MAR 1978

practical WIRELESS

45p

EXTRA
SPECIAL 8~PAGE SUPPLEMENT:
GUIDE TO AERIALS

Also:
MYSTERY TRAIN TOUR

U~DeCNOLOGY (New Series)

the PW 'EUROPA' stereo amplifier

ISSUE 853

PRACTICAL WIRELESS

MARCH 1978 · VOLUME 53 · NUMBER 11

BRITAIN'S LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

Published by IPC Magazines Ltd., Westover House, West Quay Rd., POOLE, Dorset BH15 1JG

News and Views

For our Constructors

General Interest

★ Free This Month

'GUIDE TO AERIALS'—A special supplement

● An Apology

To all who bought our February issue. We are sorry that, due to an oversight, the Active Tone Control which was mentioned on the front cover, did not appear in the magazine. The article appears instead on page 814 of this issue.

RSC 200 WATT DISCO SYSTEM

ALL RSC PRICES INCLUDE VAT

Consisting of
(1) TWIN T/TABLE CONSOLE with PRE-AMP, and POWER OUTPUT STAGES
(2) & (3) PAIR 100 WATT L'SPEAKERS including 12" UNITS

Rec. Mic. UD 150 Cardioid **£9.95** extra with system only

- ★ DISCOMAJOR POWER DISCO CONSOLE with integral Power Amplifier.
- ★ TWIN FULL SIZE GARRARD turtables with cueing device.
- ★ CARTRIDGES with Diamond Styli.
- ★ 3 SEPARATE VOLUME CONTROLS for each turntable and Mic. FULL HEADPHONE MONITORING FACILITIES CONSOLE COMPLETE WITH LID

Terms: Deposit £40·00 and 12 monthly payments £15·60 (Total £227·20) Carr. £4·75. **£199·95**

Also available **100 WATT SYSTEM £169·95**

TDI DISCO CONSOLE

Incorporating twin BSR type turntables and Sonotone or Acos Cartridges with diamond styli. Separate Vol. controls for each turntable. Also MONITORING FACILITIES, plus Treble and Bass Controls. Separate Input for 'mike' with vol. control. Black Vynide covered Cabinet with lid **£119·95**
Or Dep £16·49 & 18 f'tntly pymts. £6·75 (Total £137·99) Carr. £3·50.

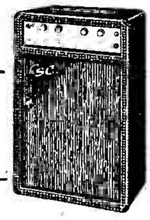
TD2S STEREO VERSION £125·00

DISCOMAJOR/100 TWIN TURNTABLE POWER CONSOLE £139.95

Twin Full size BSR turntables. Sonotone or Acos Cartridges with Diamond Styli. Facilities as TDI Console but with built-in 100 watt Power Amplifier complete with lid. Terms: Deposit £19·95 and 18 fortnightly payments £7·70 (Total £158·55) Carr. £3·50

DISCOMAJOR/200 £159·95 Carr. £4·00

200 watt version of above. Terms: Dep. £29·95 and 18 fortnightly payments £8·60 (Total £184·75)



RSC PHANTOM 50 COMBO AMP. £69·95

Rating 50 watts. 3 inputs, 2 vol controls, individual Bass & Treble presence. Suitable for Lead or Rhythm Guitar, mic., Radio, Tape, etc. Inc. High Flux 12" 50w Speaker. Dep. £10·95 & 8 monthly payments £8·71 (Total £80·63). Carr. £1·50.

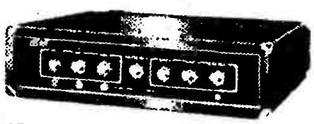
100W POWER (SLAVE) AMPLIFIER

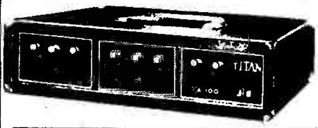
Suitable for use with DISCO-Consoles. Also for increasing output of lower-powered Amplifier. Dep. £9·00 and 8 mthly pyts of £6·05 (Total £57·40) Carr. £1·50 **£49·95**

100+100W MODEL £69·95 Carr. £1·50.

TITAN TA/50A 50W AMPLIFIER

Solid state, 3 sep. controlled inputs plus Master control. Bass, Treble & Presence Controls. Vynide covered cab. with corner protectives. Value £60. Terms: Dep. £9 & 8 monthly payments £6·05. (Total £57·40) Carr. £1. **£49.95**
Matching Cabinets 1 × 12" £29·95, 2 × 12" £49·95





TITAN TA/100A 100W AMPLIFIER

TWIN CHANNEL—4 INPUTS (NORMAL OR BRIGHT) **£69·95** Carr. £1·50
A De-luxe professional unit with many facilities. R.M.S. Rating. Matching 2 × 12" 120w Cabinet speaker £49·95 with above only. Carr. £1·50

TITAN 100W BASS BINS £99·95 value £145

High quality 15" high flux Bass Unit and J104 Horn Tweeter in folded horn enclosure providing amazing level of sound output. Terms Dep. £14·95 and 18 fortnightly payments. £5·58 (Total £115·39) Carr. £3·50.

FANE 'NEW POP RANGE' SPEAKERS

Power ratings R.M.S. Cont. 2 YRS GUARANTEE
*Gauss 14000 Imp 8—15 ohms. CARR FREE.
ALL MODELS AVAILABLE—CASH or TERMS

12"	POP 40	45w	£14·95	15"	POP 80	80w	£29·95
12"	POP 50H	50w	£16·99	18"	POP 100	100w	£49·95
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15"	POP 70	70w	£25·95				

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★
GROUP Equipment by CARLSBRO and F.A.L.
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FULL RANGE OF SPEAKERS by FANE

TITAN GROUP/DISCO SPEAKERS

GUARANTEED 5 YEARS

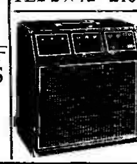
Carr. £1·20, under £18, over this add 6p per £1.

	Value	RSC Price
T12/45 12" 45w	£15·00	£11·95
T12/60 12" 60w	£21·00	£13·95
T12/100 12" 100w	£36·00	£25·95
T15/60 15" 60w	£26·00	£16·99
T15/70 15" 70w	£28·00	£19·95
T15/100 15" 100w	£41·00	£29·95
T18/100 18" 100w	£47·00	£36·95

Rating RMS Imp 8-15 ohms

CABINETS FOR ABOVE Heavy duty, finished in black Vynide with Vynair fronts, protective corner pieces. Various sizes and cut-outs. TE1 1 × 12" £11·95 TE2 2 × 12" £16·95. Low Deposit Terms on orders over £20.

TITAN TA/100C COMBO



100w R.M.S. Amp. incorporating a fabulous Fane Crescendo 12" 100 watt spkr for really superlative results with Lead Guitar Carr. £5 **£119·95**
Or Dep £17·95 & 18 f'tntly payts £6·69 (Total £138·37)

INTEREST REFUNDED on Credit Purchase, settled in 3 mths

JINGLE MACHINES from	£37·95	COLUMN SPEAKERS from	£29·95
ECHO CHAMBERS from	£53·95	GROUP DISCO SPKRS in cabs „	£11·95

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SUPER-STROBE with 5·5" parabolic reflector	£39·95
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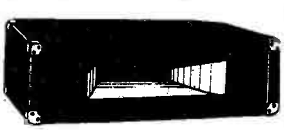
TITAN 'ADD-ON' HIGH FREQUENCY HORN UNITS

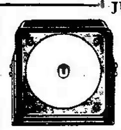


MODEL TS2H Inc. Pair of highly sensitive Horns. Range 3-15 kHz. Imp 16Ω. Use with 8 or 15Ω 2 × 12" or 1 × 15" or 18" Drive Unit for increased sound clarity and projection Rating 100 watts.

MODEL T1H With single super efficient Horn. Range 3-15 kHz. Imp 8Ω. Use with max 8Ω 2 × 12" or single 15" or 18" 8Ω Drive Units. Maximum amplifier power output to be 100 watts.

Either model **£27·95** Carr. 75p Comparable with units at twice the cost.
Terms: Dep £6·95 & 8 mthly pyts £3·12 (Total £31·91)

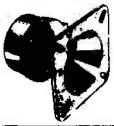
PROJECTORS Carr. Free



BUBBLELITE inc wheel	£39·95	PULSAR SL SUPER (Sound to lite)	£56·95
PATTERNLITE inc cassette	£39·95	PULSAR ZERO 3000 (Sound to lite)	£84·95
SOLAR 100B inc wheel rotator	£69·95	PULSAR SPOTBANKS (less bulbs)	£29·70
BUBBLE GUN inc liquid	£27·95	PULSAR REMOTE CONTROL	£15·95

FANE HIGH FREQUENCY HORNS 'J' SERIES

MODEL J44 Imp 8Ω Size approx. 3½" × 3½" × 3" Rating 30-50 watts Range 3-15 kHz **£6·95** Carr Free



MODEL J73 Imp 8Ω Size approx 7¼" × 3" × 6¼" Rating 50 watts Range 2-20 kHz

£10·95 Carr. Free

MODEL J104 Imp 8Ω Size approx 10½" × 3¼" × 7¼" Rating 50-70 watts Range 2-15 kHz. Carr. Free **£14·95**

Impedance or total impedance of 12", 15" or 18" Drive units must not exceed impedance of single horn or pair in series. Pair J44, Single J73 or J104 suitable for amplifier power up to 100 watts subject to above and with HPX2R 'Cross-over'

RSC MAINS TRANSFORMERS

TYPES FOR VALVE RADIOS & AMPLIFIERS (Inc. L.F. CHOKES & OUTPUT TRANSFORMERS). As previously advertised still available.

FILAMENT OR TRANSISTOR POWER PACK 12v. 1a. £1·10, 6·3v. 1·5a £1·06, 6·3v. 2a £1·10, 6·3v. 3a £1·70, 6·3v. 6a £2·60, 12v. 3a or 24v. 1·5a £2·60, 0-9-18v. 1½a £2·26, 0-12-25-42v. 2a £3·19, CHARGER TRANS 0-9-15v. 1½a £2·03; 2½a £2·26; 3a £2·32; 5a £2·84; 6a £3·19; 8a £3·48.

AUTO (STEP UP/STEP DOWN) TRANSFORMERS 0-110/120v, 200-230-250v, 80w. £2·90; 150w £5·20; 250w, £6·37; 500w, £9·84.

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Incl 2 Spotbanks and bulbs

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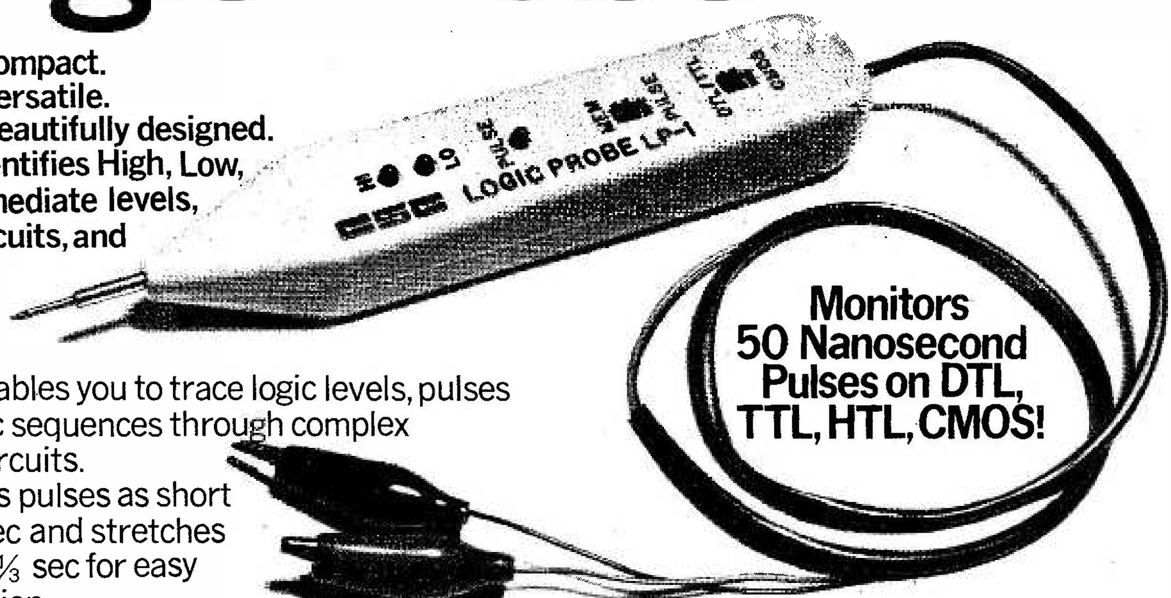
Logic Probe LP-1

It's compact.
It's versatile.
It's beautifully designed.
It identifies High, Low, or Intermediate levels, open circuits, and pulsing nodes.



Monitors 50 Nanosecond Pulses on DTL, TTL, HTL, CMOS!

It enables you to trace logic levels, pulses and logic sequences through complex digital circuits.
It detects pulses as short as 50nsec and stretches them to ⅓ sec for easy observation.

Try the LP-1 and you won't know how you ever managed without it!

How it works

You just clip the probe leads to the circuit power supply, setting the 'Logic Family' switch to DTL, TTL or CMOS. (CMOS position also covers HTL.).

Touch the probe's tip on the node you're investigating and the LP-1 lights up to show you exactly what you've got. The LED marked 'HI' comes on for logic state 1 (High) and 'LO' comes on for logic state 0 (Low).

The third LED, marked 'PULSE', shows the dynamic signal activity at the node under test. Set the switch to 'PULSE' and pulses as narrow as 50 nanoseconds are stretched to ⅓ second. Single-shot and low rep. rate pulses are clearly shown—you can't do that even with a fast CRO! High frequency pulses up to 10MHz will make the 'PULSE' LED blink continuously at 3Hz; and with assymetric signals the 'LO' LED will come on for duty cycles under 30%, and 'HI' for those over 70%.

Another useful feature is 'Pulse Memory'.

Put the probe tip on to a node, switch to 'MEM' and the next logic change-positive or negative—or the next pulse edge, will cause the 'PULSE' LED to come on and stay on, until reset. Meanwhile, 'HI' and 'LO' LEDS continue to function as usual. No other probe or logic checking device gives you all that!

ONLY £29.00

Complete with instruction book, leads, and including VAT (8%) and post and packing.

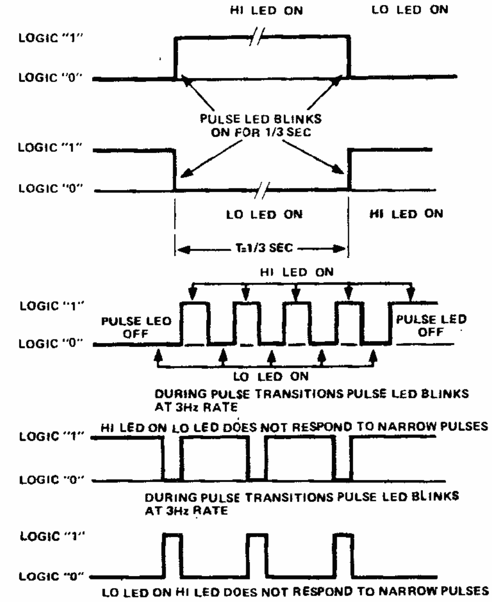
It's easy to order

Telephone 01-890 0782 and give us your Access, Barclaycard or American Express number. Your Probe is in the post same day!

Or, write your order, enclosing cheque, postal order, or stating credit card number and expiry date. (Don't post the card!)

Alternatively, ask for our latest catalogue, showing all CSC time-and-cost-saving products for the engineer and the home hobbyist.

Brief Specification:	Max. input signal frequency:
Input Impedance: 100,000 Ohms,	10MHz
constant for all functions.	Power requirements:
DTL/TTL Thresholds:	5 Volt Vcc, 30mA
logic 1, 2.25V ± 0.15	15 Volt Vcc, 40mA
logic 0, 0.80V ± 0.10	36 Volts max.
HTL/CMOS Thresholds:	Size: 6.1 x 1.0 x 0.7 inches
logic 1, 1,70% Vcc	(155 x 25 x 18mm)
logic 0, 0,30% Vcc	Weight: 3oz (85g)
Min. detectable pulse:	Power leads: 24 inches (610mm),
50 nanoseconds	colour coded.



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CHROMASONIC electronics

56 Fortis Green Road
Muswell Hill London N10 3HN
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TRANSFORMERS

6–0–6V	100mA	1·00*
9–0–9V	75mA	1·00*
12–0–12V	100mA	1·15*
0–9–17V	1A	2·15*
0–9–17V	2A	3·25*
0–9–17V	4A	4·35*
20–0–20V+	1A	3·25*
24–0–24V	500mA	2·15*
0–19–25–33–40–50V+	½A	3·25*
0–19–25–33–40–50V+	1A	3·85*
0–19–25–33–40–50V+	2A	5·45*
0–12–15–20–24–30V+	1A	3·25*
0–12–15–20–24–30V+	2A	4·35*

Please add an extra 50p to items marked +

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BA114	15p	BY105	25p	OA91	10p
BA115	25p	BY126	12p	OA200	10p
BA145	20p	BY127	12p	OA202	10p
BA148	20p	BY133	25p	IN914	5p
BA155	15p	BY182	1·65	IN4003	7p
BA156	15p	BY250	30p	IN4007	8p
BAX16	12p	OA47	12p	IN4148	5p
BB105B	50p	OA79	12p	IN5401	15p
BY103	25p	OA90	10p	IN5407	25p

BRIDGES

1A 50V 25p	1A 400V 30p	2A 50V 40p
1A 100V 25p	1A 600V 35p	2A 100V 45p
1A 200V 25p	1A 100V 40p	2A 200V 50p

ZENERS

BZY88	400mw 2·7v–33v	10p
1ZS	1w 3·6v–100v	20p

LIGHT EMITTING DIODES

0·125" (inc. clip)	1+	10+	100+
TIL209 Red	15p*	13p*	11p*
TIL212 Yellow(H.B.)	27p*	22p*	17p*
TIL216 Red (H.B.)	27p*	22p*	17p*
TIL232 Green(H.B.)	27p*	22p*	17p*
0·2" (inc. Clip)			
TIL220 Red	15p*	13p*	11p*
TIL224 Yellow(H.B.)	30p*	26p*	20p*
TIL228 Red (H.B.)	30p*	26p*	20p*
TIL234 Green (H.B.)	30p*	26p*	20p*

(H.B.)—High Brightness.

I.C. SOCKETS

8 pin	10p*	16 pin	14p*	28 pin	30p*
14 pin	12p*	24 pin	26p*	40 pin	44p*
I.C. pins	100	54p*	1,000	£3·78*	

POLYESTER CAPACITORS

Mullard C280 Series 250vw

0·01μf	5p	0·068μf	6p	0·47μf	12p
0·015μf	5p	0·10μf	6p	0·68μf	17p
0·022μf	5p	0·15μf	6p	1·0μf	25p
0·033μf	5p	0·22μf	8p	1·5μf	34p
0·047μf	5p	0·33μf	9p	2·2μf	40p

Mullard C281 Series 400vw

0·01μf	10p	0·068μf	15p	0·47μf	33p
0·015μf	10p	0·17μf	16p		
0·022μf	10p	0·15μf	18p		
0·033μf	12p	0·22μf	25p		
0·047μf	15p	0·33μf	30p		

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TO 92	7p*	TO 5 (5F)	9p*
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TV 5	24p*	U3 (TDA2020)	52p*
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3·15 E-18 (For 1xTDA2020)	1·49*	3·15 E-19 (For 2xTDA2020)	1·58*

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TO66 and TO3 12p*

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Just a selection. Send for full list

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7401	16p*	7441	56p*	7475	40p*	74123	49p*
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7403	16p*	7445	70p*	7485	76p*	74145	65p*
7404	17p*	7447	59p*	7486	27p*	74151	49p*
7408	19p*	7448	65p*	7489	2·32*	74154	85p*
7410	16p*	7451	16p*	7490	38p*	74174	72p*
7413	27p*	7470	27p*	7492	41p*	74192	86p*
7420	16p*	7472	22p*	7493	41p*	74193	86p*
7427	28p*	7473	27p*	74107	27p*	74196	79p*

CERAMIC CAPACITORS

Mullard 632 Series / **Mullard 630 Series**

1·8pf	10pf	56pf		390pf	1500pf
2·2pf	12pf	68pf		470pf	1800pf
2·7pf	15pf	82pf		560pf	2200pf
3·3pf	18pf	100pf		680pf	2700pf
3·9pf	22pf	120pf		820pf	3300pf
4·7pf	27pf	150pf		1000pf	3900pf
5·6pf	33pf	180pf		1200pf	4700pf
6·8pf	39pf	220pf			
8·2pf	47pf	270pf			
		330pf			

6p each

Mullard 629 Series
0·01uf 0·022uf

PLUGS AND SOCKETS

DIN Connectors

Pins	Plugs	Sockets	Line Couplers
2	14p	10p	18p
3	14p	10p	18p
4	14p	10p	18p
5 (180)	14p	10p	18p
5 (240)	14p	10p	18p
6	14p	10p	18p
7	14p	10p	18p

C.Mos

4000	18p*	4014	1·00*	4024	78p*	4051	86p*
4001	19p*	2015	97p*	4025	19p*	4052	86p*
4002	18p*	4016	53p*	4026	1·76*	4060	1·16*
4006	1·09*	4017	97p*	4027	58p*	4068	22p*
4007	19p*	4018	97p*	4028	87p*	4070	22p*
4009	62p*	4019	58p*	4029	1·18*	4071	22p*
4010	62p*	4020	1·08*	4040	1·08*	4081	22p*
4011	18p*	4021	97p*	4042	83p*	4082	22p*
4012	21p*	4022	88p*	4049	58p*	4510	1·24*
4013	58p*	4023	19p*	4050	58p*	4511	1·54*

POLYSTYRENE CAPACITORS

10pf	100pf	1000pf	10,000pf (0·01uf)
12pf	120pf	1200pf	
15pf	150pf	1500pf	
22pf	220pf	2200pf	
33pf	330pf	3300pf	
47pf	470pf	4700pf	
56pf	560pf	5600pf	
48pf	680pf	6800pf	
82pf	820pf	8200pf	

6p each

JACK CONNECTORS

Type	Plugs Plastic	Plugs Chrome	Sockets
2·5mm	15p	25p	12p
3·5mm	15p	25p	12p
Mono	—	30p	20p
Stereo	—	37p	25p

PHONO Connectors

Plugs		Sockets			
Plastic Moulded	10p	1 way	8p	3 way	12p
Chrome Screened	15p	2 way	12p	4 way	14p

CO-AXIAL Connectors

Plug	Surface Socket	Coupler
16p	16p	43p

SWITCHES

D.P.D.T. toggle	50p*
S.P.S.T. toggle	30p*
D.P.D.T. Slide	18p*
D.P.D.T. Slide Miniature	15p*
Push to Make Miniature	18p*

RESISTORS

Type	Range	
¼ watt 5% Carbon film	E12 Series 10R-1M	2p each
½ watt 5% Carbon film	E24 Series 3·3R-10M	2p ea.
1 watt 5% Carbon film	E12 Series 10R-1M	5p each

POTENTIOMETERS

5K 250K, 10K 500K, 25K 1M, 50K 2M, 100K

Lin and Log less Switch (inc. in Lin)	27p
Lin and Log Dual less Switch	75p
Lin and Log with Switch	60p
10K, 100K, 500K, 1M Dual log with Switch	75p
10K Log + 10K Antilde less Switch	75p

LINEAR INTEGRATED CIRCUITS

uA703 (TO99)	£1·00	LM370N	£2·75	SL415A	£2·47
uA709 (8 pin DIL)	41p	LM371	£1·75	SL440A	£2·38*
uA709 (14 pin DIL)	41p	LM372N	£1·75	SN75491N	95p*
uA710 (TO99)	50p	LM373N	£2·99	SN75492N	£1·15*
uA709 (8 pin DIL)	50p	LM337N	£1·95	SN76001N	£1·40
uA710 (14 pin DIL)	55p	LM380N-8	£1·00	SN76003N	£2·45
uA710 (TO99)	60p	LM380N	99p	SN76013N	£1·60
uA711 (14 pin DIL)	90p	LM381N	£1·75	SN76023N	£1·60
uA711 (TO99)	98p	LM322N	£1·35	SN76033N	£2·45
uA741 (8 pin DIL)	25p	LM390N	65p	SN76544N	£1·55
uA741 (14 pin DIL)	42p	LM3905N	£1·50*	SN76532N	£1·55
uA741 (TO99)	45p	LM3909N	70p*	SN76552N	65p
uA747 (14 pin DIL)	90p	MC1303/LM1303N	£1·10	SN76666N	£1·00
uA748 (8 pin DIL)	42p	MC1310P	£1·80	SN76660N	65p
uA748 (14 pin DIL)	60p	MC1312P	£2·15	TAA263	£2·50
uA748 (TO99)	65p	MC1314P	£3·50	TAA320A	75p
uA753 (8 pin DIL)	£1·95	MC1315P	£6·10	TAA350A	£2·70
AY-1-0212	£6·50	MC1327P/TDA1327	£1·59	TAA570	£2·50
AY-1-5051	£1·65			TBA120S	£1·00
AY-5-1224A	£3·39*	MC1330P	£1·15	TBA231	£1·00
AY-5-3507	£5·99*	MC1350P	£1·00	TBA520Q	£2·00
AY-5-4007	£7·99*	MC1351P	£1·00	TBA530Q	£2·00
CA3045	£1·50	MC1352P/ TDA1352	£1·20	TBA540Q	£2·00
CA3046	80p			TBA550Q	£2·00
CA3053	85p	MC1357P/ LM2111N	£1·70	TBA651	£2·25
CA3075	£2·00			TBA750Q	£2·00
CA3080	80p	MC1375P	£1·50	TBA800	£1·00
CA3081	£1·50	MC1456CG	£2·50	TBA810S/AS	£1·10
CA3082	£1·50	MC1495L	£4·90	TBA820	£1·10
CA3089/TDA1200	£2·30	MC3302P	£1·65	TBA990Q	£2·00
CA3090Q	£4·25	MFC6030A	£1·00	TCA730	£4·69
CA3123E/LM1820	£1·50	NE540L	£2·25	TCA740	£4·69
CA3097E	£1·75	NE546	£2·15	TCA940	£1·75
CA3130S	99p*	NE555	35p*	TDA2020	£3·50
CA3140S	99p	NE556	90p*	ZN414	£1·10
CA3160S	£1·60	NE560	£4·40*	ZN417E	£1·68
CA3600E	£1·75	NE561	£4·40*	ZN423T	£1·08*
LM301AN (8 pin)	40p	NE562	£4·40*	ZN424E	£1·35
LM301AT (TO99)	50p	NE565	£1·40*	ZN425E	£3·78*
LM308N (8 pin)	90p	NE566	£1·65*	ZN1034E	£2·03*
LM308T (TO99)	£1·40	NE567	£1·85*	ZN1040E	£8·43*
LM339N	£1·00	SL414A	£1·90	ZNA116E	£6·75*

SILVER MICA CAPACITORS

2·2pf	10p	68pf	10p	500pf	15p
3·3pf	10p	75pf	10p	560pf	15p
5pf	10p	82pf	10p	680pf	15p
10pf	10p	100pf	10p	820pf	15p
18pf	10p	120pf	10p	1000pf	20p
20pf	10p	150pf	10p	1500pf	20p
22pf	10p	180pf	10p	1800pf	20p
25pf	10p	200pf	10p	2200pf	20p
27pf	10p	220pf	10p	2700pf	30p
30pf	10p	250pf	10p	3600pf	30p
33pf	10p	270pf	15p	4700pf	30p
39pf	10p	300pf	15p	5000pf	30p
47pf	10p	330pf	15p	6800pf	40p
50pf	10p	390pf	15p	8200pf	40p
56pf	10p	470pf	15p	0·01μf	40p

MYLAR CAPACITORS

1000pf	5p	0·04μf	8p
2000pf	5p	0·047μf	8p
2200pf	5p	0·05μf	8p
4700pf	5p	0·068μf	9p
5000pf	5p	0·1μf	10p
0·01μf	6p	0·02μf	12p
0·02μf	7p	0·2μf	12p
0·022μf	7p		

TANTALUM BEAD CAPACITORS

0·1μf	35v	15p	10μf	25v	20p
0·22μf	35v	15p	10μf	35v	22p
0·47μf	35v	15p	22μf	16v	22p
1·0μf	35v	15p	47μf	16v	25p
2·2μf	35v	15p	100μf	3v	22p
4·7μf	35v	15p	100μf	6·3v	25p
10μf	16v	17p	100μf	10v	34p

LOW VOLTAGE DISC CERAMIC CAPACITORS

0·022μf 18V 0·047μf 12V 0·22μf 6V 5p each

PRESETS

100R	5K	250K	·1 watt
250R	10K	500K	Horizontal
500R	25K	1M	and
1K	50K	2·5M	Vertical
2·5K	100K	5M	7p each

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78L15AWC	15V	65p*
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7812KC	12V	2·17*
7815KC	15V	2·17*
7805UC	5V	1·25*
7812UC	12V	1·25*
7815UC	15V	1·25*
7818UC	18V	1·25*
7824UC	24V	1·25*
L005T1	5V	1·50*
L036T1	12V	1·50*
L037T1	15V	1·50*
L129	5V	85p*
L130	12V	85p*
L131	15V	85p*
TBAG25A	5V	1·25*
TBA625B	12V	1·25*
TBA625C	15V	1·25*
LM309K	5V	1·50*
Negative		
7905UC	5V	1·25*
7912UC	10V	1·25*
7915UC	15V	1·25*
7918UC	18V	1·58*
7924UC	24V	1·25*

TRANSISTORS

AC126	20p*	BC558	15p	MPF104	40p	2N1302	45p*
AC127	20p*	BC559	15p	MPF105	40p	2N1304	45p*
AC128	20p*	BC547	15p	MPSA05	25p	2N1305	30p*
AC176	20p*	BC548	15p	MPSA06	25p	2N1306	45p*
AC187K	35p*	BC549	15p	MPSA55	30p	2N1307	30p*
AC188K	35p*	BCY70	18p*	MPSA56	30p	2N1309	45p*
AD161	45p*	BCY71	18p*	MPSU05	50p	2N1711	25p
AD162	45p*	BCY72	18p*	MPSU06	55p	2N1893	35p
BC107	10p*	BD131	50p*	MPSU55	55p	2N2646	50p*
BC108	10p*	BD132	50p*	MPSU56	60p	2N2925	10p
BC109	10p*	BD135	40p	TIP31A	55p*	2N2926G	10p
BC147	9p	BD136	40p	TIP32A	60p*	2N3053	22p*
BC148	9p	BD139	40p	TIP41A	65p*	2N3054	55p*
BC149	10p	BD140	40p	TIP42A	75p*	2N3055	60p*
BC157	11p	BD239C	35p*	TIS43	40p*	2N3442	1·50
BC158	11p	BF180	35p*	TIS91	25p	2N3702	11p
BC159	11p	BF181	35p*	ZTX107	12p	2N3703	11p
BC169C	12p	BF184	25p*	ZTX108	12p	2N3704	11p
BC177	18p*	BF185	25p*	ZTX109	12p	2N3705	11p
BC178	18p*	BF194	12p	ZTX300	15p	2N3706	11p
BC179	18p*	BF195	12p	ZTX301	15p	2N3708	12p
BC182L	11p	BF196	12p	ZTX302	17p	2N3709	12p
BC183L	11p	BF197	12p	ZTX303	20p	2N3710	12p
BC184L	11p	BF200	35p	ZTX311	15p	2N3711	12p
BC212L	11p	BF244B	35p	ZTX312	17p	2N3772	1·50*
BC213L	11p	BFY50	20p*	ZTX341	20p	2N3819	25p
BC214L	11p	BFY51	20p*	ZTX500	15p	2N3904	20p
BC441	35p	BRY39	50p*	ZTX501	17p	2N3906	20p
BC461	35p	MJ2955	1·20*	ZTX502	17p	2N5447	18p
BC477	25p	MJ3055	1·20*	ZTX503	20p	2N5449	19p
BC478	25p	MJE340	50p	ZTX504	25p	2N5777	50p*
BC479	25p	MPF102	40p	ZTX531	25p	3N141	1·00
BC557	15p	MPF103	40p	ZTX550	17p	40673	75p*

ELECTROLYTIC CAPACITORS

uf	V6·3	10	16	25	40	63
1	—	—	—	—	—	7p
1·5	—	—	—	—	—	7p
2·2	—	—	—	—	—	7p
3·3	—	—	—	—	—	7p
4·7	—	7p	—	7p	—	7p
6·8	—	—	—	—	7p	7p
10	—	—	—	7p	—	7p
15	—	—	—	—	7p	8p
22	7p	7p	7p	7p	7p	8p
33	—	—	7p	—	7p	—
47	7p	7p	—	7p	7p	12p
68	7p	—	7p	8p	—	—
100	—	—	7p	8p	12p	25p
150	—	—	7p	8p	12p	25p
220	—	8p	8p	12p	15p	25p
330	—	8p	8p	—	—	30p
470	—	15p	—	25p	30p	35p
680	—	15p	20p	25p	30p	—
1000	15p	15p	30p	25p	40p	65p
1500	—	—	25p	—	—	—
2200	—	30p	35p	45p	70p	90p
4700	—	35p	—	55p	80p	95p

Postage and Packing 25p

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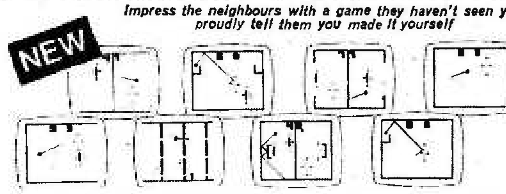

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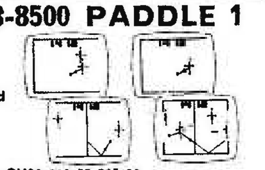

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PW 3-78

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No. THY3A/50	3Amp. 50 volt	TO64	25p
No. THY3A/200	3Amp. 200 volt	TO64	32p
No. THY3A/400	3Amp. 400 volt	TO64	40p
No. THY5A/50	5Amp. 50 volt	TO66	25p
No. THY5A/400	5Amp. 400 volt	TO66	40p
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No. MVR7818	μA7818	TO220	85p
No. MVR7824	μA7824	TO220	85p

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No. MVR7915	μA7915	TO220	£1·10
No. MVR7918	μA7918	TO220	£1·10
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BRAND NEW—FULLY GUARANTEED

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
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AC126	14p	BC178	12p	BF195	9p*	TIP41A	34p	2N1893	28p
AC127	16p	BC179	12p	BF196	12p*	TIP41B	35p	2N2218	15p
AC128	16p	BC182	9p*	BF197	12p*	TIP41C	36p	2N2218A	18p
AC128K	24p	BC182L	9p*	BF200	25p	TIP42A	36p	2N2219	15p
AC176	16p	BC183	9p*	BFX29	22p	TIP42B	37p	2N2219A	18p
AC176K	24p	BC183L	9p*	BFX84	18p	TIP42C	38p	2N2221	15p
AC187	16p	BC184	9p*	BFY50	12p	TIP2955	65p	2N2221A	16p
AC187K	26p	BC184L	9p*	BFY51	12p	TIP3055	42p	2N2222	15p
AC188	16p	BC212	10p*	BFY52	12p	ZTX107	6p*	2N2222A	16p
AC188K	26p	BC212L	10p*	MPSA05	22p*	ZTX108	6p*	2N2369	10p
AD161/ 162 MP	80p	BC213	10p*	MPSA06	22p*	ZTX109	7p*	2N2904	14p
AF139	30p	BC213L	10p*	MPSA55	22p*	ZTX300	7p*	2N2904A	15p
AF239	30p	BC214	10p*	MPSA56	22p*	ZTX301	7p*	2N2905	14p
BC107	6p	BC214L	10p*	OC44	12p	ZTX302	9p*	2N2905A	15p
BC108	6p	BC251	10p*	OC45	12p	ZTX500	8p*	2N2906	12p
BC109	6p	BCY70	12p	OC71	9p	ZTX501	10*	2N2906A	14p
BC118	10p*	BCY71	12p	OC72	12p	ZTX502	12p*	2N2907	12p
BC147	8p*	BCY72	12p	OC75	10p	2N696	10p	2N2907A	13p
BC148	8p*	BD115	40p	OC81	14p	2N697	10p	2N2926G	8p*
BC149	8p*	BD131	35p*	TIP29A	35p	2N706	7p	2N2926Y	7p*
BC154	16p*	BD132	37p*	TIP29B	36p	2N706A	8p	2N3053	12p
BC157	9p*	BF115	17p	TIP29C	38p	2N708	8p	2N3055	35p
BC158	9p*	BF167	19p	TIP30A	36p	2N1302	12p	2N3702	7p*
BC159	9p*	BF173	20p	TIP30B	37p	2N1303	15p	2N3703	7p*
BC169C	10p*	BF180	25p	TIP30C	38p	2N1304	15p	2N3704	6p*
BC170	6p	BF181	25p	TIP31A	32p	2N1307	18p	2N3903	11p*
BC171	6p*	BF182	25p	TIP31B	33p	2N1308	22p	2N3904	11p*
BC172	6p*	BF183	25p	TIP31C	34p	2N1309	22p	2N3905	11p*
BC173	7p	BF184	25p	TIP32A	34p	2N1613	15p	2N3906	11p*
		BF185	25p	TIP32B	35p				

