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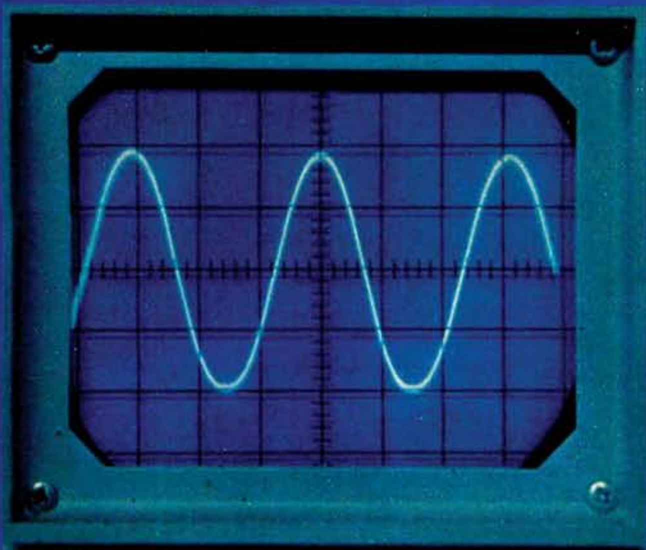

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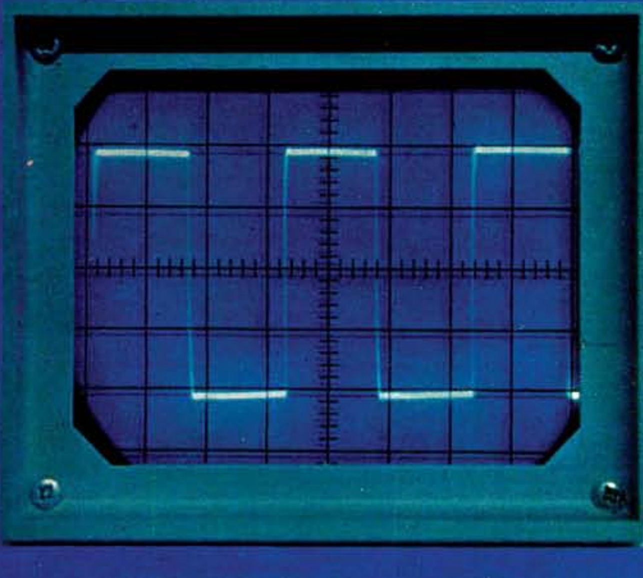

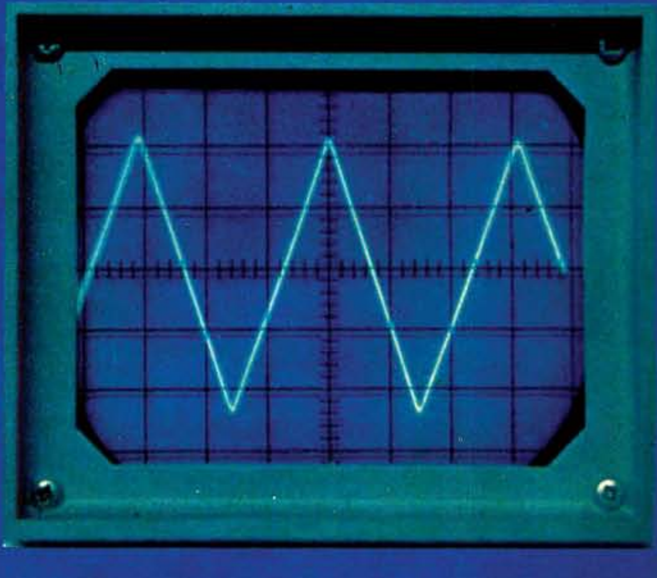

also: STEREO AUTOMATIC FADER

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Hours, mins., secs., month, date, auto calender, back-light, quality metal bracelet.

