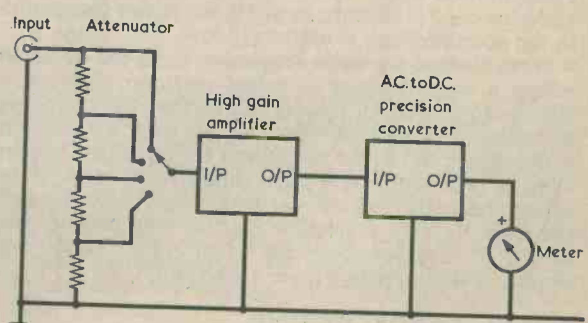
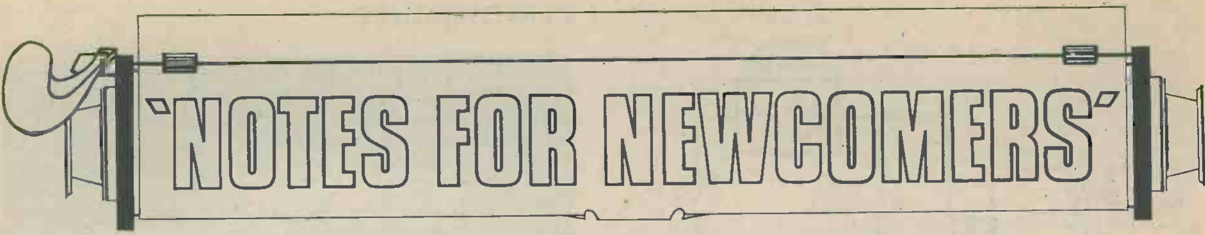


Fig. 8. A suggested arrangement for a sensitive millivoltmeter

USES

The prototype converter was added to the output of a home-constructed audio oscillator to measure its output level, but more complex uses are possible. For example, in Fig. 8 a switched controlled gain pre-amplifier has been added to provide an a.c. millivoltmeter. ■



POTENTIOMETER POWER RATINGS

By F. L. Smith

The power rating of a potentiometer really defines the maximum current its track can pass

MANY OF THE POTENTIOMETER CIRCUITS WE ENCOUNTER in radio and electronic home-construction projects involve the dissipation of negligible power in the potentiometer itself. Typical instances occur in volume and tone control circuits, in which the power dissipation in the potentiometer is extremely low.

Nevertheless, we quite frequently have the occasion where a potentiometer is called upon to dissipate a significant amount of power, and we then start thinking in terms of 3 watt, 5 watt and 10 watt wire-wound components. What we sometimes fail to realise is that what a potentiometer power rating really does is to define the maximum *current* which may flow through the track. It is quite possible that we may have to use, say, a 5 watt potentiometer when circuit conditions require it to dissipate a mere 1 watt only!

TOTAL TRACK RATING

The reason for this apparent anomaly is that a potentiometer power rating applies to the power dissipation along its total track. Let's say that we have a 5Ω wire-wound potentiometer which is rated at 5 watts. This is shown in Fig. 1(a). Fig. 1(b) demonstrates that the total 5 watts will be dissipated if a voltage of 5 volts is applied to its output track terminals. Ohm's Law tells us that current in amps is voltage divided by resistance in ohms, with the result that the current which flows when 5 volts is applied to the 5Ω potentiometer is 1 amp. Wattage is voltage multiplied by current in amps, and so we have achieved the 5 watts maximum dissipation for which the potentiometer has been designed.

Now, the 5 watts dissipation will inevitably cause a temperature rise in the resistance wire which forms the track of the potentiometer, and this temperature rise will be the highest that the resistance wire and its insulated mounting can safely handle.

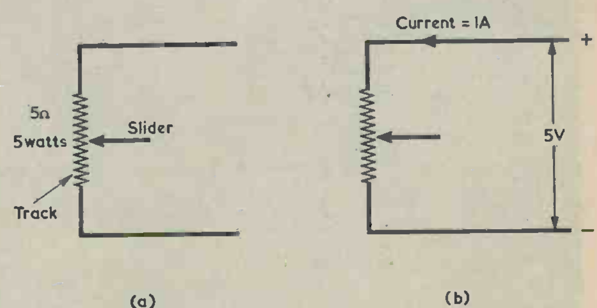


Fig. 1 (a). Circuit symbol for a 5Ω 5 watt potentiometer
(b). The full 5 watts is dissipated in the potentiometer when 5 volts is applied across its track

In Fig. 2(a) we set the slider of our 5 watt potentiometer one-fifth of the way down its track, so that there is a resistance between the top of the track and the slider of 1Ω. If, as in Fig. 2(b), we next apply a voltage which causes a power of 5 watts to be dissipated between the slider and the upper terminal of the track, we will find that this voltage will be 2.236 volts and the current which consequently flows is 2.236 amps. Both these figures are the square root of 5 and, when multiplied together, give a power of 5 watts. So we are dissipating a power of 5 watts in a 5 watt potentiometer, whereupon everything is, presumably, just as it should be. Unfortunately, such is by no means the case. We will soon find that the 1Ω section of potentiometer track through which the 2.236 amps is flowing starts issuing smoke whilst the remaining four-fifths of the track stays completely cool!

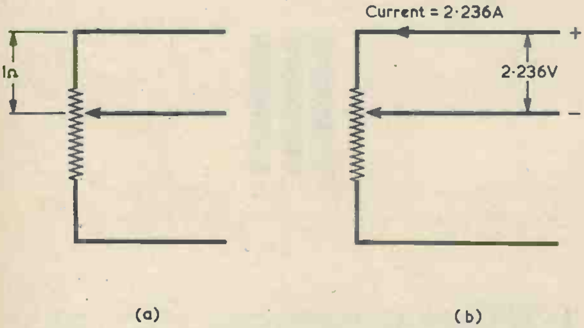


Fig. 2 (a). The potentiometer of Fig. 1 with its slider set one-fifth of the way down the track
(b). Applying a voltage to the slider and the upper end of the track which causes a dissipation of 5 watts

TRACK FRACTIONS

The reason for this state of affairs is that if 1 amp is the maximum current which the whole track of our potentiometer can safely carry then 1 amp is similarly the maximum current which can be safely carried by any fraction of the track, be it one-half, one-fifth, one-tenth or one-twentieth of the track.

Thus, we find that the power rating of a potentiometer actually defines the maximum current it can handle, regardless of whether this current flows through the whole track or just part of it.

Fig. 3. Successive steps in obtaining an equation which relates current to power and resistance

$$P = I^2R$$
$$\therefore I^2 = \frac{P}{R}$$
$$\therefore I = \sqrt{\frac{P}{R}}$$

The equation relating current, power and resistance is

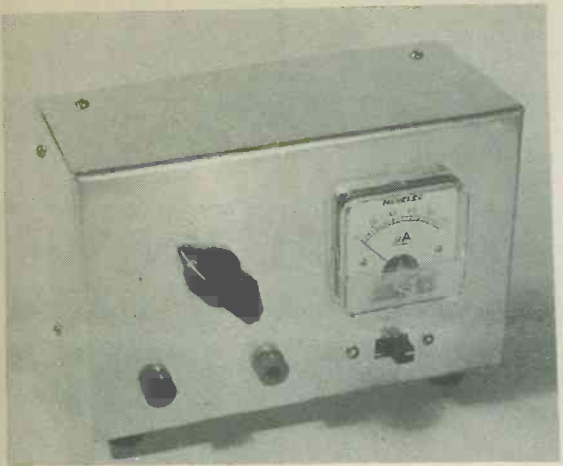
$$P = I^2R$$

where P is power in watts, I is current in amps and R is resistance in ohms; and if we rearrange this as shown in Fig 3 we find that I is equal to the square root of P divided by R. This equation enables us to find the maximum current flow for any potentiometer whose track resistance and power rating we know. In our example we had a 5Ω potentiometer rated at 5 watts and the maximum current is then easily calculated as being 1 amp. If we had a 125Ω potentiometer rated at 5 watts, the current, if you care to calculate it, works out at one-fifth of an amp, which is 0.2 amp or 200mA.

TABLE
Maximum track currents, in mA, for wire-wound potentiometers

Track resistance	Potentiometer power rating		
	3 watts	5 watts	10 watts
25Ω	340	440	630
50Ω	240	310	440
100Ω	170	220	310
250Ω	100	140	200
500Ω	77	100	140
1kΩ	54	70	100
2.5kΩ	34	44	63
5kΩ	24	31	44
10kΩ	17	22	31
25kΩ	10	14	20
50kΩ	7.7	10	14

Unhappily, the resistance and power figures of most potentiometers employed in practice do not calculate out as conveniently as this and, as a guide, the accompanying table lists calculated maximum current figures in milliamps for typical potentiometers, from 25Ω to 50kΩ, having power ratings of 3 watts, 5 watts and 10 watts. Thus, the table tells us that if we have a 50Ω 5 watt potentiometer the maximum current we can expect either the whole of its track or any part of it to carry is 310mA. ■



THREE F.E.T. VO

By A. P. Roberts

An inexpensive electronic voltmeter having an input resistance in excess of 11MΩ. If desired, the input resistance may be increased to greater than 20MΩ.

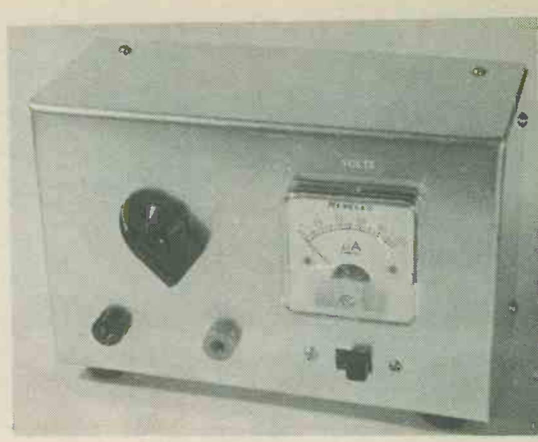
It is a well established fact that certain d.c. voltage measurements, when taken with an ordinary multimeter, can be extremely inaccurate. Such inaccuries occur when there are high resistance values in series with the points at which the voltage readings are taken. An example is given when an attempt is made to measure the base potential of almost any low level transistor amplifier stage. Many common emitter amplifier stages in this class have a base current in the region of 1 to 10μA only, whereas an ordinary 20kΩ per volt multimeter needs 50μA to give full-scale deflection of its needle. Obviously, an ordinary multimeter is completely inadequate for measurements such as this.

The unit described in this article has three voltage measuring ranges, these being 0–1 volt, 0–10 volts and 0–100 volts. The input resistance is just over 11MΩ on all ranges, which is considerably higher than that of any average multimeter. As is described later, the input resistance can be increased to over 20MΩ, if desired. The circuit incorporates two f.e.t.'s and a bipolar transistor, and it has overload protection and a built-in battery check facility. It is powered by a single PP3 9 volt battery, and the current consumption is approximately 2.5mA only.

CIRCUIT OPERATION

A basic circuit for an f.e.t. voltmeter is shown in Fig. 1. Two reasons for using an f.e.t. are, first, that its gate presents an extremely high input resistance and, second, the input terminal (i.e. the gate) can have the same potential as one of the supply rails when no test voltage is applied. Obviously a d.c. voltmeter requires that the two input terminals be at the same potential, and it is of advantage if one of these is common with a low impedance supply rail.

RANGE
LTMETER
III



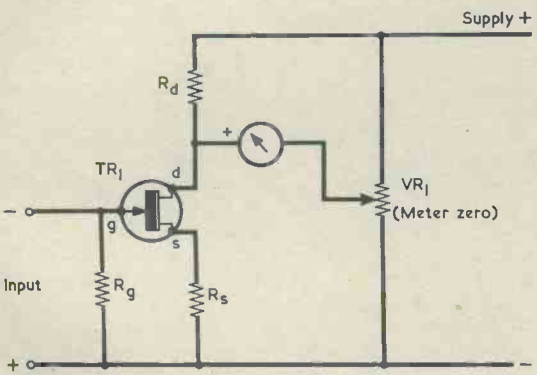


Fig. 1. A basic circuit for an f.e.t. voltmeter

The input resistance of the f.e.t. is so high in comparison with Rg, that the input resistance can be regarded as being that of Rg.

The junction of Rd and the f.e.t. drain can be considered as a tap in a potential divider connected across the supply rails. VR1 forms a second potential divider, and this is adjusted for zero reading in the meter when no input voltage is applied. If an input voltage is now connected it will cause the gate of the f.e.t. to go negative, with a consequent increase in the drain-to-source resistance. The voltage at the f.e.t. drain goes positive, causing a forward deflection in the meter.

There is an almost completely linear relationship between the input voltage and the voltage change at the drain, and so a very accurate voltmeter can be made using a circuit based on this simple arrangement.