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AAZ13	4p	BY100	15p	BYZ17	28p	OA90	6p	IN5400	10p
BA100	6p	BY127	10p*	BYZ18	28p	OA91	7p	IN5401	11p
BA115	6p	BYZ10	32p	BYZ19	28p	OA95	7p	IN5402	12p
BA144	5p	BYZ11	32p	OA47	5p	IN34	5p	IN5404	13p
BA148	10p	BYZ12	32p	OA70	5p	IN60	6p	IN5406	16p
BA173	10p	BYZ13	30p	OA79	7p	IN914	4p	IN5407	17p
BAX13/ OA200	5p			OA81	7p	IN4148	4p	IN5408	19p

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LM380	14 pin DIL	80p*	UA741C	TO99	20p	NE555	8 pin DIL	32p
LM381	14 pin DIL	£1·35*	72747	14 pin DIL	55p	NE556	14 pin DIL	60p
72709	14 pin DIL	28p	748P	8 pin DIL	28p	SL414A	10 pin	£1·80*
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7401	0·11	0·10	7450	0·12	0·10	74123	0·65	0·62
7402	0·11	0·10	7451	0·12	0·10	74141	0·68	0·65
7403	0·11	0·10	7453	0·12	0·10	74145	0·75	0·72
7404	0·11	0·10	7454	0·12	0·10	74150	1·10	1·05
7405	0·11	0·10	7460	0·12	0·10	74151	0·65	0·60
7406	0·28	0·25	7470	0·24	0·23	74153	0·70	0·68
7407	0·28	0·25	7472	0·20	0·19	74154	1·20	1·10
7408	0·12	0·11	7473	0·26	0·22	74155	0·70	0·68
7409	0·12	0·11	7474	0·24	0·23	74156	0·70	0·68
7410	0·09	0·08	7475	0·44	0·40	74157	0·70	0·68
7411	0·22	0·20	7476	0·26	0·25	74160	0·95	0·85
7412	0·22	0·20	7480	0·45	0·42	74161	0·95	0·85
7413	0·26	0·25	7481	0·90	0·88	74162	0·95	0·85
7416	0·28	0·25	7482	0·75	0·73	74163	0·95	0·85
7417	0·26	0·25	7483	0·88	0·82	74164	1·20	1·10
7420	0·11	0·10	7484	0·85	0·80	74165	1·20	1·10
7422	0·19	0·18	7485	1·10	1·00	74166	1·20	1·10
7423	0·21	0·20	7486	0·28	0·26	74174	1·10	1·00
7425	0·25	0·23	7489	2·70	2·50	74175	0·85	0·82
7426	0·25	0·23	7490	0·38	0·32	74176	1·10	1·00
7427	0·25	0·23	7491	0·65	0·62	74177	1·10	1·00
7428	0·36	0·34	7492	0·43	0·35	74180	1·10	1·00
7430	0·12	0·10	7493	0·38	0·35	74181	1·90	1·80
7432	0·20	0·19	7494	0·70	0·68	74182	0·80	0·78
7433	0·38	0·36	7495	0·60	0·58	74184	1·50	1·40
7437	0·26	0·25	7496	0·70	0·68	74190	1·40	1·30
7438	0·26	0·25	74100	0·95	0·90	74191	1·40	1·30
7440	0·12	0·10	74104	0·40	0·35	74192	1·10	1·00
7441	0·60	0·57	74105	0·30	0·25	74193	1·05	1·00
7442	0·80	0·70	74107	0·30	0·25	74194	1·05	1·00
7443	0·95	0·90	74110	0·48	0·45	74195	0·80	0·75
7444	0·95	0·90	74111	0·75	0·72	74196	0·90	0·85
7445	0·80	0·75	74118	0·85	0·82	74197	0·90	0·85
7446	0·80	0·75	74119	1·30	1·20	74198	1·90	1·80
7447	0·70	0·68	74121	0·28	0·26	74199	1·80	1·70

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CD4006	£0·80	CD4025	£0·18	CD4050	£0·46
CD4007	£0·17	CD4026	£1·85	CD4054	£0·95
CD4008	£0·80	CD4027	£0·48	CD4055	£1·60
CD4009	£0·50	CD4028	£0·80	CD4056	£1·15
CD4010	£0·50	CD4029	£0·95	CD4069	£0·32
CD4011	£0·18	CD4030	£0·46	CD4070	£0·32
CD4012	£0·17	CD4031	£1·80	CD4071	£0·20
CD4013	£0·42	CD4035	£1·40	CD4072	£0·20
CD4015	£0·80	CD4037	£0·78	CD4081	£0·20
CD4016	£0·42	CD4040	£0·78	CD4082	£0·20
CD4017	£0·80	CD4041	£0·68	CD4510	£1·10
CD4018	£0·85	CD4042	£0·68	CD4511	£1·25
CD4019	£0·45	CD4043	£0·78	CD4516	£1·10
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16168	5 pieces Assorted Ferrite rods	40p*
16169	2 pieces Tuning gangs MW/LW	40p*
16170	50 metres Single strand wire assorted wire	40p
16171	10 Reed switches	40p*
16172	3 Micro switches	40p*
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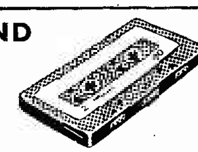

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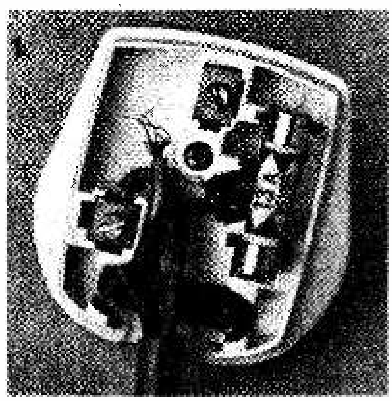
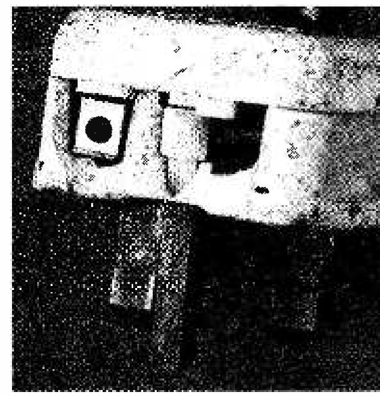
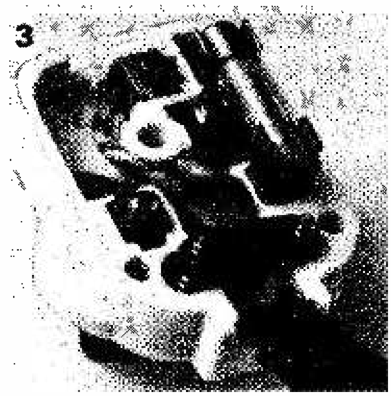
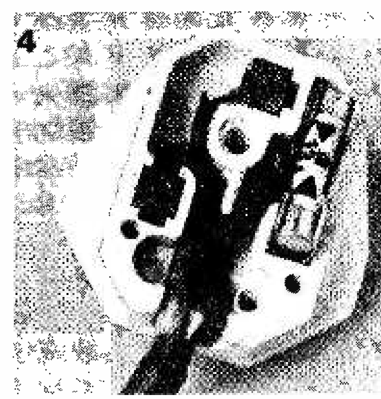
NEWS... NEWS...

Are you guilty?









1. Cord grip not in use, earth conductor detached from terminal as a result—the two most common faults pinpointed in the survey.
2. Broken plug body, possibly through being dropped onto hard floor, has exposed live and earth terminals. Use of resilient-clad plugs in areas where there is a risk of breakage (e.g. Kitchens) could minimise this problem.
3. Reversed polarity, cord-grip loose, cable sheath cut back too far necessitating binding together of conductors with insulating tape.
4. Reversed polarity, cord grip discarded by householder.

PLEASE NOTE

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.

NEWS... NEWS... NEWS...

More than 70 million electric plugs used in British homes could be potentially dangerous according to a report published last November by the Electrical Research Association.

Britain's largest manufacturer of plugs and other electrical wiring accessories, MK Electric Ltd, commissioned ERA to carry out the survey and isolate the most common faults present in plugs used in the home.

The four pictures reproduced on the opposite page show some of the most common faults, we at *Practical Wireless* hope that you are not guilty of using plugs in these sort of conditions! The survey found that just over 18 per cent of the sample had inefficient cord grips. The grip, which prevents strain on the terminal connections was in many cases found to be loose, not in use, missing or to have lost one screw. 7·4 per cent of the terminals had faulty connections, largely as a result of inefficient cord grips.

Many people were still using plugs which had been damaged, probably as a result of being dropped onto hard floors. Some of these were in a very dangerous condition because damage had left live terminals exposed. The moral here is to throw away any broken plugs and to use a resilient clad plug in areas where the floor is hard such as the kitchen.

1·5 per cent of householders had reversed the live and neutral connections. Frightening isn't it? Get to know the colour code, brown is live, blue is neutral and green/yellow is earth.

The survey states that most of the faults are due to lack of consumer education although manufacturers could be more helpful in the design of cord grips and clearer wiring instructions.

MK reckon that a conservative estimate of the number of plugs in use in this country is 400 million, which means that, if the results of the ERA survey hold good for the country as a whole, over 73 million plugs could be in a dangerous condition through inefficient cord grips alone, another 12 million because of physical damage and 6 million with incorrect connections.

If that doesn't frighten you then we don't know what will!

'Pianocorder'

An intriguing invention, which is in essence an extension of the early work by Edward Welte in 1904, is the 'Pianocorder'. Manufactured and developed by Superscope, the unit "plays" a piano by interpreting pulses recovered from magnetic tape.

Welte produced what could only be described as a 'machine' which used a paper roll as the storage medium. Each note on the keyboard was fitted with a small carbon-tipped prong which made contact with a tray of mercury when depressed, and a similar arrangement was fitted to the pedals. When the circuit was made, the initial transients and durations were recorded on the paper in a manner similar to that of a pen recorder. The resulting traces were then punched out by hand.

The player mechanism itself consisted of a wooden box fitted with eighty felt-tipped fingers and two actuators for the pedals. The entire unit was placed in front of the piano in the normal playing position and operated by vacuum, the punched paper providing the keying sequences, timing and pedalwork.

Superscope have collected thousands of these original paper rolls and transcribed the information on to magnetic tape, employing a digital process. The cassettes are fed into a controller, located at the front of the instrument, and operate solenoids and relays within the piano.

In addition to the playback of prerecorded cassettes, the device will also initiate its own recording. Thus it could be regarded as an extremely useful teaching tool for the pianoforte student, as well as an entertainment medium—if the f.o.b. price of around 1600 dollars can be accommodated, that is!

Stereo for AM broadcasts

Further details of the Harris Corporation's Compatible Phase Multiplex (CPM) system, providing a stereo AM capability, have been made available to us.

The system is uncomplicated and straightforward in its technology; a modified quadrature system, in fact, with right and left channel sideband pairs being transmitted at $\pm 15°$ from the carrier. There is absolutely no increase in occupied bandwidth or spectral density and no loss of mono coverage. Modulation of $+125\%$ and -100% is maintained.

The public can expect economical and stable receiver implementation with CPM. Tests conducted by the designers have shown that existing integrated circuits can be used for the AM/CPM receiver.

Because the CPM bandwidth is no greater than that of mono AM, there is good envelope detector compatibility, even with narrow-band receivers. As it is a linear additive system, stereo receivers will not generate distortion in any case—even under skywave conditions. Unlike non-linear systems, Harris CPM does not require flat receiver response and complex correction functions. Loudness is equal to the mono signal, unlike VHF/FM which has a loudness reduction when changing from mono to stereo. A conventional pilot indicator can be used, similar to that fitted to most VHF/FM tuners, and no stereo break-up with high modulation occurs.

Existing transmitting equipment may be used for CPM with only minor modification and the addition of a stereo exciter. Although listeners would need re-designed receivers for AM stereo in their homes or cars, costs are expected to be fairly economical and a vast consumer market is envisaged when the system is introduced and gains popularity.

Good News

We are pleased to announce the reintroduction of the publishers subscription service for *Practical Wireless*. The annual cost to either UK or overseas addresses is £10·60.

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active tone control

F. G. CANNING

This article describes an active tone control for general use in audio amplifiers, having a good performance which is largely unaffected by the input and output characteristics of the associated pre-amplifier and power amplifier stages. The permissible output of 0·84 volt r.m.s. (1·17 V peak) at 1kHz, with both controls in the "flat" position, will be sufficient to load the input stage of most power amplifiers, while still permitting use of the maximum bass boost of 17dB at 30Hz without exceeding the output limit of 6 volts for 1 per cent total distortion at that frequency. The required input from the pre-amplifier under these conditions is 0·14 volt r.m.s. (0·2 volt peak). With both controls centred, the response is linear within 0·15dB from 30Hz to 20kHz.

★ specification

Input voltage:	140mV. r.m.s.
Input resistance at 1kHz:	1 megohm approx.
Voltage gain (controls flat):	X6·5 (16·2dB)
Maximum output voltage for 1% distortion:	6 volts r.m.s.
Effective noise voltage at output into 100kΩ load (controls flat):	<150 microvolts
Range of tone controls:	
Bass (at 30Hz)	+17 to −21dB } relative to 1kHz
Treble (at 20kHz)	+21 to −20dB } relative to 1kHz
Distortion (over range 50Hz to 15kHz):	
at output of 1V r.m.s.	under 0·13%
" " 2V	" 0·25%
" " 4V	" 0·4%
" " 6V	" 1·0%
Supply:	25 volts at 4·2 mA approx.

The Circuit

The circuit (Fig. 1) is a feedback tone control based on P. J. Baxandall's circuit, first published in the 1950s, which with various detail modifications has become something of a world standard, largely displacing the loss-type controls previously used. The present design uses linear potentiometers without tappings, and achieves almost ideal control characteristics. A brief look at the design philosophy follows.

The basic control stage comprises Tr2 and the network connected between its base and the emitter or Tr1, with negative feedback from Tr2 output to the network. This stage provides the whole of the available gain and it is possible, as in the present case, to obtain sufficient open-loop gain (i.e. with feedback disconnected) to provide for the full range of boost and cut—about 20dB plus or minus—and still leave a useful positive gain over the mid-range of around 17dB. Thus, the tone-control is far from being a mere passenger, much less a "losser".

Circuits of this type work best when fed from a low impedance source, which is not normally available from a practical pre-amplifier having gain; furthermore the operation of the tone controls is liable to affect adversely the output characteristics of such a

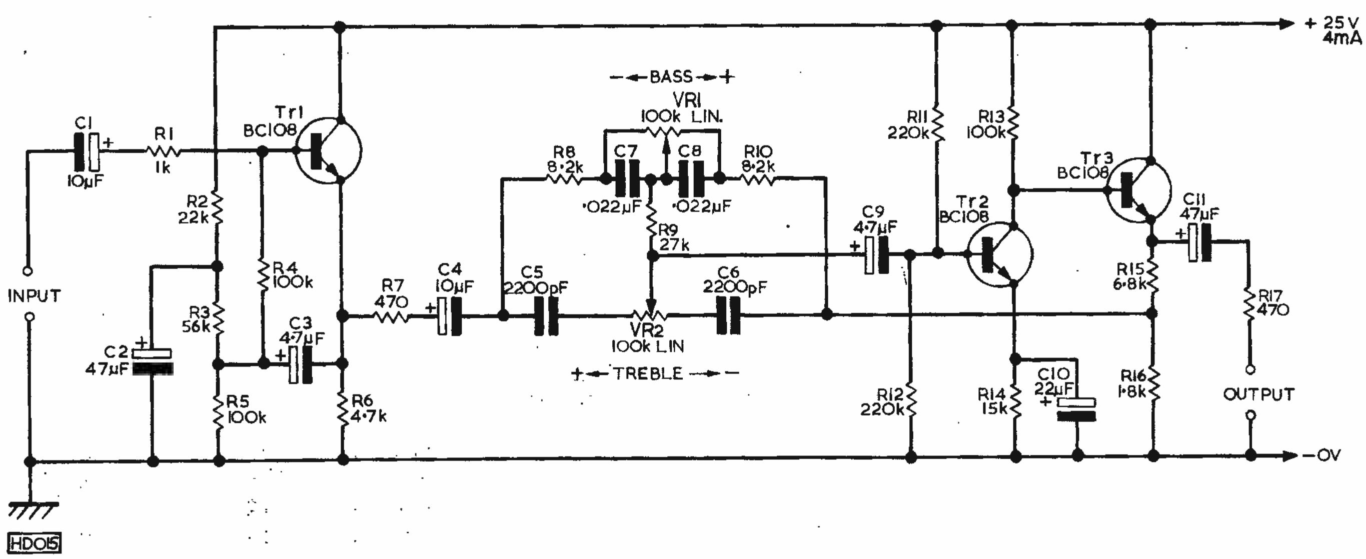


Fig. 1: Complete circuit diagram of the Active Tone Control.

pre-amplifier. Accordingly the present design employs Tr1 in an emitter-follower (common collector) circuit as an impedance transformer, to isolate the pre-amplifier from the effects of the tone controls and to provide them with the desired low-impedance source. Additionally, Tr1 input circuit is bootstrapped via capacitor C3 and its input resistance is thus raised to over a megohm, which is high enough to leave unaffected any normal pre-amplifier output circuit.

In the same way the feedback to the tone-control network is best derived from a low-impedance source, since operation of the controls causes the effective impedance of the network to vary markedly, which tends to spoil the desired uniform gain of Tr2 and also to limit its undistorted output. Therefore a second emitter-follower (Tr3), is used, DC coupled to Tr2 collector, and the feedback connection is taken from a tapping on its emitter load (this is permissible as there is no phase-reversal in an emitter-follower).

In this way the tone control stage gets its feedback from the desired low impedance and Tr2 works unhampered into a very high impedance which imposes very little loading on it and has a flat frequency response over the desired range. At the same time a low-impedance output is provided whose operation will be largely independent of the load presented by the input of the following power amplifier, unless this is very low indeed. The complete tone control unit should therefore be usable without modification between a wide variety of pre-amplifiers and power amplifiers, regardless of their input and output impedances. The two emitter-followers together reduce the effective gain to around 16dB.

The circuit of Fig. 1 of course shows a single channel only; two are needed for a stereo installation, with twin bass and treble potentiometers ganged together.

★ components

Resistors (All ¼ watt 10% carbon film)			
R1	1kΩ	R8, R10	8·2kΩ
R2	22kΩ	R9	27kΩ
R3	56kΩ	R11, R12	220kΩ
R4, R5, R13	100kΩ	R14	15kΩ
R6	4·7kΩ	R15	6·8kΩ
R7, R17	470Ω	R16	1·8kΩ
Potentiometers			
RV1, RV2	100kΩ linear, carbon		
Capacitors			
C1, C4	10μF	10V	Electrolytic
C2, C11	47μF	25V	"
C3, C9	4·7μF	10V	"
C10	22μF	10V	"
C5, C6	2200pF	polystyrene or polyester, 10%	
C7, C8	0·022μF	polyester, 10%	
Transistors			
Tr1, Tr2, Tr3,	BC108		

Overload

The question of possible overload and consequent distortion when using the maximum available boost is a point not always clearly brought out in connection with such tone controls. A published circuit may be accompanied by a claim that the total distortion is less than, say, 0·1 per cent at an input not exceeding a given figure. However, closer study may show that this statement is true only while the bass and treble controls are at or near the "flat" position. In such cases distortion in the bass or treble regions may rise rapidly with an increase of bass or treble boost and can reach an unacceptable figure, or even the limiting point, before maximum boost has been obtained. The input signal must then be reduced substantially if full boost is required without excessive distortion. This assumes, of course, that the signal up to the tone control input is substantially level at all frequencies concerned.

In the present design the maximum available output swing at low distortion (1 per cent) is 6 volts r.m.s. (8·4 volts peak). The maximum bass boost available is +17dB at 30Hz relative to 1kHz (0dB). Therefore the maximum permissible output swing at 1kHz, if the boosted bass is not to be badly distorted, is 17dB down from 6 volts, namely 0·84 volt r.m.s. or 1·17 volt peak, and this should be the maximum designed *mid-band* input voltage required by the driver stage of the power amplifier to give an acceptable output volume around 1kHz, while still having enough power in reserve to accept a 17dB increase of signal input without overloading in any part of the power amplifier. This is not always easy to achieve economically. Overload due to maximum treble boost is not, perhaps, so serious for the resulting distortion products will mostly be outside the audible range, though some purists would probably dispute this.

Assuming, therefore, a permissible mid-range output from the tone control of 0·84 volt r.m.s. and an effective gain conservatively stated as 6 times (15·5 dB), the required input to the tone control unit from the pre-amplifier will be 0·84/6, or 0·14 volt r.m.s. = 0·2 volt peak. At these levels the total harmonic distortion will be less than 0·1 per cent at any frequency within the range, with both controls in the "flat" position, and should not exceed 1 per cent at any frequency when maximum boost is in use.

Components

None of the component tolerances is very critical and 10 per cent will generally be good enough. One of the advantages of using linear potentiometers is that they are generally better matched than the logarithmic type. Layout is not very important apart from guarding against stray hum fields, and there should be no stability problems.

Other transistors of roughly similar type can be used without much change in performance, e.g., BC107, BC109, or their plastic-cased counterparts, but they must be able to accept the 25 volt supply without risk of failure. A practical point concerns the setting of the control knobs on their shafts; the mid-point of the resistance range may or may not be the mid-point of shaft rotation (speaking now of conventional carbon-type controls) and the actual total resistance is unlikely to be exactly 100,000 ohms. Use an ohmmeter to measure the actual total resistance of the potentiometer concerned, rotate its spindle to give half the measured total from either end, and then secure the knob to the spindle to indicate 0dB at that setting. ●

So you want to pass the R.A.E. (Radio Amateurs' Examination)? No. 7

John Thornton Lawrence GW3JGA & Ken Mc Coy GW8CMY

The passing of the Radio Amateurs' Examination, set by the City and Guilds, requires a certain level of theoretical technical knowledge. Whether one considers that this level is too high or too low is beside the point. The course that follows is intended, with the help of certain external aids, to prepare the reader to pass the examination. It will not teach him all about electronics!

Transistors

The diagram in **Fig. 47** shows an npn transistor. Note that the base-emitter junction (a) is forward biased whilst the base-collector junction (b) is reverse biased.

The base region in a transistor is made very thin so that current carriers, entering from the emitter, experience the attraction of the collector voltage and are able to pass right through the base region and cross the base-collector junction, to the collector. A small proportion of current carriers from the emitter will recombine in the base region and these form the base current.

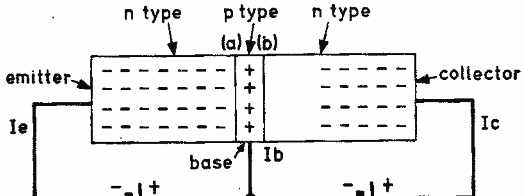
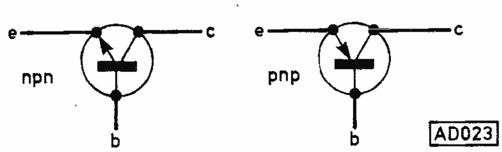


Fig. 47: Construction of an NPN Transistor.



These currents can be expressed simply as,

$$I_e = I_c + I_b$$

For example, typical values might be:—

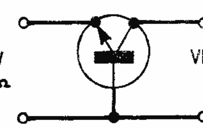
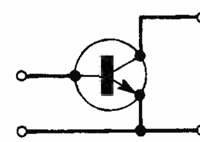
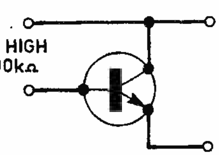
$$1\text{mA}\ (I_e) = 0{\cdot}98\text{mA}\ (I_c) + 0{\cdot}02\text{mA}\ (I_b)$$

The actual ratio of the emitter, base and collector currents depends on the type and construction of the transistor.

The ratio of the collector to emitter current is known as the DC alpha.

$$\text{DC alpha}\ (\alpha) = \frac{I_c}{I_e}\ \text{e.g.}\ \frac{0{\cdot}98\text{mA}}{1{\cdot}00\text{mA}} = 0{\cdot}98$$

and the ratio of collector to base current is known as the DC beta or h_{FE}

CIRCUIT	INPUT IMPEDANCE	OUTPUT IMPEDANCE	CURRENT GAIN	POWER GAIN	INVERSION OF SIGNAL
 COMMON BASE	LOW <100Ω	VERY HIGH >100kΩ	0·99	1000 (30dB)	NO
 COMMON EMITTER	MED 1kΩ	HIGH >10kΩ	50	10,000 (40dB)	YES
 COMMON COLLECTOR (EMITTER FOLLOWER)	VERY HIGH >100kΩ	LOW 100Ω	50	40 (16dB)	NO

AD024

Fig. 48: General characteristics of circuit configurations.

$$\text{DC beta or } h_{FE} = \frac{I_c}{I_b}\ \text{e.g.}\ \frac{0{\cdot}98\text{mA}}{0{\cdot}02\text{mA}} = 49$$

The DC beta or h_{FE} is the usual method of quoting the DC current gain of a transistor.

As you can see, there is a fixed relationship between the currents in a particular transistor, if you vary one then the other two will also vary by the same proportion.

In transistor amplifiers, input signals may be applied to the emitter or the base and the output taken from the collector or emitter. The general characteristics of each type of circuit configuration is shown in **Fig. 48.** The circuits have the biasing and supplies omitted for the sake of clarity.

In the common base arrangement (where the input signal is applied to the emitter), the emitter and collector currents are almost equal but, because the input impedance is low (forward-biased junction) and the output impedance is high (reverse-biased junction), there is a power gain. The signal power, (I^2R) in the collector is higher than the power (I^2R) in the emitter.

In the common emitter arrangement not only is there some power gain due to the output impedance being higher than the input, but there is also current gain (beta) from the base to the collector, giving the highest power gain of all the configurations. It is also the circuit which inverts the signal (positive-going signal in produces a negative-going signal out). The common collector circuit, or emitter follower as it is popularly known, has less power gain but its useful features are a high input impedance and a low output impedance.

Practical transistor circuits

In general, valve circuits have a high input impedance and are fed with an input signal voltage. Transistor circuits, on the other hand, have a medium to low input impedance (except for the emitter follower) and are usually fed with an input signal current.

The biasing of a transistor common emitter amplifier stage has already been discussed in some detail in section No. 3, page 501. These conditions apply to most small signal AF, IF and RF amplifiers, although in some instances the input and output signals may be coupled through suitable transformers or tuned circuits.

Transmitters

To state the obvious, the purpose of the transmitter is to generate a radio frequency signal for transmission to a distant receiving station. In addition, the transmitted signal must conform to the Amateur Sound Licence requirements in terms of power, frequency band, frequency accuracy and stability, absence of spurious emissions, etc., particularly when keyed or modulated by the information to be sent. Full details of these requirements are given in "How to become a Radio Amateur" Appendix B, published by the Home Office.

A block diagram of a simple CW transmitter (Emission Type A1) for 160 metres, 1·8-2·0 MHz, is shown in **Fig. 49**. It consists of a Variable Frequency Oscillator followed by a Buffer Amplifier and a Power Amplifier.

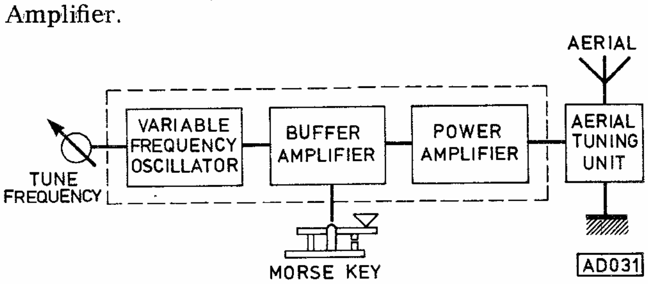


Fig. 49: Block diagram of a CW transmitter.

It is usual for the Oscillator to be operated in Class A or B, the Buffer Amplifier in Class B and the Power Amplifier in Class C. The various classes of operation refer to the condition under which the valve or transistor operates and these are summarised below and shown graphically in **Fig. 50.**

Classes of amplifier operation

Class A

In Class A, the transistor or valve is biased to near the centre of its linear operating range and the signal amplitude is insufficient to cause operation outside this range. A Class A amplifier has a low efficiency typically 50% or less (less than half of the input power is converted into useful output) but it does not distort the signal or generate harmonics.

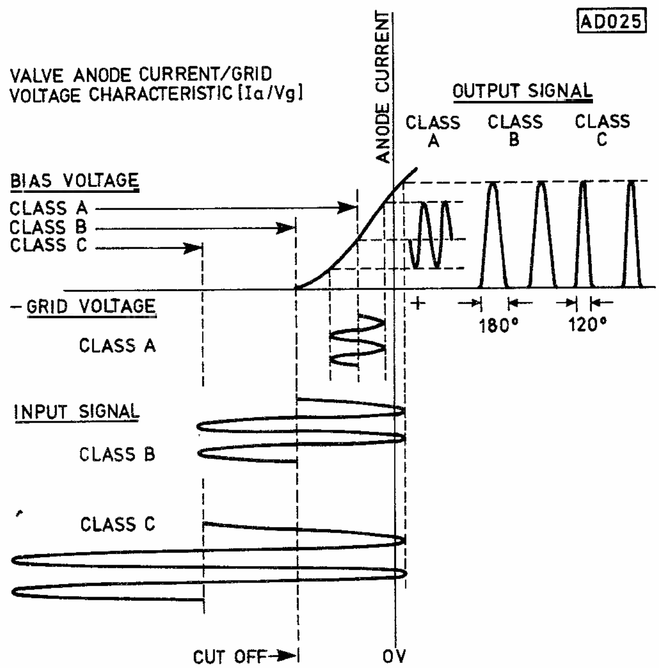


Fig. 50: Classes of operation.

Class B

In Class B, the valve or transistor is biased to the cut-off point and the input signal drives the device into full conduction for one half of the cycle of input signal (180°) and beyond cut-off during the other half. The efficiency is higher than Class A, being 60%-65% for CW (continuous radio frequency wave) operation.

A Class B amplifier stage with a single valve or transistor distorts the signal passing through it, producing mainly second harmonic distortion. In a Class B audio frequency amplifier, two valves or transistors are required. These operate in push-pull, one handling one half cycle and its partner the other, so eliminating the distortion.

A single valve or transistor Class B amplifier can be used for RF purposes in a transmitter because of the "flywheel" effect of the output tuned circuit. This type of amplifier has a reasonably linear transfer characteristic (the output signal is proportional to the input signal) and therefore an amplitude modulated RF signal can be amplified with little distortion, an important property which is essential in single sideband transmitters, as we shall see later.

Class C

In a Class C amplifier, the valve or transistor is biased well beyond cut-off and the input signal is required to have a larger amplitude in order to drive the device into conduction. Conduction only occurs for about one-third of a cycle of the input signal (120°) and the efficiency can be in the region of 70%.

The output of the device contains a high proportion of harmonics and the output circuit must be correctly tuned to the fundamental frequency to reduce the possibility of harmonics being radiated.

The Class C amplifier has a non-linear transfer characteristic and is therefore unsuitable for amplifying an amplitude modulated input signal although, as we will see later, it can be used to amplitude modulate a carrier wave.

A Class C amplifier can be employed intentionally as a harmonic generator or frequency multiplier by increasing the bias still further so that the device is only conducting for a quarter of a cycle (90°) of the input signal.

In this condition, the output is rich in harmonics and by making the output circuit resonant at the desired harmonic, power can be obtained at this frequency. For example, the input could be at 7MHz and the output tuned to the second harmonic (14MHz) and then further amplified for transmitting on the 14MHz band or the third harmonic selected for transmitting on the 21MHz band.

In Fig. 50 the bias conditions are shown in relation to a valve anode current (Ia)/grid voltage (Vg) characteristic, although they could apply, similarly, to a transistor characteristic.

Simple CW Transmitter 160 metres (1·8-2·0MHz)

The circuit of the transmitter, illustrated in block diagram form in Fig. 49, is given in Fig. 51.

The VFO is a series tuned Colpitts oscillator. The oscillator feedback is obtained from a capacitive tap (the junction of C3 and C4). Memory aid: "C" is for Colpitts and Capacitive tap. (When the feedback tap is an inductive one, on the coil, then the circuit becomes a Hartley oscillator.) The frequency stability of the oscillator depends mainly on the coil and tuning capacitor VC1 having good mechanical stability and on Tr1 being coupled in such a way that any change in its internal capacitance has little effect on the frequency. This is done by arranging that C3 and C4 are effectively across Tr1 and are large enough to swamp any small changes that might occur.

The output from Tr1 is fed to the tuned circuit L2, C5 which has a coupling winding L3 feeding Tr2. The bias for Tr2 is provided by R5 and R6 with decoupling by C6. The output from Tr2 is fed to the tuned circuit L4 C7 with a coupling winding L5 feeding the base of Tr3. Note that Tr3 is normally cut-off and only conducts when driven with an input signal. The emitter biasing resistor R8 provides extra biasing voltage when the stage is operating giving the correct Class C conditions. The output is fed to a suitable impedance matching point on L6 which, with VC2, resonates at the output frequency. Output coupling to the aerial tuning unit is provided by an adjustable coupling coil L7.

Keying and the Keying Filter

The transmitter is keyed on and off by connecting the morse key in the emitter circuit of Tr2. When the key is "up" no current will flow through Tr2 and there is no output. With the key "down" normal output is obtained.

Keying a transmitter by abruptly starting and stopping the carrier wave results in spurious signals being radiated and these are received as "key clicks" over a wide range of frequencies. To overcome this problem the transmitter must turn on and off less quickly and a key click filter L8, C9, R9 is included for this purpose. L8 restricts the rate of rise of current through Tr2 when the transmitter is keyed on and C9, the fall of current when keyed off, as shown in **Fig. 52.** The values of L8, C9 and R9 are often chosen experimentally, but the values given are typical.

Modulation

To transmit voice information by radio wave it is necessary for the microphone output signal to vary or modulate the RF carrier wave in a way that will allow the AF signal to be extracted at the receiver. The two basic methods are amplitude modulation and frequency modulation, each method having its particular advantages and disadvantages.