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Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

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M2

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M3

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M4

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- Basic alarm.
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- Timer alarm with dual.
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- Back-light.
- 8mm thick.

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M5

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M6

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M7

ALARM CHRONO with 9 world time zones

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- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£19.95

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up. 6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

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M9

SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass.

List Price £130.00

METAC PRICE

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M10

SEIKO MEMORY BANK

Calendar watch M354
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M11

SEIKO-STYLE Dual time-alarm Chronograph

Mineral glass face. Battery hatch for DIY battery replacement. Top quality finish with fully adjustable bracelet.

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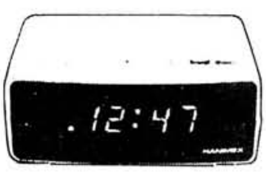
M12

HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on off control. Display flashing for power loss indication. Repeatable 9 minute snooze. Display bright dim modes control. Size 5·15" x 3·93" x 2·36" (131mm x 11mm x 60mm) Weight 1·43 lbs (0·65 kg)

AC power 220V

£9.65 Thousands sold!

Mains operated.

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M13

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- Snooze & sleep controls.
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- Quartz crystal controlled.

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M14

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M15

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- **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
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Guaranteed same day dispatch.

M16

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practical WIRELESS

APRIL 1980
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BRITAINS LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

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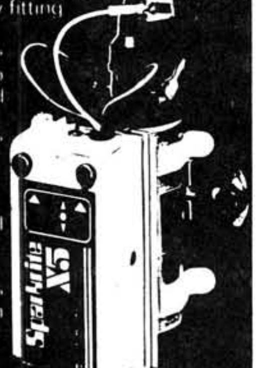

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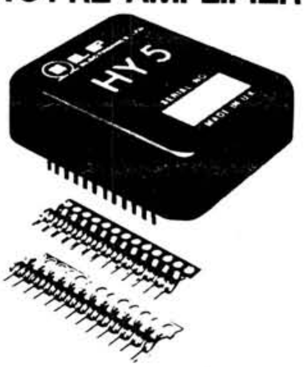
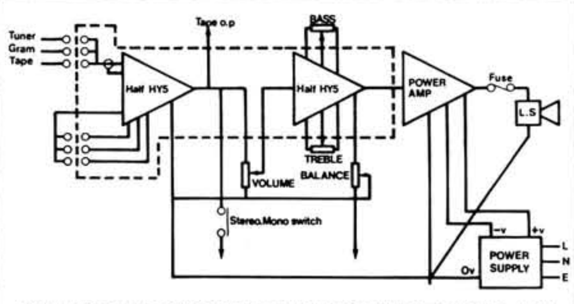
HY5 PRE-AMPLIFIER





VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume – 10K Ω log.
Bass/Treble – 100K Ω linear. Balance – 5K Ω linear.

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

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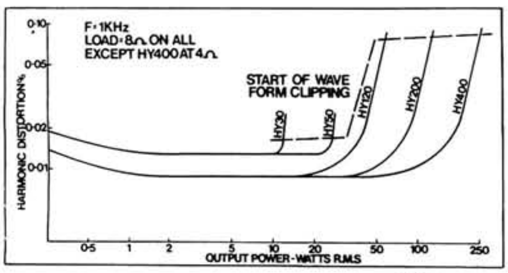
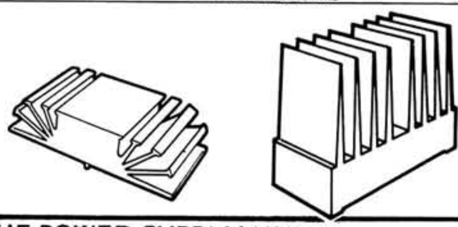
THE POWER AMPLIFIERS



Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	£27.68 + £4.15



Load impedance – all models 4 - 16Ω
Input sensitivity – all models 500 mV
Input impedance – all models 100KΩ
Frequency response – all models 10Hz - 45Hz - 3dB