COMPONENTS

Resistors
(All fixed values ¼ or ½ watt)

R1	10MΩ 1%
R2	1MΩ 1%
R3	110kΩ 1%
R4	390kΩ 5%
R5	3.9kΩ 5%
R6	1kΩ 5%
R7	3.9kΩ 5%
R8	470Ω 5%
R9	3.3MΩ 5%
R10	2.7kΩ 5%
R11	100kΩ 5%
VR1	1kΩ pre-set potentiometer, skeleton, standard size, horizontal mounting
VR2	50kΩ pre-set potentiometer, skeleton, sub-miniature, horizontal mounting

Semiconductors

TR1	MPF103
TR2	MPF103
TR3	BC107
D1	BZY88C3V3
D2	BZY88C3V3
D3	BZY88C7V5

Switches

S1(a)(b)	2 pole 4 way miniature (see text)
S2	d.p.d.t. slide switch

Meter

M1	0–100μA, 38 Series (Henelec)

Battery

BY1	9 volt battery type PP3 (Ever Ready)

Miscellaneous
2 wander plug sockets
Pointer knob
Battery connector
Veroboard panel, plain, 0.15in. matrix, 3¾ x 2½ in.
Aluminium chassis, 6 x 4 x 2½ in., with base plate
4 rubber feet

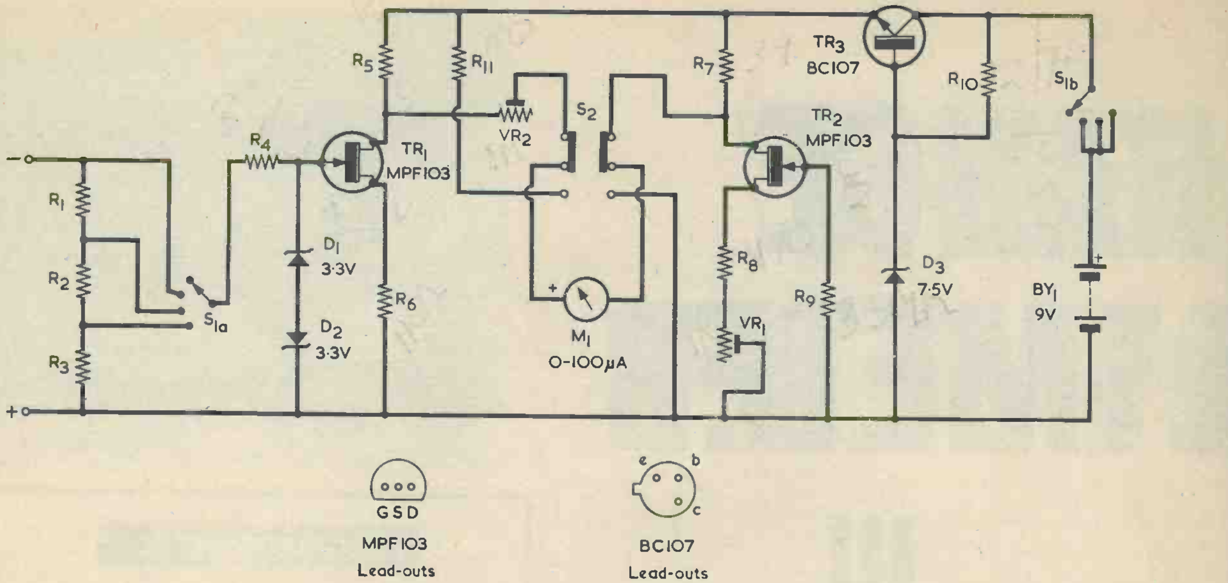


Fig. 2. Complete circuit diagram for the three range f.e.t. voltmeter

PRACTICAL CIRCUIT

Fig. 2 shows the practical circuit employed in the f.e.t. voltmeter. R1, R2 and R3 form a voltage divider, enabling S1(a) to select the full input voltage, one tenth of the voltage or one hundredth of the voltage. Whichever of these resistors is selected by S1(a) provides, in combination with R4, the gate bias resistor for TR1.

R4, D1 and D2 form an overload protection circuit, and they limit the input voltage to TR1 gate by about 3.9 volts positive and negative. With excessive positive inputs D1 acts as a 3.3 volt zener diode and D2 acts as a forward biased silicon diode giving a voltage drop of 0.6 volt, whereupon the total limiting voltage is the sum of these two voltages. At excessive negative input voltages the roles of the diodes are reversed, with D2 functioning as a zener diode and D1 as a forward biased diode.

The potential divider, VR1 of Fig. 1, is replaced by a second f.e.t. circuit similar to that around TR1. This provides temperature compensation, since any change in temperature affecting the d.c. biasing level of TR1 will similarly affect TR2. In consequence, variations in TR1 drain voltage due to temperature changes will be offset by similar variations in TR2 drain voltage, and the circuit remains in a balanced condition. The inclusion of TR2 gives very good long term stability. VR1 adjusts the biasing of TR2, and enables the meter to be zeroed. VR2 controls the sensitivity of the meter circuit and allows the unit to be calibrated against a known voltage.

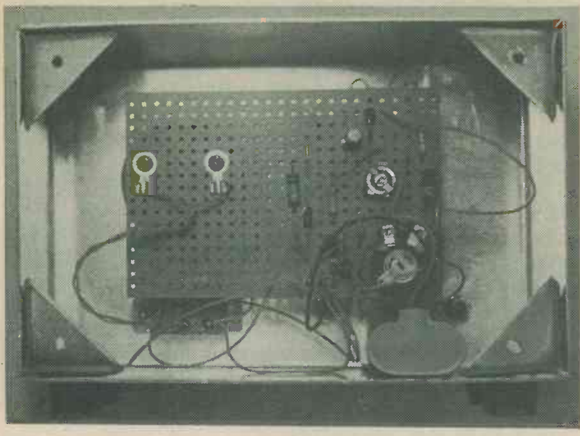
For maximum accuracy a stabilized supply voltage is required, and this is provided by TR3, R10 and D3. A voltage of approximately 7.5 volts appears across D3 and is applied to the base of TR3. This functions as an emitter follower, and approximately 6.8 volts appears at its emitter for application to the meter circuit.

S2 enables the meter to be switched across the supply via the series resistor R11. This resistor and the meter form a voltmeter having a full-scale deflection of the order of 10 volts, with the result that it is possible to check the supply voltage and to be advised when a new battery is required.

So far as components are concerned, the two f.e.t's are available from a number of suppliers, although in some cases they may be listed under the alternative type number of 2N5457. The range switch S1 must be a miniature type. The component used in the prototype is a 4 pole 3 way type having an adjustable end-stop. Only two of the poles are connected into circuit. This switch is listed in page 208 of the Henry's Radio 1973–74 catalogue, where it is described as a 'Midget Wafer (Wavechange) Switch'. The meter is a Henelec 38 Series type with an f.s.d. of 100μA, and is also available from Henry's Radio.

The resistors used in the input voltage divider, R1, R2 and R3 should preferably have a tolerance of 1%, and 2% represents the widest tolerance which is acceptable. The writer was able to obtain a single 10MΩ 1% resistor for R1, but close-tolerance components in values as high as this are not generally available, and the constructor may have to make up the resistor with two or three individual resistors in series. The 10MΩ value can, for instance, be given by a 4.7MΩ, a 3.3MΩ and a 2MΩ resistor in series. If several resistors are employed in this way, it will be found convenient to use the outside tags on the unused pole of the range switch as anchor tags for them.

VR2 is a sub-miniature skeleton potentiometer, whilst VR1 is a standard sized skeleton potentiometer. Both are intended for horizontal mounting. All the components are housed in a standard aluminium chassis measuring 6 by 4 by 2½ in., this being fitted with corner strengthening brackets capable of taking a base plate. These brackets are clearly visible in the photographs showing the interior of the unit. The author's chassis was home-constructed but it should be noted that a ready-made chassis of the required dimensions is listed by Home Radio under Cat. No. CU223.



Inside the case of the voltmeter. The majority of the components are assembled on a plain Veroboard panel. Note the solder tags under the meter terminal screw heads which also secure the component panel in place

CONSTRUCTION

Construction commences by drilling the requisite holes in the chassis deck, which now becomes the front panel of the voltmeter. The base plate becomes the rear panel, and is secured to the corner brackets with self-tapping screws. Front panel hole dimensions are given in Fig. 3. The diameter of the holes which take the two wander plug input sockets is not shown, and is found from the actual sockets employed. Similarly, the dimensions of the cut-out and mounting holes for switch S2 depend on the particular component used. The rectangular cut-out can be made by drilling a $\frac{1}{4}$ in. diameter hole, and then filing this out to the required size and shape.

The author used a fret saw with a fine toothed blade to make the large cut-out for the meter. When this has been completed the meter itself can be employed for marking out the positions of its four small mounting holes.

Also required in the chassis are holes for the mounting bolts of four small rubber feet. These are fitted near the corners of the chassis edge which is now the bottom of the case.

All the small components, apart from R1, R2 and R3, are wired up on a plain Veroboard panel, without copper strips, having a matrix of 0.15 in. The board measures $3\frac{3}{4}$ by $2\frac{1}{4}$ in., and this is a standard size. Two 6BA clear holes are drilled in this as shown in Fig. 4, and

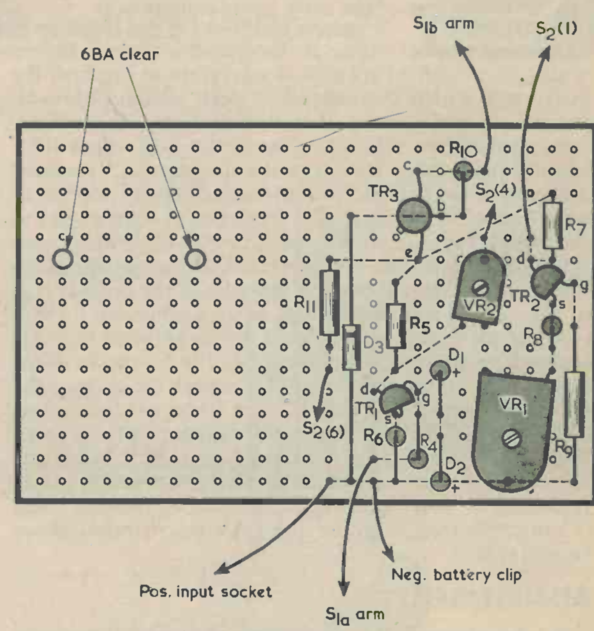


Fig. 4. How the components and wiring are laid out on the Veroboard panel

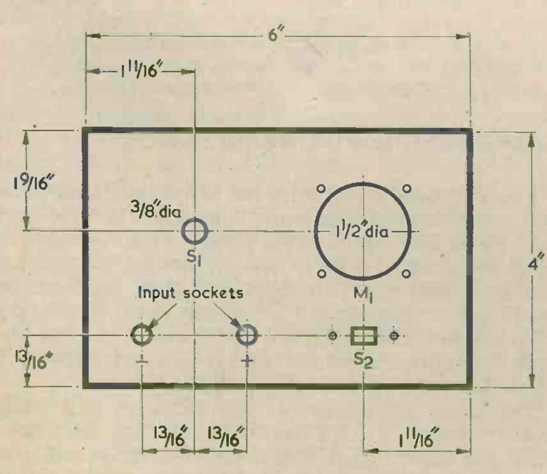


Fig. 3. Hole centres and dimensions on the front panel

these are used for securing the board to the back of the meter by means of the meter terminal screws. Fig. 4 also shows the components which are fitted to the board, wiring under the board being depicted in broken line. In most cases the component lead-out wires will be sufficiently long to reach the various connection points. Bare tinned copper wire can be employed at places where component leads are too short. None of the wiring under the board needs to be insulated. The two pre-set potentiometers do not fit perfectly into the board, but they can be carefully manipulated into the positions shown in the diagram. It does not matter if they are not fitted at precisely the holes shown in Fig. 4, provided that they are wired correctly into circuit.

Six flexible insulated wires pass from the board to the components on the front panel. These wires need to be sufficiently long to enable them to be connected to the front panel components before the board is mounted in position.

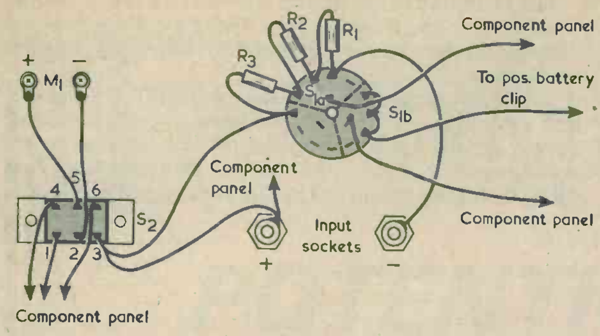


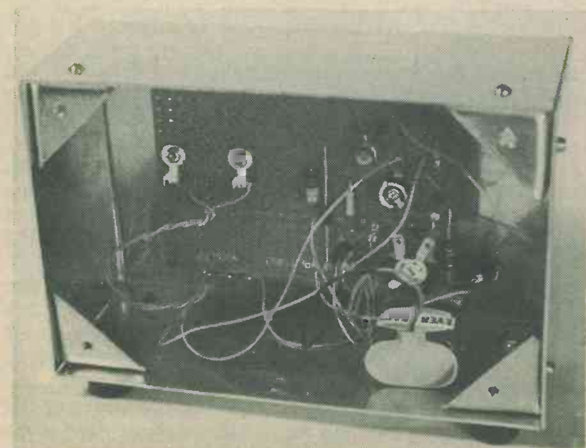
Fig. 5. The wiring of the front panel components

The front panel wiring is illustrated in Fig. 5. Before wiring to switch S1(a)(b) it is advisable to confirm the outer tags which correspond to each switch pole with the aid of an ohmmeter or continuity tester, as they may take up positions relative to the centre tags which differ slightly from those shown in the diagram. All resistors soldered to the tags of S1(a)(b) (including any additional ones needed to make up R1) should be at right angles to the switch tags, as shown, or they will otherwise come into contact with the component board underside when it is mounted. It will be seen that one of the outside tags of the unused switch pole acts as ~~an anchor~~ tag for R3.

When all wiring is completed the component board is secured to the rear of the meter, the meter terminal screws also taking the two solder tags at the ends of the wires from tags 2 and 5 of S2. The battery is located on the bottom of the case. A piece of rubber or plastic foam is glued to the rear of the case such that it holds the battery in position when the case rear is screwed in place. It should be noted that the metal case is 'floating', and is not connected to either the positive or the negative supply rail.

ADJUSTMENTS

At the outset, VR1 is adjusted to a central position and VR2 is adjusted to insert *maximum* resistance into circuit. This is the fully clockwise setting, as viewed in Fig. 4. Switch S2 should be set to the right, as viewed from the front, thereby selecting the voltmeter function. S1 selects 'Off' when its knob is fully anti-clockwise, then selects '0–1V', '0–10V' and '0–100V' as its knob is turned successively clockwise.



The battery lies on the bottom of the case and is held in position when the rear cover is fitted

After a visual check to ensure that all is well, the battery is connected and the voltmeter switched on. VR1 is then adjusted to zero the meter. Both VR1 and VR2 are easily reached for adjustment when the back of the case is removed.

The unit is now connected to a known voltage, and VR2 is slowly and carefully adjusted until the meter gives a reading corresponding to this voltage. Take care to ensure that VR2 does not insert too low a resistance into circuit as this could cause high currents to flow in the meter. A convenient approach to setting up VR2 consists of switching to the 0–10 volt range and then connecting the input to an external 9 volt battery across which a good quality multimeter is already connected. VR2 is then set up to give the same reading in the f.e.t. voltmeter as is given by the multimeter.

When S2 is moved to the left it takes up the 'battery check' position. A reading of about 65 to 70 should be indicated by the meter. A note of this reading is made, and the battery is then checked before and after each time the voltmeter is used. When, at some time in the future, a reading significantly below the initial level is obtained, this indicates that it is time for a new battery to be fitted.

There is no real need to alter the scale of the meter when it is employed in the voltmeter. If, for instance, a reading of 50 is obtained on the 0–10 volt range, it is an easy matter to mentally convert this to the voltage to which it corresponds, which is obviously 5. For the 0–100 volt range there is, of course, already a –100 scale on the meter.