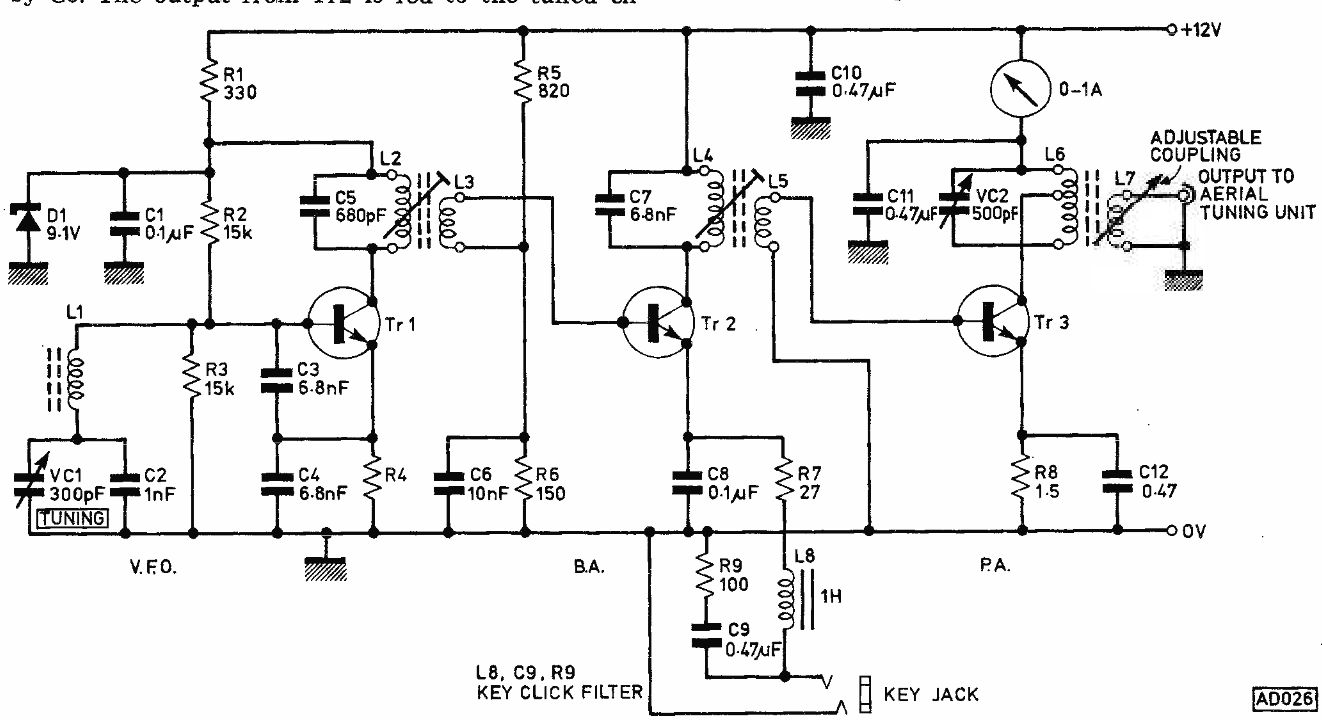


Fig. 51: The circuit diagram of the CW transmitter shown in Fig. 49.

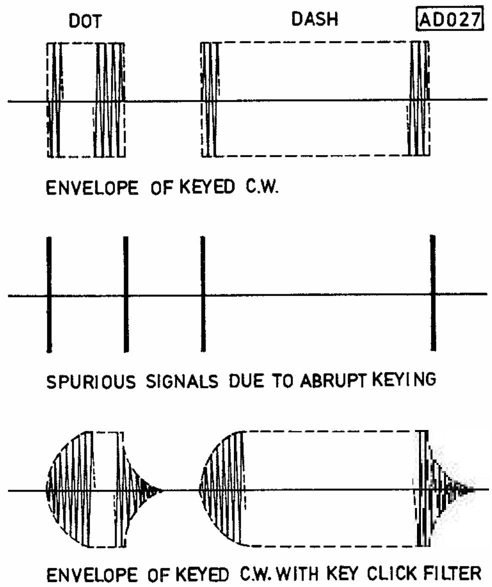


Fig. 52: Signal envelopes with and without key click filter.

Amplitude Modulation

Amplitude Modulation is produced by mixing the modulating signal with the carrier wave in a non-linear device or amplifier. Modulation can be carried out at high power level in the output stage of the transmitter or at low power in an earlier stage providing the subsequent amplifiers are linear (Class A or B).

Amplitude Modulation is shown in two ways in **Fig. 53 a, b** and **c**. On the left is a representation of the carrier wave, the modulating signal and the resultant modulation envelope as would be seen on a conventional oscilloscope. The graphs on the right show the same conditions but with frequency along the baseline. When two frequencies are fed into a non-linear stage, the output will contain a number of signals in addition to the original input signals. The main ones being the "sum" and "difference" frequencies, as shown below.

Input signals f_1 and f_2.

Output signals f_1, f_2, f_1+f_2, f_1-f_2.

If the carrier frequency is 1000kHz (f_1) and the modulating frequency is 1kHz (f_2) then two side frequencies are generated, the higher one at 1001kHz (f_1+f_2) and the lower one at 999kHz (f_1-f_2). It is the sum of the carrier and the two side frequencies which forms the "modulation envelope" shown in Fig. 53b.

The speech signal from a microphone consists of a *band* of frequencies between about 300Hz and 3·3kHz varying in frequency and amplitude with the voice patterns. Modulation by a speech signal results in two *sidebands*, the upper sideband and the lower sideband. These sidebands, which carry the AF modulation information, are mirror images of each other. The carrier wave remains constant irrespective of whether modulation is present or not and although it carries no information its presence is required at the receiver for the demodulation process.

Since the carrier wave conveys no intelligence it is possible to dispense with it altogether as shown in **Fig. 53d** (thus saving a great deal of transmitter power), provided it is generated again, locally, at the receiver for demodulation purposes. Unfortunately this carrier must be in the correct phase relationship with the sidebands or serious distortion will result. A double sideband suppressed carrier transmission is very difficult to tune in and requires a sophisticated receiver for satisfactory reception. However, if the carrier and one of the sidebands are removed and the remaining sideband transmitted then this exact phase relationship is no longer essential and the carrier can readily be inserted at the receiver.

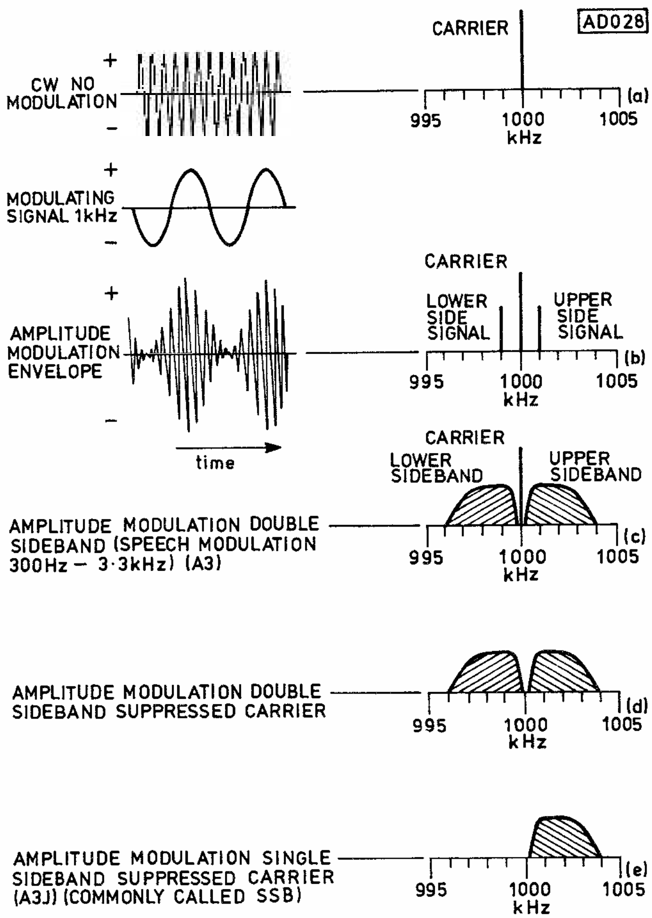


Fig. 53: Examples of AM envelopes, showing sidebands.

As the two sidebands contain identical modulation, removing one of them does not result in any loss of information and effects a further saving of transmitter power. This type of transmission, shown in **Fig. 53e**, is known as single sideband suppressed carrier or Emission type A3J and commonly abbreviated to just SSB.

Single Sideband

SSB has several advantages for the Radio Amateur.

1. Saving in transmitter power or the ability to run the equivalent of higher power for the same rating of output amplifier.
2. No carrier radiated so it does not cause the usual heterodyne interference.
3. Requires only half the usual bandwidth.
4. Less affected by transmission path disturbances.

Amplitude Modulation Transmitter

Amplitude Modulation, (A3) can be performed at high signal level in the output stage of the transmitter by applying the modulating audio voltage to the bias or to the HT supply voltage as shown in **Fig. 54.** In a transistorised transmitter it is usually necessary to modulate the driver or buffer stage as well as the power amplifier. High level amplitude modulation requires appreciable power from the modulator output stage. For example, a transmitter PA drawing 150 watts would require at least 75 watts of modulation power for full modulation.

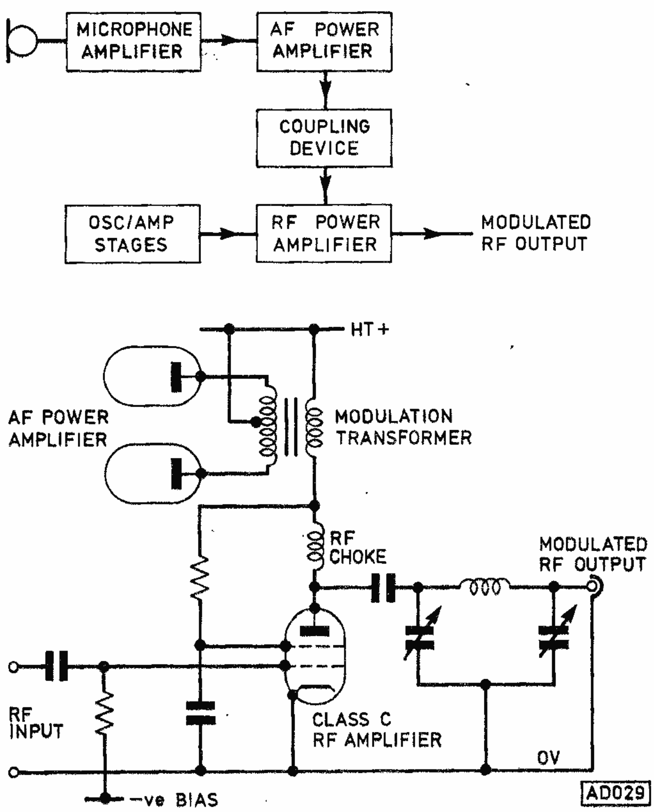


Fig. 54: An AM transmitter.

SSB Transmitters

The SSB signal is usually generated either by a phasing method, shown in **Fig. 55a** or by the use of a balanced modulator and filter, shown in **Fig. 55b.**

In the phasing method, the AF signal is processed in a phase shifting circuit which generates two signals having a 90° phase relationship over the audio frequency band, 300Hz to 3·3kHz. The RF signal is also phase shifted by 90° and fed with the AF signals, to two balanced modulators with a common output. The result is that the carrier is removed and one sideband is cancelled out. Upper or lower sideband can be selected by reversing the AF or RF inputs to the modulators.

In the filter method, the RF signal is modulated in a balanced modulator to provide a double sideband suppressed carrier signal and then one of the sidebands is selected by a high grade crystal filter to produce an SSB signal. The filter method is the simpler of the two, but requires an expensive, or very carefully home-made crystal filter.

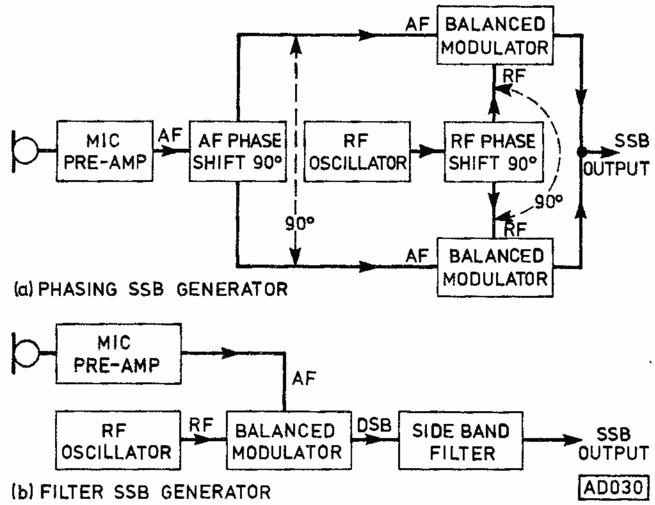


Fig. 55: Two methods of generation of an SSB signal.

Balanced Modulator or Mixer

The balanced modulator can take many forms but in essence it is a balanced circuit in which the RF input signal is cancelled or "nulled" out.

The simplest form is a diode bridge arrangement shown in **Fig. 56.** Here the RF input is fed to a bridge circuit where the centre of the diodes is a null point. RV1 and TC1 enable the bridge to be accurately balanced to provide adequate suppression of the carrier. An AF signal input causes D1 and D2 to conduct alternately, on each half cycle, unbalancing the bridge and producing a double sideband suppressed carrier signal at the output.

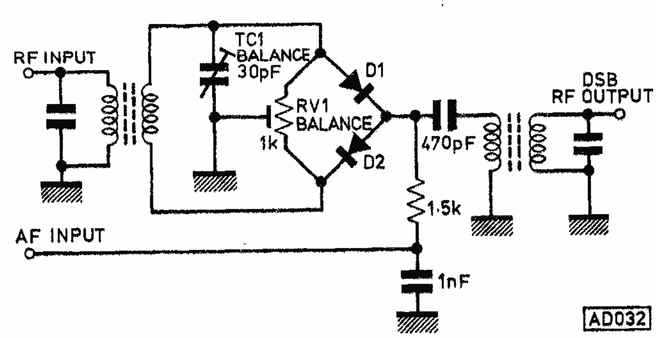


Fig. 56: Diode bridge modulator.

Simple SSB Transmitter

The block diagram in Fig. 57 shows a simple SSB transmitter for use on one band 14·00-14·35MHz. In this transmitter the SSB signal originates from a 9MHz crystal oscillator feeding into a balanced modulator and then to a crystal filter. The 9MHz SSB signal is mixed with a VFO, tuning 5·00 to 5·35MHz. The sum of the two frequencies 14·00 to 14·35MHz is selected at the output. This signal is amplified in a

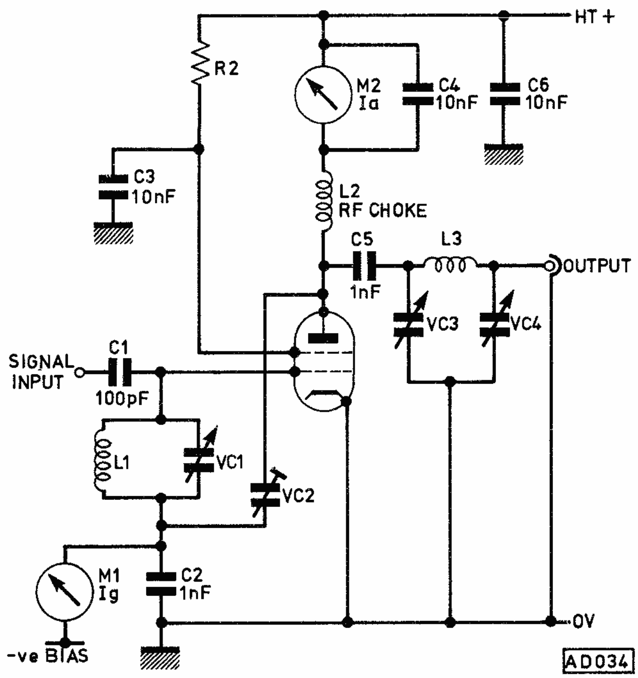


Fig. 58a: Single band SSB transmitter, above, and Fig. 58b, bridge circuit, top right.

linear buffer amplifier and then a linear power amplifier to give the required SSB power output. Operation on other bands would be possible by changing the VFO frequency.

It is essential that, once the amplitude modulated SSB signal is generated, subsequent amplification must be linear or severe distortion will result. Class C amplifiers are unsuitable for this purpose.

Linear Power Amplifier

A typical linear power amplifier, for use on one HF band is shown in **Fig. 58a.** The valve is biased to operate in Class B for good linearity combined with high efficiency.

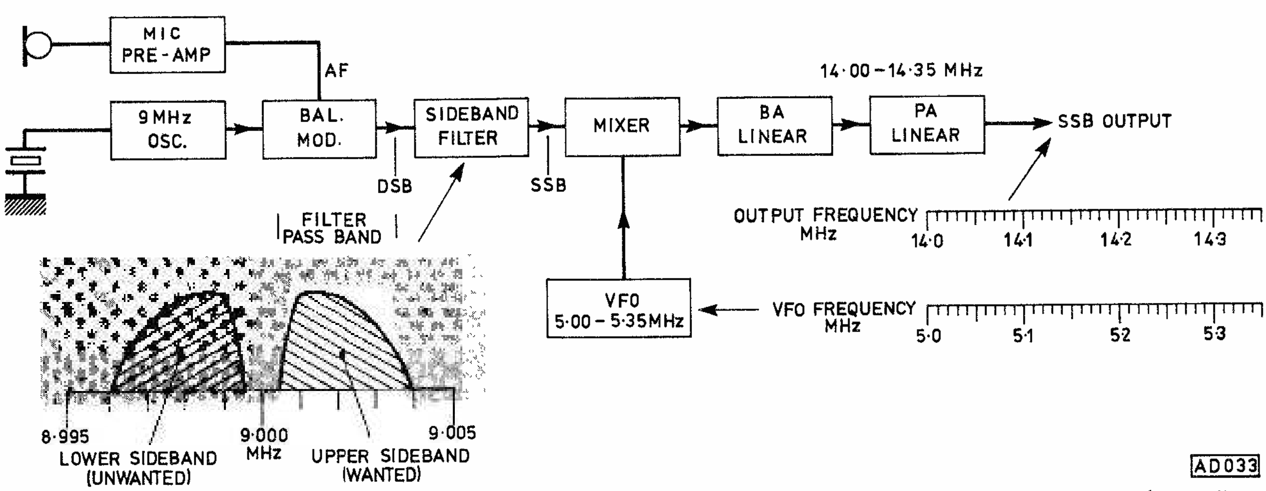
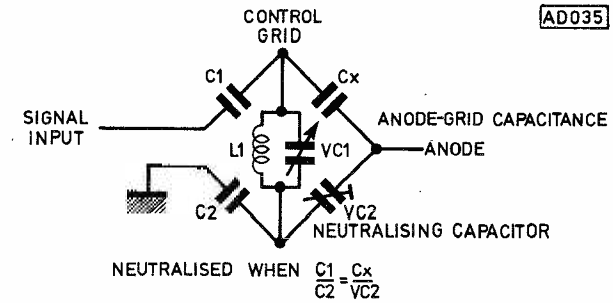


Fig. 57: Block diagram of a single band SSB transmitter.

The SSB signal is applied to the input tuned circuit and the control grid. The output signal, at the anode, is developed across the RF choke, L2 and fed via C5 to the output tuned circuit, L3, VC3, VC4. This output



circuit is called a "pi" network (similar in shape to the greek letter pi, π). In operation, VC3 tunes the output circuit to resonance and VC4 effectively provides a variable capacitive tapping point on the tuned circuit and enables the output of the transmitter to be correctly matched to the load.

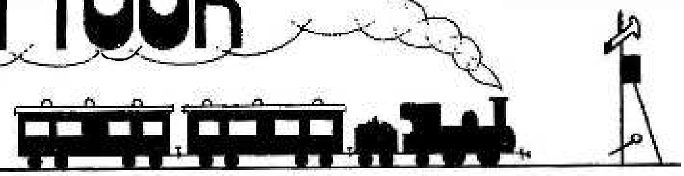
Neutralisation

There is usually some stray capacitance existing between the anode and grid of the valve both in the valve itself and in the wiring. Signal feedback through this capacitance affects the grid and anode tuning and may cause self oscillation. A neutralising capacitor VC2 feeds a small amount of RF signal from the anode to the opposite end of the grid tuned circuit and neutralises the effect of the anode-grid capacitance. The circuit is rearranged in **Fig. 58b** to show that the neutralising capacitor forms part of a "bridge" circuit. To set VC2, the HT is temporarily disconnected, an input signal is applied and VC1 adjusted for maximum drive indicated on M1. With VC4 at maximum VC3 is rotated and any variation on M1 noted. VC2 is then adjusted for negligible variation of M1, indicating correct neutralisation.

In the next section we will finish looking at Linear Amplifiers and cover Frequency Modulation and FM Transmitters, Receivers and Converters.

There is an excellent new book available, "Radio Amateurs' Examination Questions and Answers", compiled by the RSGB Education Committee and available from the Radio Society of Great Britain, RSGB Publications (Sales), 35 Doughty Street, London WC1N 2AE. Price £2 inc. postage. ●

'MYSTERY TRAIN TOUR'



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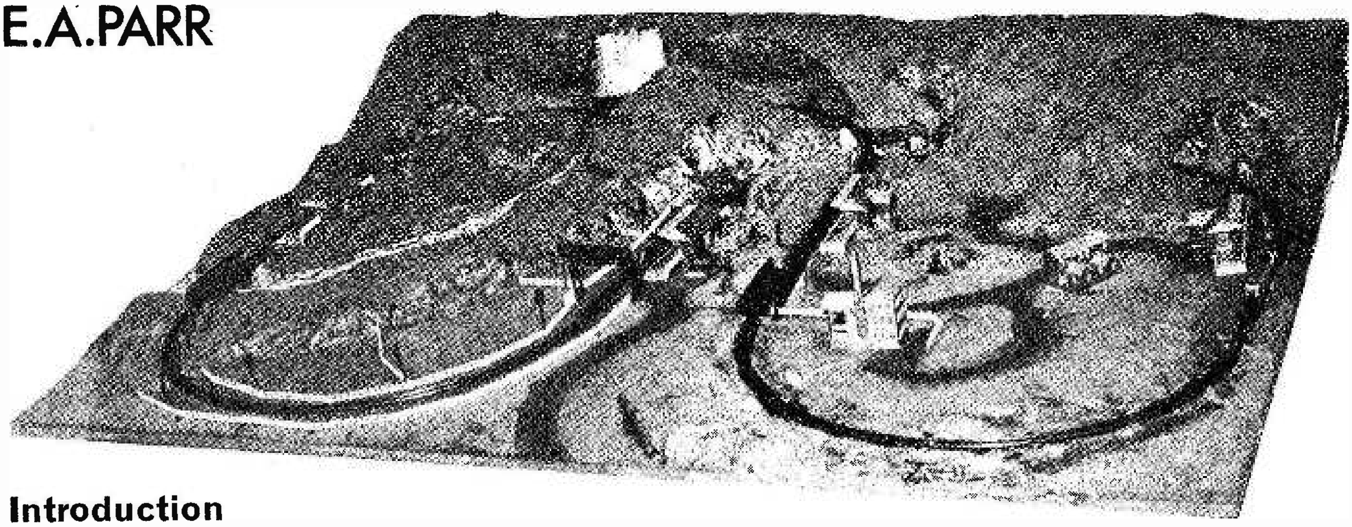


Introduction

Most clubs, churches and societies have fund raising ventures such as bazaars, cheese and wine parties and the like. These usually have side shows and competitions, one of the most popular being the "spin the arrow" game.

This article describes a similar game using a model railway train. A simple model railway layout has four stations (in the prototype named Euston, Crewe, Carlisle and Glasgow). A button is pressed and the train runs for about 30 seconds then stops at one of the stations. Players put money on the stations getting their money back, with a bonus, if the train stops at their station.

Circuit Description and Track Wiring

Before describing the circuit it is necessary to describe the railway layout and how it is split into sections. If the track circuit was continuous and power was simply removed, it is most unlikely that the train would stop exactly at a station. For four stations it is therefore necessary to split the track into eight sections. Four longer running sections all wired together, and four short station sections which can be isolated individually (see **Fig. 1**).

Originally it was thought that the running sections would be permanently energised, and all the stations sections commoned and driven off a 555 timer. The train would then run for 30 seconds, and stop in the next station section. However the period of the 555 was found to be predictable, and it was possible to guess the station with a fair degree of accuracy.

The final circuit, **Fig. 2**, was therefore developed. On this the running sections are again permanently energised, but at the end of the 30 seconds one station section is randomly de-energised. The train keeps running until it reaches the de-energised section when it stops.

The run time and the random stops are controlled by a 556 dual timer IC1. The 'a' section is connected as a monostable (period 30 seconds) and the 'b' section as an oscillator (frequency about 50 kHz) gated by the 'a' section so that it only runs during the 30 second period. This gating is carried out by pins 5 and 8.

The pulses from the 50kHz oscillator which appear on pin 9 of IC1 go to a two bit counter made from two D type flip flops (IC2). At the end of the thirty second period this will contain a "random" number from 0 to 3 inclusive. This is decoded by IC3 and used to turn off one of the four transistors TR1 to TR4, de-energising one of the station sections. The high frequency of the oscillator and long period for which it runs gives a sufficiently random count.

The positive supply for the track is derived from a very simple series regulator TR7, allowing the train speeds to be controlled by RV2. Players can be allowed to drive the train as it does not affect the station the train ultimately stops at.

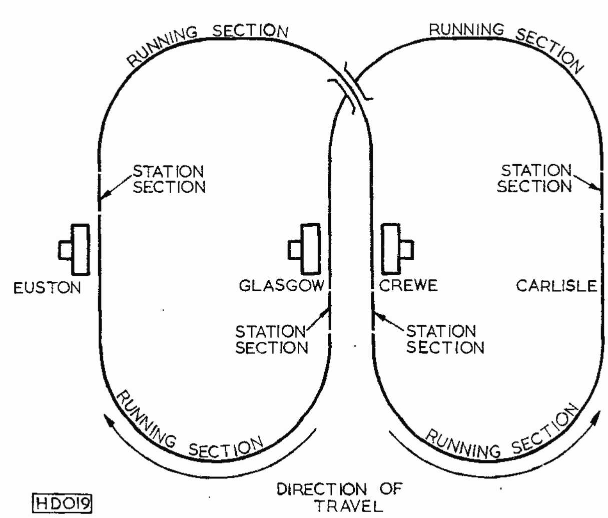


Fig. 1 : The track circuit layout.

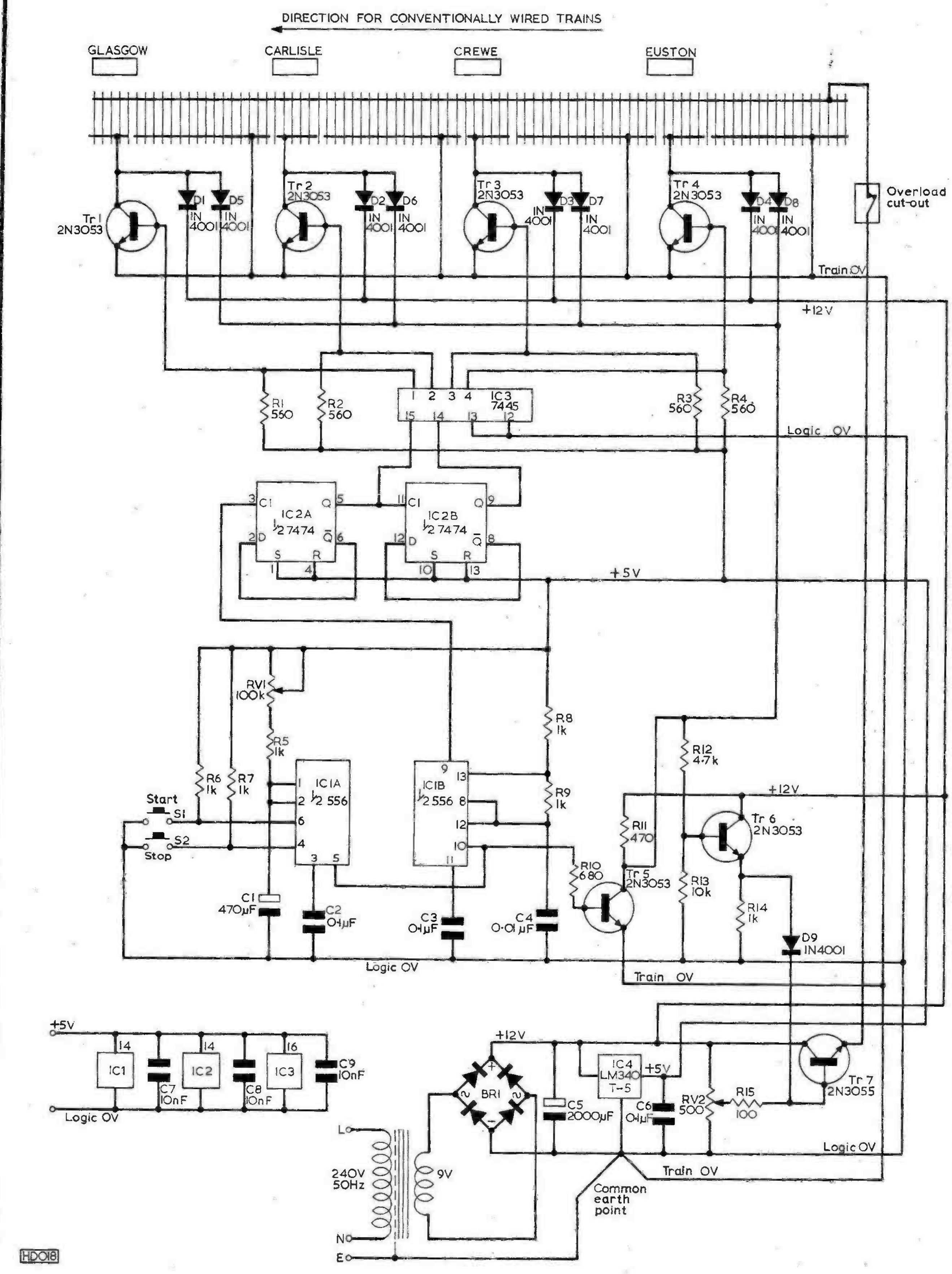


Fig. 2: The complete circuit diagram.

When the monostable times out, TR5 turns off and TR6 emitter rises to about 9V. This brings the loco supply up to 9V when the 30 second period is over, taking control away from the players.

Whilst IC2 is counting, the transistors TR1-TR4 are being briefly turned off at regular intervals. The effect of pulsing a small motor at 50kHz was not known, so diodes D5, 6, 7 and 8 are used to hold the negative supply to the track during the 30 seconds that IC2 is counting. TR5 is turned on when the monostable is running and off when it times out.

The period of IC1a can be varied by RV1, and the running period can be terminated prematurely by pressing the stop button. If it is wanted to make this a game of 'skill' the stop button could be operated by the player.

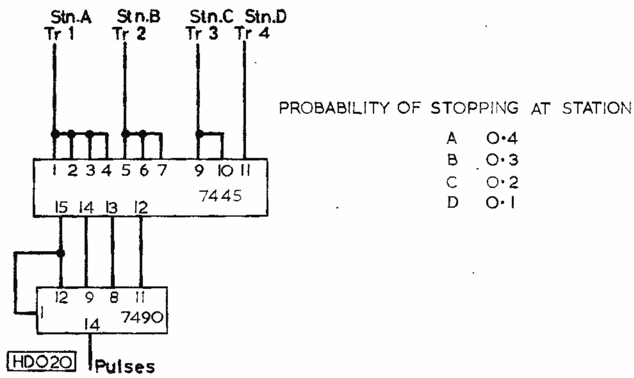


Fig. 3: The probability loading circuit diagram.

The power supply is straightforward, the 5V supply being derived from an IC regulator. Good decoupling is essential on the 12V supply to prevent noise spikes from the locomotive motor getting into the logic.

With a 7490 and a 7445 connected as shown in Fig. 3 a "loading" can be introduced, and the train will stop on average four times at station A, three times at station B, twice at station C and once at station D in ten runs. The returns to the players should be varied accordingly so as to make an overall profit on the game.

It is recommended that the trains be run in one direction only, as it is not possible to position the stations so that the train will stop at the station from each direction (remember that the loco has to stop past the station for the coaches to be at the platform).

★ components

Resistors

R1–R4	560Ω	
R5–R9	1kΩ	
R10	680Ω	
R11	470Ω	
R12	4·7kΩ	All ¼W 5%
R13	10kΩ	
R14	1kΩ	
R15	100Ω	

Variable Resistors

RV1	100kΩ
RV2	500Ω

Capacitors

C1	470µF 15V Electrolytic
C2, C3, C6	0·1µF Polyester
C4	0·01µF Polyester
C5	2,000µF 25V Electrolytic
C7, C8, C9	10nF Disc ceramic

Semiconductors

IC1	NE556
IC2	SN7474N
IC3	SN7445N
IC4	5V regulator LM340T-5 or similar
TR1-TR6	2N3053
TR7	2N3055
D1-D9	IN4001 or similar 1 Amp diode
BR1	Bridge rectifier 100V 1A

Switches

S1, S2	Push to make single pole push button switch

Miscellaneous

9V 1A transformer
Veroboard 0·1 inch pitch
0·5A overload cut-out (as sold by model railway shops)

Construction

The prototype was constructed on 0·1 inch pitch Veroboard with the layout shown in **Fig. 4.** No particular difficulty should be encountered in the construction. IC4 (the 5V regulator) and TR7 are mounted on the unit case.

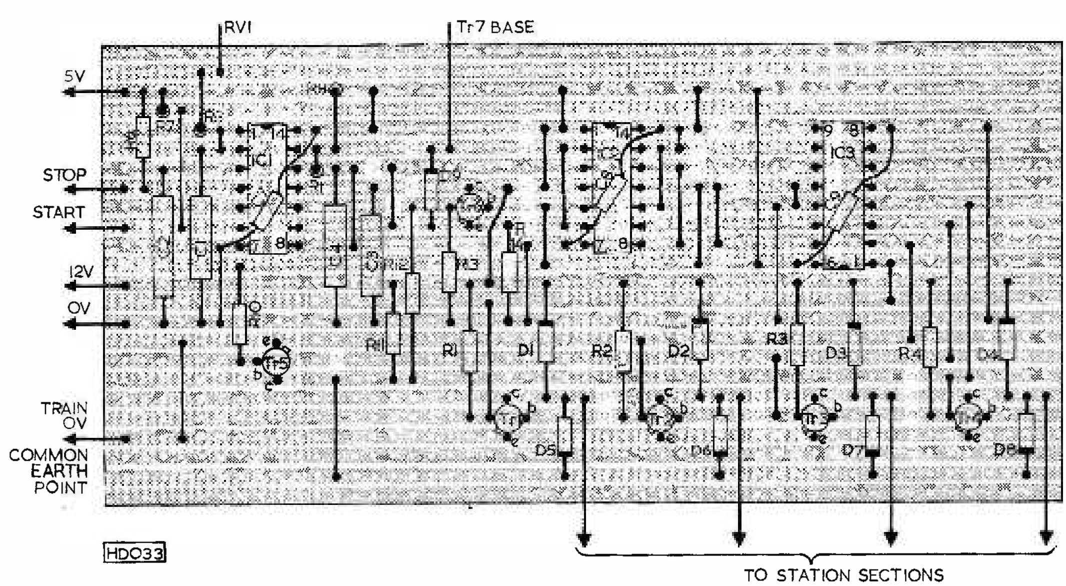


Fig. 4: General Veroboard layout of the unit.

Warning

The laws of this country regarding games of chance are somewhat complex, and are often overlooked by function organisers. Many premises and societies are licensed for gaming, many are not. If it is decided to use this for some fund raising venture and other games of chance (as opposed to games of skill) are being used then the venture is licensed (or the club is already taking a risk).

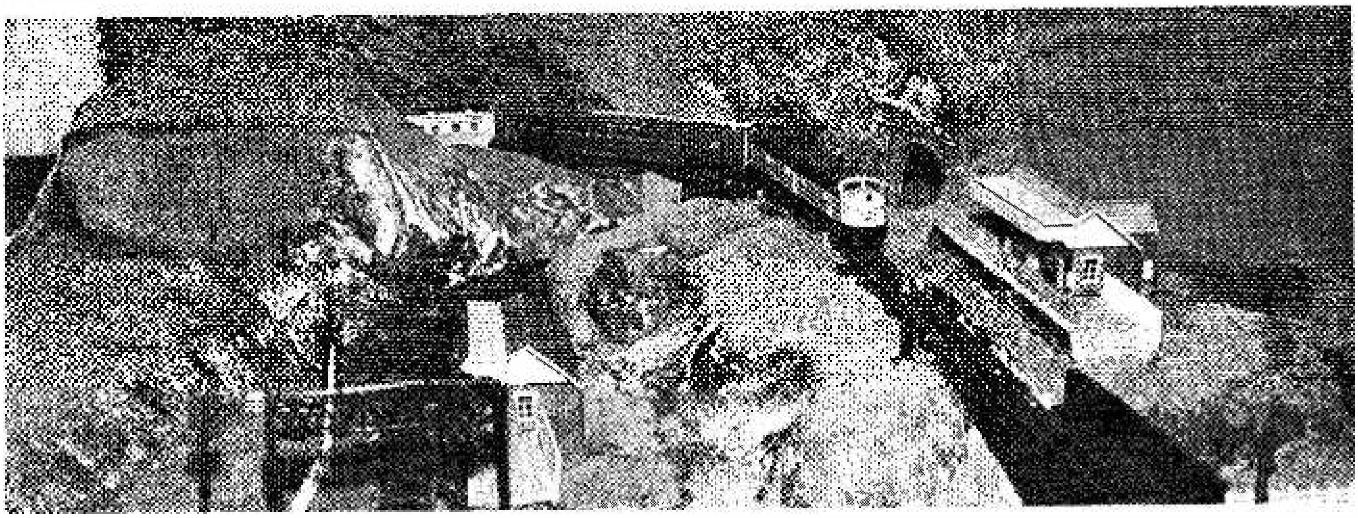
If there is any doubt, the local police should be consulted.