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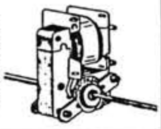

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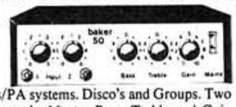

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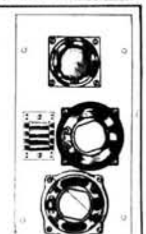

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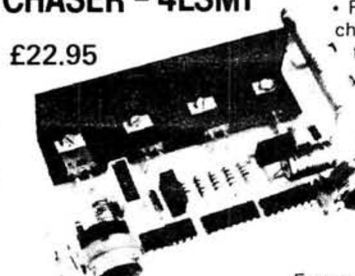

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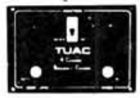

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12A6	0.70
12AT6	0.55
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12AU7	0.60
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12SH7	0.85
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13D6	0.70
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19AQ5	0.90
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20D1	0.75
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20E1	1.30
20P1	0.65
20P3	0.80
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20P5	1.30
25L6GT	0.95
25Z4G	0.85
30C15	1.15
30C17	1.35
30C18	2.10

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30F5	1.15
30FL2	1.70
30FL12	1.45
30FL14	2.05
30L15	1.15
30L17	1.15
30P12	1.15
30PL1	1.15
30PL13	1.25
30PL14	1.25
35L6GT	1.15
35W4	0.80
35Z4GT	0.85
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957	1.05
1625	1.15
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6060	105
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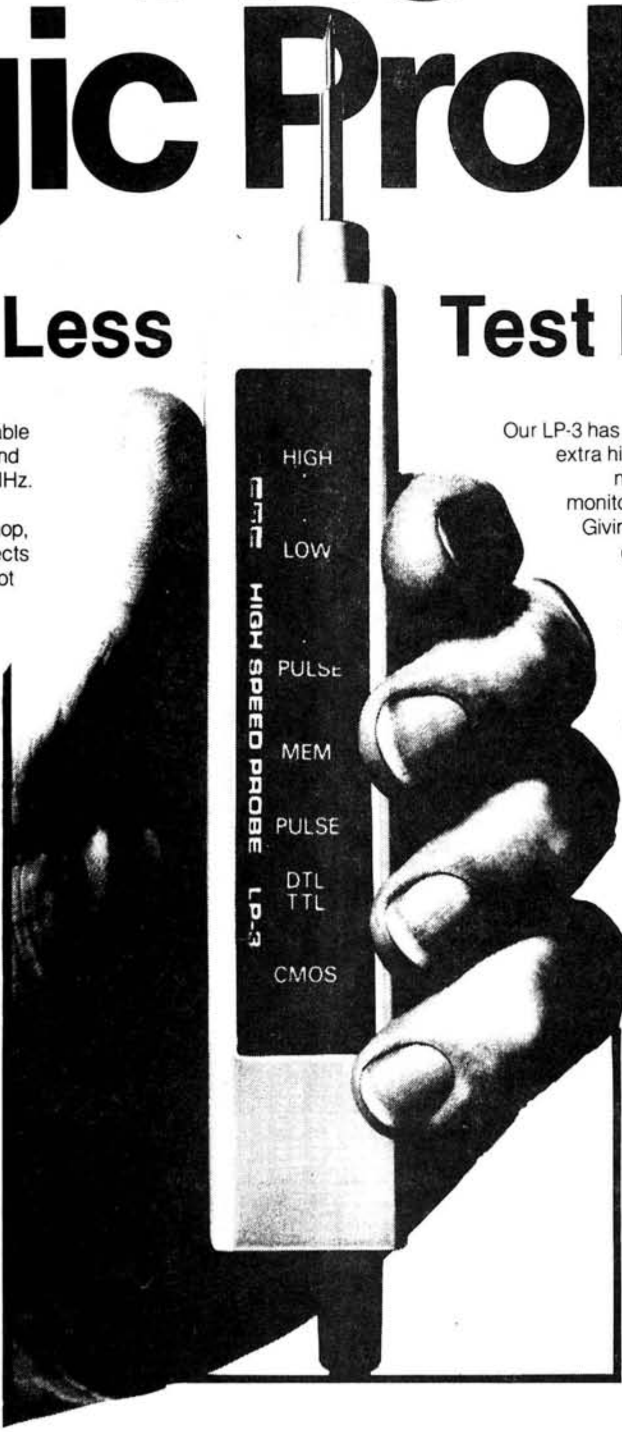