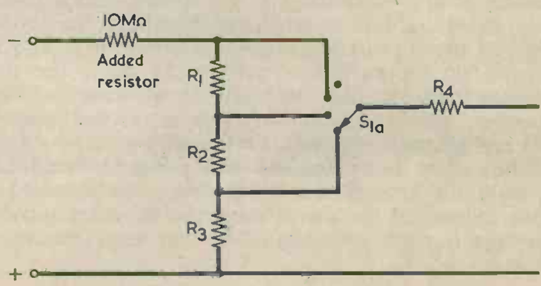


Fig. 6. If desired, a high value resistor of around 10MΩ can be added at the input in order to provide an even higher input resistance

INCREASED INPUT RESISTANCE

For all practical purposes the input resistance of the unit can be regarded as being constant. Therefore, it is possible to add a high value resistor in series with the input and readjust VR2 to compensate for the resultant loss in sensitivity. This does not alter the accuracy resulting from the use of 1% resistors in the R1, R2 and R3 positions. The added resistor does not need to be a close tolerance component and it can cause the input resistance to be considerably boosted.

The main limitation on the value of the added resistor is that, if VR2 has to be adjusted too low in value, the meter circuit becomes over-sensitive and there is a loss of stability. A value of 10MΩ was found to be quite acceptable in the prototype and this boosts the input resistance to slightly greater than 21MΩ. ■

'SKYWIRES'

By Frank Osborn, G2CVO

Some practical notes on the erection of aerial masts

IN SPITE OF THE GREAT EFFICIENCY OF MODERN COMmunication receivers which give an adequate performance on random lengths of wire strung from eaves to fence, or around rooms and lofts, there are many short wave listeners who wish to expand their knowledge by experimenting with different types of resonant aerials and to erect a mast from which to hang such 'skywires'.

For the transmitting enthusiast who prefers long wires and dipoles to beams and verticals, a mast is a necessity if there is no convenient tree available.

MATERIALS

The problem of what to use for such a mast without incurring too much expense faces many who do not receive the large pay packets one reads about in current press reports. The author's preference in this direction is for aluminium or duralumin masts because of the great advantage of permanency which they confer. The materials employed by the author can be freely adapted to individual requirements as to length, etc.

At his previous QTH the author's 45 ft. mast comprised three 2 in. diameter 5 ft. long ex-W.D. interlocking tubes at the bottom followed by a 20 ft. length of builder's aluminium scaffold pole, and finally topped with a 10 ft. length of $1\frac{3}{4}$ in. tubing. A standard 9 ft. length of $1\frac{1}{2}$ in. TV mast could, alternatively, be used in this last position. The ex-W.D. interlocking tubes used at the bottom of the mast are still, at the time of writing, advertised in the amateur press. These interlocking sections are usually of steel, although if one is lucky, the American Army duralumin types may be found.

The marrying in of each length can be achieved by an inner sleeve with a bolt right through above and below the joint, or by a J Beam 15 in. Mounting Sleeve for 2 in. masts type JBL59/15.

It will be found that in some cases the male end of the 2 in. interlocking sections will enter a length of 2 in. scaffolding with the application of a little grease. Fix with a high tensile bolt above and below the joint as it is surprising how much such masts can bend when erecting. There is no problem with shorter masts, which can be erected single-handed.

The 45 ft. mast was guyed at the tube joins at 15 ft. and 35 ft. from the bottom, and at the top. Ex-Government stainless steel guy wire may be found in some of the older junk shops, but the author finished up finally with polypropylene cord, which is easier to handle. Also developed, for easier subsequent lowering and raising, was the framework shown in Fig. 1. Two spare 5 ft. sections were cemented in the ground with the cement smoothed down so that rainwater would run off. Rocks, pieces of old iron or similar can be consolidated in the cement.

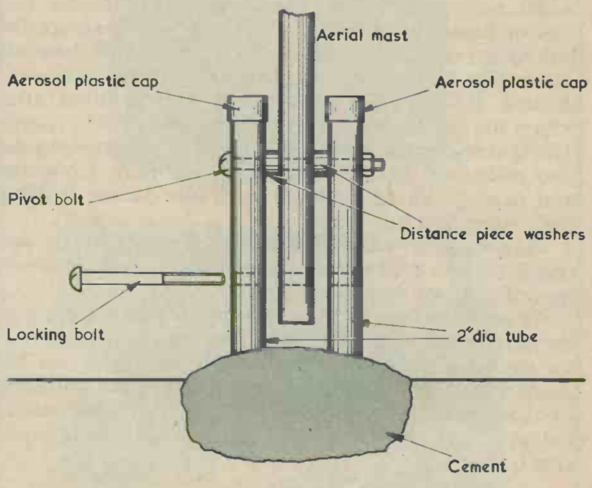


Fig. 1. Mounting framework at the base of an aerial mast. The mast pivots on the upper bolt and, when erected, is locked in place with the lower bolt

The two upright posts formed by the 5 ft. sections should be coated with bitumen or several coats of rust-proof paint. Their tops may be sealed off by fitting aerosol plastic caps over them. The distance between the two posts should be sufficient to take the 2 in. mast and two clamps which hold a counterweight at the mast bottom. Spacing washers are fitted, on either side of the mast, over the pivot coach bolt which passes through the upper holes in the posts and mast, and over the locking coach bolt which passes through the lower holes.

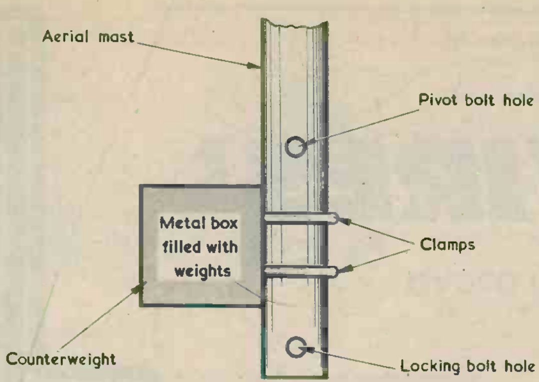


Fig. 2. A counterweight clamped to the bottom of the mast eases lowering and raising during maintenance

For the counterweight the author used an ex-Army metal radio spares box filled with heavy bricks and similar items. See Fig. 2. The clamps which secure the box to the mast are exhaust pipe clamps, and these are obtainable up to $2\frac{1}{2}$ in. diameter from motor accessory dealers. Initially, the pivot coach bolt is fitted, after which the locking bolt is fitted when the mast is raised. The spacing washers keep the mast central between the two posts and ensure there is no side play. Lowering and raising can be achieved with one person holding the two middle guy wires.

Maintenance with this mast was minimal and consisted of a coat of paint every three years. This was more for looks than of necessity.

As were the tops of the two support posts, the top of the aerial mast was sealed by fitting the plastic cap from an aerosol can. As may be seen from Fig. 3, an old Admiralty 'shell' china insulator overcame the problems of rusting or binding pulleys. A polypropylene aerial halyard runs very smoothly through an insulator of this type.

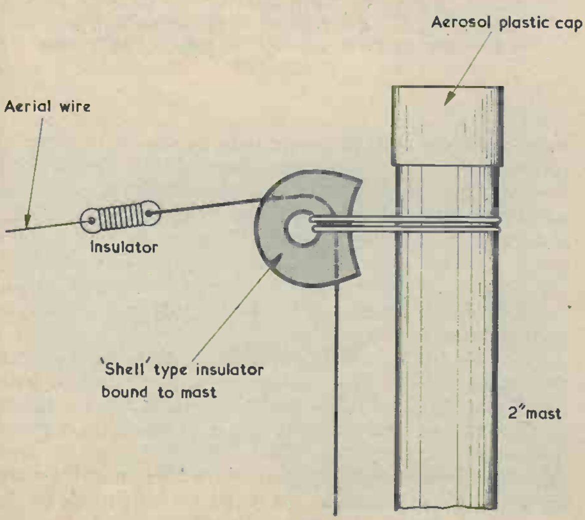


Fig. 3. A china insulator of the type shown here replaces the usual pulley

Fig. 3 shows a 2-hole glass insulator. However, the author prefers an egg-type insulator as this ensures that the aerial will not come down in the (admittedly) remote possibility of its fracturing.

20 FOOT MAST

At his new QTH the author uses a vertical trap dipole for h.f. transmitting together with a top band long wire which is attached to a pair of less ambitious masts having a height of 20 odd feet. A mast of this nature would suit the average short wave listener and should not offend neighbours or local bye-laws. Councils usually become difficult over the bigger masts.

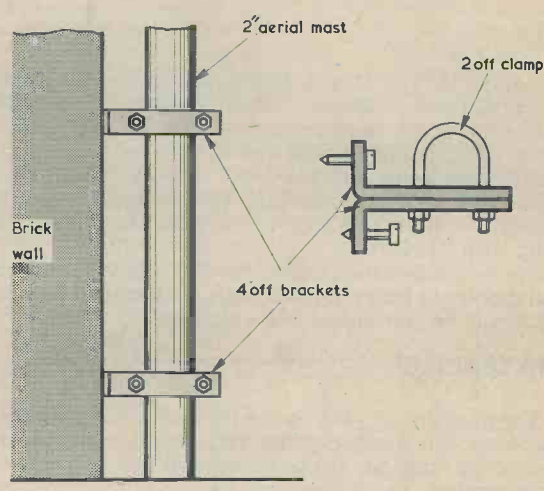


Fig. 4. One method of securing an aerial mast to a brick wall

Each of the author's masts consists of a 20 ft. length of 2 in. builder's scaffold pole with a 9 ft. $1\frac{1}{2}$ in. TV mast inserted at the top. The space between the two at the join is filled with scraps of aluminium tapped into place and a high tensile $\frac{1}{4}$ in. bolt is passed through the pole and TV mast to lock them together. One of the aerial masts is secured to a fence at the end of the garden and the other to a wall of the author's bungalow. It should be mentioned that many of the materials used for the masts had been in use at the previous QTH, a factor which proves the permanency of these items.

Search of a junk shop produced ex-Army truck lamp brackets, drilled and slotted. These are as shown in Fig. 4, which also illustrates how the brackets are secured to the brick wall of the bungalow and the manner in which the bottom end of the mast is clamped to them.

If the reader cannot obtain these brackets a suitable alternative, employed by the author in an earlier

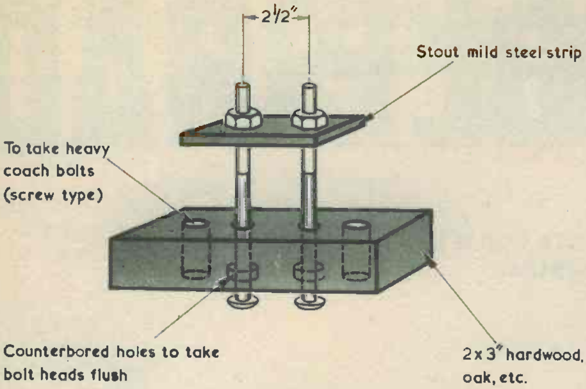


Fig. 5. An alternative bracket for wall fixing

installation, is shown in Fig. 5. A piece of hardwood, such as oak, is bolted to the wall and this has two countersunk holes to take the bolts which secure the mast.

The present mast fitted at the bungalow wall has 4 guys, and it carries a 20 element 2 metre beam and a 3 element f.m. beam in addition to the long wire.

The fence posts at the end of the garden are strong, with metal and concrete spurs, and so the other mast is clamped direct to one of these, as illustrated in Fig. 6.

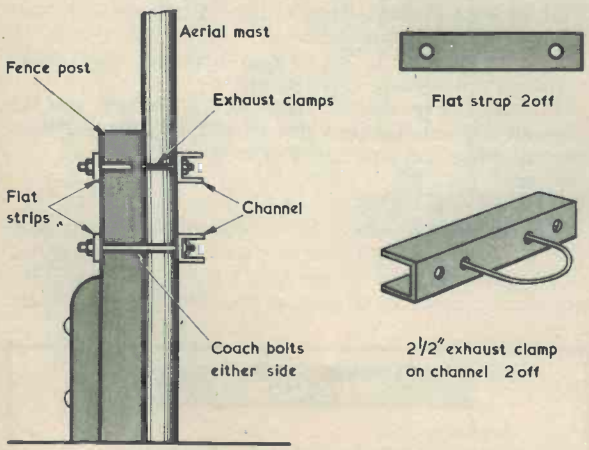


Fig. 6. Provided it is sufficiently firm and strong, a garden fence post can support a small aerial mast

Exhaust clamps hold the lower end of the mast to two lengths of metal channel which, in turn, are held in place by bolts which straddle the fence post.

One of the pleasures of assembling aerial masts of the type described in this short article is that, after having scoured around for the bits and pieces, made the mast and prettied it up with a coat of paint, one can stand back and survey it with satisfaction as being all one's own work, remembering also the money saved in comparison with a commercial equivalent. ■

PORTABLE RADI

A stabilized unit which provides 9 volts for a portable radio from a 12 volt car system

IT IS OFTEN USEFUL TO BE ABLE TO POWER A NINE VOLT transistor radio from a car's 12 volt electrical system. This can be done quite simply by using a zener diode, but as the current demands may easily approach 100mA or more a high dissipation diode is required. The low cost stabilized circuit described in this article requires more components than a single diode circuit, but it performs very well and is easy to construct. In the author's case, all the items came from the spares box.

CIRCUIT OPERATION

In the circuit, shown in Fig. 1, regulation is provided by the zener diode, ZD1. The output voltage is held at the zener voltage plus the emitter-base voltage drop in TR3, and can be adjusted to various output levels by selection of the zener diode.

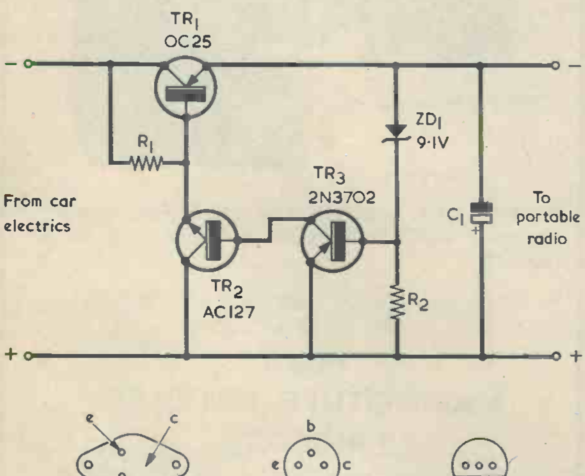
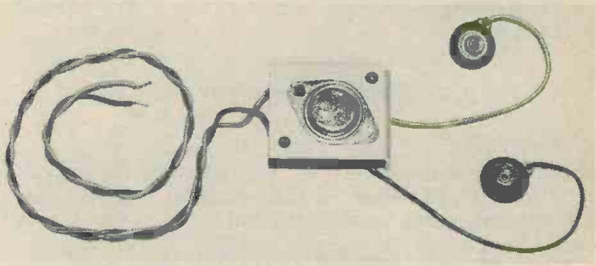


Fig. 1. The circuit of the supply unit. This offers a stabilized output at approximately 9 volts



The completed unit is small, and can in most instances be positioned in the receiver in place of the battery

To explain the stabilizing action let us assume that the output voltage tends to increase. This increase is communicated to TR3, which passes a higher collector current. This causes TR2 to turn on harder and starve TR1 of base current. Hence, the output voltage from TR1 is reduced to counteract the postulated rise. A similar action, but in the reverse direction, takes place if the output voltage tends to fall.