The layout was built on a 3ft x 4ft base board to a design as shown on Fig. 1. This gives a lot of track in a small area.

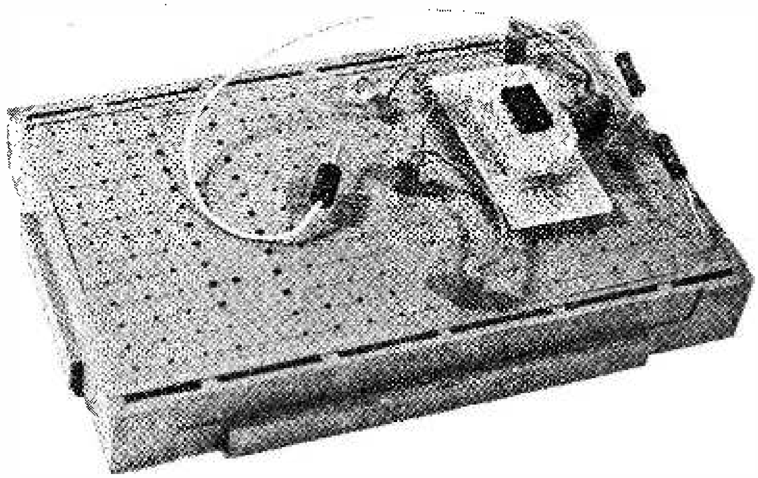
N gauge was used, and 6 inches was found to be a reasonable length for the station sections. The actual stations should be placed just before the station section and positioned so the coaches will be at the platform when the train stops.

The whole layout was landscaped with fields, cuttings, a waterfall and a tunnel so the simple track layout was not immediately apparent.

There is actually more work in building the layout than in the electronics. The electronics were built in one evening, but laying the track and building the scenery took nearly a fortnight! ●



μ-DeCnology



DAVID GIBSON

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THIS MONTH

'Simple Light Modulator'

This new series of simple projects continues where the previous S-DeCnology articles left off. The S-DeC projects all used discrete components, but the new series will feature circuits which employ one IC.

All projects will be built on a μDeCB. Like the S-DeC it has lettered and numbered holes into which the components are plugged using their lead wires. Beneath the holes in the plastic top, tiny retaining clips/sockets (connected electrically) connect up the individual components. Their connection patterns are shown as raised lines on the plastic top surface of the DeC.

Whereas the S-DeC had but 70 holes, the μDeCB has 208. It will accept discrete components, but also has provision for taking two ICs. Special IC carriers are employed to avoid damaging the IC pins by repeatedly plugging them in and out. Two types of IC carrier are available but we will use the one which accepts standard 16-pin DIL flat packages (the other carrier accepts round ICs in TO-5 packages).

Wherever possible, the circuits to be described will use the same component values. Thus once a circuit is built, the components may be simply unplugged and used again for future projects. Circuits which are required in permanent form can either be transferred directly onto Blob Board, or a small PCB may be designed, drawn and etched.

The circuits have been designed with cost in mind, and to this end the first IC chosen was the ubiquitous 741 operational amplifier—advertised in *Practical Wireless* for as little as 24p including VAT.

Let us get to know our new friend, the 741 IC. The pin connections are shown in Fig. 1. The transistors we used in the last series each had three leads. The IC isn't really so complex (connectionwise) since we are only going to use 5 leads. And because pins 7 and 4 got to the positive and negative battery terminals respectively, then we have, like the transistor, just three wires or leads. See how easy these ICs really are!

There is just one odd thing to resolve; we have one output (pin 6) but two inputs—pins 2 and 3. We'll talk about those later, but first let's look at some of the figures or specs for our 741 op amp.

It has low frequency gain, between input and output, of some 100,000. Each of its inputs has an input impedance of around 1MΩ while the output impedance at pin 6 is of the order of a few hundred ohms.

The positive (pin 7) and negative (pin 4) power connections are straightforward, and all amplifiers have an output (pin 6 in our case). So let's look at those two inputs.

The input at pin 2 marked with a negative or minus sign gives an "inverted output" at pin 6. Alternatively, pin 3 (marked with a plus or positive sign) will give a "non-inverted output" at pin 6.

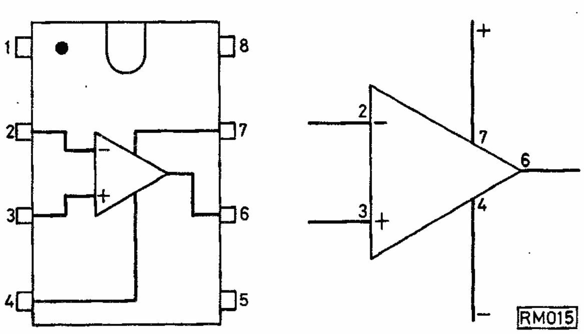
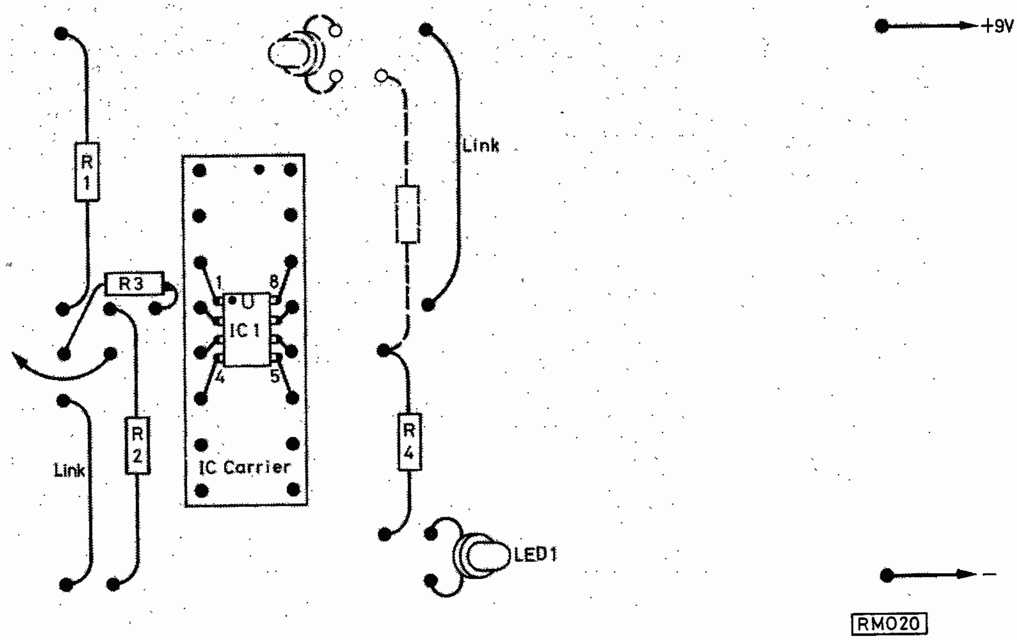


Fig. 1: The 741 op. amp. pin connections.

★ components

R1 100kΩ	IC1 741 op amp (8-pin DIL)
R2 100kΩ	LED1 almost any LED
R3 100kΩ	One μDeC B
R4 1kΩ	One DIL μDeC B carrier
9V battery	solid cored wire, or DeC jumper leads



The μDeC layout for this month's project shown actual size. Note the orientation of the 741 op. amp. in the carrier and also the way in which the carrier is plugged into the μDeC.

This merely means that if we apply a positive voltage to the negative input (pin 2) with pin 3 grounded, then the output will swing negative. In other words; positive input=negative output: inverted.

Conversely, if we applied our positive voltage to pin 3 (with pin 2 connected to ground this time) the output would swing positive. So: positive input=positive output: non-inverted.

Now let us examine two preliminary circuits to get the feel of the 741 op amp, and to actually see what we mean by inverting and non-inverting. You can easily build these on your μDeC if you wish.

Figure 4 has a 741 op amp, 6 resistors and an LED. The circuit is powered from a single 9V battery. Pin 3 is held at half the battery voltage (4·5V) by the potential divider R1/R4. We can vary the voltage applied to the negative input (pin 2) from negative ground (zero volts, or "low") up to positive 9V or

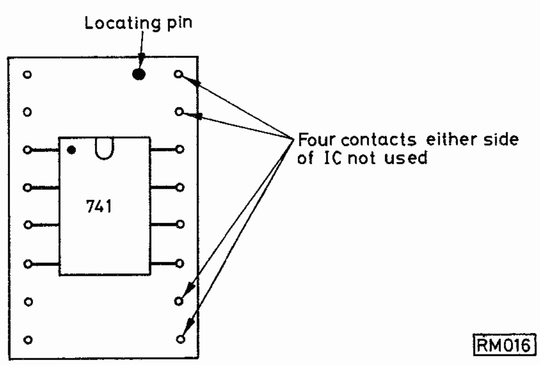


Fig. 2: μDeC carrier with 741 in position.

"high". In other words we can make pin 2 up to +4·5V above pin 3 or −4·5V below it since at either end of its track the potentiometer will connect pin 2 to +9V or zero respectively. Resistors R2 and R3 are included to prevent excessive currents flowing. This is particularly relevant when VR1 is at the top or most positive end of its track.

A clear indication of output voltage is given by the LED. Resistor R5 limits the current drawn by the LED.

The diode will light when the output voltage is positive or "high", and extinguish when it is low. If you wanted to be absolutely sure what the input was, then you could ignore the potentiometer and take a wire from point X connecting it in turn first to the positive battery terminal and then to the negative

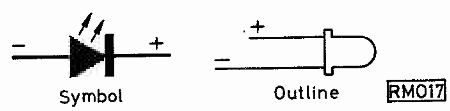


Fig. 3: L.E.D. symbol and outline.

one. It can then be seen that when the connection is made to the negative or "low" terminal, the output at pin 6 is "high" and the LED lights. Connecting the wire to the positive terminal extinguishes the LED showing the inverting action of the circuit.

To see the effect of the non-inverting circuit, look at Fig. 5. Again we have a potentiometer and series resistor (R1). The LED and its limiting resistor also remain. Connecting the 100kΩ resistor R2 directly between output and the negative input (pins 6 and 2) means that the voltage at pin 2 is the same as the output voltage at pin 6. One can again turn the potentiometer from negative ground (zero volts, or "low") up to +9V or "high". Here it will be seen that when the input to pin 3 is high (+9V) the output is also high (LED lights). When pin 3 is "low" the LED does not light. Thus we have a non-inverting situation.

The above simplified theory is important and we will return to it when building other projects in this series.

Our first suggested project makes use of the very high gain and input resistance mentioned earlier. Figure 6 shows the circuit. Because of the high gain and high input impedance, pin 3 is easily affected by surrounding conditions.

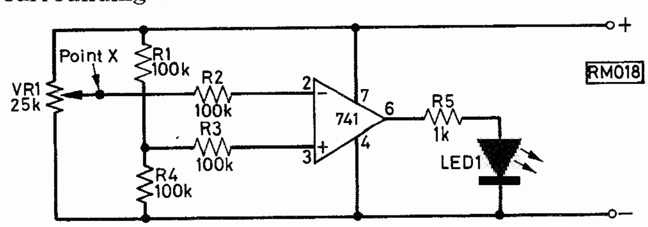


Fig. 4: Inverting op. amp. circuit.

The inverting input (pin 2) is fixed at 4·5V by the potential divider R1/R2. Pin 3 is also taken to the potential divider via R3. Pin 3 is now extremely sensitive to changes. So much so that if the end of the probe wire from μDeC hole B13 is merely touched the LED will immediately light up. In the prototype, just gripping the insulation of the probe wire caused the LED to illuminate.

On test, the circuit was found to function at 5V. Voltages above 9V are not recommended.

The project can be used for numerous things. For example, it could be useful to send visual morse by 'tapping' the probe wire. Hams might consider using

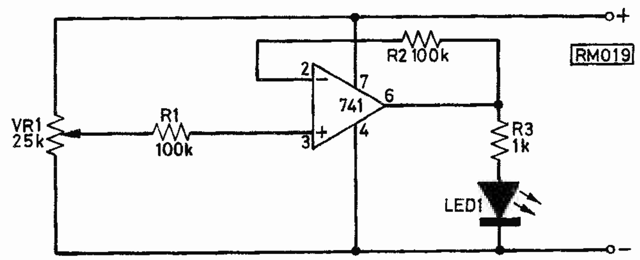


Fig. 5: Non-inverting circuit.

the circuit as a noiseless morse key. The input or probe wire could be connected to a small (say 15mm²) aluminium plate. The c.w. could be sent with one finger touching out the morse characters. The 741 might be used to drive a transistor or thyristor to effect actual keying of the rig. With the touch wire connected to a metal door knob the circuit could be used as some form of alarm—how about trying it on the metalwork of your car?

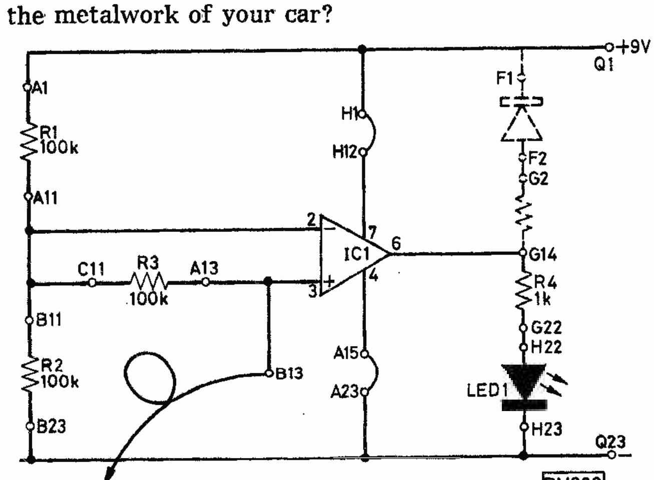


Fig. 6: Circuit diagram of the Light Modulator.

By connecting a crystal microphone between pin 3 and earth (unplug the probe and connect the mike to μDeC holes B13 and D23) the LED can be modulated by speech and/or music. The circuit can thus be used as a simple light modulator.

When building μDeC projects watch out for jumper or shorting wires—they are easy to forget because they are not actual electronic components. There are two in this month's project; between holes H1/H12, and B15/C13.

The IC carrier will only fit one way round into the μDeC so there is no danger of error here. Note that our 741 is the 8-pin DIL type (because it was the cheapest!). This is plugged into the middle eight sockets in the carrier, and it is helpful to label the different pin numbers on the DIL carrier with a felt pen (or whatever). This makes wiring easier and helps enormously when checking out a circuit. ●

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

In general, the author does not have any more information on products than appears in the article.

Charging meters

Having made use of rechargeable batteries I know how long it takes to fully recharge them. There have been some achievements in this area and at least one manufacturer had cells which could be recharged in just four hours.

Now I read with great joy about a sealed lead-acid battery which can be recharged to its full capacity in exactly 60 minutes if one follows the manufacturers special recharging procedure. Perhaps, instead of parking meters of the future we will have charging meters for the electric car—it charges your battery while you shop, and charges you when you return!

Electronic au-pairs

Doubtless everyone is all for labour saving devices—things which make life easier in the home (apart from one au-pair francaise!) are naturally popular. One manufacturer has given thought to a number of things and has sought to combine all the answers in one unit.

The original item of manufacture was an environmental chamber into which various pieces of electronics were put. These were then subjected to anything from freezing cold to tropical heat, salt spray, high humidity, etc., etc.

The makers then had a brilliant idea —why not make an environmental chamber for the home. A combined sauna, cold water bath, tropical sunshine sun-tanner, you-name-it-we-do-it chamber.

It seems that they've hit onto a winning idea, too. Orders are flooding in from health hydros, hotels and motels all over the place.

Needless to say the whole thing is electronically controlled and each sequence of whatever you've dialled in is electronically timed. Instead of having a sauna and then having to rush out and hurl yourself into a freezing puddle, you can climb into your environmental chamber, press a button, and immediately after your carefully timed sauna is over—a freezing puddle will rush in and hurl itself all over you!

And just for the record; the same company is manufacturing things called "whirlpool tubs". One's imagination could run riot here, thinking of things like automatic brushes which pop up to scrub your back—although faulty body positioning could prove fatal!

Radio Sundial

With electronic watches ever keeping up with the times I often wonder if there is any real limit to it all. At a recent electronics show at Basel, a famous watch manufacturer hung up an electronic watch with a conventional face. It was powered by its own solar cells and contained a radio receiver which was tuned to time signals broadcast from Switzerland. The result was that the clock maintained an accuracy of $\pm 0{\cdot}1$ second per day. When the time signal went off the air, the watch went on ticking away to a frequency set by its own internal quartz crystal. Immediately the Swiss time signal came back on the air, the clock would synchronise and automatically correct any error which had crept in. We've come a long way since sun dials.

Phonemes

Chatting to a computer is a common enough happening in television science fiction, but it isn't quite so far away as one might think. If you haven't already—meet the Phonic Mirror Handivoice. Don't shake hands with it too eagerly; it costs around £1111·00 excluding VAT!

So; what do you get for the money. Well, all words are made up of sounds. These basic sounds (which make up everything we say) are called phonemes. The device above has a memory which accepts up to 40 commands from a small keyboard (the whole unit is a little larger than a calculator). Inside is an electronic analogue of the human voice—a thing called a phonetic synthesiser. It produces all these basic sounds or phonemes. When the 'talk' button is depressed, the memory sends the commands to the phonetic synthesiser which then emits all the right squeaks and moans in the right sequence and the result is 'human' recognisable words.

Perhaps the most obvious question is how limited is the vocabulary. In theory, since it produces all the necessary phonemes, the vocabulary is virtually limitless. Surprisingly there aren't all that many phonemes required —about 45 for 90% of our normal useage. By making different sensor inputs it is envisaged that even severely handicapped people could 'talk'. A sensor might sense breath, or perhaps muscle movement etc. Needless to say, the unit boasts a microprocessor in addition to its read-only memory and synthesiser.

Oh for my PL81

I can remember when a large semiconductor manufacturer claimed to have reduced the colour television receiver to just five integrated circuits. "Wonderful" mumbled an awed Press gathering. An even more "awed Ginsberg" heard recently that a German manufacturer had succeeded in reducing the number of ICs required to process colour TV signals down to three little chips. Apparently this current video miracle has been achieved by putting both luminance and chrominance amplifiers onto a single chip. While I bow my head to such great technical achievements I believe that it is sometimes a double-edged weapon. Think; as more and more is crammed onto a single chip—how much more complex and expensive that chip becomes. How very much more difficult it is to service—to check that chip as it comes off the production line.

Sad, sad, I still hold fond memories of my local TV service man assuring me, "It's yer PL81 mate—they always go about this time of year".

Goodbye pot!

If you have a light dimmer it's certain that you're using a potentiometer, with a knob on the end, as the control. Well, a manufacturer has come up with a touch plate plus complementary IC to change all this to touch control. Just touch the plate and the light will brighten or dim automatically. The punch line is that the cost of the IC and touch plate will be less than the cost of a potentiometer and knob! Look out knob twiddlers—this is your life!

Ginsberg

THE 5 METRE STORY part 2

Ron HAM BRS15744

Following the great success of the Crystal Palace tests it was decided to attempt further experiments with aircraft and on June 18th, 1933 two De Havilland Dragon-Moth aeroplanes were fitted with transmitters and receivers for 56 Mc/s. One aircraft was again chartered by the *Daily Herald* and the other by *Popular Wireless*. Douglas Walter's gear was installed in the *Herald's* plane and George Jessop fitted his sets into the *Popular Wireless* plane. The Dragon-Moth was chosen because of its large cabin which normally held six passengers. Several seats were removed in order to provide space for the radio equipment and the associated power supply.

Ordinary 2V valves were used as oscillators (Osram P2's) and modulators (Osram PT2's in parallel). The power supply consisted of 200V from Hellesen super-capacity batteries, specially supplied for the occasion. The aerials were half-wave and slung inside the cabin and a transmitter power of about 5W was used. The receivers were conventional 3-valve super-regens as used before. When both planes were airborne, two-way radio communication was established between them. Owing to thick mist and heavy rain, the two aircraft lost sight of each other but met again over Harrow. At this time, Doug could hear George Jessop working duplex phone with G2JV of Harrow and shortly after, Doug did the same. Later they worked G6YK and G6NF with absolute ease and when both planes landed at Romford Aerodrôme they talked about the running commentary given by G5CV as he was landing.

Radio in Gliders

After spending an afternoon on Dunstable Downs watching the London Gliding Club's flying activities, Doug Walters decided that radio could really assist gliding. Pilots attempting long distance flights could obtain the latest information from ground stations and instructors correct faults and give advice to their pupils. Once more here was an opportunity to prove again the efficiency of 56Mc/s for reliable "local" communication.

One fine Sunday in 1934, "the old firm" of Walters and Jessop arrived on Dunstable Downs with a car load of 56Mc/s apparatus including a midget 5m receiver specially made by George. It had three valves housed in an aluminium case and measured 6 x 5 x 2½in. A 60V HT battery and a small unspillable accumulator were contained in a small suitcase which was placed in a recess behind the seat of the glider. The aerial was a 3ft length of wire inside the suitcase!

While the glider was being towed up the hill, Doug tested out his transmitter which was totally enclosed in an aluminium cabinet and mounted immediately below the feeder of their wire dipole, which was suspended between two 6ft rods supported at each end by the car. When the glider was airborne, Doug told the pilot that he was the first person to "listen-in" while gliding, and then asked him to "bank" to the left, which he did, as if to salute the expertise of G5CV and G6JP!

56 Mc/s Field Days

Field days have always brought out the best in both operators and equipment and records have often been established and broken and new ideas tested out. During a local 56Mc/s Field Day in 1934, BRS157 took his receiver to the top of Chanctonbury Ring in Sussex and heard G6CJ (50 miles), G2YL and G6NF (both 27 miles) and G5NF (30 miles). These listener reports were valuable in those early days because they could evaluate the differences between several stations.

The first 56Mc/s National Field Day was held in July 1937 and certificates of merit were awarded by the RSGB to T. P. Allen GI6YW and W. Jones GW6OK in recognition of the first 56Mc/s contact between Northern Ireland and Wales. Good distances were covered from various locations in the UK. For instance, G2DC/P located in Buxton, Derbyshire worked G6OK/P (85m), G6MX/P (77m) and G5MQ (40m), while down in Sussex at Kithurst Hill, near Storrington, G5MA/P worked G2NH/P, G5CM/P, G6RD, G5JW/P, G2MV, G6GR and G8IX/P. Up in Cumberland G6JZ using a QRP rig heard no signals all day, but over in Bristol G5JU/P contacted G6FV (14m) and heard G5BK/P at 60 miles.

One of the highlights of the second 56Mc/s NFD, held in 1938, was the contact between GW6AA/P on Snowdon and EI2J (98 miles) running 0·5W input to a type 30 valve from his car on a hill behind Dublin. Although the official report shows that the number of transmitting logs was down from 19 (1937) to 15 the prize for enthusiasm must go to G2NM/P operated by the West Sussex SW and TV Club situated on Bury Hill, in Sussex. Their transmitter was a 6L6 Tritet ECO, 6L6 PA, modulated with a 6N7 in Class B and was powered from a rotary converter giving 110V AC. Many receivers were used besides the receiver associated with the field day transmitter. There was quite a gathering on the site with 35 members and visitors being present. They had a good log to show for their day's work: 11 contacts made and six stations heard, compared with G2JK/P on Epsom Downs, Surrey, who worked 14 and heard eight, and G5MA at Holybourne Down, Hants, who made 13 contacts and heard 10, while up on Snowdon, GW6AA/P worked 11 and heard one plus very strong signals from 5m police stations.

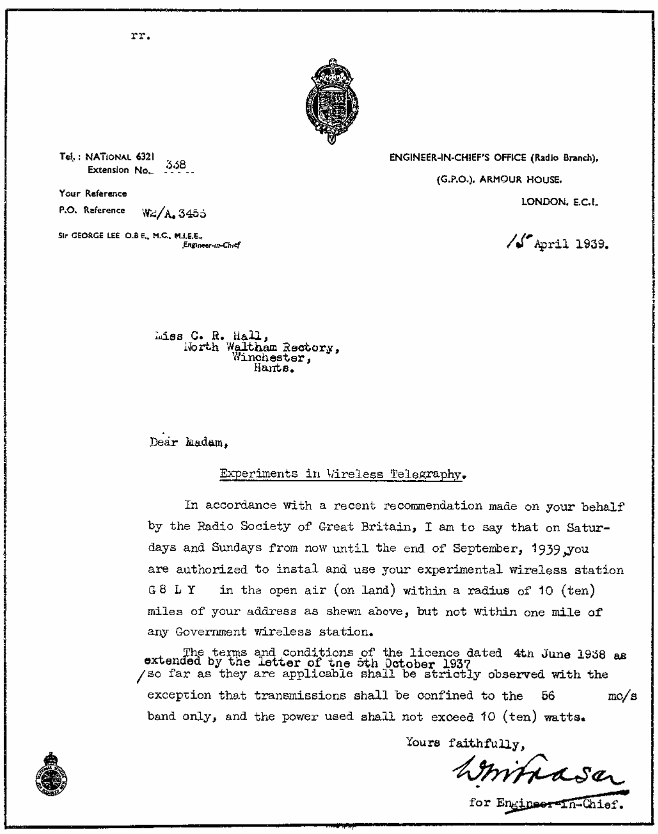
Thirteen listener logs were submitted compared with nine for the 1937 field day, and, apart from 2CIL's record entry, the leading stations were BRS2601 (Ewell, Surrey 21 stations), 2AAH (Chichester Sx 12), and 2DFG accompanied by BRS3322, each with their own receiver, situated on Ditchling Beacon, Sx. Between them they heard 13 different stations, eight were on phone and 11 on CW.

1939

While researching this story, the author realised that the report of the 56Mc/s NFD held in July 1939 was published in the September issue of the *T & R Bulletin,* several days after the outbreak of World War 2, and the withdrawal of the amateur radio transmitting licence. The RSGB estimated that about 100 amateurs took part in the portable operations during this event, in addition to the large number of fixed stations who joined in from home. During this event, BRS1173 heard three European stations, F8AA, F8NW and ON4DJ, but unfortunately none of the portable stations was able to work them.

The RSGB was pleased to see that their policy of encouraging the use of crystal-controlled transmitters and modern types of receiver was bearing fruit. Of the 16 portable transmitting stations who entered logs no less than 11 employed crystal control and many of them used Acorn valves as RF amplifiers in their receivers.

The adjudicators decided that C. J. Rockall G2VZ and his partner E. Cosh 2DDD were the joint winners of the RSGB's Mitchell-Milling Trophy, not so much on the actual performance of their station or the number of contacts made, but for the clear, concise, and extremely interesting log which they submitted. After the war Eric Cosh became G2DDD and was one of the pioneers of both the 70cm and 23cm bands.



rr.

Tel.: NATIONAL 6321
Extension No. 368

Your Reference
P.O. Reference W2/A.3455

Sir GEORGE LEE O.B.E., M.C., M.I.E.E.,
Engineer-in-Chief

ENGINEER-IN-CHIEF'S OFFICE (Radio Branch),
(G.P.O.). ARMOUR HOUSE.
LONDON. E.C.1.

15 April 1939.

Miss C. R. Hall,
North Waltham Rectory,
Winchester,
Hants.

Dear Madam,

Experiments in Wireless Telegraphy.

In accordance with a recent recommendation made on your behalf by the Radio Society of Great Britain, I am to say that on Saturdays and Sundays from now until the end of September, 1939, you are authorized to instal and use your experimental wireless station G 8 L Y in the open air (on land) within a radius of 10 (ten) miles of your address as shewn above, but not within one mile of any Government wireless station.

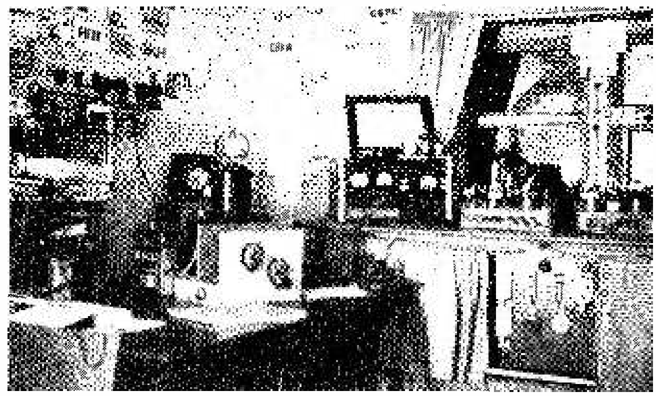
The terms and conditions of the licence dated 4th June 1938 as extended by the letter of the 5th October 1937 so far as they are applicable shall be strictly observed with the exception that transmissions shall be confined to the 56 mc/s band only, and the power used shall not exceed 10 (ten) watts.

Yours faithfully,

W. M. Fraser

for ~~Engineer-in-Chief.~~

The permit issued to Constance Hall G8LY allowing her to operate with portable equipment. The authorisation "until the end of September 1939" was somewhat prophetic!



The "shack" of Constance Hall G8LY, in the mid-30's, located at North Waltham Rectory, Winchester.

He spent the summer of 1975 going through the author's collection of *T & R Bulletins* (1930-1940) marking all the references to the 5m band. This work was of great value to the author when writing this story. Eric died in 1976 having devoted his life to the experimental side of amateur radio.

Miss Constance Hall G8LY also qualified for a transmitting award of merit, again not so much for the number of contacts made but for the interesting report which accompanied her entry, including a plan showing the direction and distance of each station that she heard or worked. The equipment used by G8LY was housed in one cabinet and operated from the rear seat of her car and she could rotate her beam aerial through the window.

The third transmitting award went to Ernie Dedman G2NH, partly for his interesting report but more particularly for the consistency with which contacts were made during the whole event; 21 QSOs were made in 10 hours.

In the receiving section two awards of merit were made; one to G. F. Keen 2BIL and the other to J. Cymerman BRS3101 because of the general excellence of their results and well written reports. 2BIL proved the value of CW for making DX contacts, hearing three CW stations over 100 miles away, 11 over 50 miles, but none over 50 miles were received on telephony.

The Trail Blazers

A small group of experimenters known as the "Folkstone Radio Amateurs" established the first 56Mc/s link between England and the Continent in March 1936. This was arranged through correspondence between the group's chairman G2IC and F8WY. On 29th March the operators at G2FA heard F8NW working F8AA. They gave F8NW a short call and to their great joy he came back, giving them R7 QSA5. Mutual congratulations were exchanged, and it must have been amusing to hear each of the 10 club members present take the microphone in turn and try his hand at French. Later they made contact with F8WY, F8ZF and F8AA.

The apparatus used at G2FA was a long-lines oscillator with a couple of Tungsram 15/400 valves in push-pull and an input of 8W at 250V. The aerial was a vertical dipole, Windom fed, with a reflector spaced at a quarter wave. The receiver was a two-valve self-quenching super-regen with a vertical doublet aerial.

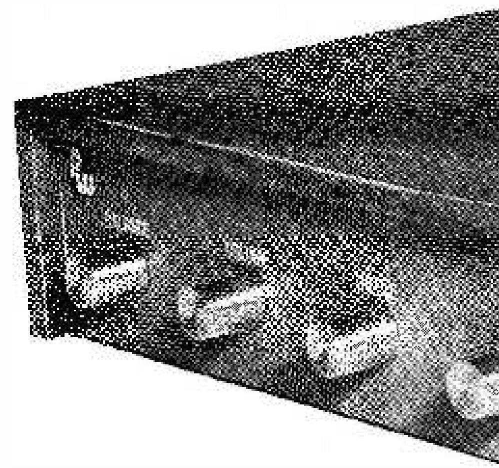
TO BE CONTINUED

PW 'EURO
stereo

This is a general-purpose quality amplifier which has been specially designed with the amateur constructor in mind. Virtually all the components are mounted on a single printed circuit board, greatly simplifying assembly and eradicating the intangible problems of earth loops and hum pick-up from the power supply section. A simple, but very effective, method of heat sinking the output stage is used which, again, avoids a bugbear for the home constructor. Even though construction is simple the circuit is fairly sophisticated and it is imperative that there is no variance from the specified component values. Equally, because of the large number of components, care must be taken to insert them in the right places on the p.c.b.

The design provides push-button input switching and equalisation for a magnetic pick-up cartridge, a tape recorder playback head, a tuner and one auxiliary channel. The output stage provides maximum power into a 4 ohm loudspeaker; however, it is permissible to use 8 or 16 ohm loads provided the reduction in output power is acceptable. Controls are quite conventional utilising ganged potentiometers for Volume, Treble and Bass together with a Balance control. A simple switchable rumble filter can be introduced when required.

A nominal 56V power rail supplies the power amplifiers without stabilisation and has proved to be more than adequate. Nevertheless to avoid damage to speakers from switch-on surges a slow turn-on circuit has been incorporated. This will be described later. The supply to the pre-amplifier is 30V; obtained from a conventional series stabiliser circuit.



★ Author's specification

INPUT **Mag. PU** 5mV RIAA equalised
Tape head 5mV NAB equalised
Tuner 350 to 500mV Low Impedance 'Flat'
Auxiliary, sensitivity 100 to 180mV. Low impedance, 'flat', suitable for:
Transistor radio or tape recorder earpiece
Or, medium output crystal cartridge with 470kΩ series resistor
Or, ceramic cartridge using 100kΩ series resistor

POWER OUTPUT Continuous, both channels driven 30 + 30 watts into 4Ω load

TOTAL HARMONIC DISTORTION (75dB gain at 1kHz) Better than 0·05 to 0·1% typical up to clipping level

CROSSOVER DISTORTION at 1W into 16Ω-nil

HUM AND NOISE 115dB below 50W

RUMBLE FILTER −7dB at 100Hz

CHANNEL SEPARATION 45dB at 1kHz

FREQUENCY RESPONSE 10Hz to 18kHz

TREBLE/BASS CONTROLS −20dB to +20dB

OUTPUT IMPEDANCE Minimum 1Ω, maximum to infinity
Open and short circuit protected

STABILITY Unconditionally stable

Pre-amplifier

The circuit of one pre-amplifier channel is shown in Fig. 1. The heart is an LM381AN integrated circuit which contains two ultra-low-noise amplifiers. They are completely independent and draw their power from an internal power supply decoupler-regulator that provides better than 120dB supply rejection and 60dB channel separation.

The alternative pin numbers shown on IC1 refer to the second channel connections.

Gain, and equalisation, options for the various inputs are selected by switching components into the feedback circuit for IC1. For example, when S4 is depressed the magnetic cartridge input is selected. Resistors R11, 12 and 13 together with C4 and C5 are switched into the feedback loop. R11 and R13 in conjunction with R4 set the d.c. working point of the amplifier and the frequency dependent components —C4, C5 and R12 shunted across R11 determine the compensatory roll-off for the RIAA recording characteristics.

Switch S3 selects the tape-head input. Note that this is designed to accept a signal direct from a tape recorder head and NOT after a tape pre-amplifier stage! NAB playback equalisation is provided by C2 and R7 shunted across R9 in similar manner to that for the magnetic cartridge.