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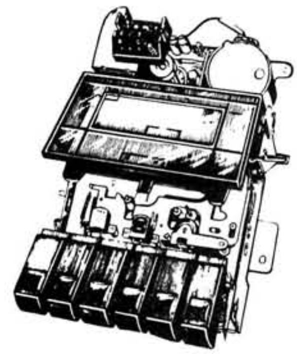

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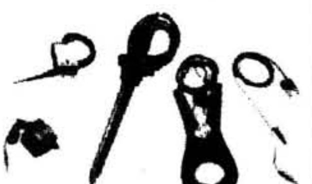

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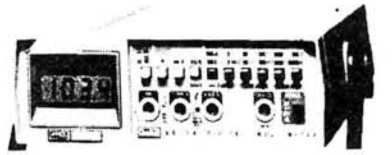

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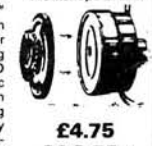

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1505	MIL5251 (TIL222)	5mm (·2)	GREEN	£0·22
1506	MIL5351 (MV5353)	5mm (·2)	YELLOW	£0·22
1509	FLV111	5mm (·2)	CLEAR (ill. Red)	£0·13

SUPER 'HI BRITE' TYPE

1521	MIL32	3mm (·125)	RED	£0·12
1522	MIL52	5mm (·2)	RED	£0·12
1514	ORP12 Light dependent resistor			£0·63
1520	OCP71 Photo transistor			£0·40

LED CLIPS

1508/125 pack of 5	125 clips	£0·17
1508/2 pack of 5	2 clips	£0·21

DISPLAYS

DL703 7 segment D P left (30" height) Common Anode
RED Single Digit — O/NO. 1523 — £0·85
DL707 7 segment D P left (30" height) Common Anode
RED Single Digit — O/NO. 1510 — £0·92
DL527 7 segment D P left (50" height) Common Anode
RED Two-Digit Reflector — O/NO. 1524 — £2·08
DL727 7 segment D P right (·10" height) Common Anode
RED Two-Digit Light Pipe — O/NO. 1512 — £2·07
DL747 7 segment D P left (630" height) Common Anode
RED Single Digit Light Pipe — O/NO. 1511 — £1·73

OPTO-ISOLATORS

Isolation Breakdown–Voltage 1500–continuous fwd. current 100 mA

CIL74 Single Channel 6 pin DIP standard type–optically coupled pair with infra-red LED Emitter and NPN Silicon Photo Transistor — O/NO. 1497 — £0·61

CILD74 Multi-Channel 8 pin DIP Two Isolated Channels — O/NO. 1498 — £1·22

CILQ74 Multi-Channel 16 pin DIP Four Isolated Channels — O/NO. 1499 — £2·69

MELL II (TIL81) NPN LIGHT DETECTOR
Silicon Photo Darlington Amplifier–VCBO 30V VECO 10V 1c 100mA Ptot 300mW IL Min. 0·5 Typ 2mA 1D 100mA nA — O/NO. 1495 — £0·29

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm · 5mm chassis mounting	506	£0·18
1¼in. · ¼in. chassis mounting	507	£0·14
1¼in. car inline type	508	£0·18
Panel mounting 20mm	509	£0·23
Panel mounting 1¼in.	510	£0·37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1·5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2·5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1/6A	627	5A	630

All **8p** each

QUICK-BLOW 1¼in.