R2 allows a reasonable zener current to flow, and R1 is made low enough in value to supply sufficient base current when the input voltage is low.

CONSTRUCTION

Transistor TR1 may be called upon to dissipate powers approaching a watt at maximum output, and it can conveniently be of the OC25 class. TR2 and TR3 are small transistors of general purpose type. The zener

COMPONENTS

Resistors
- R1 560Ω ¼ watt 10%
- R2 390Ω ¼ watt 10%

Capacitors
- C1 50μF electrolytic, 12 V.Wkg.

Semiconductors
- TR1 OC25
- TR2 AC127
- TR3 2N3702
- ZD1 9.1V zener diode, 250 or 400mW

Miscellaneous
- Printed circuit board
- Heatsink and hardware

O SUPPLY UNIT

By James Kerrick

diode is a small 250 or 400mW component.

The components are wired on a small printed circuit board which is shown, viewed from the copper side, in Fig. 2. This diagram is reproduced full-size, and may be traced. TR1 is fitted to a small heat sink having a flat

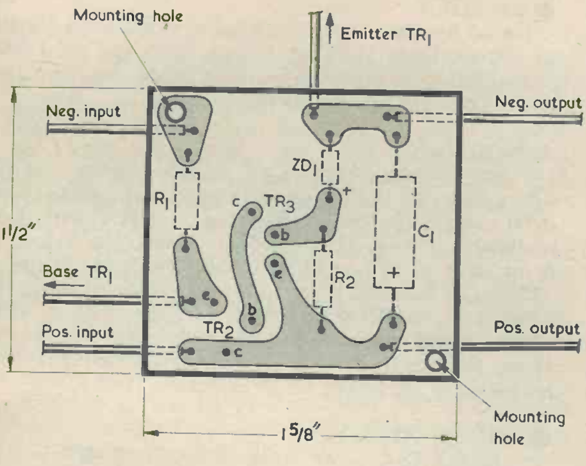
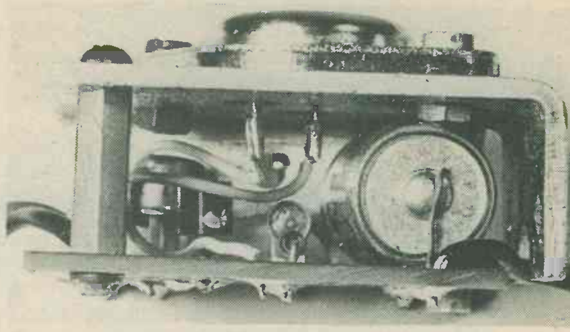


Fig. 2. The copper side of the printed circuit board. This is reproduced full size

surface area of $1\frac{3}{4}$ by $1\frac{1}{2}$ in., with a $\frac{5}{8}$ in. flange at one end. No insulating washer is provided, and TR1 is bolted direct to the heat sink. The printed circuit board is secured to the sink by means of two metal spacing pillars tapped 6BA, as shown in Fig. 3. The copper side of the board is mounted outwards so that the components face towards the heat sink, and this makes a very compact unit. The collector connection to TR1 is made by way of one of the spacing pillars, the appropriate mounting hole being at the top left in Fig. 2. When making up the printed circuit board, ensure that the copper foil does not too closely approach the bottom right mounting hole, where connection to the mounting screw is not required.

The whole unit can, in most instances, be fitted in the radio in place of its battery. Flexible wires then run to a



Side view of the unit, illustrating the manner in which it is assembled

suitable point in the car's electrical system. If the radio has any metallic parts on its outside which are electrically connected to its circuit, great care must be taken to ensure that these do not come into contact with the car body as it is then possible for supply short-circuits, or even damage to the radio or supply unit, to result.

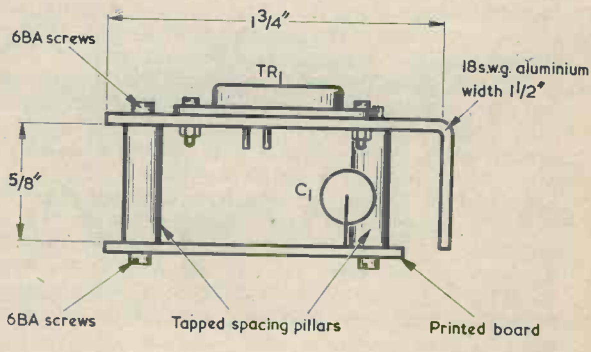


Fig. 3. How the heat sink and the printed board are assembled

PERFORMANCE

The performance of the supply unit is more than adequate for running a radio from a car battery. With a 15 volt input, which is the most likely to be encountered in practice, the output voltage drops only some 20 to 30mV with a 150mA load. At an input voltage of 12 there is a fall of some 600mV under the same current condition.

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

In the July issue, mention was made of the reception of Peru here in the UK and this has resulted in some correspondence with readers who have written directly to the writer. The questions asked most were ". . . what is the best time to hear Peru here in the UK" and ". . . which stations and on what channels".

Dealing with the question of times to hear Peru for listeners here in the UK, this will be found to be between 0330 and 0500 depending on the time of year. The signal path (short route) must be entirely, or at least mostly, in darkness. In this month (August) the path across the South American continent and the Atlantic is in darkness from approximately 2300 to 0500. However, from 2300 onwards to around 0300 many other Latin American stations are active and on the same channels as the, often, weaker Peruvians, therefore the wise SWL awaits the closure of many of these LA's before proceeding with the Peruvian Quest. In general terms, most of the Brazilians close around 0300 (many of them earlier) and the Venezuelans likewise around 0400. From 0300 onwards then many of the channels become less cluttered and from 0400 even more so, leaving the field largely clear for the Peruvians who, again in general terms, tend to close around 0500. It all sounds so easy, there must be a catch somewhere. There is – beware of the Africans opening from 0400 onwards!

Which stations on what channels? Well, try the following, OAX8F R. Atlantida on **4788**; OAX8X R. Samaren on **4815**; OAZ4C R. Andina on **4995**; OAX8V R. Eco on **5010**; OAX7Q R. Quillabamba on **5025**; R. Libertad on **5040**; and OAX8E R. Loreto on **5050**.

CURRENT SCHEDULES

● CZECHOSLAVAKIA

Radio Prague operates an External Service in English to the UK and Eire from 1630 to 1700, 1900 to 1930 and from 2000 to 2030 on **5930** and **7345**. From 2130 to 2200 on **6055**. The "Inter-Programme" to Europe in in English is radiated on **6055** and on **9505** from 0745 to 0800, 0845 to 0900, 0945 to 1000, 1045 to 1100 and from 1145 to 1200.

● SWITZERLAND

The "Overseas Service of S.B.C." from Berne has a service in English to Europe as follows – from 1100 to 1130 on **3985, 6165, 9535, 15305, 15430, 17795** and on **21520**. From 1315 to 1345 on **3985, 6165, 9535, 15140, 15305, 17795, 17830** and on **21520**. From 1530 to 1600 on **3985, 6165, 9535, 15430, 17830** and on **21520.**

● SWEDEN

Radio Sweden, from Stockholm, radiates in English to Europe from 1100 to 1130 on **9630** and on **17840**; from 1230 to 1300 on **6065** and on **15240** and from 2045 to 2115 on **6065** and on **11970.**

● NORWAY

"The Overseas Service of Radio Norway", Oslo, offers a service in English to Europe on Mondays from 0200 to 0230 on **9550, 11850** and on **11860**; from 0400 to 0430 on **9645, 11850** and on **11860.** On Saturdays from 1800 to 1830 on **6130, 11860, 21655, 21730** and on **25730.** On Sundays from 1200 to 1230 on **6130, 15175, 21655** and on **25730** and from 1400 to 1430 on **9590, 17800, 21655** and on **25730.** The entire Norwegian Home Service from 0500 (Sundays from 0615) to 2315 is relayed to the North Atlantic area on **7240.**

● SOUTH AFRICA

" 'Radio RSA' – the Voice of South Africa", Johannesburg, beams a programme in English to West Africa and Europe from 2100 to 2150 on **4875, 5980, 7270** and on **9525.** Some other programmes in English that may be heard here in the UK are from 1100 to 1200 to Central and East Africa on **11900, 15220** and on **17805**; from 1300 to 1550 on **9525** (from 1500), **11900** (to 1456), **15220** (to 1456) and on **17805.** To East Africa and the Middle East from 1600 to 1650 on **7270, 9525** and on **11900.** To North Africa from 2230 to 2320 on **5980, 6035, 9585** and on **9695.**

● CHINA

Radio Peking provides an English Service to Europe from 2030 to 2130 on **6860, 7590** and on **11685** (also on **8490** with suppressed-carrier SSB); and from 2130 to 2230 on **6860, 9030** and on **11685.**

● CANADA

"Radio Canada International" radiates to Europe in English from 0600 to 0657 on **6140** and on **9655** and from 2058 to 2155 on **11855, 15325** and on **17820.**

● **BRAZIL**
Radio Nacional de Brasilia has a programme in English from 2100 to 2200 on **15245.**

● **LEBANON**
Radio Beirut operates a service in English, Arabic and French, to Europe, from 1830 to 2030 on **15210.**

● **HUNGARY**
Radio Budapest is in English to Europe from 1745 to 1800 on **5970, 6110, 7220, 9833, 11910, 15415, 17795** and on **21505**; from 1945 to 2000 on **6110, 6130, 7220, 9833, 11910, 15415, 17795** and on **21505**; from 2130 to 2200 on **3995, 5965, 7220, 9833, 11910, 15415, 17890** and **21505.**

A Dx programme, in English to Europe, may be heard from 1615 to 1630 on Tuesdays and Fridays on **5970, 7220, 9625, 9833, 11910, 15415, 17890** and **21505**; also from 2245 to 2300 on Tuesdays and Fridays on **3995, 5965, 7220, 9833, 11910, 15155, 15220, 17710** and on **21685.**

● **EAST GERMANY**
"Radio Berlin International – Voice of the German Democratic Republic" from E. Berlin has transmission in English to Europe from 1730 to 1815 on **7260**; from 1830 to 1915 on **6080, 6115, 7185, 7300** and on **9730**; from 2115 to 2200 on **7260.**

● **USSR**
Radio Moscow radiates in English to the UK and Eire from 1130 to 1230 on **9450, 9530, 11705, 11745, 11810** and on **11830**; from 1900 to 1930 on **7205, 7310, 7390, 9550** and on **9710**; from 2000 to 2030 on **6045, 7205, 7250, 7310, 7320, 7390, 9480, 9550, 9610, 9685, 9710, 12020**; from 2100 to 2200 on **6045, 7250, 7310, 7390, 9550, 9610** and on **9710**; from 2200 to 2230 on **6045, 7160, 7250, 7390, 9550, 9610** and on **9710.**

Radio Kiev offers an English Service to Europe on Mondays, Thursdays and Saturdays from 1930 to 2000 on **6045, 7205** and on **7390.**

AROUND THE DIAL

Time at the controls has been limited over the past few weeks owing to various other interests, mainly country cottage decorating, hi-fi listening and reading up to date accounts of the latest archaeological 'digs'. However, the following did emerge from the speaker during the last few weeks.

● **CYPRUS**
BBC Relay, Limassol, at 2220 on **6180** with a programme in English about the UK countryside and its problems.

● **VENEZUELA**
YVXJ Radio Barquisimeto from 2330 on **9510** with Latin American music, announcements in Spanish, heard often.

● **SWITZERLAND**
Berne at 0700 on **9535,** news of Swiss affairs in English then "Reporters Notebook" at 0703.

● **AUSTRALIA**
Radio Australia at 0705 on **9570** with the "Mailbag" programme in which SWL's are named and thanked for reception reports etc.

● **VATICAN CITY**
In English at 2049 on **11740** with recording of the Pope welcoming visitors from Japan and other countries.

● **CUBA**
Radio Havana at 2025 on **15155** presenting their English programme to Europe and announcing as "Free America".

● **SWEDEN**
Radio Sweden at 1838 on **15240** in English with programme about Swedish schoolchildren and their educational facilities.

● **GHANA**
Accra at 2005 on **3365** when presenting a newscast in English (good luck with the surrounding commercial QRM).

● **ROMANIA**
Radio Bucharest at 1305 on **11940** with news in English and a following review of local sporting activities.

● **BRAZIL**
R. Nac. Brasilia at 2400 on **15245** with a programme in English, testing and asking for reports. Also heard on **15385** at 2010 with similar programme.

● **JAPAN**
Radio Japan at 0800 on **17825** with identification and a newscast in English.

● **NORWAY**
Radio Norway at 1415 on **9590** presenting a Dx programme in English.

● **EQUATORIAL GUINEA**
Bata at 2112 on **4926** in Spanish then local music. Not often heard, the station is apt to 'vanish' for long periods at a time, as yet unexplained.

● **SOUTH AFRICA**
Johannesberg at 2103 on **4875** with a newscast in English, quite often heard of late.

● **CHINA**
Radio Peking at 2047 on **11675** in English with a talk on Soviet foreign policy (Chinese version).

● **MALAWI**
Blantyre at 1950 on **3380** with a programme of colourful African music and announcements in local dialects.

CLANDESTINE

"Radio of the Patriots" operates from 1030 to 1130 and from 1515 to 1615 on **7320** in Farsi (Persian). Believed located in Iraq, this is an anti-Shah, anti-Iranian Government transmitter.

"Voice of Palestine" transmits from 0900 to 1100 on **6662** and is operated by the Palestine Liberation Organisation.

"Radio Liberation" operated by the African Party for the Independence of Guinea Bissau and the Cape Verde Islands (PAIGC) is reported operating from 0730 to 0900 and from 2000 to 2300 on **6122,** from 1330 to 1500 on **9585** and from 2000 to 2300 on **15275,** all in Portuguese and vernaculars.

MINIATURE CERAMIC FILTERS

By J. B. Dance, M.Sc.