PA' amplifier

C. Toms B.Sc

Part 1

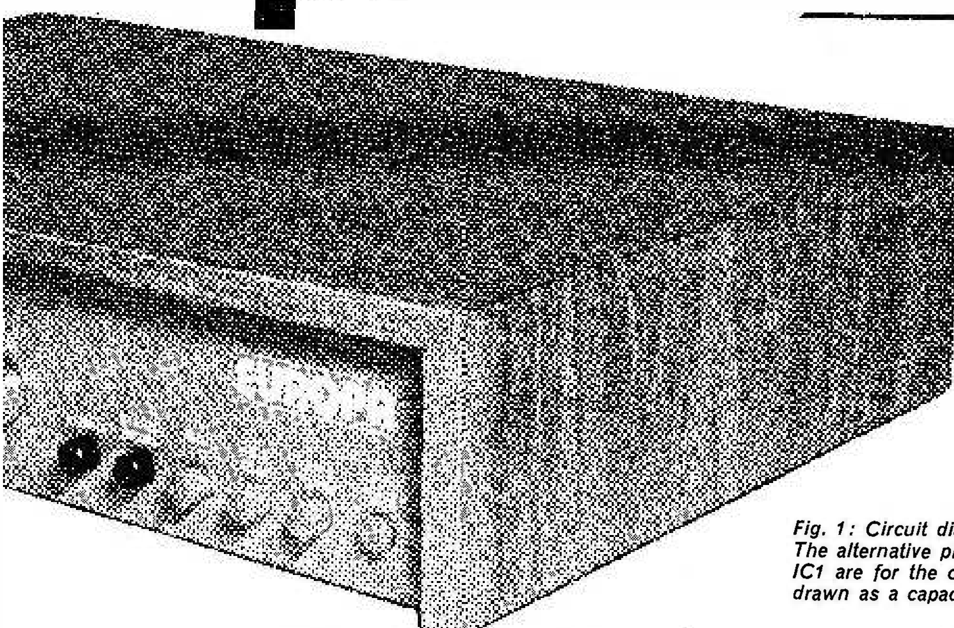
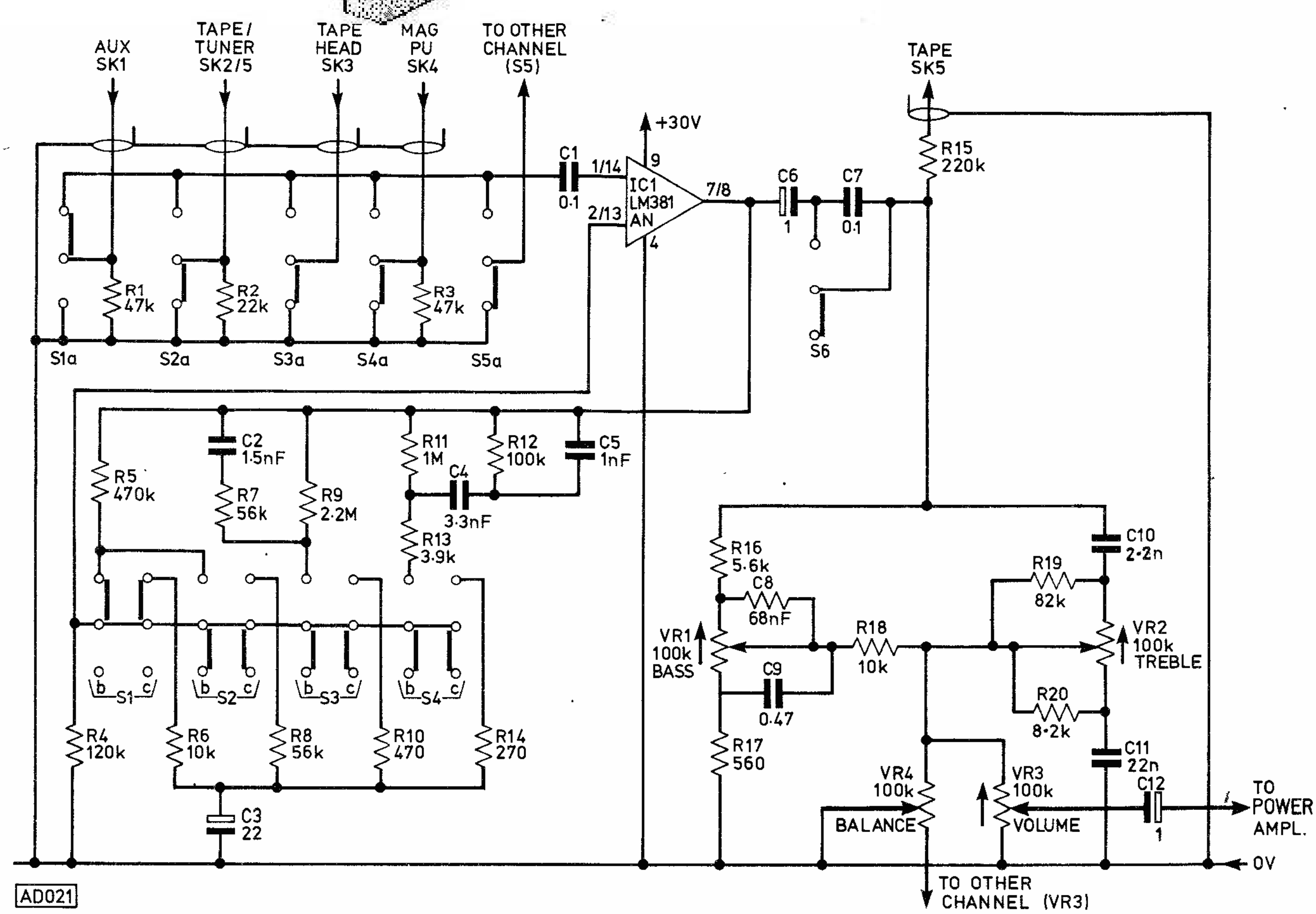


Fig. 1: Circuit diagram of one channel of the pre-amplifier section. The alternative pin numbers given against the inputs and output of IC1 are for the other channel. Note that C8 should (of course) be drawn as a capacitor!



★ components

Resistors (all $\frac{1}{3}$W unless otherwise stated)

R1	47kΩ	R22	10kΩ $\frac{1}{2}$W Metal oxide
R2	22kΩ	R23	330kΩ
R3	47kΩ	R24	820Ω $\frac{1}{2}$W Metal oxide
R4	120kΩ	R25	10kΩ $\frac{1}{2}$W Metal oxide
R5	470kΩ	R26	39kΩ
R6	10kΩ	R27	150kΩ
R7	56kΩ	R28	270kΩ
R8	56kΩ	R29	27kΩ
R9	2·2MΩ	R30	6·8kΩ
R10	470Ω	R31	1·5kΩ
R11	1MΩ	R32	1kΩ
R12	100kΩ	R33	220kΩ
R13	3·9kΩ	R34	12kΩ
R14	270Ω	R35	2·2kΩ
R15	220kΩ	R36	100Ω $\frac{1}{2}$W Metal oxide
R16	5·6kΩ	R37	100Ω $\frac{1}{2}$W Metal oxide
R17	560Ω	R38	27Ω
R18	10kΩ	R39	1kΩ 2W Wirewound
R19	82kΩ	R40	560Ω
R20	8·2kΩ	R41	120kΩ
R21	18Ω	R42	1kΩ
		R43	See Specification

Two off each resistor required, except R39 and R40.

Potentiometers

VR1 100kΩ + 100kΩ ganged lin.
VR2 100kΩ + 100kΩ ganged lin.
VR3 100kΩ + 100kΩ ganged lin.
VR4 100kΩ lin.
VR5 100kΩ min. horinzontal preset
VR6 1kΩ min. horizontal preset
Two off each preset VR5 and VR6 required.

Capacitors

C1	0·1μF poly.	C12	1μF 25V elect.
C2	1·5nF poly.	C13	0·1μF poly.
C3	22μF 25V elect.	C14	100μF 63V elect.
C4	3·3nF ceramic	C15	4·7μF 63V elect.
C5	1nF ceramic	C16	22μF 63V elect.
C6	1μF 25V elect.	C17	1nF ceramic
C7	0·1μF poly.	C18	1μF 35V tant.
C8	68nF poly.	C19	2200μF 30V elect.
C9	0·47μF poly.	C20	0·1μF poly.
C10	2·2nF poly.	C21	3300μF 63V elect. (high ripple)
C11	22nF poly.		
		C22	220μF 40V elect.

Two off each capacitor required, except C21 and C22.

Switches

S1 6 p.c.o. push button
S2 6 p.c.o. push-button
S3 6 p.c.o. push-button
S4 6 p.c.o. push-button
(S1–S4 interlocking)
S5 4 p.c.o. latching push-button
S6 2 p.c.o. latching push-button
S7 S.P.S.T. mains on/off

Semiconductors

Tr1 BC147
Tr2 BC147
Tr3 BC461
Tr4 BC109c
Tr5 BC109c
Tr6 BC109c
Tr7 TIP31A
Tr8 BFY56
Tr9 BC461
Tr10 TIP3055
Tr11 TIP3055
Tr12 BFY50
IC1 LM381AN
D1 3A 200V bridge
D2 BZY88 C30V 400mW 30V Zener
Two off each transistor Tr1–Tr11 required.

Transformer

T1 Low profile, low flux leakage transformer
Pri: 240V 50Hz
Sec: 45V off load
38V at 2A r.m.s.

Fuses

FS1 2A 20mm
FS2 500mA 20mm
FS3 2A 20mm
Two off fuses FS3 required.

Connectors

PL1 3-pole, chassis-mounting mains plug
SK1 5-pole DIN (180°)
SK2 5-pole DIN (180°)
SK3 5-pole DIN (180°)
SK4 5-pole DIN (180°)
SK5 5-pole DIN (180°)
SK6 2-pole DIN speaker socket
SK7 3-pole, chassis-mounting mains socket
Two off sockets SK6 required.

Miscellaneous

Insulating mounting kits for Tr7, Tr10, Tr11 (two off each)
Heat-sinks for Tr3, Tr8, Tr9 (two off each)
Horizontal mounting clip for C21
Printed circuit board, (available from Reader's PCB Service)
Materials for chassis, heat-sink and case.
Knobs for VR1-VR4. Fuse holders for FS1-FS3 (4 off)

NOTE—Many components need to be duplicated (as indicated above) for the two stereo channels

The mains transformer T1 and switch assembly comprising S1-S6 are available from WKF Electronics, 60 Welbeck Street, Whitwell, Worksop, Notts.

The remaining two inputs, selected by S2 and S1, are very similar to each other. Neither is provided with equalisation networks so when these are selected it can be assumed that the amplifier exhibits a flat response. They are therefore suitable to match the outputs of tuners, transistor radios, tape recorder pre-amplifiers and, provided a suitable series input resistor is incorporated, crystal or ceramic cartridges.

An equalised output is provided to feed an external tape recorder via R15 if required and this, of course, is not affected by the pre-amplifier tone, balance or volume controls.

Tone controls

Due to the high gain of IC1 and its large output signal it becomes possible to use a passive tone control system. This obviates the need for further feedback loops and reduces the chances of introducing instability or noise from an extra stage. The circuit is very similar to that which is normally incorporated in a feedback loop and provides bass and treble boost or cut from a centrally flat characteristic.

Potentiometer VR1 is the Bass control and when its wiper is nearest R16 maximum bass is obtained.

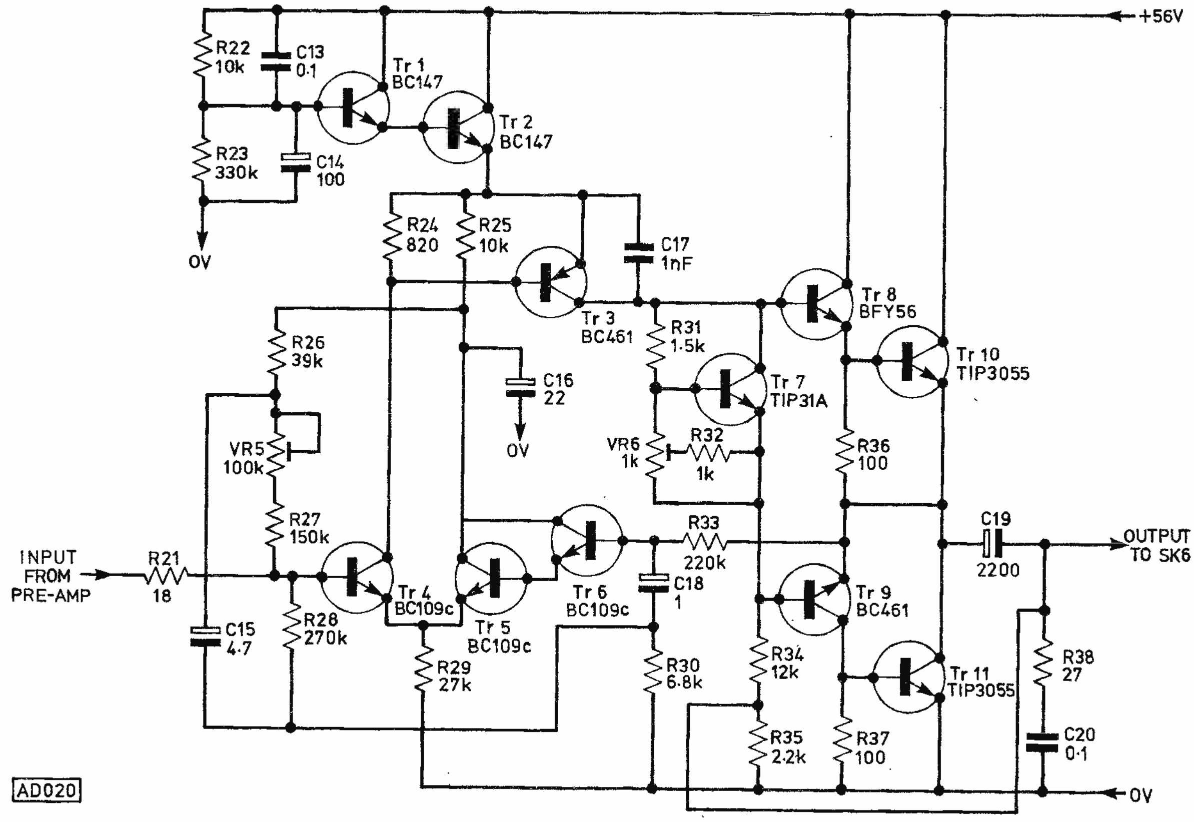


Fig. 2: Circuit diagram of one channel of the power amplifier section.

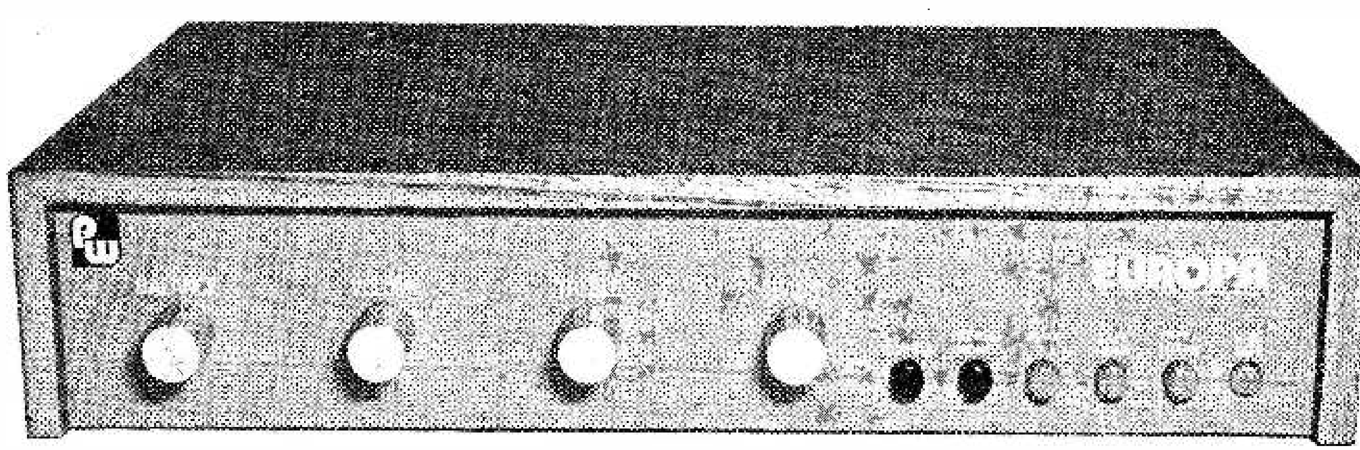
VR2 provides maximum treble boost when its wiper is nearest C10. A simple rumble filter is incorporated before the tone controls. This is C7 which is in circuit when S6 is released, providing a low-frequency roll-off, but shorted out when S6 is depressed.

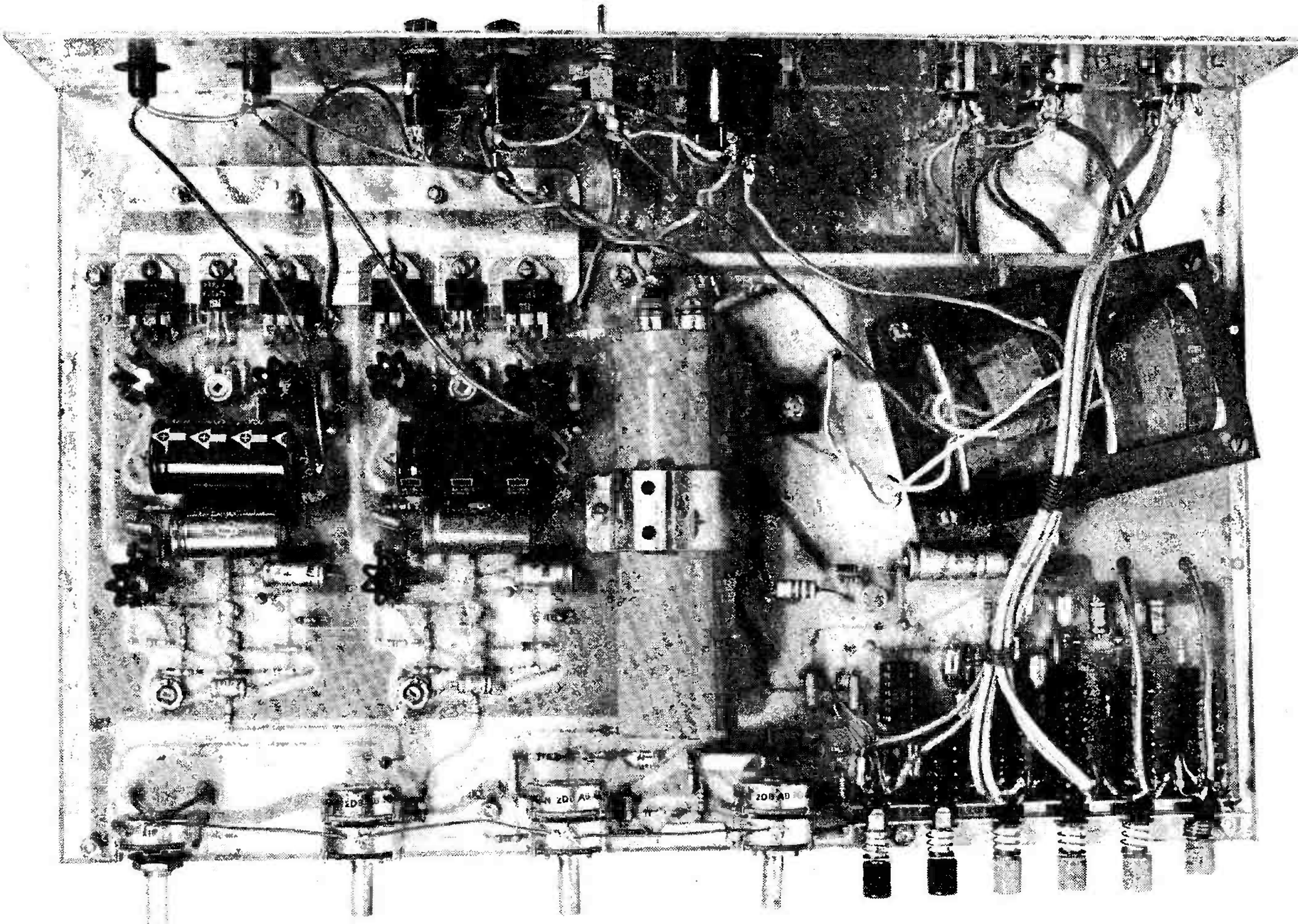
Power amplifier

The circuit of one channel's power amplifier is shown in Fig. 2. Transistors Tr4, 5 and 6 make up a differential input stage. The base of Tr6 is the inverting input which is used for main feedback stabilisation. Naturally the centre voltage of the quasi-complementary class B output is going to depend on this d.c. feedback and the state of balance of the long-tailed pair input stage. The latter can be adjusted by means of VR5 and this control is used during the setting-up procedure to make sure that the quiescent voltage at the positive end of the output capacitor C19 is mid rail.

The two transistors Tr1 and 2 are not in the main audio route but serve as a slow turn-on circuit which prevents a surge of power from damaging the loudspeakers. Rate of application of power to the input and driver stages is determined by the charging curve of C14 on the base of Tr1.

Biasing of the output stage is controlled by Tr7 and can be adjusted by VR6 to set the standing output stage current and minimise cross-over distortion.





Internal view of one of the prototype amplifiers. There are minor differences in layout compared with the final version of the p.c.b., which will be shown next month.

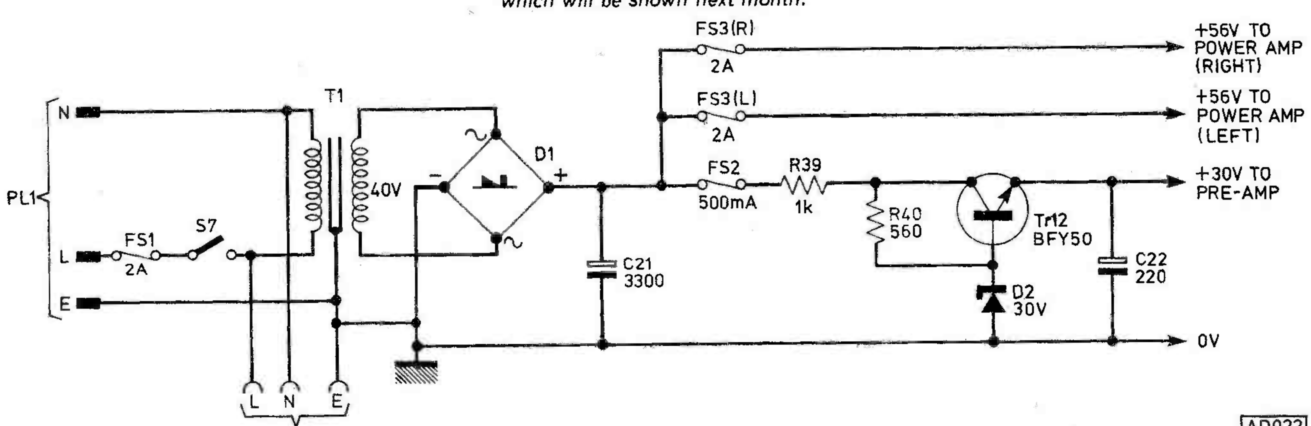


Fig. 3: Circuit diagram of the power supply, which is common to both channels.

Power supply

The circuit of the power supply is shown in Fig. 3. A low-profile, twin-bobbin transformer is used which gives extremely low flux leakage and it is precisely located on the printed circuit layout to minimise any flux linkage with the pre-amplifiers and input switching. The transformer delivers 40V a.c. to a conventional bridge rectifier and thence to the smoothing capacitor C21 which is specified to have a high ripple rating. No regulation is provided for the power amplifier supply; however the pre-amplifier supply is taken from a small stabiliser based on Tr12, R40 and D2.

NEXT MONTH

CONSTRUCTION

AND SETTING UP

PRODUCTION LINES

alan martin

Versatile clock module

The LT601 red LED display electronic clock module can function as both a 12 or 24hr display system and operates at 50 or 60Hz.

The series provides four basic selectable display modes; time, seconds, alarm and sleep display, and is a 4-digit, 0·5in LED display complete in itself apart from the mains transformer and function switches.

Featuring power failure indication the module includes brightness control capability, 'sleep' and snooze times, alarm 'on' and PM indicators, direct drive—no r.f. interference, fast/slow time setting control, pre-settable 59min sleep timer, 9 min snooze alarm and lead zero blanking.

For the 12hr display modules the colon flashes at one hertz rate and for 24hr displays it is fixed.

The module finds application as a clock radio timer, desk clock, alarm clock, television-stereo clock and instrument panel clock.

At £6·00 plus VAT and 30p P&P, the module type LT601, manufactured by Litron Electronics is available with full specification and application information from:

Bywood Electronics Ltd., 68, Ebberns Road, Hemel Hempstead, Herts, HP3 9QR.

New ABS boxes

A new range of ABS boxes, manufactured in four colours (orange, blue, black and grey) is now available. Each incorporates slots on all four sides for holding 1·5mm (0·062in) thick P.C.B's. The 1·5mm thick front covers sit recessed into the front of the boxes and are held by four fixing screws, running into threaded brass inserts. Available in three sizes measuring from 56 × 85 × 28·5mm to 96 × 161 × 52·5mm, BIM4000 BIMBOXES have excellent electrical insulation properties, rated at 85°C (185°F) and are supplied with four self-adhesive rubber feet. Prices range from 80p to £1·49 plus VAT and P&P each.

BOSS Industrial Mouldings Ltd., Higgs Industrial Estate, 2, Herne Hill Rd., London SE24 0AU. Tel: 01-737 2383

Scrub up

We have recently received a handy little tool for cleaning electrical contacts and surfaces.

The cleaning tool consists of a plastic body in which is mounted a stiff spun glass insert. The tool works on the same principle as a propelling pencil, as the exposed end of the insert wears, its length may be adjusted by a screw at the top of the tool.

The E105 contact cleaner is suitable for a variety of cleaning applications especially the cleaning of contacts, joints and pcb tracks prior to soldering.

The E105 costs 0·98p inclusive of P&P and VAT from:

Eraser International Ltd., 2/3, Hampton Court Parade, East Molesey, Surrey KT8 9HB. Tel: 01-979 8141/2.

KINDLY NOTE!

Jubilee Organ, Part 2, October 1977 PW

ICs 3, 4, 5 and 6: connections to pins 8 and 14 are shown reversed. It is unlikely that damage will occur as a result of this error, but these ICs will not function connected as previously shown.

Traffic Light Controller, December 1977 PW

C1 is shown reversed. The positive end should connect directly to +6V, i.e. between pins 1 and 7 of IC1. To suit variations in timing, C1 may be varied from 1000μF to 3000μF. In the components list, IC3 is shown as SN7411A. This should read SN7441A.

Direct Conversion Receiver, January 1978 PW

The resistor, ident R7 in the PCB layout on P655 (Fig. 8) should be shown as R11. The circuit diagram is correct.

Proportional Power Controller, January 1978 PW

C5 voltage rating was omitted; this should be 600V DC working (300V AC). If single polystyrene types are not available, one 10nF and one 22nF in parallel will suit. The jack socket should be a fully insulated type (for TH1) and care must be taken to ensure correct polarity of connection to the mains. IC1 is basic type L121 (Doram order code 65-600-9).

RAE No. 5, January 1978 PW

We regret that two errors occurred in formulae on page 662.

For the Parallel Impedance case, left-hand column, line 6, please read:

$$Z = \frac{R.X}{\sqrt{R^2 + X^2}}$$

For the current flowing in a Series Resonant Circuit, right-hand column, line 14, please read:

$$I = \frac{V}{Z} = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$$

MULTI-RANGE TEST METERS

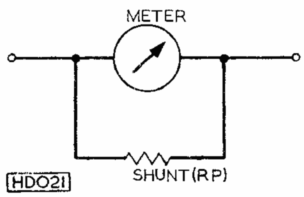
D. JONES

The small savings made in building a multi-range meter, rather than purchasing a commercially-produced model, do not as a rule justify the decision. The commercially assembled product is more often than not of greater accuracy and reliability. However, were it possible to build such a device at a considerable saving whilst maintaining a high degree of precision, then the project must surely be considered worthwhile.

This article covers the theory which will enable readers to produce an accurate instrument at favourable cost. It can be applied to movements of any FSD or coil resistance.

Ammeter Formulae

In order for a meter to read higher than its basic movement will allow, it is necessary to divert a proportion of the current away from it. This is achieved with a by-pass resistance—known as a "shunt"—which is placed across (or "in parallel with") the movement. **Fig. 1** shows this in circuit form. The shunt R_P is of a precisely-calculated value and diverts a finite proportion of the total current away from the movement.



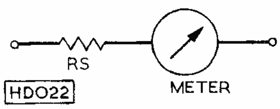


Fig. 1 (left)
Fig. 2 (above)

Thus the meter will pass a percentage of the total current in the circuit, the remainder being carried by R_P, whose value may be determined from the formula:

$$R_P\ (\text{ohms}) = \frac{V_{FSD}\ (\text{volts})}{\text{Required FSD} - \text{Meter FSD}\ (\text{ampères})}$$

The FSD Voltage of the meter coil (V_{FSD}) can be obtained from:

$$V_{FSD} = \text{FSD (amps)} \times \text{meter resistance (ohms)}.$$

Problems are likely to occur when shunt resistances become very small and attention has to be directed to difficulties arising from manufacturing techniques; even the contact resistance of range switches must be taken into account. Accurate resistors below a few ohms in value are difficult to obtain and will probably have to be made from resistance wire.

Voltmeter Formulae

The principle in the voltmeter is to measure the amount of current produced by applying a voltage across a fixed resistance. If the meter itself does not present a high enough resistance to the circuit, excessive current will be drawn and the meter will swing hard over or even burn out. In this case a series resistor will have to be inserted "in line" with the meter to reduce the current to a value within the range of the movement. This is illustrated in **Fig. 2.**

The series resistor R_S can be calculated from:

$$R_S\ (\text{ohms}) = \frac{\text{FS reading required (volts)}}{\text{Current for FSD (amps)}} - R_M$$

Again, this formula holds good for all values, but in practice, problems are likely to be met. If the combined meter and series resistance is too low it will load the circuit under test, producing inaccuracies. Likewise, if high voltages (in the order of hundreds of volts) are to be measured, the resistors will have to be adequate if breakdown is to be avoided.

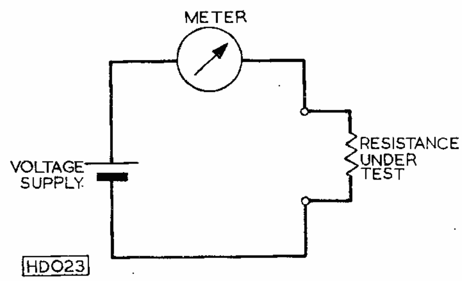


Fig. 3

Ohmmeters

With an ohmmeter the idea is to monitor the current passed through a resistor when a known voltage is applied, and this is demonstrated in **Fig. 3.** Assuming the movement to have little or no internal resistance compared to the device under test, a simple application of Ohm's Law produces the result:

$$\text{Resistance to be tested (ohms)} = \frac{V_{supply}}{I_{meter}}$$

Fig. 3 in fact constitutes the simplest form of ohmmeter. Usually a multi-range meter will be used, with a resistor for current-limiting. Several test voltages are often provided and a potentiometer enables the pointer to be set at zero. **Fig. 4** is a more likely basic design, providing switched ranges, but here the series resistors for each range may have such widely-differing values that the zero adjustment is inadequate. A more satisfactory solution is to select different current-limiting resistors, and **Fig. 5(a)** illustrates the technique. A three-gang switch is used to obtain four ranges.

Using the lowest value current-limiting resistor and adding a high and low value potentiometer offers an overall solution and this is the popular method of achieving switched ranges. **Fig. 5(b)** shows the final progression.

The scale calibration of an ohmmeter is not linear, see **Fig. 6**, and this can be explained using Ohm's Law. Doubling the resistance halves the current, so as the needle deflection doubles, the resistance halves. Consider a resistance which will permit 1mA to flow from a 1·5 volt battery (assuming a meter of 1mA FSD), then from Ohm's Law $\frac{V}{I}=R$

Where V= test voltage, I=current, R=resistance

$$\frac{1\cdot5}{0\cdot001}=1500 \text{ ohms}$$

The minimum measurable resistance is therefore 1,500 ohms.

Considering the centre point (0·5mA) of the scale:

$$R=\frac{V}{I}=\frac{1\cdot5}{0\cdot0005}=3000 \text{ ohms}$$

If the scale were linear we would expect its resistance at half-scale to be twice that at full scale and half that at the beginning. However, 3000 is not half of infinity but *is* twice 1500. Now the peculiarity will be apparent, and the scale will resemble Fig. 6.

Movements in excess of 1mA are rare in ohmmeters and 50μA is sometimes used. Parallel resistances increase the FSD if required.

Ammeter Shunt Switching

The correct approach for selecting current ranges using a double-pole switch is shown in **Fig. 7**. Note that any resistance introduced by the contacts is applied to the entire circuit, thus the resistor-to-meter ratio is maintained. The two poles of the selector switch are ganged together to reduce contact resistance to a level negligible with meters having a resistance greater than a few ohms.

Voltmeter Switching

Range selection in voltmeters is quite simple and if only voltage is required single pole switching as in **Fig. 8** can be employed. Contact resistance in this case can be ignored.

Series resistances will be fairly high and values of at least 1000 ohms should be used in order to provide a reasonable accuracy. Sensitivities are usually quoted in "ohms per volt" and this is the resistance of the voltmeter on the 1 volt range. Switching to a higher voltage range will increase the internal resistance by a similar factor. Thus, switching from the 1 volt range to the 5 volt range multiplies the resistance by a factor of 5; e.g. 5000 ohms on a 1000 ohms-per-volt instrument. Note that this is not expressed as 5000 ohms-per-volt, because it is not the resistance of the meter on the 1 volt range. The sensitivity of a meter provides a guide to its accuracy, since the higher the resistance the less loading of the circuit under test. Commonly, meters of 20,000 ohms-per-volt are found and even 100,000 ohms-per-volt is not uncommon. Nowadays most quoted measurements are made using a 20,000 ohms-per-volt standard (i.e. AVO 8 or 9).

Combining a voltmeter with an ammeter requires only the techniques as applied to the ammeter, and **Fig. 9** gives a practical circuit for this.