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All **8p** each

Type	No.	Type	No.	Type	No.
1A	635	2/5A	638	4A	641
2A	637	3A	639	5A	642

All **60** each

NUTS AND BOLTS

BA BOLTS–packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in. OBA	839	£1·38	½in. 4BA	846	£0·37
½in. OBA	840	£0·86	¼in. 4BA	847	£0·29
1in. 2BA	842	£0·75	1in. 6BA	848	£0·46
½in. 2BA	843	£0·52	½in. 6BA	849	£0·24
¼in. 2BA	844	£0·60	¼in. 6BA	850	£0·20
1in. 4BA	845	£0·51			

BA NUTS–packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	855	£0·83	4BA	857	£0·35
2BA	856	£0·55	6BA	858	£0·28

BA WASHERS–flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	859	£0·16	4BA	861	£0·14
OBA	860	£0·14	6BA	862	£0·14

SOLDER TAGS–Hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	851	£0·46	4BA	853	£0·25
2BA	852	£0·32	6BA	854	£0·25

TANTALUM CAPACITORS

3137	1MFD	35V	£0·13	3142	4.4MFD	35V	£0·21
3138	22MFD	35V	£0·13	3157	3.3MFD	25V	£0·21
3139	47MFD	35V	£0·13	3143	10MFD	35V	£0·25
3140	1.0MFD	35V	£0·13	3144	22MFD	16V	£0·25
3141	2.2MFD	35V	£0·14	3156	33MFD	35V	£0·13

AUDIO LEADS

No.	Type	Price
107	FM indoor Ribbon Aerial	£0·69
113	3·5mm Jack plug to 3·5mm Jack plug length 1·5m	£0·86
114	5 pin DIN plug to 3·5mm Jack connected to pins 3 & 5 length 1·5m	£0·98
115	5 pin DIN plug to 3·5mm Jack connected to pins 1 & 4 length 1·5m	£0·98
116	Car aerial extension screened insulated lead. Fitted plug and socket	£1·44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0·78
118	5 pin DIN phono plug to stereo headphone. Jack socket	£1·21
119	2 · 2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones. Length 0·2m	£1·04
120	Car stereo connector. Variable geometry plug to fit most car cassettes. 8-track cartridge and combination units. Supplied with inlined fuse power lead and instructions	£0·69
123	6·6m Coiled Guitar Lead Mono Jack plug to Mono Jack plug Black	£1·72
124	3 pin DIN plug to 3 pin DIN plug. Length 1·5m	£0·85
125	5 pin DIN plug to 5 pin DIN plug. Length 1·5m	£0·85
126	5 pin DIN plug to Tinned open end. Length 1·5m	£0·85
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1·5m	£1·49
128	5 pin DIN plug to 5 pin DIN socket. Length 1·5m	£0·92
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1·5m	£1·21
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1·5m	£0·95
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1·13
133	5 pin DIN plug to 2 Phono plugs. Connected pins 3 & 5. Length 1·5m	£0·86
134	5 pin DIN plug to 2 Phono sockets. Connected pins 3 & 5. Length 23cm	£0·78
135	5 pin DIN socket to 2 Phono plugs. Connected pins 3 & 5. Length 23cm	£0·78
136	Coiled stereo headphone extension lead. Black, length 6m	£2·01
178	AC mains lead for calculators, etc	£0·52

REGULATORS

Positive	Price		Price
uA7805 TO220	£0·75	uA7912 TO220	£0·85
uA7812 TO220	£0·75	uA7915 TO220	£0·85
uA7815 TO220	£0·75	uA7924 TO220	£0·85
uA7824 TO220	£0·75	uA7818 TO220	£0·85
uA7818 TO220	£0·75	72723 14 pin DN	£0·52
Negative		uA723C TO99	£0·52
uA7905 TO220	£0·85	LM309K TO3	£1·72