Our contributor describes some recently introduced i.f. filters which are suitable for both a.m. and f.m. radio receivers

THE FREQUENCY SELECTIVE FILTERS IN THE INTERmediate frequency stages of a.m. and f.m. superheterodyne receivers provide virtually all the adjacent channel selectivity of the receiver. It is possible to obtain a sharply peaked selectivity curve with critically coupled tuned circuits. A curve with a flatter top can be obtained by using a combination of critically coupled and over-coupled tuned circuits. This fairly flat top provides improved audio quality.

A.M. RECEIVERS

A better way of obtaining a response with a flat top involves the use of a ceramic filter. This may take the form of a small component which is screened like an intermediate frequency transformer; it contains the parts shown in Fig. 1. This component can replace a conventional intermediate frequency transformer, but additional tuned circuits are usually used in the receiver to provide steep skirts in the selectivity curve; these steep curves enable a weak station to be received even if it is close to a much stronger one.

The input tuned circuit in Fig. 1 is coupled by a coil to the ceramic filter at the centre of the unit. The current passing through this filter passes through the output coupling winding and generates a voltage across the output tuned circuit.

The ceramic filter itself at the centre of the unit consists of a miniature ceramic disc with contacts deposited on each side. The filters are usually designed to operate at the conventional intermediate frequencies of 450kHz to 480kHz for use in a.m. receivers.

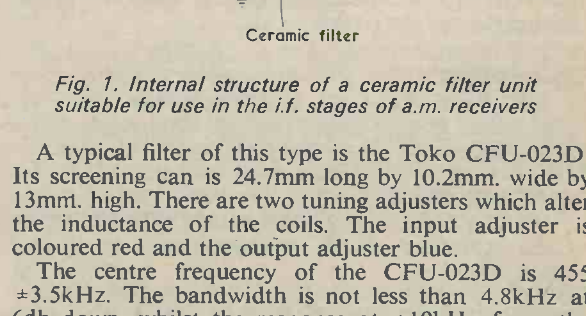


Fig. 1. Internal structure of a ceramic filter unit suitable for use in the i.f. stages of a.m. receivers

A typical filter of this type is the Toko CFU-023D. Its screening can is 24.7mm long by 10.2mm. wide by 13mm. high. There are two tuning adjusters which alter the inductance of the coils. The input adjuster is coloured red and the output adjuster blue.

The centre frequency of the CFU-023D is 455 ±3.5kHz. The bandwidth is not less than 4.8kHz at 6db down, whilst the response at ±10kHz from the centre frequency is over 27db down.

Another type of filter for a.m. receivers is the CFT-455C. Internally, it is similar to the CFU-023D but it is even smaller, its screening can being only 17.3 by 7 by 11.7mm. in size. The pass band is at least 6kHz at 6db down and any 'ripples' within this band are less than 1.5db in amplitude.

These components and other similar filters have been developed especially for use in commercially manufactured radio receivers, but are now readily available to the amateur enthusiast. The price at the time of writing is around 50 pence each, depending somewhat on the particular type concerned.

All the twelve connections shown in Fig. 1 are brought out to separate pins on the base of the unit and will fit into a printed circuit board. The three sections can be carefully extracted from the screening can by those who wish to examine the miniaturised internal construction.

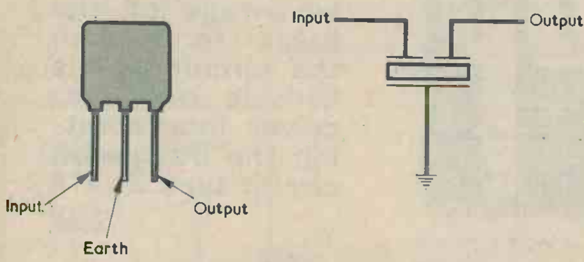


Fig. 2. Appearance and circuit symbol of a type CFS 10.7MHz ceramic filter

FILTERS FOR F.M. RECEIVERS

Another type of ceramic filter has been developed for use in the 10.7MHz intermediate frequency stages of f.m. receivers. For example, the Toko type CFS filters have body dimensions of only 9mm. by 7.3mm. by 3.5mm. See Fig. 2. They have three connections, these being input, earth and output.

Two of these filters can be used in an f.m. receiver to provide the required selectivity and pass band; no additional tuned circuits are necessary.

This type of filter contains a single ceramic resonator which (owing to the positions of the electrodes) is equivalent to a multi-section filter composed of conventional tuned circuits. It has a good band-pass characteristic.

The two ceramic filters required in an f.m. receiver should not be directly coupled together or their band-pass characteristic will be affected and an asymmetrical response obtained. A stage of moderate gain is normally used between the two filters. The driving and load impedances should be of the order of 330Ω. This relatively low impedance is one of the few disadvantages of these components.

Five colour coded types are available with centre frequencies ranging from 10.64MHz to 10.76MHz The two filters in a receiver must have the same colour code. The response of a single filter is 3db down at ±300kHz, the tolerance on this last figure (300kHz) being ±50kHz. The response is at least 20db down at ±600kHz. The change of centre frequency with temperature does not exceed ±150 parts per million per degree Centigrade in the range −10°C to +60°C.

The price of these ceramic filters is just under 50 pence each at the time of writing.

AVAILABILITY

The ceramic filters mentioned in the article are all available from Ambit International, 37 High Street, Brentwood, Essex, CM14 4RH. ■

In your workshop

As is their habit in August, Dick and Smithy take time off away from the Workshop to enjoy the dual pleasures of fresh air and sunshine. But not to escape from matters electronic, for Smithy takes advantage of the break to explain the circuit of his bedside radio receiver incorporating the integrated circuit type ZN414

"Ah," said Smithy blissfully, "this is the life."

He leaned back on the park bench and surveyed the scene in front of him. In the distance a cluster of children played around a group of swings and a slide. The far corner of the park was taken up by a cricket pitch, and the occasional thwack of bat and ball reached his ears comfortingly. Lazily, he watched the players, musing idly on the time which elapsed between the hitting of the ball and the instant when the resultant sound reached his ears. Soothed by the warm August afternoon sunshine, he closed his eyes and fell into a state of philosophic meditation.

"Stap me," came a voice beside him. "I've only got to leave him on his own for five minutes and he darned well falls asleep."

ZN414 RECEIVER

Smithy opened his eyes and looked irritably up at his assistant.

"I am not asleep," he stated scathingly. "As it happens, I'm pondering."

"Pondering? On what?"

"On the mysteries of life," replied the Serviceman loftily. "Do you realise, Dick, that we are, every one of us, all slaves of time?"

"Blimey," remarked Dick, impressed by this intelligence. "In what way?"

"Well," said Smithy. "When the batsman in that game of cricket over there hits the ball I assume that I see him at the exact instant that he does so. But I don't, because the light rays reflected from him take a finite time to reach my eyes. Then again, if I rely on my ears to judge when he hits the ball there is, relatively, a very large time lag between his hitting the ball and my aural perception of his doing so. Even the batsman himself isn't aware of the precise instant at which he hits the ball, because the sensation from his hands takes at least a fraction of a second to travel through his nerves up to his brain."

"I don't think I like the sound of this," commented Dick uneasily. "If you carry your argument to its conclusion, everything happens in advance of our realising it."

"That's exactly so."

"You shouldn't dwell on things like that," stated Dick firmly. "Mysteries are best left as mysteries. Anyway, here are the ice-creams."

Abruptly, Smithy turned his thoughts from abstractions to realities.

"Hey, I said wafers."

"They didn't have any wafers. They've only got these ones on sticks."

Sitting up, Smithy took the ice-cream from his assistant and looked at it with disfavour.

"Nothing's the same as it used to be," he complained. "In the old days you could get a nice runny wafer with a bit of toilet paper put round it so you didn't get the ice-cream on your fingers. Nowadays, it's all these things on sticks. What nourishment is there in a stick?"

But there was no reply from his assistant, who was already busily engaged in licking away the outer layers of his ice-cream. Smithy proceeded to do likewise. When he was about half-way through the ice-cream he glanced at his watch, then produced a rather large plastic case from his pocket. This had three knobs on the front surface.

"What's that?" queried Dick.

"Just a radio I've knocked up," replied Smithy. "It's really a bedside set, but I thought I'd bring it along with me today just to hear the news."

Smithy consulted his watch once more, switched on the receiver and adjusted its tuning control. Almost immediately the Radio 4 time signal became audible, to be followed by the announcer recounting a summary of the day's strikes, demonstrations, hijackings and riots.

"Just the same old things," grunted Dick, as Smithy switched off the radio. "Dead boring the news is these days."

The pair returned to their ice-creams. After some moments, a thought occurred to Dick. He turned to examine the radio receiver, which Smithy had now placed beside him on the bench.

"Is there anything peculiar about that set, Smithy?" he asked curiously. "I can't see you spending your time making up a conventional radio when you've got plenty of manufactured ones available to you."

"It *is* a bit unusual," replied Smithy. "Actually, it's a set which incorporates the Ferranti ZN414 integrated circuit."

"The ZN414, eh?" repeated Dick, his interest aroused. "Isn't that the integrated circuit which provides all the r.f. amplification, together with detection, for an a.m. receiver?"

"It is," confirmed Smithy. "In its simplest form the ZN414 can be employed in a circuit which requires only one resistor, two fixed capacitors, an earphone and a ferrite rod aerial tuned circuit. Wait until I've got through this ice-cream and then I'll show you what I mean."

The pair finished their ice-creams at about the same moment, after which Dick took the two sticks and pieces of wrapping paper and deposited them in a nearby litter bin. As he returned to the bench he noticed a very scruffy old man just entering at the park gate.

Then he glanced once more at Smithy's receiver, and the latter once more took up all his attention.

Smithy had taken a piece of paper from his pocket, and was sketching out a circuit on it.

"As it happens," he remarked, "I had the circuit of the receiver on me, but before I get down to that let me show you the basic ZN414 circuit."

Smithy showed Dick the circuit he had just drawn. (Fig. 1).

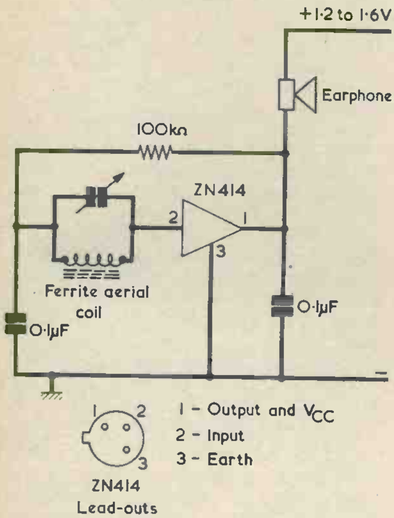


Fig. 1. The ZN414 integrated circuit may be employed in a basic circuit of the type shown here. The earphone should have a d.c. resistance of 250Ω or more

"You couldn't," he continued, "have anything simpler than this. The ferrite aerial can be a medium wave type and the a.f. output from the ZN414 is sufficiently high, at around 30 millivolts or more, to operate a reasonably sensitive earphone having a suitable impedance. Or, of course, the earphone can be replaced by a load resistor and the output fed to an a.f. amplifier which then drives a speaker."

"In that case," said Dick, "what you've got in your receiver must obviously be a ZN414 followed by an amplifier and speaker."

"You're right," confirmed Smithy. "Now, there's nothing particularly marvellous in making an a.f. amplifier, and so I decided to concentrate on making an amplifier which was pretty well as simple as it could be. To my way of thinking, the very simple circuit around a ZN414 should be complemented by an almost equally simple a.f. amplifier circuit, and that's what I've attempted to provide in this radio of mine. It doesn't have as high an a.f. output as the usual superhet does, but it can give adequate volume for a bedroom or a similarly quiet place from the local medium wave B.B.C. stations."

LOW SUPPLY VOLTAGE

"If the circuit is so simple," asked Dick, "could it be made up to give a really miniature radio?"

"Well, it could," replied Smithy. "But I don't recommend such a course because you would then have to use a very small speaker, and this would be rather insensitive. This circuit works best with a speaker having a cone diameter of about 4 inches or more. When I tried it out after I built it I connected it to an 8 inch speaker housed in a proper cabinet, and I got quite an appreciable volume level from this. Anyway, I'll now show you the complete circuit."

Smithy turned over the sheet of paper on which he had sketched the basic ZN414 circuit. The circuit of the receiver had already been drawn on the other side. (Fig. 2).

"Blow me," remarked Dick. "The battery supply is only 3 volts in this circuit."

"True," agreed Smithy. "The specified supply voltage range for the ZN414 is 1.2 to 1.6 volts, with 1.3 volts recommended by the makers. The current consumption is tiny, being only 0.3mA typical and rising to 0.5mA under strong signal conditions. It seems reasonable, therefore, to supply the ZN414 from one 1.5 volt cell of the battery and to use the full 3 volts from this and a second 1.5 volt cell to supply the a.f. amplifier. The fact that the voltage dropped across the base-emitter junction of a silicon transistor is around 0.6 to 0,7 volt then enables a very simple amplifier to be made up, as I'll explain to you in more detail shortly."

"Well," remarked Dick, "the circuit doesn't seem to be particularly complicated."

"It isn't," said Smithy. "Now, seeing that we are thinking in terms of a 3 volt supply the best choice of speaker impedance is 3Ω. There won't be much a.f. output voltage available so we'll obtain the greatest output power by using the lowest standard speaker impedance. If the two output

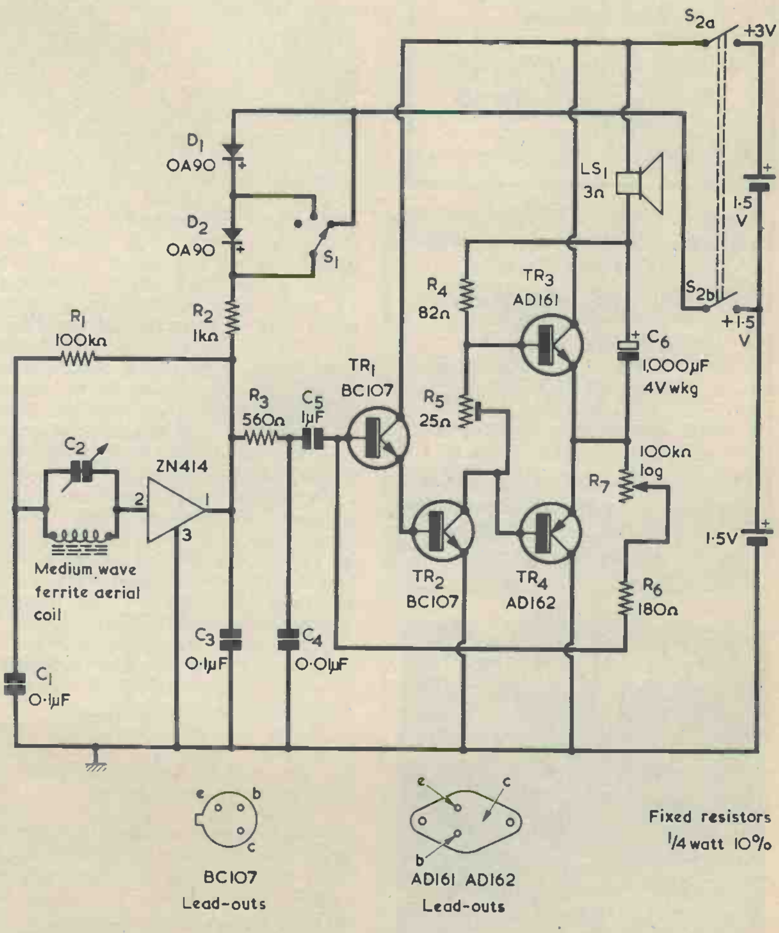


Fig. 2. The circuit of Smithy's medium wave radio incorporating a ZN414

emitters are at half supply voltage in the absence of signal we can assume for the moment that they are then able to swing positive and negative by up to nearly 1.5 volts. This corresponds to an r.m.s. value of about 1 volt. Now, the r.m.s. output power is equal to voltage squared divided by speaker impedance, and the figures I've just mentioned point to an output of a third of a watt. In practice the r.m.s. output power will be lower than this because the two output emitters won't be able to swing positive and negative by quite as much as I assumed and because there'll be a small loss in the 1,000μF capacitor coupling the emitters to the speaker. I would guess that the maximum output power is of the order of 250 milliwatts or so."