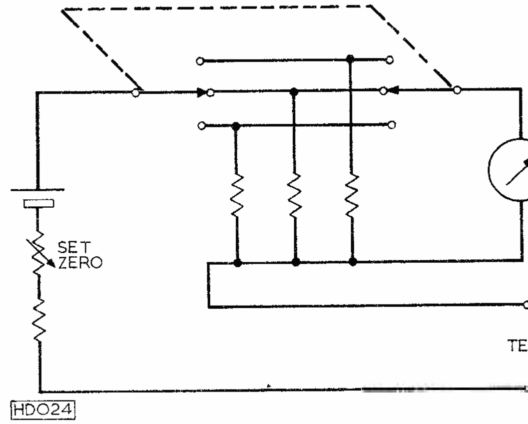


Fig. 4

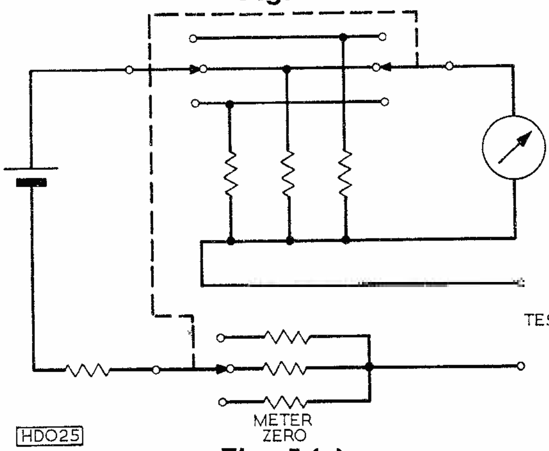


Fig. 5 (a)

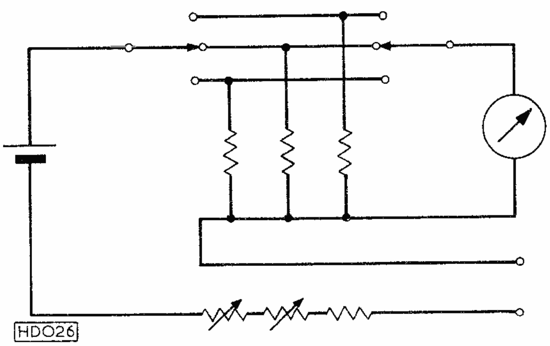


Fig. 5 (b)

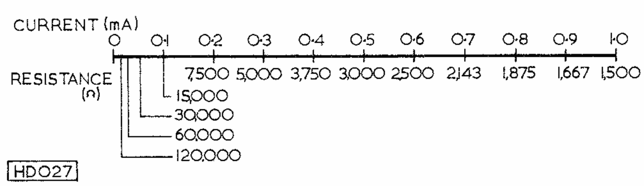


Fig. 6

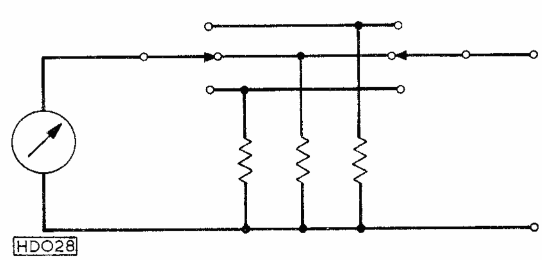


Fig. 7

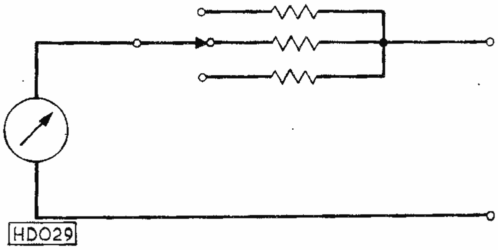


Fig. 8

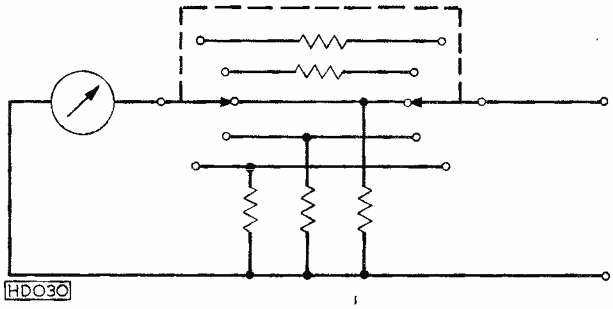


Fig. 9

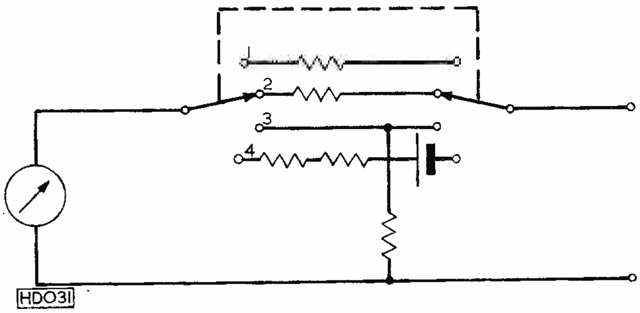


Fig. 10

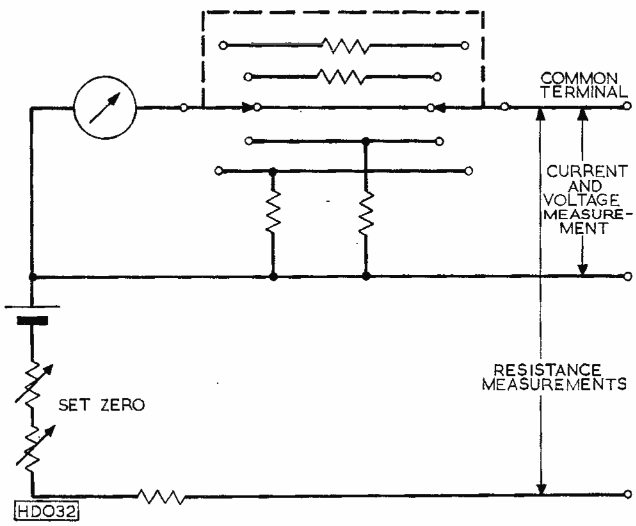


Fig. 11

Adding an Ohmmeter

Two methods of including an ohmmeter can be utilised; direct wiring into the switch or by using a separate terminal on the instrument. The first of these options is obviously the simpler but reduces the number of ranges available for current and voltage measurement. A basic wiring diagram is shown in **Fig. 10.**

The latter of the choices offers many advantages: principally, though, it does not use valuable range-space on the function switch. A disadvantage, however, is the requirement for a third terminal on the multimeter, which may be considered to be confusing. Careful layout should avoid ambiguity in this instance, and a typical circuit is shown in **Fig. 11.** The separate terminal enables current ranges to be used for extending the lower end of resistance ranges.

Another idea for altering the ranges is to change the test voltage. If this voltage is increased, the lower and upper measuring ranges will decrease and increase respectively.

Some Notes on General Construction

In most cases, the precise value of resistor will not be obtainable and the solution here is to combine two or more resistors, of one or two per cent tolerance, to achieve the desired value.

Scale calibration is best performed by removing the meter covers and possibly the face as well. This is not always practical, so choose a meter which can be dismantled. The scale as supplied can be copied onto a piece of white card or stiff paper and other ranges calibrated against it.

Resistance ranges can be a little tricky as they are non-linear. The resistance of the current-limiting resistor and that of the meter must be considered, and the following expression is helpful in determining the resistance under test at any given point on the scale.

$$R_D = \frac{V_T}{I_C} - (R_M + R_L)$$

Where R_D = Resistance indicated meter
R_M = Meter resistance
I_C = Current through circuit
R_L = Limit resistance
V_T = Test voltage

A more elaborate method is to use close-tolerance resistors of known value, "zero" being obtained by shorting the test terminals. Precision resistors of low value can be cut from "resistance wire" using the formula: Resistance = Length × ohms/metre. Typical examples of ohms-per-metre against gauge are shown below for "Eureka" wire.

Gauge	Ohms/metre	Gauge	Ohms/metre
16	0·236	28	4·41
18	0·420	30	6·23
20	0·746	32	8·29
22	1·23	34	11·40
24	2·00	36	16·70
26	2·98	38	26·90

It is important that these resistors should, when made, be less than 75mm long.

When not in use, it will be noted that sharp movement of the instrument causes a violent swing of the meter needle. This is due to 'eddy currents' being induced into the coil. It is therefore good practice to arrange for the meter terminals to be 'shorted' during transportation.

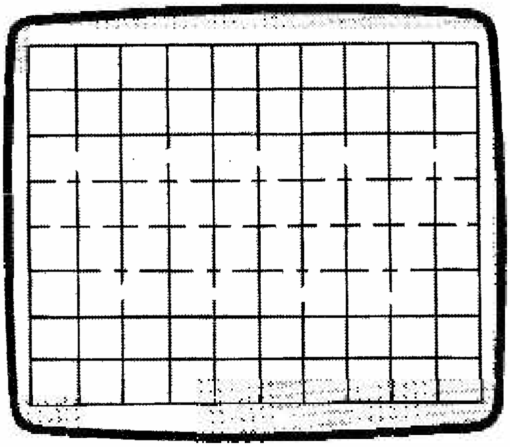
Finally, it will be found that 1000 ohms/volt and 20,000 ohms/volt meters require movements with FSDs of 1 milliamp and 50 microamps respectively. The 50 microamp movement is a good one to use and will cost only a little more than one of 1 milliamp. ●

ON SALE MAR. 3RD.

NEXT MONTH IN...

practical WIRELESS

Construct the PW 'PURBECK'



scilloscope

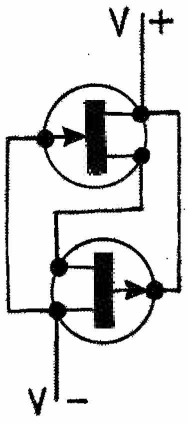
The oscilloscope is probably the most useful instrument in the workshop, enabling as it does the constructor to look at the waveforms occurring in his equipment. The 'Purbeck' is a 5MHz single beam scope especially designed for easy building by the home constructor yet providing him with a professional piece of equipment.

also: 'SLIM JIM' 2~METRE AERIAL

"Slim Jim"—an omni-directional free-space two-metre aerial featuring a radiation efficiency 50% better than a ground plane. It is slender, offering low wind resistance, and will operate with equal facility on lower or higher frequencies, with only minor modification of dimensions.

and VHF WAVEMETER

This is an attractively simple design for checking that the operating frequency of VHF transceivers is within the authorised band, and is cheap to construct, using only ten basic components.



audio/visual logic probe

PHILIP BOND

Introduction

Over the past decade the digital electronics scene has passed through several phases. In this time, the amateur electronics market has seen the popularity of digital ICs rapidly increase. At the moment there are two main logic families used in amateur electronics and radio, these are called TTL and CMOS. TTL (which means Transistor-Transistor Logic) was developed in the late 1960s and uses bi-polar transistors to perform the logical operations. CMOS (sometimes called COSMOS which means Complementary symmetry Metal Oxide Semiconductor) uses FETs to perform the operations. Each family has its various advantages, so they will both be in use for some time yet.

This project leads on to construct a logic probe which will aid fault finding and testing on equipment which has either of these families in its design. The display is given by LEDs and an audible output is also given, a low pitched tone for low logic level and a high pitched tone for the high logic level. This is particularly useful when the user does not wish to keep turning to look at the visual display.

In order to enable the device to be used on either logic family, certain design parameters were necessary. These are:—

1. High input impedance to minimise circuit loading
2. Wide supply voltage (5-15 volts)

It must also be:

1. Relatively inexpensive
2. Compact

The device is powered from the logic supply rails of the equipment under test and current consumption is only about 15 mA enabling testing to be carried out on battery powered equipment.

Circuit description

Let us assume that we have connected the logic probe to the supply rails of the device under test and switched S1 into the "tone on" position. Under idle conditions the potential divider formed by R2, R3, R4 and R5 puts a bias on the inputs of the inverters. The inputs of IC1 (a) and (b) are biased such that they have a logic HIGH on their inputs. Their inverting action causes their outputs to be a logic LOW level. Hence, LED1 is not lit and D1 is reverse biased which prevents the astable from oscillating. Likewise, the bias on the inputs of IC1 (c) and (d) cause LED2 to be off and the output of IC1 (e) is low which reverse biases D2 and similarly stops the astable from oscillating.

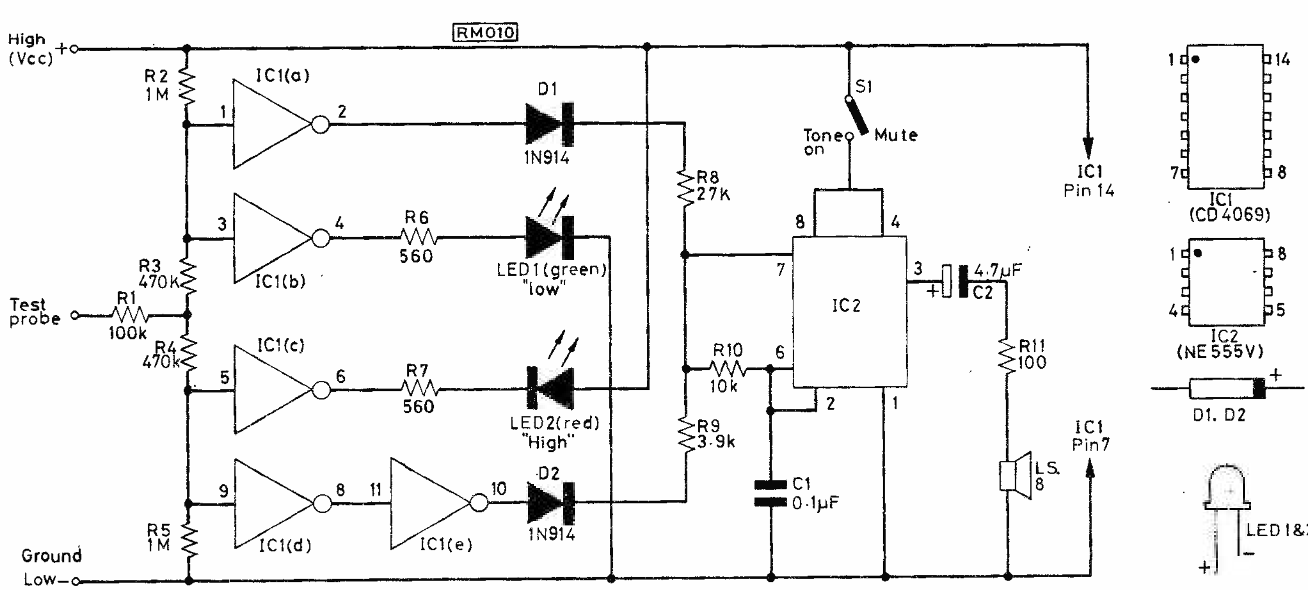


Fig. 1: Complete circuit diagram of the logic probe.

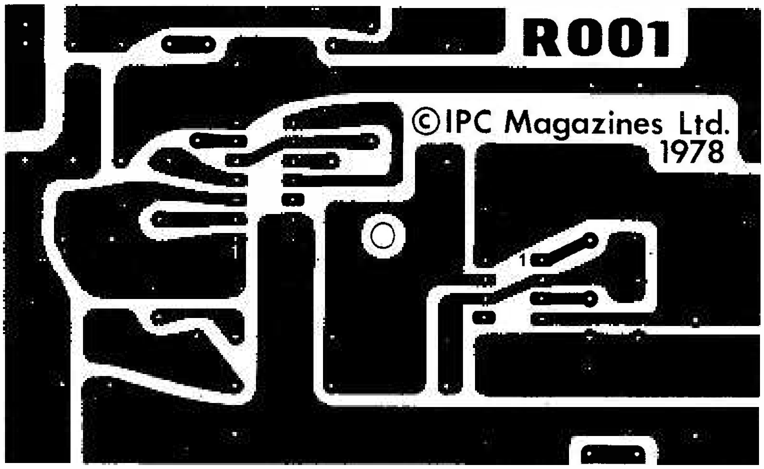


Fig. 2: The PCB viewed on the copper side. This board is obtainable from the PW Readers' PCB service. Details page 825.

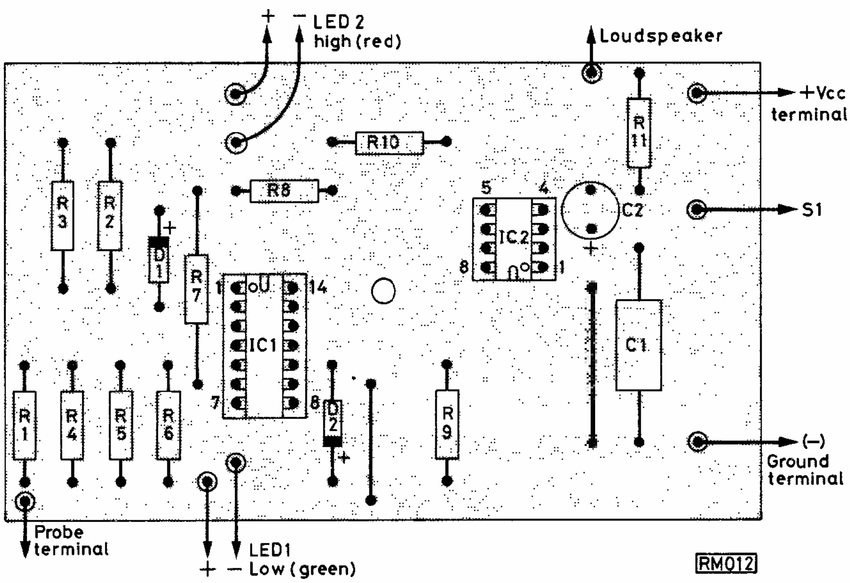


Fig. 3: The PCB viewed on the component side.

Let us now assume that we connect the probe to a HIGH logic level. The inputs of IC1 (a) and (b) are not altered but the inputs of IC1 (c) and (d) are now such that they are almost at the logic HIGH rail voltage. Consequently they invert and their outputs swing LOW. Pin 6 is now low so that LED2 illuminates and pin 10 of IC1 goes HIGH, D2 is forward biased and R9 is effectively connected to the positive (HIGH) supply rail. The astable oscillates at a frequency of about 600 Hz. This is reproduced in the loudspeaker.

Now when the probe is applied to a LOW logic level the inputs of inverters IC1 (a) and (b) are pulled LOW and their outputs swing towards the positive (HIGH) rail. LED 1 is now lit and D1 pulls R8 to the positive rail. Once again the astable action takes place but since the value of R8 is larger than that of R9 the frequency of oscillation is lower. In fact the oscillator (IC2) now operates at about 300Hz, an octave below the HIGH tone.

If the probe is applied to a point in a circuit which is half the supply voltage then no LED will light or tone be heard. Normally these results occur if a point is disconnected, and the fault would soon be isolated. If the tone is not required the oscillator can be disabled by switching S1 to the mute position.

★ components

Resistors

R1 100kΩ	R7 560Ω	
R2 1MΩ	R8 27kΩ	
R3 470kΩ	R9 3·9kΩ	All ¼ or ⅓ W
R4 470kΩ	R10 10kΩ	5%
R5 1MΩ	R11 100Ω	
R6 560Ω		

Capacitors

C1 0·1μF (Mylar)
C2 4·7μF 16V (Electrolytic)

Semiconductors

D1 and D2 1N914
LED1 TIL 209 Green (or TIL 211) with bezel
LED2 TIL 209 Red with bezel
IC1 CD 4069 AE or E (See text)
IC2 NE 555 V timer

Miscellaneous

Small (3″) loudspeaker 8 or 16Ω impedance. Verocase (153mm × 84mm × 79mm) Part no. 75-1239-K. SPST Miniature toggle switch. 2mm Plugs and sockets (Red, black and white). Ball point pen case, paper clip, wire, 6BA nuts and bolts.

Construction

The neatest way to mount the components is to use a small printed circuit board, and the design for such a board is shown in Fig. 2. The component layout is shown in Fig. 3.

The CMOS IC listed in the table of components for IC1 shows that a CD 4069 AE or E is required. However, there is the possibility that readers may be given a device which does not comply with this number. The different manufacturers use different codes to identify their devices and this takes the form of a prefix group of letters. CD is used by RCA, but you may see ICs with the letters SLC or MC1 printed on them. The important parts are the four figure number code and the suffix, i.e. the "4069 AE or E". The AE is one of many suffix codes used to show the range of characteristics which the device will possess. AE means the device is in a plastic DIL encapsulation, with a voltage range of 5 to 15 volts. There is also an indication of the temperature range of the device within this code too, but that does not matter in this application. The "E" device will operate over a slightly wider voltage range than the "AE" device, but this wider range is not necessary.

CMOS ICs are prone to damage if subjected to large static charges, so the CMOS IC, (IC1) should be the last component to be put in the circuit. Do not remove it from its special conductive packing until you are ready to use it. Damage may also arise if the pins are heated for too long, when soldering the device into the circuit. So if the constructor does solder the device directly in, then make sure the iron is not held at the individual pins for more than 5 or 6 seconds. Alternatively, the problem can be removed by using holders for the ICs.

The board and its subsidiary components were mounted in a plastic box, which was available commercially. This had the advantage that the top could be easily removed if any repair was necessary. Also, the box seemed to be tough enough to withstand a fair deal of knocking about, so it was an obvious choice for a test instrument case.

The loudspeaker and LEDs were mounted in the lid of the case; holes for the loudspeaker and the LED bezels were drilled plus two small holes for accommodating the 6BA bolts which were used to secure the loudspeaker.

The wiring layout is shown in Fig. 4. The LEDs have an anode and cathode like any other diode and the correct polarity must be observed. The longer lead of the two is the anode (positive) and it is best to wire

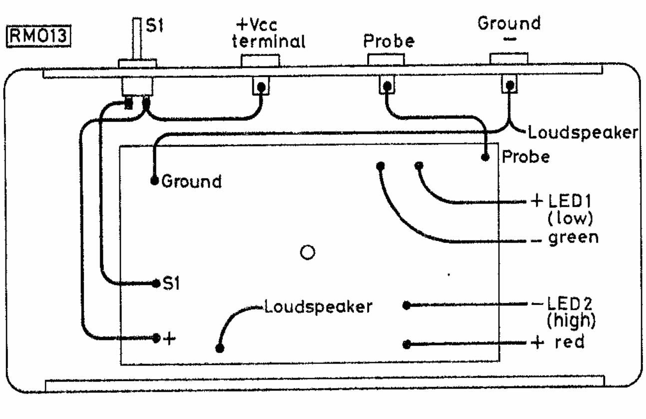


Fig. 4: Wiring the case-mounted components.

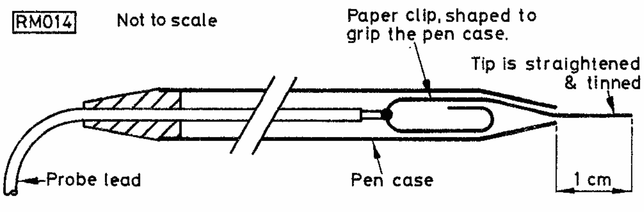


Fig. 5: Details of the probe assembly.

these leads in one at a time so that errors cannot occur when the lead is trimmed short. Also note that S1 must be closed when it is in the lower position. This is the "tone on" state and since down for on is widely used in electronics, this way was chosen here. The panel lettering was done with dry rub-down transfers: Vcc + marks the logic 1 rail, GND (Ground) marks the logic low rail and "probe" indicates the probe terminal.

The probe itself I claim no originality for whatsoever, since the method of making one has bedecked the pages of *PW* on a number of occasions. A ball point pen case was used as the tube, and the tip was made from a re-shaped paper clip. The clip was partly opened out and tinned (See Fig. 5). A small hole was made in the cap of the pen and the probe lead was passed through the hole and soldered to the paper clip. The clip was then pushed down the tube with a piece of stiff wire until 1 cm protruded through the end. The cap was put on again and the probe lead was terminated on a small plug, which, of course matched the socket on the front panel of the main unit. Two other leads were made but instead of probes they had small crocodile clips on their ends to connect to supply points in the circuit, under test. These leads were also connected to some small plugs which matched the sockets on the front panel. In fact two sets of test leads were made: one set for use where the probe is in close vicinity to the work being done, and a much longer set of leads for when the probe is located some few feet away.

Testing the unit

With all components mounted and the wiring checked the device can be tested. The device detects whether the probe is at a voltage nearer to the positive rail (Logic HIGH) or negative, in other words at the LOW rail. By connecting the leads of the device to the positive and negative terminals of a PP9 battery, the action of the logic probe can be checked. The probe should then be put to the appropriate connection on the box, and S1 can be switched to the "tone on" state. When the probe is not connected to either terminal, the LEDs should be off (or very dim) and the tone should be non-existent. If the probe is touched to the positive terminal the "HIGH" LED should now light up and the tone will be relatively high in pitch. And conversely when the probe tip is touched to the negative terminal the "LOW" LED will come on and the tone should be about one octave (which is "half" for all readers who are not musicians) below the first tone.

If these results are obtained the device is ready for use. There are many instances when a straightforward logic state display is useful; slow speed logic circuits and combinational logic elements can be checked. It also provides a very powerful teaching aid for those who are teaching or indeed learning the rudiments of digital electronics. ●

OF THE MONTH 67

Brian DANCE M.Sc

SPRAGUE ULN-3006T HALL EFFECT SWITCH

This month we will review one of the rather less well known devices, namely a Hall Effect switch. This is a miniature device in a plastic transistor type package which produces a sudden large change in its output voltage when the magnetic field exceeds a certain level.

There are many possible applications of such magnetic switching devices. For example, if a magnet is fixed to a revolving shaft (such as the propeller shaft of a car) and a stationary Hall Effect device is fixed close to it so that the magnet passes near to the device each time the shaft revolves, the pulse rate will be equal to the rate of revolution of the shaft. One can therefore use the pulse rate to measure the rate of rotation of the shaft or, in the case of a vehicle, its speed.

Applications

The Hall Effect device can also be employed to generate the pulses required for electronic ignition systems by employing a rotation magnet fixed to the camshaft. Similarly, it can be used to detect when the wheels of a vehicle lock on braking and an electronic system can be made which will keep releasing the locked brakes for a small fraction of a second whenever the locking occurs; skidding can then be greatly reduced, if not eliminated.

In general, the ULN-3006T can be used whenever one wishes to detect the close proximity of a magnet to the device, actual contact being unnecessary. For example, it can be used to generate the pulses required when the magnetic keys of a keyboard are depressed.

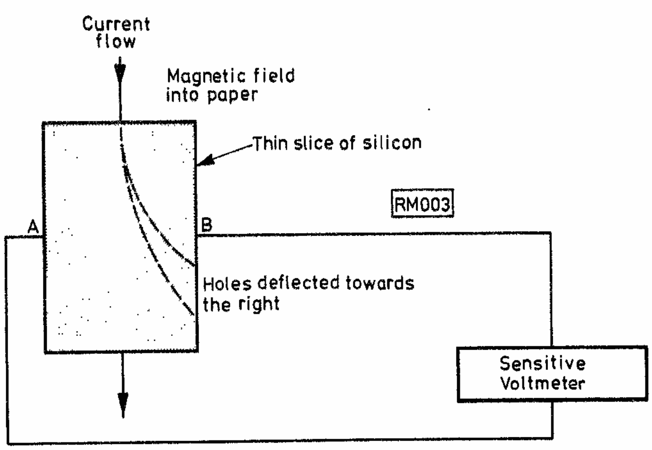


Fig. 1: The basic principle of the Hall Effect, showing deflection of "holes" in relation to current flow.

The Hall Effect

In order to understand how the ULN-3006T operates, we must first mention the basis of the Hall Effect. Let us consider a thin slice of silicon of rectangular shape, as shown in Fig. 1. A current flows from the upper to the lower edge and the whole slice is placed in a strong magnetic field which is perpendicular to the plane of the silicon.

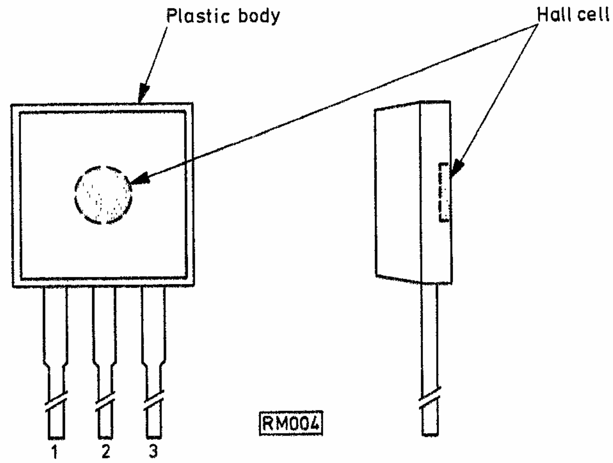


Fig. 2: The packaging of the Sprague Hall Effect device.

The current carriers in the silicon (electrons or holes) are deflected to opposite sides of the semiconductor material, just as an electron beam is deflected to one side in a television tube or oscilloscope tube by the magnetic field generated by the scan coils or by any small magnet brought near to the tube. The deflection of holes is indicated in Fig. 1 although in actual practice the movement would be far less than that indicated.

If the electrodes A and B on each side of the silicon slice are connected to a sensitive voltmeter, a small potential difference will be detected across the slice. This is known as the Hall Effect voltage and is due to the deflection of the current carriers.

Hall Effect voltages have been used to measure magnetic fields and to measure currents. Hall Effect devices have also been used as analogue multipliers, since the Hall Effect voltage is proportional to the magnetic field intensity multiplied by the current passing through the device.

The ULN-3006T

In the ULN-3006T, the Hall Effect is used as the basis of a simple digital switch which will detect the presence of a magnetic field exceeding a certain intensity. The Hall Effect voltage is applied to the inputs of a differential amplifier, the output from this amplifier being applied to a trigger circuit. The trigger circuit switches suddenly when the input voltage exceeds a certain value and drives an output stage. The Hall Effect cell, the differential amplifier, the trigger circuit, and the output stage are all integrated on a single silicon chip inside the device; the internal circuit contains 36 components, including 14 transistors.

Package

The miniature ULN-3006T package is shown in Fig. 2, the Hall Effect silicon chip being placed in the centre of the body of the device. There are only three connections and, as shown in Fig. 3, the circuit is extremely simple. In the absence of a magnetic field, the internal output transistor is cut off and passes little current (about 1μA). The full supply voltage therefore appears at the output of the device. When a magnetic field perpendicular to the body of the device is applied to it, the internal output transistor is driven to saturation and the output voltage falls to about +150mV (the maximum for any device is +400mV).

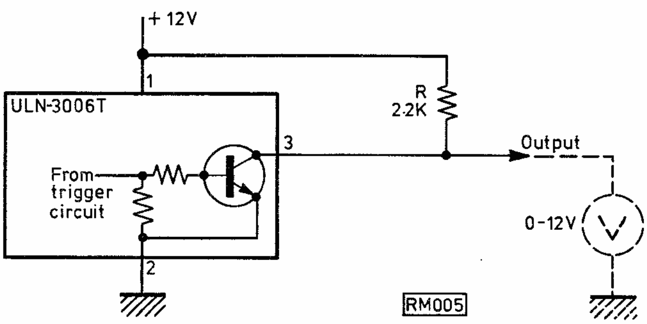


Fig. 3: A typical circuit used with the ULN-3006T. The transistor shown is one of the internal components of the device.

Power Supply

The absolute maximum permissible power supply voltage for the ULN-3006T is 20V. However, the device characteristics are specified over the range 5V to 16V and it is wise to operate it within these limits. The writer found that satisfactory operation occurred when the supply voltage was as low as 3·4V.

When a small, but fairly strong, bar magnet was brought up to the device as shown in Fig. 4, switching to the low voltage state occurred at a distance of about 2·5mm. The magnet had to be moved back to a distance of about 8mm from the device before the circuit switched back to its high voltage state. Thus there is a built-in hysteresis effect in this type of circuit; that is, the switching to the low and high output voltage states occurs at two different magnetic field intensities.

The current passing to pin 1 of the device increases from about 7mA to about 12mA (with a maximum of 16mA) as the supply voltage is increased from +5V to +12V. The current passing through the load resistor R of Fig. 3 when the output voltage is low is additional to the current passing to pin 1. The output transistor is capable of sinking (or accepting) currents of up to 15mA, so the load resistor R can have any value exceeding 1kΩ with a 15V supply.

Smaller values of load resistor can be used with lower supply voltages provided that the 15mA limit is not exceeded.

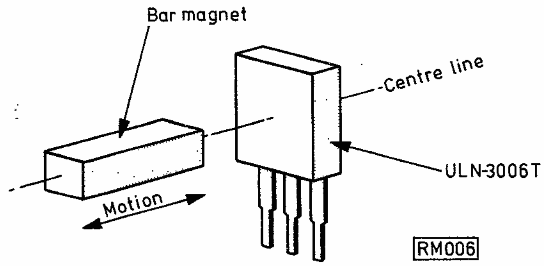


Fig. 4: The use of a magnet in switching the ULN-3006T.

Magnetic Field

If the magnetic field is applied with incorrect polarity, no switching will occur. In other words, only one end of the bar magnet will be effective when brought up to one particular face of the device. The other end of the same magnet will cause switching when brought up to the other face of the device. Weak magnetic fields will not cause switching. The magnet must produce a field of not less than 0·075 Weber/sq. meter (750 Gauss) for certain operation. The device is immune to stray magnetic fields from transformers, relays, etc., since such fields are normally too small in value.

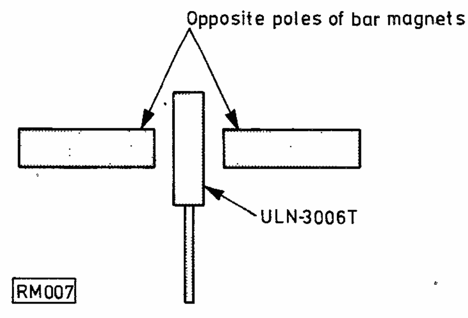


Fig. 5: Arrangement permitting the use of weaker magnets.

If two magnets with unlike poles towards each other are placed on each side of the device (as shown in Fig. 5), the switching will occur with much weaker magnets, since the two fields reinforce one another. Alternatively, a piece of soft iron or other magnetic material placed behind the device on the opposite side from the magnet will concentrate the flux and reduce the strength of the magnet required to produce switching.

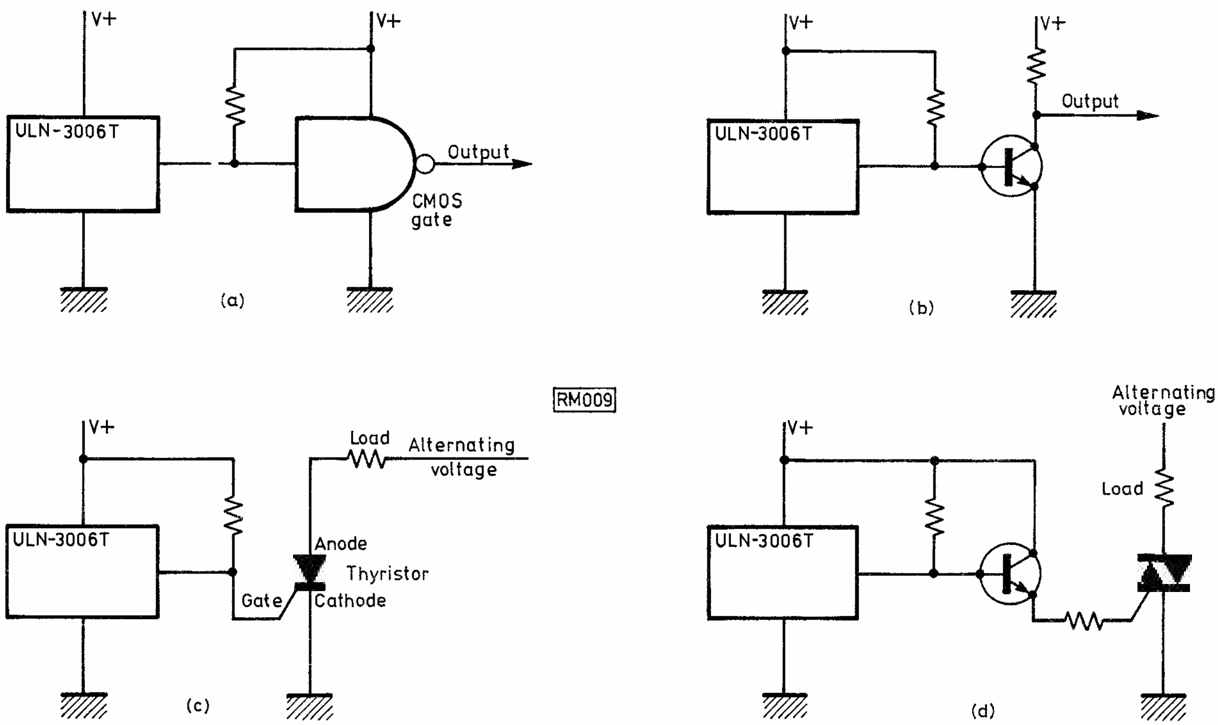


Fig. 6: Suitable circuits in which the ULN-3006T is used to drive (a) a CMOS gate, (b) an NPN transistor, (c) a thyristor, and (d) a triac.

If the magnet is not on the centre line of the body of the ULN-3006T, the maximum distance at which it will cause the circuit to switch to the low output voltage state becomes smaller. This effect is shown in Fig. 7 for distances of 1/10 to 1/100 of an inch between the magnet and the device.

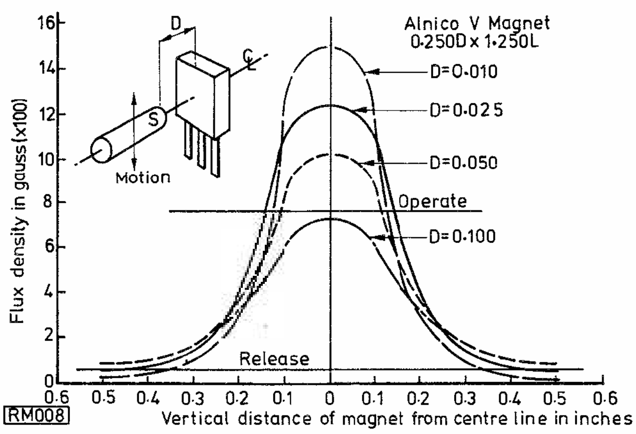


Fig. 7: Variation of magnetic field required for switching with distance from magnet, and with distance from the centre line.

The output from the ULN-3006T can be used to drive COS/MOS logic gates, transistors, thyristors, triacs and other devices. Some typical basic circuits are shown in Fig. 6.

The ULN-3006T is available from Phoenix Electronics (Solent) Ltd., 46 Osborne Road, Southsea, Portsmouth, Hants PO5 3LT at £2·50; this price includes VAT, but 20p must be added for post and packing to UK addresses.

BATTERY STATE INDICATOR

W. MOONEY G3VZU

When equipment is supplied from an internal battery its performance, calibration and output level are often unsatisfactory below a certain supply voltage. Some form of battery condition indicator can therefore help. The indicator described here consists of a small Veroboard circuit driving a panel mounted LED whose state reflects the battery condition. The LED has three possible states as follows:—(1) LED on, indicating an adequate supply voltage, (2) LED flashing at 2Hz, indicating that supply has dropped to a pre-set critical range, and (3) LED off, indicating that the supply voltage is too low for satisfactory operation.