SUPER SOUND
SAVING!
DINDY
LOW NOISE CASSETTES

O/no. 3193	30 min lettertape	£0·38 each
O/no. 301	Dindy C60 tape	£0·41 each
O/no. 302	Dindy C90 tape	£0·52 each
O/no. 303	Dindy C120 tape	£0·75 each

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V–0–6V 100mA	£1·04
2022	9V–0–9V 100mA	£1·04
2023	12V–0–12V 100mA	£1·29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280–0–6V 0–6V RMS	£1·84
2025	MT150–0–12V 0–12V RMS	£1·84

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V–0–6V 1 amp	£2·88	P & P 45p
2027	9V–0–9V 1 amp	£2·30	P & P 45p
2028	12V–0–12V 1 amp	£2·00	P & P 55p
2029	15V–0–15V 1 amp	£3·16	P & P 66p
2030	30V–0–30V 1 amp	£3·97	P & P 86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp. 1 amp and 2 amp current rating. Secondary taps are 0–19–25–33–40–50V. Voltages available by use of taps. 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25–0–25V

No.	Rating	Price	
2031	½ amp	£3·91	P & P 85p
2032	1 amp	£5·06	P & P 85p
2033	2 amp	£6·27	P & P £1
2035	240V Primary 0–55V · 2A Secondary	£7·30	P & P £1

SPECIAL OFFER
2042 240V Primary 0–20V · 2A Secondary. By removing 5 turns for each volt from the secondary winding any voltage up to 20V · 2A is easily obtainable ideal for the experimenter.
£1·50 P & P 86p

HEATSINKS

Type	No	Price
TO3 – single heat sink	873	£0·31
TO3 – double heat sink	874	£1·38
Double sided heat sink	875	£1·67
TO5 39 heat sink	876	£0·16
TO18 – heat sink	877	£0·14
TO1 – heat sink	878	£0·09

TERMS CASH WITH ORDER. CHEQUES/POSTAL ORDERS MADE PAYABLE TO BI-PAK AT ABOVE ADDRESS

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EXPERIMENTOR BREADBOARDS FROM CSC

No soldering breadboards. Simply plug components in and out of letter number identified.
Nickel-silver contact holes. Start small and simply snap-lock boards together to build a breadboard of any size.
All EXP Breadboards have two bus-bars as an integral part of the board. If you need more than two buses, simply snap on 4 more bus-bars with the aid of an EXP 4B.

EXP 325 The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22-pin IC's. **ONLY £1·84** 48mm (1.9")

EXP 350 270 contact points with two 20-point bus-bars. **ONLY £3·62** 91mm (3.6")

EXP 300 550 contacts with two 40-point bus-bars. **ONLY £6·61** 152mm (6.0")

EXP 650 For Micro-processors. **ONLY £4·14** 91mm (3.6")

EXP 4B More bus-bars. **ONLY £2·65** 152mm (6.0")

EXP 600 As EXP 300 but accepts 24 pin DIL and over. **ONLY £7·25** 152mm (6.0")

All EXP 300 Breadboards mix and match with 600 series.

ANTEX IRONS

1943	15 watt quality soldering iron with 3/32" bit	£4·88
1947	Replacement element for 1943	£2·18
1944	Iron coated bit 3/32" for 1943	£0·53
1945	Iron coated bit 1/8" for 1943	£0·53
1946	Iron coated bit 3/16" for 1943	£0·53
1948	18 watt iron with iron coated bit	£4·59
1952	Replacement element for 1948	£2·18
1949	Iron coated bit 3/32" for 1948	£0·53
1950	Iron coated bit 1/8" for 1948	£0·53
1951	Iron coated bit 3/16" for 1948	£0·53
1931	X25 25 watt iron, ceramic shaft and another shaft of stainless steel to ensure strength	£4·88
1935	Replacement element for 1931	£1·84
1932	Iron coated bit 1/8" for 1931	£0·57
1933	Iron coated bit 2/16" for 1931	£0·57
1934	Iron coated bit 3/32" for 1931	£0·57
1953	SK1 soldering Kit – contains 15 watt soldering iron with 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to Solder	£6·38
1939	ST3 iron stand made from high grade bakelite chrom plated steel spring, suit all models – includes accommodation for six bits and two sponges to keep the iron bits clean	£1·86
1724	Model MLX as X25 iron but 12 volts	£5·29