"Even that," remarked Dick, "isn't to be sneezed at. I see that you've used power transistors type AD161 and AD162 for TR3 and TR4 in the output stage. Aren't these rather large types for use in a low power stage like you've got here?"

"They are," agreed Smithy, "and, in fact, they're considerably under-run. I had some difficulty in selecting the output transistors when I was working out the circuit. To start off with, the output transistors must be germanium as there just isn't enough supply voltage available to allow silicon transistors, with their relatively high base-emitter voltage drops, to be used. Now, in theory, the output emitters should be capable of applying 1.5 volts to a 3Ω load, and this corresponds to an output current of half an amp. Also, if an excessively high signal were applied to the output stage, clipping could cause the output transistors to handle what is effectively a square wave with a peak-to-peak amplitude of 3 volts. Each output transistor would then dissipate a power equal to 1.5 volts multiplied by 0.5 amps, or 750 milliwatts, for half the time. The average dissipation for each transistor would then be 375 milliwatts. These theoretically possible output currents and powers made me a little unhappy about using smaller transistors, such as the AC127 and AC128. So I decided to plump for the AD161 and AD162, even though they would be used far below their normal dissipation level. Since the design is not intended to be for a miniature radio, little is lost by using bulkier transistors. The AD161 and AD162 do not need to be fitted to heat sinks."

"I notice," remarked Dick, "that you haven't fitted any series resistors in the output emitter circuits to counteract thermal runaway."

"There isn't," grinned Smithy, "enough output voltage available to allow such resistors to be employed! Also that's another of the marginal reasons which caused me to use the AD161 and AD162. Their cases are large enough to keep them cool in normal working, and in the very unlikely event of thermal runaway actually taking place they almost certainly wouldn't come to any harm anyway. Both types are capable of passing currents up to 3 amps, and all they'd do under thermal runaway conditions would be to run the supply battery down very quickly."

FEEDBACK CIRCUIT

A shadow fell across them and they looked up, to see that the unkempt old man who Dick had spotted at the park gate was now shuffling past. At this closer range, Dick was able to examine him in greater detail. On his head he wore a cloth cap with a ragged brim whilst, lower down, Dick noted a torn and ragged jacket from one pocket of which hung a repulsively filthy rag which presumably served the function of handkerchief. Crumpled and dirt-stained trousers augmented the ensemble, which was completed by dust-laden shoes, the sole of one of which flapped up and down as its owner shambled by. He was muttering peevishly to himself, and a large drop hung precariously from the end of his nose.

Dick and Smithy watched the old man as he proceeded shakily along the park path. Eventually, he passed out of earshot, and they tore their eyes away.

"What a disgusting old man," said Smithy.

"I'll say," agreed Dick. "He ponged a bit too, didn't he?"

"I think it's a scandalous state of affairs," commented Smithy, "letting people like that into public places. Anyhow, he's gone past now, thank goodness, so let's forget about him. What were we talking about?"

"You were describing the output stage of your radio."

"Was I? Oh yes, I remember now. Well, as I was saying, I decided after a lot of thought to choose the AD161 and AD162 as output transistors. Both of these have a minimum current gain of 80 whereupon, if they are to pass output currents of half an amp, they need a minimum base drive of half an amp divided by 80. This works out at just over 6mA. In consequence, the standing current in the collector load for driver transistor TR2 needs to be quite a bit higher than this. The collector load is R4, and I've given it a value of 82Ω. Assuming a voltage drop of 1.5 volts across this resistor, the current which flows through it then works out at just a little lower than 20mA. In practice it's about 18mA or so because some of that 1.5 volts is dropped in R5. A current of 18mA in R5 is quite high enough in practice."

"I notice," remarked Dick, "that you've bootstrapped the top of R4 to the lower terminal of the speaker."

"True," agreed Smithy. "You may remember that we were talking about a.f. amplifier output stages and bootstrapping during our last gen sesh, so we don't need to go into that subject all over again, apart from saying that the bootstrapping causes R4 to have a much higher effective resistance at a.c. than its physical value of 82Ω."

"Fair enough," said Dick. "Now what exactly do TR1 and TR2 do?"

"TR1," replied Smithy, "acts as a current amplifier feeding into TR2. And here we come to a point which I mentioned at the start and which is very helpful in the present design. Both TR1 and TR2 are silicon transistors, which means that there is a voltage drop of 0.6 to 0.7 volt across their base-emitter junctions. Thus, the voltage at the base of TR1 is about 1.2 to 1.4 volts positive of the negative supply rail. Negative feedback is applied from the output emitters to TR1 base via R7 and R6, with the result that the output emitters are also held at around 1.2 to 1.4 volts positive of the negative rail. As you can see, this voltage is quite close to the half-supply voltage. What happens here is that R4 attempts to pull the output emitters up to the 3 volt positive rail, but as soon as they go sufficiently positive for current to flow into the base of TR1 both TR1 and TR2 conduct and hold them at this level. The circuit is then in a state of balance. If, for any reason, the output emitters went positive, base current in TR1 would increase as also would its collector current and the collector current of TR2. The increase in TR2 collector current would then cancel out the positive excursion of the output emitters." (Fig. 3(a).)

"Blow me," remarked Dick. "That's a bit of luck, Smithy! Just by using a couple of silicon transistors in a very simple amplifying circuit you can automatically set up the output emitters really close to half-supply voltage."

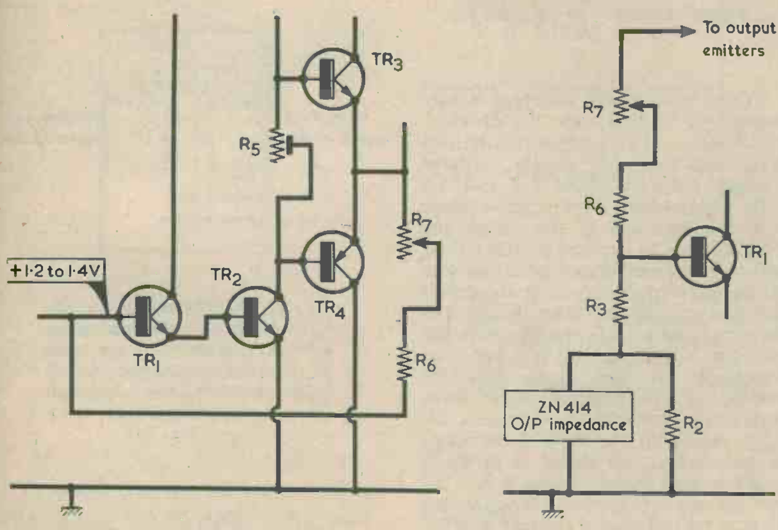
"Yes, it's an extremely fortunate state of affairs," agreed Smithy. "In my set I find that the output emitters actually sit at around 1.4 volts. They go slightly more positive as R7 inserts more resistance into circuit but only by a tiny amount."

"Now, that's something else I was going to ask you about," said Dick. "What is the idea behind making R7 variable?"

"R7 is the amplifier volume control," said Smithy. "The feedback circuit which keeps the output emitters at half-supply voltage is a d.c. arrangement, and the feedback components at d.c. are just R7 and R6 on their own. But the a.c. feedback circuit is quite different, because at audio frequencies C5 has a low impedance. The feedback circuit becomes a potential divider, with R7 and R6 forming the upper arm, and the lower arm being given by R3, the output impedance of the ZN414 and R2." (Fig. 3(b).)

"Won't the input impedance of TR1 base also be in the lower arm of the potential divider?"

"It will be," confirmed Smithy. "However, it will be very much higher in value than the resistive components and the output impedance



(a) (b)

Fig. 3 (a). The d.c. feedback loop in the a.f. stages of the receiver. This causes the output emitters to take up a potential slightly higher than that at the base of TR1

(b). Assuming that C5 has zero reactance and that the upper end of R2 is at chassis potential, the a.c. feedback loop takes up the form shown here

of the ZN414, and it can be ignored. So also, incidentally, can the reactance of C3, which is of the order of 15kΩ at 1kHz. When R7 is set to insert minimum resistance into circuit, the upper arm of the potential divider is given by R6 on its own. The very high level of feedback at the base of TR1 results in the a.f. amplifier stages having almost zero gain. When R7 is set to insert maximum resistance into circuit the upper arm of the potential divider is given by R6 in series with all of R7, and the amount of feedback is negligible. Under these conditions the amplifier is working virtually all out. R7 offers a very smooth control of volume, the minimum volume position being given when it inserts zero resistance into circuit, and the maximum volume position occurring when it inserts full resistance. A log pot is used here, and it is wired so that it inserts increasing resistance as its spindle is turned clockwise. If desired, this can be a pot fitted with a double-pole switch, and the latter can then be the on-off switch, S2(a) (b)."

"Why did you put R6 into circuit?"

"To avoid the situation where there is zero resistance between the output emitters and the base of TR1," explained Smithy. "Without R6 the a.f. stages would tend to go into r.f. oscillation when R7 slider is right at the minimum resistance end of its track. R6 prevents this happening."

ZN414 OPERATION

"Well," remarked Dick, "that seems to have the a.f. amplifier part all buttoned up. What about the coupling between the ZN414 output and the base of TR1?"

"Things are pretty straightforward here," replied Smith. "C3 and C4 are r.f. bypass capacitors, and C5 is a plastic foil a.f. coupling capacitor. Resistor R3 is part of the r.f. filter, and it also provides part of the resistance needed in the lower arm of the a.f. negative feedback potential divider. One important practical point is that C3 must be wired very close to the earth and output lead-outs of the ZN414. If it isn't, the ZN414 tends to become a little unstable; which isn't surprising, of course, when you consider the fantastic amount of gain it has at radio frequencies. Also, input wiring should be kept well spaced from output wiring."

As Dick turned to look once more at Smithy's circuit, he noticed something out of the corner of his eye.

"Ye gods, Smithy," he muttered, "just look over there."

Smithy glanced in the direction indicated by his assistant and stiffened.

"Why, the dirty old man," he snorted disgustedly.

"Shocking, I call it," said Dick, primly.

"It didn't ought to be allowed," stated Smithy firmly. "Quite disgraceful."

"I've seen everything now," pronounced Dick censoriously. "Just imagine it, going through the litter bins like that. I suppose he's looking for scraps to eat or something."

"This is a Welfare State," retorted Smithy, "and there should be no necessity for behaviour like that. I wish he wouldn't keep hanging around us here, though."

"Oh, let's forget about him," stated Dick, purposefully turning his gaze back to the circuit of Smithy's receiver. "What are those germanium diodes for at the top of the 1kΩ resistor?" (Fig. 4).

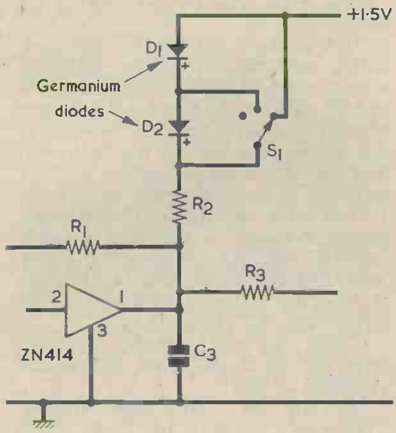


Fig. 4. Switch S1 and diodes D1 and D2 enable varying supply voltages to be applied to the ZN414

"They're to enable different supply voltages to be applied to the ZN414," said Smithy. "This integrated circuit is very sensitive to supply voltage changes between about 1.2 and 1.6 volts. I found that, if the supply voltage is at the high end of this range, the ZN414 tends to become a little chirpy and to give heterodynes on either side of the received signal, with the result that tuning becomes rather the same as the tuning of a t.r.f. receiver with the reaction advanced a little too far. Reception of the more powerful stations is still possible under these conditions, presumably because the a.g.c. action in the ZN414 decreases its gain when the signal is properly tuned in and thereby takes it just below the oscillation point. When switch S1 is at its right-hand contact, the full 1.5 volts from the battery is applied to R2. If S1 is set to the middle position the voltage applied to R2 is 1.5 volts minus 0.1 to 0.2 volts dropped in diode D1. Setting S2 to the left hand position puts both diodes in circuit and the supply voltage drops by another 0.1 to 0.2 volt. Having the diodes in series does not affect the load resistance given by R2 to any great extent because, whilst the diodes drop the supply voltage, the resistance they present into circuit is only their low forward slope resistance. I find S1 is very useful for setting up the ZN414 at just the right supply voltage for a particular station. It also caters for the situation given when the battery voltage falls with age. I've shown the diodes as OA90 in my circuit, but in practice almost any germanium diodes could be used here."

"That seems to be a jolly good circuit approach," commented Dick. "What about the ferrite rod aerial?"

"Any medium wave ferrite aerial can be used," said Smithy. "I used a ready-wound aerial and simply connected its tuned winding into circuit. The value of C2 is that required for the particular aerial being employed and would, typically, be 208pF."

"How about long waves?"