All this information can be gleaned from a single panel mounted LED and this is driven by an operational amplifier.

The circuit takes up little space and can be added to almost any piece of equipment, where the LED will probably replace an existing indicator, or if not a suitable hole can be drilled. Two small board mounted pre-sets are used to make adjustments up to 12 volts, the current requirement being about 5mA.

The Circuit

Several discrete circuits which would give the required action were considered, however these had unpredictable change-over levels or were too costly using many transistors and lacked "style". The use of a moving coil meter for this application is electrically the easiest solution. Unfortunately, such meters are very expensive and must be designed into the equipment taking up considerable panel space, a valuable commodity on modern equipment. The 741 op-amp circuit shown in Fig. 1 was eventually chosen.

Power for the circuit is supplied from the equipment being monitored, and the indicator will normally be wired between the circuit side of the on/off switch and the common supply line. Positive or negative earth circuits can be accommodated by wiring up the indicator as appropriate. Both inputs to the op-amp are used. The potential of the non-inverting input is held steady at the stabilising voltage of the Zener diode D1. The resistor R2 has practically no effect on the DC conditions due to the high input impedance; the non-inverting input will therefore be the reference voltage across D1, i.e. 3-5V. The inverting input is supplied from the pre-set potential divider VR1 and the circuit DC gain is set by VR2 and R3. The indicator LED is driven by the ICI output at pin 6, R4 limiting the current drawn for LED protection and current economy. Since the 741 IC output can fall to about 2·5V min. but will rise to almost the supply voltage, the LED must be connected to the positive supply line as shown in **Fig. 1** rather than to the negative otherwise it will still glow slightly when a low output (LED off) condition is required.

Normally the voltage of the inverting input at pin 2, will be higher than that on the non-inverting input and thus the output, pin 6, will be at its lowest possible level with the LED alight. As the supply voltage drops, a voltage range will be reached when the potential of the inverting input will approach, reach parity, and finally become lower than the reference voltage on the non-inverting input. Over this range the IC will sweep through its transfer characteristic and the output will finally limit at its highest value causing the LED to extinguish.

Whilst the IC is between its upper and lower saturation limits, the circuit will act as a high gain amplifier and will oscillate at a frequency primarily governed by the values of C2 and R2. The output is a square wave and the LED will flash on and off. The range of supply voltage over which the circuit is in the oscillating mode is governed by the gain and hence the flashing range is set by VR2. With VR2 at its minimum resistance setting the gain is at a maximum

continued on page 856

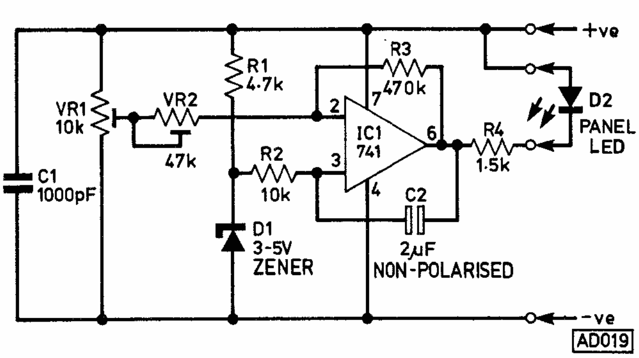


Fig. 1: Circuit diagram of the Battery State Indicator.

★ components

Resistors
R1 4·7kΩ R2 10kΩ R3 470kΩ R4 1·5kΩ
All ¼ or ⅛W carbon film
VR1 10kΩ VR2 47kΩ Both linear, pre-sets

Capacitors
C1 1000pF disc ceramic C2 2μF 50V non-polarised (Electrovalue type EX50)

Semiconductors
D1 Zener diode 3 to 5V 400mW D2 LED TIL209 with clip
IC1 741

ON THE AIR

by Eric Dowdeswell G4AR

I must begin with an apology for not having wished all my contributors and readers a VERY HAPPY NEW YEAR which I should have done in the last issue! Only excuse is the lead time required for copy and the fact that the "January" issue comes out at the beginning of December! Anyway, have a successful year, with plenty of DX. There certainly shouldn't be any dearth of it on the 10m and 15m bands according to the reports coming in and it can only get better as we climb the somewhat unpredictable curve of the new sunspot cycle.

As I have said before, the newcomers to these two bands just don't know what they are in for! 10m especially will be a knockover and even the worst of receivers will be copying the DX! Apart from sensitivity the most important characteristic of a 10m set will be selectivity!

So far this month there is more news from the clubs than from individuals, so let's press on with that. New Secretary of the Edinburgh DARC is **Tom Melvin** GM8MJV of 17 Dundas Crescent, Eskbank, Dalkeith, Midlothian. Coming events run from Slow-scan to RTTY, not to mention skittles, so write to Tom for more info. Incidentally, Tom, tell the Editor of your Newsletter that info on your meeting place and addresses of Committee members would not be out of place in following issues!

The AGM of the Wessex AR Group revealed a membership of 82 plus 12 postal members, which sounds pretty healthy to me! A suggestion that membership should be limited was not the view of the majority of members present, however. **Geoff Cole** G4EMN of 6 St. Anthonys Road, Bournemouth remains Secretary and meetings take place in the Club room at the Dolphin Hotel, Holdenhurst Road, at 8 pm. You might read this in time to get to a talk on RTTY by G3VPC on February 3rd and you shouldn't miss H. H. Journeaux on Vintage Radio Equipment on February 17th.

D. Lively G3KII will be glad to meet newcomers to the Cheltenham AR Association at The Old Bakery, Chester Walk, off Clarence Street, at 8 pm on the first Thursday of any month, plus the third Friday, a New Year innovation. On to Wales where the Blackwood DARS has elected **Steve Cole** GW4GLE "Entertainments Secretary". From 10 Llanthewy Road, Newport, he tells me that club night is on Fridays at Oakdale Community, Near Blackwood, Gwent, with GW8LJJ presenting "Construction Techniques" on 10 February. A "special" will be G3IOR on "Oscar 7" on the 24th with part two of this tape/slide show on March 3rd. The club is well-equipped with gear for the HF and VHF bands and if you feel like having a go at the RAE there is a class running now. GW3KYA on Blackwood 225 825 can give up-to-the-minute info on club activities.

From Leamington Spa, **Nick Smith** A9050 reports buying a Codar CR70A, which, with a 120ft wire, has been mainly operational on 15m, 20m and 80m so far. **Neil Braeman** G4FUP took time off from operating to tell me how much he enjoys being on the air. He has a Panda Cub plus a Collins TCS12 receiver on the HF bands on CW, "I'm proud to say", but admits to using "fone on 2m with someone else's rig!" He comments on the "rubbish and pointless QSO's" on this band but I wonder if it is any different on the HF bands! Next project is an RTTY set-up and already bits and pieces are littered around the shack!

Steve Roberts writes from Mississauga in Ontario, Canada concerning my remarks on "strange calls", in the November issue, inferring that they came from the Citizens Band. He points out that the introduction of 40 channels this year to the band over there has caused the price of the old 23-channel transceivers to drop to around $50! Then he remarks, most strangely that "the serious SSB operator had to go to the illegal use of a linear amplifier"! Not to mention the illegal "sliders", presumably meaning VFO's. Steve cites cases where he has found his CB gear of real use but as I have pointed out before, over here a licence is readily available for those that have a genuine need. Steve says he is not electrically minded so does not feel able to take an amateur licence exam. It would be worth making the effort OM!

D. W. Waddell in Herne Bay, Kent, tried a pre-selector in front of his lovely FRG7! I don't know what Yaesu would say, if they knew! Fortunately the p-s has now been dumped in favour of an ATU which I'm sure is much more worthwhile. D.W.W. wonders when the "experts" get their DX on the 80m and 160m bands. Very briefly, between dusk and dawn! But listen an hour or so before and after this period if only to get the feel of the bands.

More club news! The Silverthorn RC has its HQ and club stations G3SRA and G8CSA at Friday Hill House, Simmons Lane, Chingford, London E4 and Hon. Sec. is **Chris Hoare** G4AJA of 41 Lynton Road, South Chingford, London E4 9EA. Chris together with Colin G4EZQ and Ted G8NPF have been /P on 160m recently, usually on Saturday or Sunday evenings, with a TX using the SL600 series of ICs feeding into a 2N5591 PA, mainly on SSB. Long wires have been slung up with the help of a crossbow! Oh, yes, club meetings are at 7.30 on Fridays so do go along if you live around that part of London.

Well, that is the sum total of information to hand and I can only presume that there is more knocking around the system somewhere. I'm sure that all you chaps and girls haven't stopped listening! Let's hope that all the radios that Father Christmas will have been distributing will soon increase the flow of reports!

Log extracts

D. W. Waddell:— 80m EP2TY JY9DI **UI8KAG UL7KBN 20m** FP8DG TU2EF **15m** C5AAD **KG6RT PJ9CG** 5T5JD 7P8AR 9L1SL/A **10m C5AT** CE6EZ CW0A FG7BA FM0FC HH2MC TU2GM

N. Smith:— 20m VR2XL **15m** SV1DH

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

The Austrian Short Wave "Panorama", which can be heard on 6155kHz, 9725, 15355 and 17770 at 1805 on Sundays, is holding a DX Trophy competition during the first three months of 1978. The idea is to log broadcasting stations in half-hour blocks. Every contestant will receive a diploma stating his score and the highest scorer will receive a DX Trophy, suitably engraved. Full details can be obtained by sending a SAE (in the UK) to Jonathan Marks, 12 South Bailey, Durham DH1 3EE or direct to DX Trophy, Austrian SW Panorama, Austrian SW Service, A-1136 Vienna, Austria.

"Now is the time of year when one can start looking for rare birds from the other side of the world. One of the most elusive is Radio New Zealand, which I have managed to hear during the past four winters" writes **John Godwin** from Rugeley in Staffordshire. John recommends the 25m band transmission of the Pacific Islands service which is on 11780kHz from 0530 until 0715 and on 11820 from 0730 until 1030, up to March 5th, 1978. The power is 7½kW. Radio New Zealand is also on 11960 and 15130 from 1800 to 2215, on 17710 from 2230 to 0520, on 15380 from 2300 to 0345 and on 15130 from 0400 to 0715. DX reports, which should be accompanied by two International Reply Coupons, should go to Radio New Zealand, PO Box 2092, Wellington, NZ.

A 1957 Ferguson 391T receiver and 40ft long wire were used by thirteen-year-old **Andrew Brade** of Stone (Staffs) to pull in an interesting log of DX. Radio Uganda was heard signing-off in English on 9515kHz at 2105, Radio Cyprus on 7195 signing-on in Greek to the UK at 2215, Sri Lanka in English on 11795 at 1500 and the Voice of Greece on 11730 starting a programme in Greek at 1230. Andrew has been looking for Radio Veritas, Philippines on 11725 between 1400 and 1500 and he wonders if the station has changed frequency. Radio Veritas (PO Box 939, Manila, Philippines) has been logged on 11955kHz at 1425 by **Philip Grainger** of South Shields using a Trio 9R59DS receiver and long wire antenna. Philip would be interested in hearing from anyone who would be prepared to help him start a DX club in his area. Letters should go direct to 26 Beattie St, South Shields, Tyne and Wear.

"Please recommend an International SW Broadcasting frequency book that gives the stations, frequencies, transmission times, etc", asks **Van Ommen Kloeke** (EI3CM) from Arklow in Ireland. A similar request comes from **R. J. Bedall** of Cheam in Surrey who has a Sony ICF-5900 which pulls in plenty of stations. He wants to know who they are and where to write for a QSL. The *World Radio and TV Handbook*, published annually in Denmark, lists all known broadcasting stations on the long, medium, short and FM bands with the exception of some low power locals on the MWs. TV stations are also listed. There is a section for each country which gives the hours of transmission, addresses and QSL information and AM broadcasting stations are listed separately in frequency order. The 1977 edition cost £5. The 1978 edition is expected out in February and it can be ordered through booksellers or by post from the Modern Book Company, 19-21 Praed St, London W2 1NP, who advertise in *PW*.

Reader **Bill Iball**, who has been a SWL since the mid 1930s now has a Yaesu Musen FRG7 communications receiver and he would like to compare notes on aerials and the general performance of this receiver with other DXers. Write to Bill at "Garswood", 53 Winstanley Rd, Billinge, Wigan WN5 7XE. Stations heard with the FRG7 and end-fed 50ft aerial were Radio Globo, Brazil on 11805kHz, Radio Club Pernambuco, Brazil on 11865, Radio Australia on 6005, Radio South Africa on 4810, USSR (Kalinin listed) on 4860, Benin Republic on 4870, Conakry, Guinea on 4910 and Radio Malaysia, Sarawak on 5005. No times are given but the 60m logging would be after dark and Brazil on the 25m band probably around 2100.

"I am not a regular DXer but I do enjoy a bit of knob twiddling between listening to the amateurs" says **Christopher Silk** who lives at Leigh-on-Sea in Essex. Using an Eddystone 740 and a 20ft vertical aerial with 60ft of co-ax feeder he pulled in Radio Australia on 7240kHz at 1500. Reception continued until 1555 when an intermittent signal damaged reception. The transmission on 7240 is beamed on 325° to the Pacific Islands but the bearing also covers Europe on the short route across Asia.

Twelve-year-old **Chris Howles** who is a regular reader of *PW* recently took up SW DXing as a hobby and he bought a Vega 206 receiver. He added a 30ft long wire to an old VHF TV aerial and with this set-up heard Radio Australia at 0900 on 21570kHz in the 13m band, Radio Canada International at 1655 on 15325, All-India Radio at 2020 on 9590, Baghdad at 2010 on 9635 and the Voice of Turkey at 2200 on 9515. Chris is puzzled why the 13m, 16m and 19m bands go blank after about 1930 hours. The reason is that signals on these bands pass through the ionosphere after dark instead of returning to earth. The ionosphere is maintained by ultra violet radiation from the sun and its strength and hence its ability to return the higher frequencies is at a maximum on the sunlit side of the earth. On any particular path the frequencies in use will be higher during the day than at night.

Frequencies will also be higher for long distance (low angle) than short distance (high angle) communication. From the DXer's point of view this means that during the day, the highest frequencies will be in use for long distance and lower frequencies for short distance reception. After dark, the higher frequency bands are dead; long range reception is now found on lower frequencies while short range reception moves to the Tropical Bands (the 75m band in Europe) or to the medium waves.

A Trio 9R59DS receiver and long wire aerial are in use at Braintree in Essex by **R. Guest** who heard Radio Australia on 11740kHz at 0640, on 21570 at 0800 and on 6035 at 2100, KWTR Guam on 9640 at 1330, Havana, Cuba on 17885 at 2055, Nigeria on 15120 at 0800 and Spain on 6100 at 2030 (there is a DX programme in English on this frequency at 2215 on Sundays). From the International Short Wave Club comes news of programmes in English from Radio 4VEH Cap Haiti on 9770kHz and 11835 between 2230 and 0030, from Sri Lanka over 11955, 15120 and 17850 between 1845 and 1940, from Taiwan on 9600 from 2130 to 2230 (reports to 53 Jen A Rd, Sec 3, Taipei, Taiwan) and from Benin on 4870 (60m) from 2015 to 2030 (reports to PP 366, Cotonou, Benin).

An old Ever-Ready radio of uncertain age works "incredibly well" for **P. Gatehouse** of Buckingham. All-India Radio came in on 9525kHz at 2230, Radio Canada on 11945 at 2039, Radio Israel on 7412 in English at 2330. On Sundays there is a DX programme from 2000 to 2030 and the station address is PO Box 1082, Jerusalem, Israel.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands **must** be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

MEDIUM WAVE DX

by Charles Molloy G8BUS

The mystery surrounding the CJON Radio Network has now been cleared up by **Ian Rennison** of Horsham in Sussex. CJON on 930 is no more. It has a new callsign (CJYQ), the address of the station is PO Box 6180, St John's Newfoundland and the slogan used over the air is "Q Radio". The callsigns of the rest of the network have also been changed. CJOX on 610kHz is now CKYQ South Coast, CJNW 670 is now CHYQ Bonavista Estuary, CJCN 680 is now CIYQ Central Newfoundland and CJCR 1350 is now CFYQ Gander. Ian, who uses a MW loop, differential amplifier, Trio 9R59D receiver, audio notch filter and the *PW* CMOS crystal calibrator, reports hearing a new CBC outlet on 750kHz relaying CBN (640) and that CFBC Saint John N.B. on 930 has now become prominent on this channel in place of CJYQ. All very confusing!

A Trio 9R59DS and a 36in loop are in use at Steyning, Sussex by **Alf Cosham** who reports hearing CKVO Clarenville Newfoundland on 710kHz at 2330, WINS New York on 1010 at 0710 and WNEW also in New York on 1130 at 0705. The CJYQ frequency (930) seems dead at Alf's QTH and reports from other DXers suggest that CJYQ (ex CJON) may no longer be the strongest, most consistent and earliest North American to be heard in the UK. Stations seem to come and go on the medium waves. CBA Moncton N.B. at one time was a solid signal every night on 1070 after Paris closed down, while others, such as CBH in Halifax on 860, WMEX Boston on 1510 and WKBW Buffalo 1520 which used to be reported regularly are now inconspicuous. It is interesting to speculate why this should be. Interference is probably one cause but the explanation that appeals most to the writer is the thought of the Chief Engineer, tired of answering reports from DXers, who adjusts his aerial system so that more signal goes into the service area and less goes out to distant lands and to eavesdropping DXers!

At the moment CKVO on 710kHz and WINS on 1010 are the stations to look for around midnight, if you have never heard North America on the medium waves. WINS has its studios in New York City but the transmitter is in New Jersey and the directional aerials boost the signal to the north east, towards New York and also to the DXer in Europe.

More North American DX from **David Sidebottom** who lives in Fleetwood and uses a Realistic DX160 receiver with an 80ft longwire aerial. Some of the stations heard by him between 0030 and 0200 are VOCM St John's on 590kHz, WHDH Boston on 850, CJCH Halifax on 920, CHER in Sydney on 950, CHNS Halifax on 960, CBY Corner Brook 990, WHN New York on 1050, CBA Moncton 1070, WCAU Philadelphia 1210 and WVOJ Jacksonville in Florida on 1320. "Q Radio" on 930 was also heard mixed with CFBC. **Robin Harvey** writes again from Halesworth to say that he now has a Trio 9R59DS communications receiver and he is set to do some serious DXing. He has been unable to hear MEBO2 which has not been transmitting on 773kHz recently nor has he been able to locate the Voice of Peace on 1540. The latter has changed frequency to 1538 which is occupied also by the 700kW outlet at Mainflingen in West Germany and it will be very difficult to hear the "V of P" on this channel in the UK.

"I would like to know if readers ever write to you about hearing DX on the long waves" asks **Peter Ramsey** of Stevenson in Ayrshire. Occasionally, is the answer, and it is a pity that more DXers do not try this band. The main obstacle to DXing on the LWs is interference from the line timebase of TV receivers which appears as a buzz at intervals of about 15kHz. This trouble disappears after midnight, when it is worth tuning around the band for weak signals. Asiatic Russia, Turkey, Iceland, Algeria, Morocco, Romania, Sweden, Norway, Finland and Mongolia are to be found on the long waves. A good outdoor aerial is an advantage but a transistor portable with internal aerial can perform very well as its directional aerial will cut down static and QRM.

A report of Asiatic DX on the medium waves comes from our regular reporter **Harold Emblem** who DXes in Mirfield with an Eddystone 730 receiver and loop. Radio Pakistan's outlet at Quetta was heard on 750kHz, Astrakhan USSR on 791, Novosibirsk in Siberia on 1025, Saransk on 1061 with local identification. Also logged were Conakry, Guinea on 1403 which is on the air all night and EAJ28 Radio Tarasa in Spain on 1412.

"What kind of ATU (Aerial Tuning Unit) must I use with a loop"? asks **Raphael M. F. de Witte** who lives at Whitley Bay. An ATU is used to match a long wire to a receiver and it is not suitable for use with a loop as it would act as an aerial itself, pick up signals and therefore mask the loop's null. Even if it were placed inside a screened box it would still give trouble as the type in general use is electrically unbalanced and would upset the operation of the loop.

"Is it possible to receive local radio stations from other parts of the UK"? enquires **C. J. Roe** of Warwick who says he is something of a novice regarding radio. The best type of receiver for this sort of DXing is the ordinary transistor portable with its internal directional aerial. Tune in a station on a portable, rotate the receiver without tilting it and two positions will be found where the station disappears or drops to a very weak signal. This ability to null-out stations can be put to good use when searching for local radio stations as most of the channels in use are shared. Try after dark on 755kHz, 854, 998, 1034, 1106, 1115, 1457, 1484, 1502, 1520, 1546 and 1594 for BBC locals and on 989kHz, 998, 1025, 1151, 1169, 1277 and 1546 for IBA outlets.

"Long time no hear" writes **Ralph Newman** from Reading who has not been idle, though. He has been doing a "few mods" to his homebrew receiver and he now has a really good 8-element ceramic IF filter to sort out the QRM. Highlights from his log are Nigeria on 945kHz with identification at 2357, CBM Montreal on 940, WHN New York on 1050 at 0018, WCAU Philadelphia on 1210 at 0024, WOKO Albany NY (5kW) on 1460 at 0025 and WQXR in New York City on 1560 at 0030. WINS was heard at 0745 in the morning until its carrier finally went out as a heterodyne with 1007kHz at 0810. The fadeout of the sky wave from WINS would be caused by the reforming of the "D" layer in the ionosphere due to the action of ultra violet radiation from the rising sun. The "D" layer absorbs MW signals, but Lopik in Holland on 1007kHz would still be heard via the ground wave.

VHF BANDS

by Ron Ham BRS15744

Gordon Goodyer BRS 37345 of Petworth, has purchased an Eagle SR550 amateur bands receiver and finds it very good on both the 20m and 10m bands and the long scale between 28 and 30MHz makes it an ideal tunable IF amplifier for his 2m converter. Around midday on December 4th Gordon heard an EI on 2m SSB during the RSGB Fixed Station contest and, according to the grapevine, a GM was also heard in the south, which is not surprising because conditions were right for a tropospheric opening. The atmospheric pressure rose sharply from 30·1in at midday on December 1st to 30·4in by midday on the 3rd and was falling rapidly throughout the 4th. The first sign of a lift came at 0248 on the 3rd when signals from GW mobiles, through the Bristol Channel repeater, were opening the squelch on my receiver.

At 1454 I received a 53 signal from GB3SUT on 70cm, and a picture from the IBA transmitter at Lichfield on Ch.8, 189MHz. A dipole aerial was used to feed each receiver. By 1054 on the 4th, repeater signals were strong and I heard GW8MVA working a French station through GB3BC. The AP continued to fall for the next few days reaching a low of 29·2in at 0400 on the 8th which meant very bad weather over much of the UK and very poor VHF conditions. Later in the day the AP began to rise and by midday on the 12th it was back above 30·0in rising to 30·5in on the 14th bringing back good VHF conditions.

At 2020 on the 12th **Dave Butler** G4ASR London, worked F6DJF Paris, on 2m SSB and was called by an HB9 whose signal suddenly disappeared into the noise; one of those VHF annoyances! Dave has an excellent VHF record; recently, while staying at the Lizard, he worked more than 1300 stations from 16 countries on 2m and 9 on 70cm. His best DX on 2m is Liechtenstein and Switzerland on 70cm. During the opening last September, Dave noticed that many south coast amateurs were able to work into Holland yet he could not hear the Dutch stations although he could easily work into Spain from his location at the Lizard. From his many aerial experiments Dave has found that his VHF Quad is by far the best of his equipment.

Alan Baker G4GNX Newhaven, noticed a lift during the evening of the 13th when he heard G3ZIG Norfolk, work a GM on 2m SSB and on the 14th he heard signals from GB3BC right along the south coast to Rottingdean. Also on the 14th **Lee Reynolds** G8LCK London, worked stations via the 2m repeaters in Birmingham, Bristol, Buxton, Dover, Four Marks, Martlesham Heath and Belgium, ON0OV, all with 2·5W. **Roy Bannister** G8LXR Lancing, heard French stations on 2m CW on both the 14th and 15th several of those repeater signals were operating the squelch on my receiver and during the early evening of the 15th, **Alf Lee** G4DQS Brighton, worked a French station via the Normandy repeater FZ3THF on R4. Frequently on these two days signals were heard from both GB3SUT and GB3EM on 70cm.

Congratulations are due to our readers **Roy Bannister** G8LXR and **Barry Ainsworth** G8HYN who went together to North Foreland and passed their morse tests. Roy now has the call sign G4GPX and Barry is G4GPW.

Brian Oddy G3FEX Storrington and **J. A. Tipping** G8JXE Brighton, have been carrying out tests between Devils Dyke, a high spot Nr Brighton, and Storrington on 23cm. Both stations are using Microwave Modules converters into their respective receivers and they have been experimenting with a variety of aerials, including a 4ft home-brew dish, a J-Beams 15/15 slot and Brian's 16in dish which he used back in 1962 when he held a record for a 104 mile QSO on 1296MHz. Readers wishing to take part in these tests, which take place on most Saturday mornings, should write to G3FEX, QTHR.

The Haywards Heath ARC held its inaugural meeting on November 17th which was attended by 12 people including two, in an advisory capacity, from the Crawley ARC. The meeting elected **Alec Parsons** G8MDP chairman, **Andy Mepham** G4CBZ secretary, and **Chris Stagg** G8MZO treasurer. At present the club is very much VHF orientated and future meetings, where new members are welcome, will be held monthly at the Liverpool Hotel, opposite Haywards Heath Station; for further information phone Andy Mepham, H.H. 57609.

A period of solar activity began on December 1st and was dying down on the 16th, during which time **Cmdr Henry Hatfield,** Sevenoaks, **John Smith,** Rudgwick, and myself recorded many individual bursts of solar radio noise, and noise storm conditions prevailed on the 10th, 11th and 12th. On the 4th, Henry, using his spectrohelioscope, located the cause of the noise when he identified two sunspot groups, 16 filaments and 4 plages on the sun's disc. As usual this solar activity disturbed the normal path of many radio signals.

Between 1720 and 1920 on the 2nd, **John Branegan,** Saline, Fife, observed an aurora borealis both optically and by radio. John sent me a fine drawing of the event, which I will pass on to G2FKZ, and he described it as pale pearly-grey and white and the pattern was fluctuating in a few seconds. While this natural phenomenon continued, John received signals from five Continental FM stations, between 88 and 92MHz; 6 GMs, 1 GI, and a PA0 on 2m and several beacons including DL0PR, LA4VHF, GB3ANG, GI, NEE, VHF and CTC, all being reflected from the changing auroral display. The BBC World Service reported ionospheric disturbances on December 1, 2, 6, 12 and 13 and during the evening of the 12th, **Alan Baker** reported that the HF bands were unusually noisy.

No doubt this solar activity was responsible for the variable conditions on 10m. I heard signals from the Bahrain beacon A9XC on the 12th, the Mauritius beacon 3B8MS on the 1st and 11th, the Cyprus beacon 5B4CY on November 22, 24, 29, December 9, 11, 12, 13 and 17 while **Nigel Golds** BRS 36910 West Chiltington, Sussex, received a 599 signal from the German beacon DL0IGI at 0800 on the 10th and **Ralph Cathles** G3NDF Great Bookham, heard DL0IGI during the morning of the 13th in addition to signals from the Bermuda beacon VP9BA 28·165MHz. Both Nigel and myself heard signals from Europe, Italy, Russia and north and south America during the 10m contest on the 10th and 11th.

Anthony Mann, Applecross, Australia, says that there was "a most intense opening" during the evening of November 13th when he heard signals on 10m from A9XC, 5B4CY, 3B8MS and from amateurs in Europe and the UK as far north as Scotland. Anthony noted a lot of sporadic-E activity between November 6th and 20th.

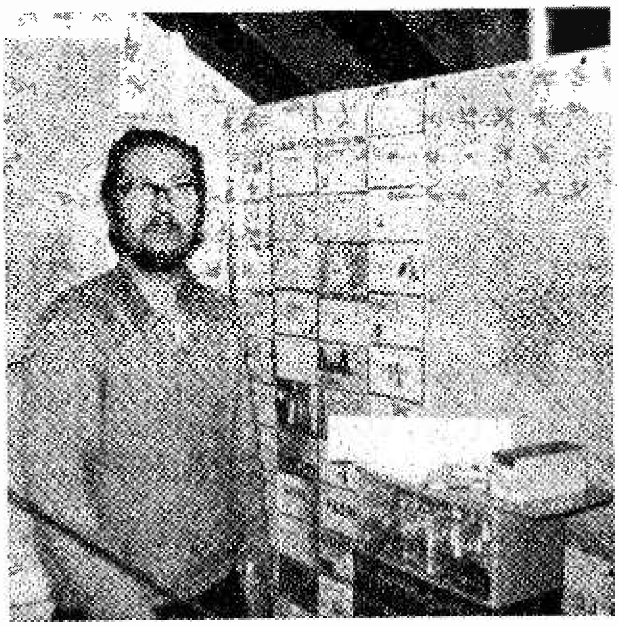
From his DX TV observations he reports Malaysia's Network 1, Ch.E2 and E3 in West Malaysia, came in on three occasions and during one of these he also received East Malaysia's Network 3 on Ch.E2. On November 13th and 18th he received pictures from New Zealand on 45·25MHz and says "November 17th was a very good day for all of us". At the time Malaysia was being received in Perth, 2000 miles east in Sydney, Band 1 and 2 stations in the far north of Queensland were being received by friend **Robert Copeman.**

Thank you all for your interesting reports. Don't forget the RSGB 144/432MHz Open and SWL contest on March 4th/5th and the 70MHz Open contest on March 19th; good luck if you compete and I will look forward to hearing from you after the events.

VHF PERSONALITY

ALAN BAKER

by Ron Ham



Alan Baker G8LGQ an electronics engineer from Newhaven, Sussex, is a familiar name to the readers of my VHF column in this journal. According to his father, Alan showed signs of becoming an engineer at the age of three when he played with a pair of pliers and eventually put them across the mains! At the age of six his favourite toy was a crystal set, with the headphones in a pudding basin to increase the audio gain. On leaving Redhill Technical College at 16, Alan began work as a telephone engineer with the GPO and later became a TV service engineer with a private firm in the Kingston area. He was married in 1967 and in 1969 his technical ability took him into the field of public address and the specialised recording of folk music.

In 1975 Ralph Cathles G3NDF loaned him a Hallicrafters Super Skyrider receiver and it was hearing the W's on 20m that convinced him that it was time to take up amateur radio and by February 1976 he was sporting the call sign G8LGQ. Immediately he began exploring the 2m band with a Pye Cambridge which was later replaced with a Yaesu rig.

As a committee member of the Sussex repeater group Alan was involved with the installation of GB3BR, the Brighton repeater on 70cm, and as an enthusiastic mobile operator with an IC22A in his car, he has worked much DX through many of the British Isles and Continental repeaters. His constructional projects include a VHF linear, a frequency counter and a 3-manual theatre organ complete with pit and lift! Alan is a member of the Mid-Sussex Amateur Radio Society and the RSGB, and in May 1977 at the age of 30, he was elected chairman of the newly-formed Brighton and District Radio Society.

In the latter half of 1977 he polished up his morse code and passed the test at North Foreland in November. In just less than two years Alan Baker mastered the art of working DX on the 2m band and now intends to do the same on the HF bands with his new call sign G4GNX.

BATTERY STATE INDICATOR

continued from page 849

and hence the supply voltage range over which oscillation takes place is very narrow, about 0·1V.

Construction and Component Selection

The Zener diode D1 should ideally give good stabilisation at a low current and can be simply checked by connection to a variable voltage supply with a 4·7kohms series resistor whilst monitoring its voltage with a multimeter. Selection of the Zener in this way is merely a refinement however, as in several indicator circuits lashed up so far all diodes were off the shelf and worked well. The actual Zener voltage is not critical, so a device anywhere between 3V and 5V will be suitable. The LED type is also non-critical except that it should have a suitable mounting clip.

The circuit is best fabricated on a small piece of Veroboard which can be located inside equipment where space permits. A suitable layout is shown in **Fig. 2**. Four Veropins are soldered in place at the board edge for connection to equipment being monitored.

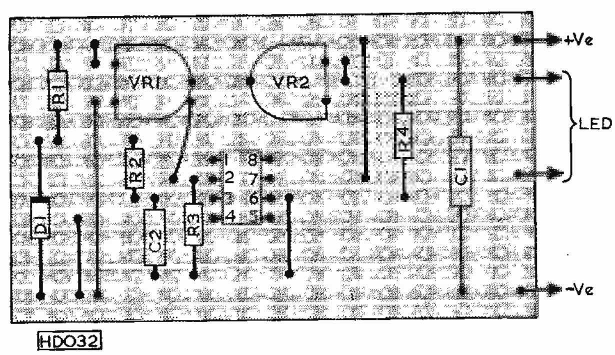


Fig. 2: A suggested Veroboard layout.

Setting Up

This is a simple matter and is best carried out as follows. Connect the circuit to a variable voltage supply, monitoring the current drain, which should be about 5mA at 9V. Set the supply voltage to the value at which you want the LED to start flashing, say 7V, and adjust VR1 until oscillation begins. With VR2 in its minimum resistance position, the LED will flash between 7V and 6·9V.

This small range will be adequate for low current equipment when the battery voltage drops slowly e.g. a low distortion oscillator taking about 15mA from a PP9 battery, where it is convenient to take the onset of flashing as the "change battery" point. The flashing LED will attract attention if the equipment is being used when the battery voltage drops.