"I wouldn't recommend this receiver for long wave reception," said Smithy, "unless it is to be used in an area where the Radio 2 signal on 1,500 metres comes in at pretty good strength. Incidentally, whilst talking about long waves, there's one point I would like to bring up. Ready-wound ferrite rod aerial assemblies for medium and long waves normally have the medium and long wave coils separate. If no connection is made to the long wave coil it is quite possible for it to resonate, with its own self-capacitance, at a frequency in the medium wave band. It then acts as an absorption tuned circuit and considerably attenuates medium wave signals picked up on the medium wave coil." (Fig. 5).

Fig. 5. It is possible for the long wave tuned winding on a ferrite rod to resonate, with its own self-capacitance, at a frequency in the medium wave band

"That's awkward," commented Dick. "How do you know if the long wave coil is doing this?"

"By simply slipping it off the ferrite rod," replied Smithy, "whereupon any effect it has on medium wave reception should disappear. It's because of this absorption trouble that the long wave ferrite aerial tuned coil is frequently short-circuited in medium and long wave sets when medium waves is selected. Anyway, we're straying from our subject, which is this medium wave set of my own."

"Fair enough," said Dick. "What about current consumption?"

"It's about 24mA from the 3 volt battery under quiescent conditions," stated Smithy. "And it rises up to well over 100mA or more when it's reproducing a signal at the maximum volume level."

"Blimey," said Dick, "that's a bit high, isn't it?"

"Not really," replied Smithy. "Don't forget that the supply voltage is only 3 volts. The current consumption compares quite favourably with the usual situation in a superhet receiver having a 9 volt battery, where quiescent current is around 10mA, rising to 50mA or so at high volume levels."

"What sort of battery do you recommend?"

"Probably the best buy here," said Smithy, "is a twin cell cycle lamp battery, such as the No. 800 made by Ever Ready. If you pull up the cardboard at the top of this battery it's quite easy to solder a lead to the internal wire joining the two cells. This gives the 1.5 volt supply needed by the ZN414. The advantages with these cycle lamp batteries are that they are intended to provide quite high currents for long periods, they have a low internal resistance and they're relatively inexpensive." (Fig. 6.)

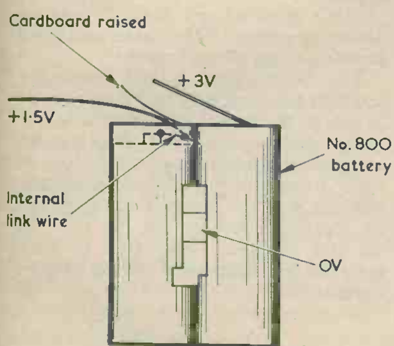


Fig. 6. An Ever Ready No. 800 battery, or equivalent, can be used to power the receiver. A connection made to the internal wire linking the two cells provides the positive 1.5 volt point

"I see," commented Dick. "Now there's only one final question I want to put to you."

"Fire away."

"How do you set up R5?"

"That's not too difficult," remarked Smithy. "When the set has been assembled, you connect the negative supply rail to the negative terminal of the battery, and the 3 volt rail to the positive battery terminal via a testmeter switched to read currents of the order of 25mA. R5 should be initially set to minimum resistance, and the 1.5 volt supply rail is not connected to the battery. Then switch on. You don't need to worry if the meter gives a reading that's a little lower than the 18mA I mentioned earlier as the current which flows through R4; the lower reading is merely due to the fact that testmeters tend to drop a relatively large voltage across their terminals when they're switched to the higher current ranges. Then gradually increase the resistance inserted into circuit by R5 until the current reading increases by about a third. If, for instance, the original reading was 15mA, then R5 is adjusted for a reading of 20mA, and so on. Incidentally, you can't use a skeleton pre-set for R5 as these aren't normally made for values below 100Ω, and so this resistor can be a small wire-wound potentiometer. It should also be in reasonably good condition because, if the wiper is in poor contact with the track, it will present a high resistance between the bases of TR3 and TR4, and these transistors could pass an excessively high current as a result." (Fig. 7.)

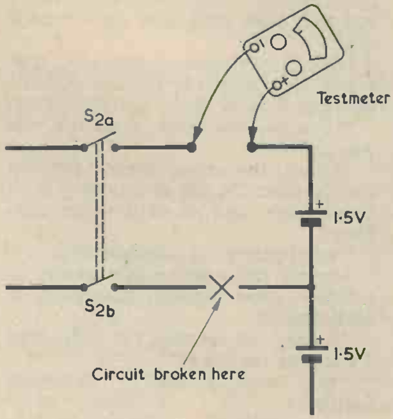


Fig. 7. The test set-up required for adjusting R5. This potentiometer should be initially adjusted to insert zero resistance into circuit

DESTINY

Smithy folded up the circuit diagram of his receiver and returned it to his pocket. Even Dick's enquiring mind seemed to be satisfied for the time being, and a long peaceful minute passed as they sat contentedly in the sunshine.

"Hey, guv," wheezed a tremulous voice at Smithy's ear.

Startled, Smithy shook himself out

of his reverie and found himself gazing into the rheumy blood-shot eyes of the disreputable old man who had been haunting them during the afternoon.

The old man drew a faltering breath and brought his face closer to Smithy. The Serviceman leaned back as far as he could on the bench.

"Have yer," continued the old man purposefully, "got the price of a cup of coffee?"

"I'm not certain if I have," replied Smithy, attempting the near-impossible task of talking without inhaling. "In fact, I don't even know how much coffee costs these days. I always drink tea myself."

The old man looked at the Serviceman with acute distaste.

"It's always the same," he grumbled. "Nobody's ever prepared to help me."

Dick decided to come to Smithy's rescue.

"You should be ashamed of yourself," he said sternly, "going around begging like this."

Quivering, the old man turned towards Smithy's assistant.

"Hah," he coughed bitterly, "it's all right for you young ones, you've got all your time in front of you. I was starry-eyed and full of hope myself once, but the world has cheated me. I can only look back now on a wasted life."

Dick's ever-present curiosity rose above his aversion to the disreputable figure in front of him.

"How do you mean, your life was wasted?"

"I chose the wrong career," faltered the old man. "A life of drudgery is all I've known, and all of it to no purpose."

"What career did you choose?"

The old man, now in an ecstacy of self-pity, drew himself, trembling, to his full height.

"I was," he intoned, "a radio and TV service engineer!"

"You were a *what*?" spluttered Smithy.

"I was a radio and TV service engineer, mate, Just think of it: all those years breathing in solder fumes, getting shocks and fixing sets free for in-laws."

The old man drew in a rasping breath.

"But worse was to come."

"Don't tell me," implored Smithy. "Just don't tell me."

"I *must* tell you," said the old man. "I was promoted to Service Manager."

"Oh no," breathed Smithy.

"So," went on the quavering voice, "not only did I have the solder fumes, the shocks and the in-laws, but I also had staff troubles and non-delivery of spares. Well, that's the story of my life, and now I haven't even got the price of a cup of coffee."

Hastily, Smithy reached into his pocket, fished out a tenpence piece and handed it over to the old man. He clutched the coin with a muttered grunt of thanks, then set off towards the park gate. Dick and Smithy watched in silence as he shuffled along the path and eventually disappeared outside the gate.

There was a thoughtful pause, after which Smithy reached down absently at the park bench beside him. A frown creased his brow, and, unwillingly, he looked down.

"Why, the old devil," he burst out. "Do you know what he's done?"

"No," replied Dick, "what has he done?"

"He's pinched my radio!" snorted Smithy furiously. "He's been and gone and nicked my darned radio!"

The Serviceman rushed feverishly towards the park gate and then started to search the streets on the outside.

But, as he himself had observed, we are indeed the slaves of time. Just as apart from rare moments of precognition the future is hidden from our eyes, so also had the aberrant old man, in the few minutes vouchsafed to him, apparently disappeared off the face of the earth. ■

Dammit Jackson! WHY does it have to be TODAY when the Board discover the results of your METRIC CONVERSION TRAINING PROGRAMME?

SIMPLE SQUARE WAVE GENERATORS

By M. J. Darby

Five Square wave generator circuits incorporating the 555 i.c. timer

VARIOUS CIRCUITS FOR CONVERTING THE SINE WAVES from a signal generator into square waves have appeared in the past, whilst other circuits have been designed to generate square waves directly. Such circuits normally employ several transistors and quite a number of associated components.

This article shows how the economical 555 integrated circuit (which was developed mainly for use as a timer) can be employed in very simple circuits to generate square waves or to convert sine waves into square waves.

The output waveform is very suitable for checking the frequency response of audio amplifiers and similar equipment.

THE 555

The 555 is basically a voltage comparator system which controls a bistable circuit; it can be used for many purposes other than those for which it was mainly designed.

The basic internal circuit of the device is shown in block form in Fig. 1. If pin 5 is left unconnected, the bistable circuit will be switched when the voltage at pin 2 falls to a value of less than one-third of Vcc; this results in the voltage at the output rising to its 'high' state, where it is only a little less than Vcc.

The circuit will remain in this state until the voltage at pin 6 rises to a value equal to two-thirds of Vcc; the bistable will then be reset and the output will return to

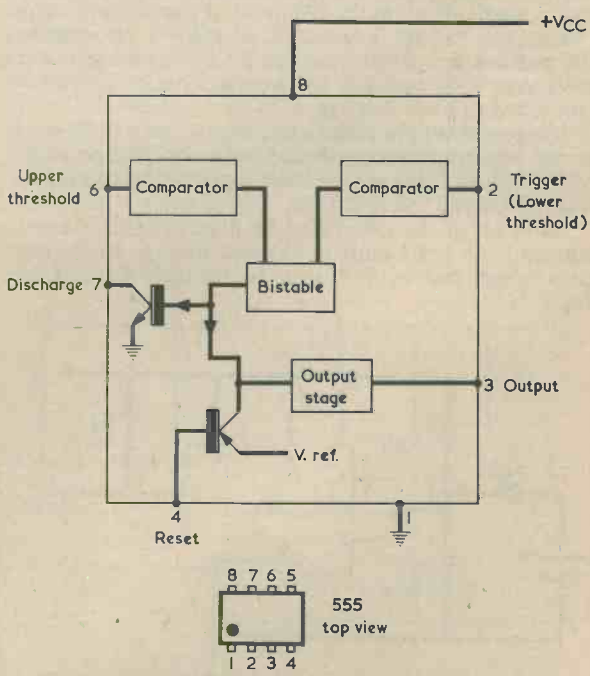


Fig. 1. Block diagram for the 555 i.c., showing the functions employed in the circuits described in this article

its 'low' voltage state in which it is only slightly above the negative supply line potential. In this state the internal transistor connected to pin 7 conducts, so this pin is effectively grounded.

Th rise and fall times of the output waveforms are about 0.1 microsecond, so one can obtain reasonable square wave outputs at frequencies up to about 1MHz.

USE WITH SIGNAL GENERATOR

If one already has a signal generator which provides sine waves, one may wish to convert the sine waves into square waves so as to be able to use the calibrated frequency scale of the generator.

A very simple circuit which will convert sine waves into square waves is shown in Fig. 2. The sine wave input must have an amplitude which is not less than about 2 volts peak-to-peak.

The mean potential of pins 2 and 6 is half of the supply voltage, namely $2\frac{1}{2}$ volts. When the applied sine wave raises the potential of pin 6 to two-thirds of the positive line voltage (i.e. to $3\frac{1}{3}$ volts) the output is switched to its low voltage state.

Similarly, when the sine wave drives the potential of pin 2 to below one-third of the positive supply line voltage (i.e. to $1\frac{2}{3}$ volts) the output returns to its high voltage state.

Pins 5 and 7 of the 555 are left unconnected in this circuit.

The lowest frequency at which the circuit can be used is determined by the value of the time constant formed by C1 multiplied by R1 and R2 in parallel, although the input voltage has some effect on the minimum frequency. If the circuit ceases to provide an output as the frequency is reduced, either C1 or the input voltage may be increased.

The values of R1 and R2 have been chosen so that the current taken by pins 2 and 6 (less than 1μA) produces only a small effect on the potential of these pins.

The reset facility is not used, so pin 4 is returned to the positive line to prevent the possibility of spurious resetting. This cuts off the internal p.n.p. transistor connected to pin 4 (see Fig. 1).

The power supply voltage has been chosen to be near to the minimum recommended value for the operation of the 555 so that the sine wave input voltage required is a minimum.

As in all of the circuits to be discussed, the output current from pin 3 must not exceed 200mA. In the circuits which follow, Vcc may be between 4.5 and 16 volts.

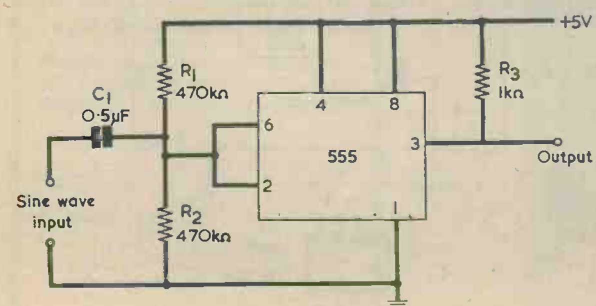
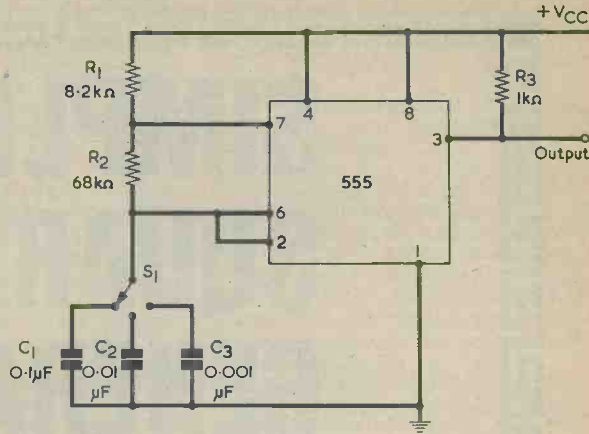


Fig. 2. A circuit for converting a sine wave to a square wave



$$f = \frac{1{\cdot}44}{(R_1 + 2R_2)C}$$

Fig. 3. A square wave generator which provides outputs at approximately 100Hz, 1kHz and 10kHz

ASTABLE MODE

A simple square wave generator circuit using the 555 in the normal astable circuit is given in Fig. 3. The component values shown have been selected so that the circuit will provide three output frequencies (selected by S1) at about 100Hz, 1kHz and 10kHz for the testing of audio amplifiers. Pin 5 is not connected in this circuit.

The capacitor selected by S1 charges through R1 and R2 in series until the potential across it reaches two-thirds of vcc, whereupon the upper threshold comparator switches the bistable and the output voltage falls to its low state. The same capacitor then discharges into pin 7 through the one resistor, R2, until the voltage at pin 2 falls to one-third of Vcc; the bistable is switched back again at this point and the output voltage rises. Thus the capacitor continually charges and discharges between one-third and two-thirds of Vcc.

The charging time is slightly greater than the discharging time in this circuit, since charging takes place through R1 and R2 in series, but discharging takes place through R2 only. R1 has therefore been made much smaller than R2 in Fig. 3 so that the output waveform is not very asymmetrical.

The frequency of oscillation is given by the equation, included in Fig. 3.

If R2 is replaced by a variable resistor, the frequency is continuously adjustable, but a few 'spot' frequencies are usually adequate for audio amplifier testing. The maximum value of (R1 + R2) is about 20MΩ, but this limit is only of importance at very low frequencies.

The output voltage is slightly less than Vcc, its exact value depending on the output current. The frequency is not affected by the output current.

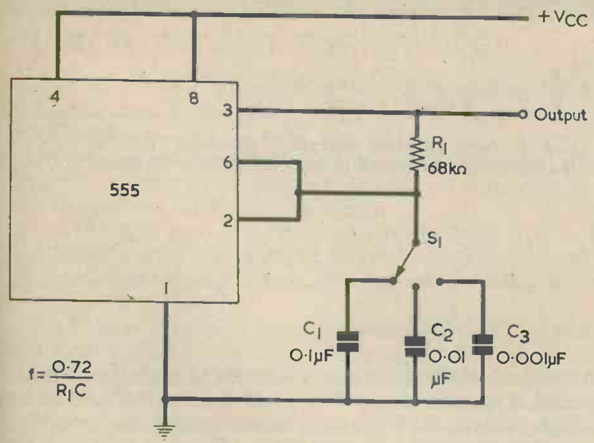


Fig. 4. A simple square wave generator for 100Hz, 1kHz and 10kHz

SIMPLER CIRCUIT

An even simpler circuit for producing symmetrical square waves at three frequencies is shown in Fig. 4; only one resistor is required.

If the output voltage in the circuit is initially high, the capacitor selected by S1 will charge through R1 from the output pin of the 555. When the potential of pin 6 reaches two-thirds of Vcc, the bistable switches and the output changes to its low state. The capacitor then discharges through R1 into pin 3. When the voltage at pin 2 falls below one-third of Vcc, the output is switched to its high state again. Thus the circuit continues to oscillate.

In this circuit the charging and discharging currents both pass through the same resistor, so the waveform is symmetrical. The frequency of operation is given approximately by the equation shown in Fig. 4. If appreciable current is taken from the output, the voltage swings at pin 3 will be slightly reduced and this will reduce the frequency somewhat.

The three frequencies produced by the circuit of Fig. 4 are approximately 100Hz, 1kHz and 10kHz.

IMPROVED WAVEFORM

The circuit of Fig. 4 provides an output which may show some minor defects in its waveform immediately before the output voltage rises. This trouble can be avoided by the use of the circuit shown in Fig. 5 which is designed to provide three switched frequencies of the same approximate values.

When the output is in the low voltage state, the capacitor selected by S1 charges through R1, the current passing into pin 3; the voltage at pin 2 therefore falls. When this voltage reaches a value of one-third of Vcc, the output is switched to the high voltage state and the capacitor discharges through R1 into pin 3.

The output waveform is fairly symmetrical. The frequency is given by the same equation as that for the circuit of Fig. 4.

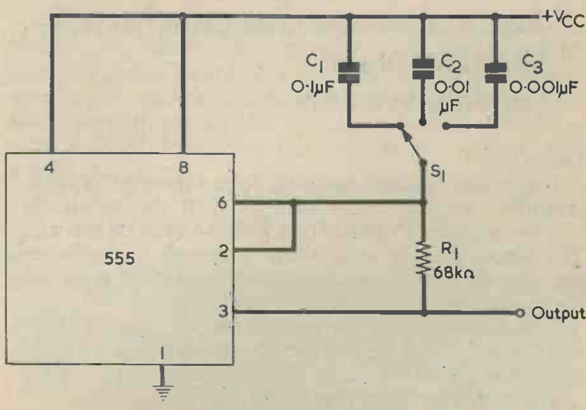


Fig. 5. A square wave generator offering an improved waveform

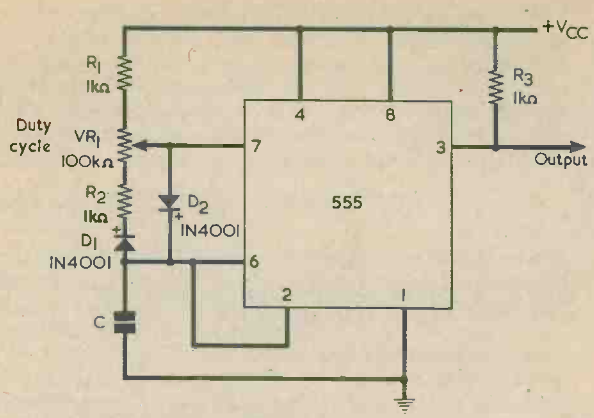


Fig. 6. A rectangular waveform generator having a duty cycle which can be varied over wide limits

VARIABLE DUTY CYCLE

In the circuit of Fig. 3, the charging time cannot be less than the discharging time. The output therefore spends more time in the high voltage state than in the low voltage state. The circuit of Fig. 6 is a modified version of Fig. 3; it has the advantage that the duty cycle can be varied over a very wide range by the potentiometer VR1. The frequency of oscillation is almost independent of the setting of VR1. Only one capacitor is shown in this circuit for simplicity. If this has a value of 0.001μF the frequency is approximately 14kHz.

The capacitor charging current flows through R1, part of VR1 and D2. The discharging current flows through D1, R2 and part of VR1 to pin 7. The two diodes therefore effectively separate the charging and discharging paths and enable the value of the resistors in these paths to be chosen independently.

When the slider of VR1 is at the upper end of its travel, the charging time is very short and therefore the output spends only a very small part of its time in the high voltage state. Short positive pulses are in consequence obtained at the output.

Similarly, when the slider of VR1 is at its lowest point in Fig. 6, the discharging time is short compared with the charging time and a series of short negative-going pulses are obtained at the output.

The duty cycle may be varied anywhere between these two extremes. The frequency is not very dependent on the setting of VR1. In addition, the frequency is independent of the output current up to the 200mA recommended maximum output current for the 555.

CONCLUSION

The 555 i.c. is available from a number of suppliers as NE555V or LM555CM. It can also be obtained as the R.S. Components '555 type' timer, from retailers of R.S. Components parts. ■

LETTERS...

The Editor,
Readers' Letters,
Radio & Electronics Constructor,
57 Maida Vale,
London, W9 1SN.

Dear Sir,

I have just finished building John Green's "Wyvern" amplifier, and am very pleased with the result. My version supplies 15 watts from a mono cassette recorder. The whole project took about a month to finish, and the only difficulty experienced was that of obtaining components.

The amplifier was my second project, the first being a rather unsuccessful multimeter, so I was pleased when it worked first time.

Many thanks for a great magazine.

Peter P. Garner – Peterborough.

Dear Sir,

Many readers of *Radio & Electronics Constructor* are also members of the Radio Society of Great Britain, and will be familiar with the book entitled *World at Their Finger Tips*. This book was written by the late John Clarricoats and covers the history of the society and the work of many of its members from 1913 to 1963.

The RSGB have honoured me with the task of writing a sequel to this book in order to bring the society's historical records up to date. During the past decade the RSGB and numerous members have contributed to the tremendous advance in all fields of radio communication throughout the world.

In order for me to make a success of this book, and do the society justice, I must have information, therefore I appeal to RSGB members who read this journal to send to me at Faraday, Greyfriars, Storrington, Sussex, details of their radio achievements during the past ten years. I would like to have this information by August 31st, because there is a lot to do, and I hope to have the work complete within a couple of years.

Ron Ham, Storrington, Sussex.

Trade News . . .

FRENCH STEREO TURNTABLE

A new French stereo turntable of very high quality, the ERA 3033, is now being marketed in the UK by De Banks Electronics Ltd., of High Street, Tring, Herts.

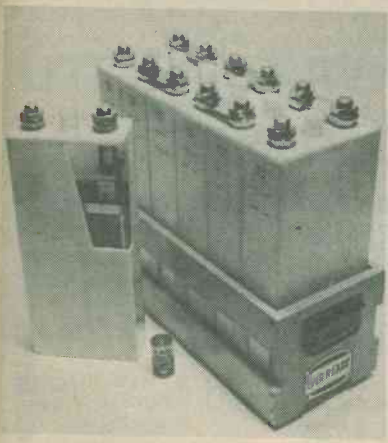
This is a precision-engineered transcription unit, manually operated, extremely simple in design, yet capable of reproducing recorded sound with the utmost fidelity to the source.

At 33⅓ rpm, wow and flutter are better than 0.04%. Rumble is better than 73dB, a level undetectable except by laboratory instruments. This has been achieved through the use of a lightweight 48-pole synchronous motor and neoprene belt drive.

The 3033 is equipped with a statically balanced tone arm, with counterweight calibrated for stylus pressures of ½gm to 4gm. Setting up is extremely simple: anti-skating bias correction is controlled by a graduated ring integral with the arm. The turntable, dynamically balanced, is internally suspended, together with the arm and cueing mechanism, on a sub-chassis and patented 'Silent-Bloc' system.

At £106.92 plus VAT, the 3033 is available from ERA De Banks appointed dealers, and is guaranteed for one year.

OPEN POCKET PLATE STORAGE BATTERIES



Ever Ready (Special Batteries) Ltd., are introducing a range of open pocket plate, storage batteries. This augments their range of sintered sealed Nickel Cadmium Cells.

The new range is divided into basic groups; T range for continuous discharge requirements from 1–10 hours and the TS range which is designed for high current loads and impulse discharge. Cells are available in sheet steel cases or in plastic cases depending on capacities, the latter being identified by the letter P.

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TP – a range of 10 cells from 10–140 Ah (in plastic case).
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In addition a range of battery crates are available of either wooden or plastic construction. The individual cells can be installed on floor, tier or table stands, as well as in battery boxes.

The availability of these cells should greatly ease the problems of emergency lighting installations, indeed any project requiring stand-by power.

Details are available from: Ever Ready (Special Batteries) Ltd., Hockley, SS5 4AH, Essex.

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The new Heathkit AR-2020 4-channel Receiver is a simple, straightforward design that can reliably operate at performance limits usually only associated with far more expensive components. Amplification is a clean 25 watts, IHF, 15 watts continuous, per channel into 8 ohms. The FM receiver section boasts two integrated circuits and two ceramic filters in the IF for selectivity greater than 60 dB, with superior amplifying/limiting characteristics. A phase lock multiplex demodulator offers 40 dB typical channel separation at less than 0.5% distortion. The preassembled FM tuner provides 2μV sensitivity and a 2 dB capture ratio.

There are individual front-panel controls on all four channels, plus a master volume control. Pushbuttons give access to mono, stereo, discrete 4-channel and matrixed 4-channel programme sources. And the generous rear-panel input cluster provides sockets for Phono, Tape, Tape-Out, plus two sets of auxiliary inputs – one for a stereo source, the other for 4-channel.

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For further information write Heath (Gloucester) Ltd., Bristol Road, Gloucester, GL2 6EE.

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(Continued on page 61)

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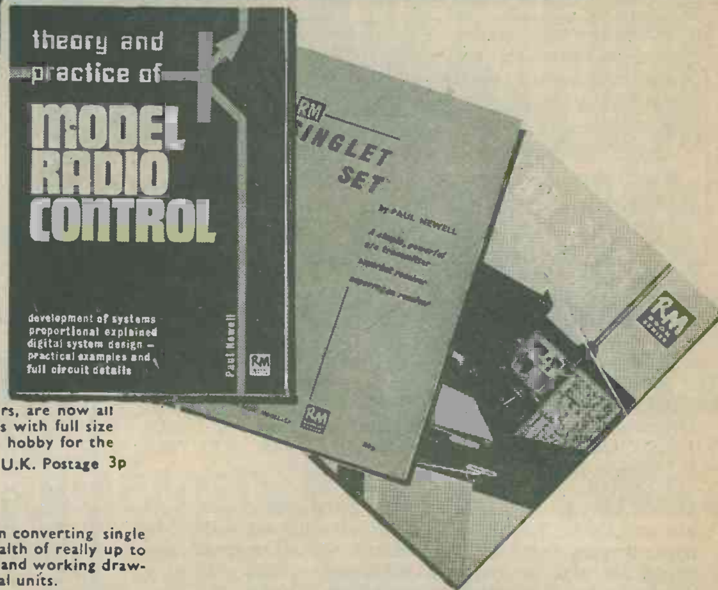

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(Continued from page 61)

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2,000	27	10	5.3	3.2	1.1	0.80	0.40	0.16
1,000	53	20	11	6.4	2.1	1.6	0.80	0.32
500	110	40	21	13	4.2	3.2	1.6	0.64
250	210	80	42	25	8.5	6.4	3.2	1.3
100	530	200	110	64	21	16	8.0	3.2
50	1,100	400	210	130	42	32	16	6.4
25	2,100	800	420	250	85	64	32	13
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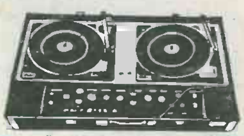

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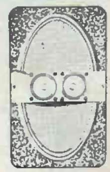

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Free of charge with the kit for the more advanced technologist is a 32-page booklet explaining how to calculate Logs, Tangents, Sines etc.

SPECIAL OFFER £13.60 + VAT
Also available assembled ready for use **£19.95 + VAT**

SUPER TESTER 680R— The complete testing system

price £18.50

Volts AC=11 ranges from 2V to 2500V
Volts DC=13 ranges from 100mV to 2KV
Amp DC=12 ranges from 50oA to 10A
Amp AC=10 ranges from 200μA to 5A
Ohms=6 ranges from one tenth of Ohm to 100MQ
Reactance=1 range from 0 to 10MQ
Capacity=6 ranges from 0 to 500pF and from 0 to 0.5μF and from 0 to 50.000pF
Frequency=2 ranges from 0 to 500Hz and from 0 to 5000Hz
Output Voltage=9 ranges 10V to 2500V
Decibels=10 ranges from—24 to +70dB

Accessories

Transistor tester	£11.00
Electronic Voltmeter	£18.00
Ampclamp	£11.95
Temperature probe	£11.95
Guass meter	£11.95
Signal Injector	£5.95
Phase Sequence	£5.95
EHT Probe	£5.95
Shunts 25/50/100A	£4.50

**10% VAT to be added to all orders. Export Supplied. Prices and descriptions correct at time of proof. Subject to change without notice.
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