If when switched on after a period of little use the LED does not light, the battery voltage is too low, probably due to normal deterioration. Increasing the value of VR2 will increase the flashing range over wide limits. A small degree of interaction between the two presets is inevitable. For monitoring higher supply voltages than 12V the LED series resistor will need to be increased in order to keep the current at a safe and economic level. ●

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AC142K	0·25
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AC187	0·25
AC188	0·25
ACY17	0·65
ACY18	0·65
ACY19	0·65
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ACY21	0·65
ACY39	1·25
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AD161	0·75
AD162	0·75
AF106	0·45
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·25
AF139	0·40
AF186	1·50
AF239	0·45
AFZ11	2·75
AFZ12	2·75
ASY26	0·45
ASY27	0·50
ASZ15	1·25
ASZ16	1·25
ASZ17	1·25
ASZ20	0·75
ASZ21	1·50
AU110	1·70*
AU113	1·70*
AUY10	1·70*
BA145	0·15*
BA148	0·15*
BA154	0·10
BA155	0·12
BA156	0·13
BAW62	0·05
BAX13	0·07
BAX16	0·07
BC107	0·12
BC108	0·12
BC109	0·13
BC113	0·15*
BC114	0·18*
BC115	0·19*
BC116	0·19*
BC117	0·22*
BC118	0·16*
BC125	0·18*
BC126	0·25*
BC135	0·15*
BC136	0·19*
BC137	0·16*
BC147	0·10*
BC148	0·10*
BC149	0·13*
BC157	0·12*
BC158	0·11*
BC159	0·13*
BC167	0·13*
BC170	0·16*
BC171	0·14*
BC172	0·13*
BC173	0·15*
BC177	0·19
BC178	0·18
BC179	0·20
BC182	0·11*
BC183	0·11*
BC184	0·12*
BC212	0·14*
BC213	0·14*
BC214	0·17*
BC237	0·17*
BC238	0·12*
BC301	0·45
BC303	0·60
BC307	0·20*
BC308	0·18*
BC327	0·22*
BC328	0·18*
BC337	0·19*
BC338	0·18*
BCY30	1·00
BCY31	1·00
BCY32	1·00
BCY33	0·90
BCY34	0·90
BCY39	3·00
BCY40	1·25
BCY42	0·30
BCY43	0·32
BCY58	0·23
BCY70	0·18
BCY71	0·22
BCY72	0·17
BCZ11	1·50
BD115	0·60
BD121	1·50
BD123	1·50
BD131	0·51
BD132	0·54
BD135	0·35*
BD136	0·36*
BD137	0·37*
BD138	0·40*
BD139	0·43*
BD140	0·47*
BD144	2·00
BD181	1·38
BD182	1·48
BD237	0·80
BD238	0·85
BDX10	0·75
BDX32	2·25
BDY20	1·42
BDY60	0·75
BF115	0·39
BF152	0·25
BF153	0·25
BF154	0·25
BF159	0·35
BF160	0·30
BF167	0·39
BF173	0·39
BF177	0·38
BF178	0·45
BF179	0·48
BF180	0·45
BF181	0·45
BF182	0·45
BF183	0·45
BF184	0·39
BF185	0·37
BF194	0·12*
BF195	0·11*
BF196	0·13*
BF197	0·14*
BF200	0·32
BF224	0·20*
BF244	0·35*
BF257	0·37
BF258	0·42
BF259	0·45
BF336	0·50*
BF337	0·53*
BF338	0·55*
BFS21	2·27
BFS28	1·38
BFS61	0·25*
BFS98	0·25*
BFW10	0·90
BFW11	0·90
BFX84	0·38
BFX85	0·41
BFX87	0·35
BFX88	0·32
BFY50	0·28
BFY51	0·26
BFY52	0·26
BFY64	0·30
BFY90	1·32
BSX19	0·34
BSX20	0·34
BSX21	0·32
BT106	1·25
BTY79/400R	3·19
BU205	2·25*
BU206	2·25*
BU208	2·50*
BY100	0·45
BY126	0·14
BY127	0·15
BZX61 Series	0·20
BZY88 Series	0·13
CRS/105	0·45
CRS/140	0·60
CRS/305	0·45
CRS/340	0·75
CRS/360	0·90
GEX66	1·50
GEX541	1·75
GJ3M	0·75
GJ5M	0·75
GM0378A	1·50
KS100A	0·40*
MJE340	0·58
MJE370	0·65
MJE371	0·81
MJE520	0·65
MJE521	0·75
MJE2955	1·25
MJE3055	0·75
MPF102	0·30*
MPF103	0·30*
MPF104	0·30*
MPF105	0·30*
MPSA06	0·25*
MPSA56	0·25*
MPSU01	0·32*
MPSU06	0·40*
MPSU56	0·45*
NKT401	2·00
NKT403	1·73
NKT404	1·73
NE555	0·45
OA5	0·75
OA7	0·55
OA10	0·55
OA47	0·14
OA70	0·30
OA79	0·30
OA81	0·30
OA85	0·30
OA90	0·08
OA91	0·08
OA95	0·08
OA200	0·10
OA202	0·11
OA210	0·75
OA211	0·75
OAZ200	0·65
OAZ201	0·65
OAZ206	0·65
OAZ207	0·65
OC16	1·25
OC20	2·00
OC22	2·50
OC23	2·75
OC24	3·50
OC25	0·90
OC26	0·90
OC28	2·00
OC29	2·00
OC35	1·50
OC36	1·50
OC41	0·50
OC42	0·50
OC43	1·50
OC44	0·50
OC45	0·50
OC71	0·45
OC72	0·45
OC73	1·00
OC75	0·50
OC74	0·75
OC76	0·50
OC77	1·20
OC81	0·75
OC81Z	1·00
OC82	0·75
OC83	0·55
OC84	0·60
OC122	1·50
OC123	1·55
OC139	2·25
OC140	1·95
OC141	2·25
OC170	0·75
OC171	0·75
OC200	1·00
OC201	1·50
OC202	1·25
OC203	1·25
OC204	1·25
OC205	1·75
OC206	1·75
OC207	1·25
OCP71	1·25
ORP12	0·83
R200SB	2·25*
R2009	2·25*
R2010B	2·25*
T1C44	0·36
T1C226D	1·30
T1L209	0·25
T1P29A	0·50*
T1P30A	0·60*
T1P31A	0·62
T1P32A	0·75
T1P33A	1·00
T1P34A	1·20
T1P41A	0·70
T1P42A	0·90
T1P2955	1·00
T1P3055	0·50
T1S43	0·35*
ZS140	0·25*
ZS170	0·12*
ZS178	0·54*
ZS271	0·22*
ZS278	0·56*
ZTX107	0·11*
ZTX108	0·10*
ZTX109	0·12*
ZTX300	0·12*
ZTX301	0·13*
ZTX302	0·17*
ZTX303	0·17*
ZTX304	0·19*
ZTX311	0·12*
ZTX314	0·20*
ZTX500	0·13*
ZTX501	0·14*
ZTX502	0·16*
ZTX503	0·17*
ZTX504	0·20*
ZTX531	0·20*
ZTX550	0·16*
1N914	0·07
1N916	0·07
1N4001	0·06
1N4002	0·07
1N4003	0·08
1N4004	0·09
1N4005	0·13
1N4006	0·15
1N4007	0·15
1N4009	0·15
1N4148	0·07
1N5400	0·14
1N5401	0·16
1S44	0·06
1S920	0·08
1S921	0·08
2G301	1·00
2G302	1·00
2G306	1·10
2N404	0·60
2N696	0·25
2N697	0·16
2N698	0·30
2N705	0·80
2N706	0·12
2N708	0·21
2N930	0·26
2N1131	0·26
2N1132	0·26
2N1302	0·37
2N1303	0·37
2N1304	0·45
2N1305	0·45
2N1306	0·50
2N1307	0·50
2N1308	0·60
2N1309	0·60
2N1613	0·33
2N1671	1·50
2N1893	0·33
2N2147	1·40
2N2148	1·65
2N2218	0·33
2N2219	0·42
2N2220	0·35
2N2221	0·22
2N2222	0·25
2N2223	2·75
2N2368	0·17
2N2369A	0·21
2N2484	0·21
2N2646	0·50
2N2904	0·35
2N2905	0·35
2N2906	0·25
2N2907	0·21
2N2924	0·15*
2N2925	0·17*
2N2926	0·13*
2N3053	0·25
2N3054	0·50
2N3055	0·65
2N3440	0·60
2N3441	0·80
2N3442	1·20
2N3525	0·90
2N3614	1·20
2N3702	0·15*
2N3703	0·15*
2N3704	0·15*
2N3705	0·15*
2N3706	0·14*
2N3707	0·18*
2N3708	0·14*
2N3709	0·15*
2N3710	0·14*
2N3711	0·15*
2N3771	1·60
2N3772	1·70
2N3773	2·65
2N3819	0·36*
2N3820	0·46*
2N3823	0·60*
2N3866	1·00
2N3904	0·21*
2N3905	0·22*
2N3906	0·22*
2N4058	0·20*
2N4059	0·15*
2N4060	0·20*
2N4061	0·17*
2N4062	0·18*
2N4124	0·17*
2N4126	0·17*
2N4286	0·20*
2N4288	0·25*
2N4289	0·25*
2N5457	0·35*
2N5458	0·35*
2N5459	0·35*
3N125	1·75
3N141	0·85

VALVES

Type	Price
AZ31	1·10*
CBL31	1·50
CL33	2·00*
CY31	1·00*
DAF91†	0·40*
DAF96	1·00*
DF91†	0·40*
DF96	1·00*
DK91†	0·55*
DK92	1·25*
DK96	1·10*
DL92	0·75*
DL94	1·20*
DL96	1·10*
DY86/7†	0·45*
DY802	0·80*
E88CC†	1·00
EABC80	0·40*
EAC91	0·50
EAF42	1·25*
EAF801	1·75*
EB41	1·75*
EB91†	0·30*
EBC33	1·75*
EBC41	1·25*
EBC81	1·10*
EBC90	0·65
EBF80	0·45*
EBF83	1·25*
EBF89†	0·40*
EBL31	2·50*
ECC40	1·25*
ECC81†	1·52*
ECC82†	0·47*
ECC83†	0·55*
ECC84†	0·50*
ECC85†	0·55*
ECC88†	0·75*
ECC91†	0·55*
ECC189	1·00*
ECF80†	0·60*
ECF82†	0·60*
ECH35	2·00*
ECH42	1·15*
ECH81†	0·50*
ECH83	0·85*
ECH84†	0·85*
ECL80†	0·68*
ECL82†	0·55*
ECL83	1·50*
ECL86†	0·65*
ECLL800	7·00*
EF37A†	1·60*
EF39†	1·60*
EF40	1·15*
EF41	1·20*
EF42	2·00*
EF50†	0·60*
EF80†	0·45*
EF83	1·75*
EF85†	0·50*
EF86†	0·45*
EF89	0·60*
EF91†	0·65*
EF92†	0·75*
EF98	1·25*
EF183†	0·50*
EF184†	0·50*
EH90	0·75*
EL32	1·50*
EL33	3·50*
EL41	1·25*
EL42	1·75*
EL81	1·10*
EL84†	0·35*
EL86†	0·50*
EL91	3·85*
EL95†	0·80*
EL360	2·75*
EM80	1·10*
EM81	1·00*
EM84	1·00*
EM85	1·25*
EM87	1·50*
EN91†	0·55
EY51†	0·75*
EY86†	0·50*
EZ40	1·25*
EZ41	1·25*
EZ80†	0·30*
EZ81†	0·35*
EZ90†	0·45*
GZ32	0·75*
GZ33	4·00*
GZ34†	1·52*
KT61	3·50*
KT66	4·00*
KT88	4·75*
KTW61	1·75*
KTW62	1·75*
KTW63	1·75*
MU14	1·00*
N78	7·50*
OA2†	0·45
OB2†	0·45
OC3†	0·45
OD3†	0·45
OZ4	0·75*
PC86†	0·85*
PC88†	0·85*
PC97	1·08*
PC900†	0·75*
PCC84†	0·45*
PCC88	0·65*
PCC89†	1·05*
PCC189†	0·65*
PCF80	0·72*
PCF82†	0·50*
PCF86†	0·65*
PCF87†	1·00*
PCF200†	1·05*
PCF201†	1·05*
PCF801†	0·55*
PCF802†	0·88*
PCF805	1·44*
PCF806	0·80*
PCF808	1·44*
PCL82†	0·50*
PCL83†	0·92*
PCL84†	0·50*
PCL85†	0·96*
PCL86†	0·65*
PCL805/85†	0·96*
PD500	3·60*
PFL200	1·12*
PL36†	1·12*
PL81	0·55*
PL81A†	1·12*
PL82	0·60*
PL83†	0·55*
PL84†	0·60*
PL504/500†	1·20*
PL508†	1·60*
PL509†	2·72*
PL519†	3·60*
PL801	1·10*
PL802†	2·16*
PY33	0·68*
PY81†	0·72*
PY82	0·45*
PY83	0·60*
PY88†	1·16*
PY500A†	1·60*
PY800/81†	0·92*
PY801	0·92*
QQV02-6	9·60
QQV03-10†	2·00
QQV03-20A†	10·50*
QQV06-40A†	13·00*
R17	1·65*
R19	1·00*
R20	1·44*
U18-20	2·50*
U25	1·16*
U26	1·44*
UABC80†	0·50*
UAF42	0·75*
UB41	1·25*
UBC41†	0·75*
UBF89	0·50
UCC84	0·75*
UCC85†	0·50*
UCF80	0·75*
UCH42	1·20*
UCH81†	0·50*
UCL82†	0·50*
UCL83	1·44*
UF41	0·75*
UF80†	0·50*
UF85†	0·50*
UF89†	0·50*
UL41	1·00*
UL84†	0·60*
UM80	1·00*
UY41†	0·75*
UY85†	0·65*
1B3GT†	0·55*
1R5†	0·55*
1S5†	0·40*
1T4†	0·40*
2AS15	10·00
2D21†	0·55
3A5	1·35
3CX100A5	20·00
3S4†	0·75*
3V4†	1·00*
4CX250B	17·50
5R4GY†	1·00*
5U4G	1·52*
5U4GB	1·00*
5V4G†	0·65*
5Y3GT	0·85*
5Z3	1·50*
5Z4G	1·12*
5Z4GT	1·00*
6-30L2	1·00*
6AB7	0·75*
6AC7	0·75*
6AF4A†	0·70*
6AG7	0·75*
6AH6†	0·70*
6AK5†	0·30
6AK6	0·95*
6AL5†	0·30*
6AM4	2·30*
6AM5	3·85*
6AM6†	0·65*
6AN5	2·50*
6AN8A†	0·70*
6AQ5†	0·75*
6AR5	0·70*
6AS6†	0·80*
6AS7G†	1·50*
6AT6†	0·65*
6AU5GT	4·26*
6AU6†	0·55*
6AV5GT	3·74*
6AV6†	0·50*
6AW8A†	1·00
6AX5GT	3·10*
6B7	0·75
6B8	0·75
6BA6†	0·50*
6BA7	5·12*
6BA8A	3·75
6BC4	3·71
6BE6†	0·45*
6BH6†	1·20*
6BJ6†	0·80*
GBK4	4·21*
6BL6	85·00
6BL7GT	3·86*
6BN6	0·80*
6BQ7A	1·55*
6BR7	4·00*
6BR8†	1·20*
6BS7	4·00*
6BW6	3·75*
6BW7	1·12*
6BX7GT	4·96*
6BZ6	1·78*
6C4†	0·40*
6CB6A†	0·50*
6CD6GA	4·00*
6CG7	1·72*
6CH6	4·42*
6CL6†	0·75*
6CW4	4·72*
6D2†	0·30*
6DK6	2·49*
6DQ6B	3·04*
6EA8	2·21*
6EB8	2·12*
6EW6	0·80*
6F6	0·75
6F23	1·60*
6F28	1·60*
6H2N	0·75*
6H3N	0·75*
6H6	0·75*
6J4†	0·75*
6J6†	0·55*
6J7	0·75*
6K4N	0·75*
6K6GT	0·75*
6K7	0·75*
6K8	0·75*
6KD6	4·79*
6L6G	2·50*
6L6GA	1·50*
6L6GT	0·85*
6L6GC	1·75*
6L7	0·75
6N2P	0·75
6N3P	0·75
6N7	0·75*
6P25	3·60*
6Q7	0·80*
6R7	0·80*
6SA7	0·80*
6SC7	0·80*
6SF7	0·80*
6SH7	0·80*
6SJ7	0·80*
6SK7	0·80*
6SL7GT†	0·70*
6SN7GT†	0·70*
6SQ7	0·75*
6SR7	0·75*
6SS7	0·75*
6U5G	2·00*
6U8†	0·40*
6U8A†	0·55*
6V6GT†	0·60*
6X4†	0·45*
6X5GT†	0·55*
7B7	1·00*
7C5	1·75*
7C6	1·25*
7H7	1·00*
7R7	1·50*
7S7	2·25*
7Y4	0·75*
7Z4	0·75*
12AT6	0·45*
12AT7†	0·45*
12AU6	0·50*
12AU7†	0·45*
12AV6	0·60*
12AV7	2·84*
12AX7†	0·45*
12AY7†	0·82*
12B4A†	1·00*
12BA6	0·50*
12BE6	0·60*
12BH7†	0·60*
12BY7†	0·80*
12E1	4·00
30C15	1·20*
30C17	1·20*
30C18	1·44*
30F5	1·60*
30FL1/2	1·12*
30FL12	1·72*
30FL14	1·44*
30L1	0·84*
30L15	1·72*
30L17	1·72*
30P4	0·92*
30P19	1·12*
30PL1	1·32*
30PL13	1·72*
30PL14	1·68*
30PL15	1·72*
35W4	0·60*
50C5	0·70*
85A2	1·50
90AG	7·26
90AV	7·16
90C1	1·50
90CG	5·74
90CV	5·99
92AG	7·26
92AV	7·16
150B2	1·80
150C2	1·50
150C4	2·30
211	5·00
723AB†	8·00
807†	1·00
811A†	3·80
812A	7·25
813†	10·00
833A	30·00
866A	8·85
872A	11·40
931A	12·24
2050	2·50
5642	3·16*
5654	3·61*
5651	1·80*
5670	2·86*
5814A	2·60*
6080†	6·85*
6146A	4·27
6146B	4·65
6159	6·00
6442	15·00
6973	2·61
7586	6·79
7587	12·54
7868	2·93*
8068	5·50
8136	1·54

INTEGRATED CIRCUITS

Type	Price
7400	0·20
7401	0·20
7402	0·20
7403	0·20
7404	0·26
7405	0·23
7406	0·55
7407	0·55
7408	0·28
7409	0·28
7410	0·20
7412	0·26
7413	0·45
7416	0·40
7417	0·40
7420	0·20
7422	0·25
7423	0·35
7425	0·35
7427	0·35
7428	0·50
7430	0·20
7432	0·36
7433	0·37
7437	0·42
7438	0·37
7440	0·22
7441AN	0·92
7442	0·78
7447AN	1·20
7450	0·20
7451	0·20
7453	0·20
7454	0·20
7460	0·20
7470	0·35
7472	0·36
7473	0·36
7474	0·40
7475	0·59
7476	0·42
7480	0·60
7482	0·85
7483	1·00
7484	1·00
7486	0·40
7490	0·52
7491AN	0·85
7492	0·60
7493	0·70
7494	0·80
7495	0·80
7496	0·90
7497	3·67
74100	1·75
74107	0·45
74109	0·86
74110	0·57
74111	0·86
74116	1·89
74118	0·95
74119	2·00
74120	1·10
74121	0·45
74122	0·60
74123	1·00
74125	0·80
74126	0·80
74128	0·80
74132	0·80
74136	0·68
74141	0·85
74142	3·00
74143	3·00
74144	3·00
74145	1·00
74147	2·45
74148	2·00
74150	1·75
74151	0·90
74154	2·00
74155	0·90
74156	0·90
74157	0·90
74159	2·50
74170	2·60
74172	5·00
74173	1·75
74174	1·57
74175	1·00
74176	1·10
74178	1·65
74179	1·65
74180	1·65
74190	1·48
74191	1·48
74192	1·25
74193	1·25
74194	1·25
74195	1·10
74196	1·20
74197	1·00
74198	2·25
74199	2·25
76013N	1·75*
LM309K	1·50
TAA570	2·30*
TAA630S	3·50*
TBA480Q	1·84*
TBA520Q	2·30*
TBA530	1·98*
TBA540Q	2·30*
TBA550Q	3·22*
TBA560CQ	3·22*
TBA673	2·19*
TBA700	1·52*
TBA720Q	2·30*
TBA750Q	2·07*
TBA990Q	2·99*
TCA270Q	2·99*
TCA760A	1·38*

DIL Sockets

Type	Price
8 PIN	0·15
14 PIN	0·15
16 PIN	0·17

BASES

Type	Price
BG7 unskirted	0·15
B7G skirted	0·30
B9A unskirted	0·15
B9A skirted	0·30
Int Octal	0·20
Nuvistor	0·25
Loctal	0·55
8 pin DIL	0·15
14 pin DIL	0·15
16 pin DIL	0·17
Valve screening cans all sizes	0·30

CRT'S

Type	Price
1CP31	31·00
2AP1*	8·50
2BP1*	9·00
3BP1	8·00
3DP1*	5·00
3EG1*	7·00
3FP7*	3·00
3GP1	6·00
3JP1*	8·00
3JP2*	8·00
3JP7*	10·00
SKP1*	15·00
3RP1*	35·00
4EP1	25·00
4EP7	25·00
4EP11	25·00
5ADP1	35·00
5BP1*	5·00
5CP1*	5·00
5CP1A	40·00
5FP15A	5·00
5UP7*	5·00
DG7-5	25·00
DG7-32	36·00
DH3-91	31·00
DH7-11	68·00
VCR97*	5·00
VCR138*	10·00
VCR138A*	12·50
VCR139A*	8·00
VCR517A*	3·00
VCR517B*	3·00
VCR517C*	3·00
Tube Bases	0·75

*=Surplus

VAT 8%

Terms of business: CWO. postage and packing valves and semiconductors 25p per order. CRTs 75p. Items marked* add 12½% VAT. Others 8%. † Indicates cheap quality version or surplus, but also available by leading UK and USA manufacturers. Price ruling at time of despatch. Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1 on credit orders. Over 10,000 types of valves, tubes and semiconductors in stock. P&P 8% VAT

QUOTATIONS FOR ANY TYPE NOT LISTED SAE.

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E & O.E.

MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£14·00**.

ROOM THERMOSTAT

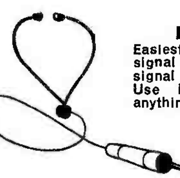
Famous Satchwell, elegant design, intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30°C. Special snip this month **£3·00**.

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make. **£3·75**.

MICRO SWITCH BARGAINS

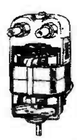
Rated at 5 amps 250 volts. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 (2 types) for **£1·00**.



RADIO STETHOSCOPE

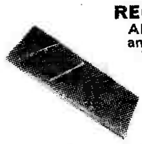
Easiest way to fault find, traces, signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set. **£3·95**.

MULTISPEED MOTORS



Six speeds are available 500, 850 and 1,100 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼" diameter and approximately 1" long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2" dia. × 5" long. Price **£2·00**.

RECTANGULAR HOT PLATE

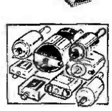


Aluminium panel with ridged top and angled underneath to strengthen it. This is approx. 10" × 4½" of flat plate. Beneath plate is 100w element and sensor switch which will maintain the surface of the plate just too hot to touch. With leads and tages. This is ideal if you are making up a food warmer or for an airing cupboard, etc. Price **£1·03**.

HUMIDITY SWITCH

American made by Ranco, their type No. J11. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch adjustable by a screw, quite sensitive—breathing on it for instance will switch it on. Micro 3 amp at 250v AC. Overall size of the device approx. 3¾" long, 1" wide and 1⅝" deep. **75p**.

8 POWERFUL BATTERY MOTORS



For models, Meccanos, drills, remote control planes, boats, etc. **£2**.

PP3/PP9 REPLACEMENT MAINS UNIT

Japanese made in plastic container with leads size 2" × 1½" × 1½", this is ideal to power a calculator or radio, it has a full wave rectified and smoothed output of 9 volts suitable for a loading of up to 100mA. **£2·53**.

SWITCH TRIGGER MATS

Wiring dig, supplied for complete house protection—'Keep Those Robbers Away'.
13" × 10" — **£2·10**
24" × 18" — **£2·60**

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer, rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **£1·95**.

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95**.

DRILL CONTROLLER

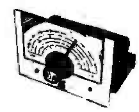
Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3·45**
Made up model £1·00 extra

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied. Model 1153 500mW power output **£1·50** including Post and VAT.

Model 1172 1W, power output **£1·85**
Model EP9000 4 watt power output **£2·90**
EP 9001 twin channel or stereo pre-amp. **£2·90**

SHORTWAVE CRYSTAL SET



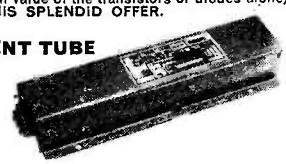
Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·90** —crystal earphone **55p**.

BREAKDOWN PARCEL

Four unused, made for computer units containing most useful components, and these components unlike those from most computer panels, have wire ends of usable length. The transistors for instance have leads over 1" long—the diodes have approx. ½" leads.

List of the major components is as follows:—17 assorted transistors—38 assorted diodes—60 assorted resistors and condensers—4 gold plated plugs in units which can serve as multipin plugs or as hook up boards for experimental or quickly changed circuits (note we can supply the socket boards which were made to receive these units). The price of this four unit parcel is **£1** including VAT and post (considerably less than value of the transistors or diodes alone). DON'T MISS THIS SPLENDID OFFER.

FLUORESCENT TUBE INVERTOR



For camping — car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting, it will offer plenty of well distributed light and is economical. We offer invertor for 21" 13 watt miniature tube for only **£3·75** with tube and tube holders as well.

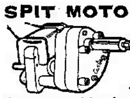
THIS MONTH'S SNIP

is a miniature sealed relay 12v dc operated with two sets of changeover contacts. The unique feature of this relay is its heavy lead out wires. These provide adequate support and therefore the relay needs no fixing; on the other hand there is a fixing bolt protruding through one side so if you wish you can fix the relay and use its very strong lead outs to secure circuit components—an expensive relay; but we are offering it for only **87p** each. Don't miss this exceptional bargain!

EXTRACTOR FAN

Ex computers—made by Woods of Colchester, ideal for fixing through panel—reasonably quiet running—very powerful 2500 rpm. Choice of two sizes 5" or 6½" dia. **£5** and **£6**.

SPIT MOTOR WITH CARTER G/BOX



Probably one of the best spit motors made. Originally intended to be used in very high priced cookers, however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact there are no ends to its uses. Normal mains operation. **£4·32**.

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1-2 or 3 10 amp 250V changeover micro-switch thro panel mounting by cock nuts 1" dia black knob 1 switch **40p** 2 switch **55p**, 3 switch **70p**.

LATCHING RELAY

by Guardian Electric, mains operated it is in fact two relays mounted on a metal base plate. The relays being mounted in such a way to ensure that when one closes the other opens and vice versa thus when closed relay A would remain locked until manually released or electrically released by energising relay B. Each relay has 2 sets of 10 amp changeover contacts. Should be ideal for burglar alarms and similar applications **£2·11**.

TERMS:

Cash with order—prices include VAT and carriage unless stated but orders under £6 must add 50p to offset packing, etc. BULK ENQUIRIES WELCOMED. Phone 01-688 1833.

J. BULL (ELECTRICAL) LTD

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CROYDON CR9 1SG

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

FM Tuner and decoder, two very well made (Japan) units, nice clear dial, excellent reproduction **£9·95** the pair £1·25 VAT.

12 Volt Heavy Duty Relay, plug in type has three pairs of 10 amp changeover contacts. A transparent dust cover, price **£1** + 8p, suitable 11 pin base 27p + VAT 2p.

4 Changeover Mains Relay, upright mounting with perspex type dust cover, the really interesting feature is 4 sets of 10 amps changeover contacts price **£1·62** + VAT 12p.

12 Volt Pump. Designed we believe as a bilge pump, this is 12 volt AC/DC motor coupled by a long enclosed shaft to a submersible pump. Suitable for water or most any fluids. Price **£11·70**.

Just arrived. Fruit machines, working order very impressive choice of several but very heavy so you must collect. **£50.**

High Load 24 Hour Clock Switch, made by the famous AEG Company for normal mains but with clockwork reserve has load capacity of 80 amps at 240v 50hz. Therefore suitable for dealing with large loads of say shop lighting, water heating, storage heaters, etc., etc. Has triggers for on and off once per 24 hours but extra triggers will be available. Price **£1·50** per pair. Size of clock approximately 8" × 5" × 5", totally encased but has lift up flap for ease of altering switching times. Price, new and unused **£10·65** or used but guaranteed o.k. **£6·50**.

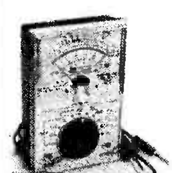
Enclosed 24 Hour Clock, with contacts for breaking 10-12 amps at 240 volts. This one has two sets of on/off per 24 hours, price **£7·00**.

Smiths 24 hr. Timers–Heart only, with over-ride similar to those used in the auto set, etc. **£4·75** + VAT 33p.
Ditto but in grey plastic wall mounting case, with leads ready for attaching to plug and socket, price **£6·98**.

Light Dimmer, our timer module with small mods makes an excellent light dimmer. Contains a 4 amp 400V SCR so it should be suitable for loads approaching 1kW. Price of module with variable resistor and instructions **£2·25**.

Push Pull Solenoids, mains operated solenoids which will push as well as or instead of pull. Very heavy duty estimate this at 20lbs push or pull 1¾" × 3½" × 4" made Magnetic Devices Co. **£7·50**.

MINI-MULTI TESTER



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FREE

Amps ranges kit enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one send **£1·50p**.

Flat Reed Switches, for stacking greater quantity in confined space. Price **50p** each VAT 4p.

Single Ended Types for jobs where it is not easy to bring a load to each end **75p** each. All these switches are normally open but can be biased to a normally closed position by fitting a magnet adjacent. The reed switch would then be opened by a magnet of opposite polarity being brought up to it.

Ceramic Magnets suitable for operating reed switches, central fixing hole, 10 for **£1**.

Music Centre Transformer 12-0-12 at 1 amp and 9 volt at ½ amp. Normal primary, upright mounting, impregnated and varnished for quiet operation. Price **£2·95**. Post 54p.

Extension Speakers 8 ohm 4·5 watts handling power. We have 5 or 6 different models in stock, cheapest being the Partytime at **£3·956** each, again only really a bargain for callers as postage is £1·50 per speaker.

T.V. Monitor, an item for callers, believed to be in good working order, switchable thro' 405-525 & 625. 21" tube line systems, normal controls, volume, brightness, contrast, width, etc. Price **£16·20**, 12" model **£18**, suitable for conversion into special purpose scope, etc.

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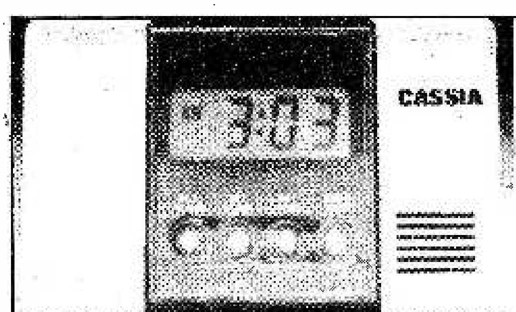

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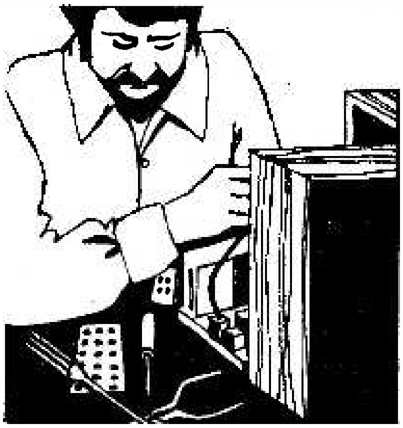

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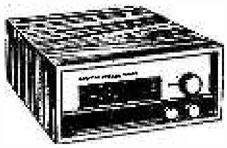

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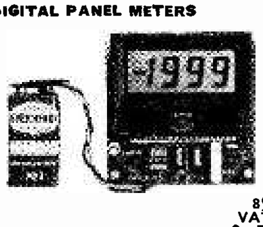

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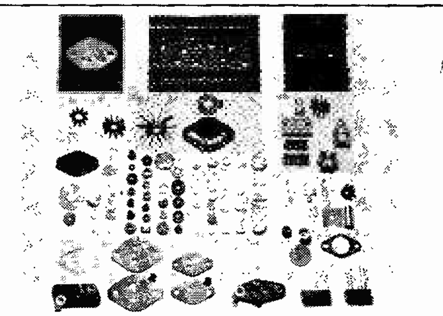

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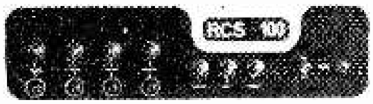

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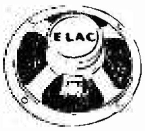

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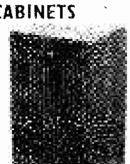

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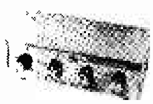

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TWO CHANNEL STEREO VERSION OF ABOVE £8·50

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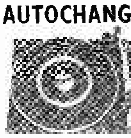

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BAKER MAJOR 12" £15·00

Post £1

90-14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s rated 25 watts. NOTE: 4 or 8 or 16 ohms must be stated.

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BAKER SPEAKERS "BIG SOUND"

Robustly constructed to stand up to long periods of electronic power. As used by leading groups.
Useful response 30-13,000 cps.
Bass resonance 55 cps.

GROUP "25" 12in. 30 watt 4, 8 or 16 ohms. **£12·00** Post £1

GROUP "35" 12in. 40 watt 4, 8 or 16 ohms. **£14·00** Post £1

GROUP "50/12" 12in. 60 watt professional model. 4, 8 or 16 ohms. **£21·00** Post £1·60
With aluminium presence dome.

GROUP "50/15" 15in. 75 watt 8 or 16 ohms. **£26·00** Post £1·60

Send for leaflets on Disco, P.A. and Group Gear.

BAKER 150 WATT QUALITY TRANSISTOR MIXER/AMPLIFIER

Professional amplifier using advanced circuit design. Ideal for disco, groups, P.A. or musical instruments. 4 inputs 4 way mixing. Master treble, bass and volume controls. 3 speaker output sockets to suit various combinations of speakers. 4-8-16 ohm. Slave output. A/C mains. Guaranteed. Details S.A.E. **£75** Carr. £1·50

100 WATT DISCO AMPLIFIER

MADE BY JENNINGS MUSICAL INSTRUMENTS **£59**
4 Speaker outputs volume, treble, bass, controls
CAN BE USED AS 100 WATT SLAVE Carr. £1

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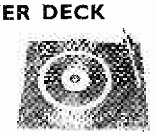

3 speed. Plays all size records, Stereo Cartridge. Cueing device, Ideal Disco Deck.

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STEREO PRE-AMP KIT. All parts to build this pre-amp. 3 inputs for high medium or low gain per channel, with volume control and P.C. Board. Can be ganged to make multi-way stereo mixers. Post 35p **£2·95**

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Complete kit of parts with R.C.S. printed circuit. Three channels. 600 to 1,000 watts each. Will operate from 20MV. to 100 watts signal source. Price **£17**
Cabinet extra £4.

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw Fitting 75p. Each.

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20 VOLT 1 AMP. £2·00 2 AMP. £2·20 20-0-20 VOLT 1 AMP. £2·95
30 VOLT 1½ AMP. £2·50 40 VOLT 2 AMP. £2·95
0-20-40-60 VOLT 1 AMP. £3·50 2 × 18 VOLT 6 AMP. £9.

GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at

2A, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V	£5·30
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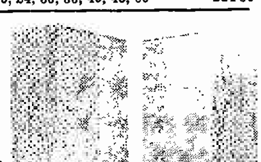
2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£8·50
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£11·00
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£14·50

R.C.S. BOOKSHELF SPEAKERS



13 × 10 × 6in.
50 to 14,000 cps.
8 watts rms. 8 ohms

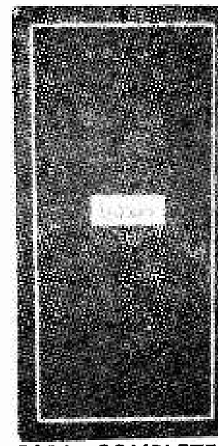
£16 pair Post £1·30

BAKER DISCO SPEAKERS

HIGH QUALITY—BRITISH MADE

2 x 12" CABINETS

for Disco or PA all fitted with carrying handles and corners. Black vynide covered. Other cabinets in stock. SAE for leaflet



60 WATT R.M.S. £52
With one horn £60
With two horns £68
Carr. £3

80 WATT R.M.S. £56
With one horn £64
With two horns £72
Carr. £3

100 WATT R.M.S. £69
With one horn £78
With two horns £86
Carr. £5

SINGLE 12inch CABS COMPLETE
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40 WATT R.M.S. £34. WITH HORN £42.
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CARR £3 EA.

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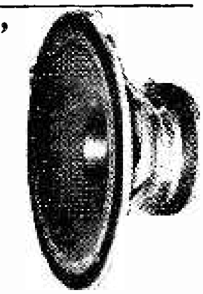


12in 25 watts

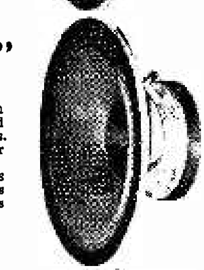
A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance	25cps
Flux Density	16,500 gauss
Useful response	20-17,000cps

8 or 16 ohms models.

£22·00 Post £1·60

"AUDITORIUM"



12in. 35 watts

A full range reproducer for high power, Ideal for Hi-Fi and Discotheques. Electric Guitars, public address, multi-speaker systems, electric organs.

Bass Resonance	35cps
Flux Density	15,000 gauss
Useful response	25-16,000cps

8 or 16 ohms models.

£21·00 Post £1·60

"AUDITORIUM"

15in. 45 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic Instruments and the home Hi-Fi.

Bass Resonance	35cps
Flux Density	15,000 gauss
Useful response	20-14,000cps

8 or 16 ohms models.

£26·00 Post £1·60

Loudspeaker Cabinet Wadding 18in wide, 20p per ft.

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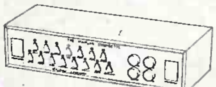

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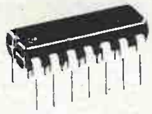

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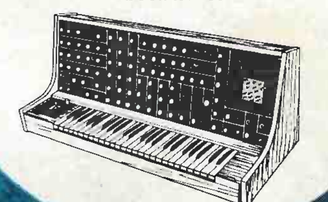

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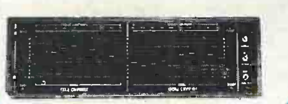

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