CASES AND BOXES

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4·14
171	140mm	75mm	205mm	£4·62
172	140mm	110mm	205mm	£6·00

INSTRUMENT CASES in two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5½in	2in	£1·72
156	11in	6in	3in	£2·92
157	6in	4¾in	1¾in	£1·79
158	9in	5¼in	2½in	£2·43

ALUMINIUM BOXES made from bright alli, folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	£0·85
160	4in	4in	1½in	£0·85
161	4in	2¼in	1½in	£0·85
162	5¼in	4in	1½in	£0·97
163	4in	2½in	2in	£0·87
164	3in	2in	1in	£0·60
165	7in	5in	2½in	£1·43
166	8in	6in	3in	£1·82
167	6in	4in	2in	£1·18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front – strong construction easily accessable.

169	2¼in	5¾in	2¾in	12in	3½in	8in	£5·45
168	2⅞in	7¼in	4in	16in	4½in	11in	£8·21

AUDIO MODULES

AMPLIFIERS

AL10	3 watt Audio Amplifier Module 22-32v supply	£3.63
AL20	5 watt Audio Amplifier Module 22-32v supply	£4.73
AL30A	7-10 watt Audio Amplifier Module 22-32v supply	£5.51
AL60	15-25 watt Audio Amplifier Module 30-50v supply	£6.81
AL80	35 watt Audio Amplifier Module 40-60v supply	£10.67
AL120	50 watt Audio Amplifier Module 50-70v supply	£17.38
AL250	125 watt Audio Amplifier Module 50-80v supply	£25.91

STEREO PRE-AMPLIFIERS

PA12	Supply voltage 22-32v input sensitivity 300mv suit: AL10/AL20/AL30	£9.63
PA100	Supply voltage 24-36v inputs:– Tape, Tuner, Mag P.U., Suit: AL60/AL80	£20.30
PA200	Supply voltage 35-70v inputs:– Tape, Tuner, Mag P.U., Suit: AL80/AL120/AL250	£20.98

MONO PRE-AMPLIFIERS

MM100	Supply voltage 40-65v inputs: Mag. P.U., Tape Microphone Max. output 500mv	£14.29
MM100G	Supply voltage 40-65v inputs: 2 Guitars, Microphones Max. output 500mv	£14.29

POWER SUPPLIES

PS12	24v Supply suit 2 × AL10, 2 × AL20, 2 × AL30 & PA12/S.450	£1.90
SPM80	33v Stabilised supply – suit 2 × AL60, PA100 to 15 watts	£5.57
SPM120/45	45v Stabilised supply – suit 2 × AL60, PA100 to 25 watts	£7.34
SPM120/55	55v Stabilised supply – suit 2 × AL80, PA200	£7.34
SPM120/65	65v Stabilised supply – suit 2 × AL120, PA200, 1 × AL250, PA200	£7.34
SG30	15-0-15 Stabilised power supply for 2 × GE100MKII	£4.37

MISCELLANEOUS

MPA30	Stereo Magnetic Cartridge Pre-Amplifier-input 3.5mv Output 100mv	£3.76
S.450	Stereo FM Tuner Supply Voltage 20-30v – Varicap tuned	£29.39
STEREO30	Complete 7 watt per Channel Stereo Amplifier Board – includes amps, pre-amp, power supply, front panel, knobs etc – requires 2050 Transformer	£24.25
BP124	5 watt 12v max. – Siren Alarm Module	£4.43
GE100MKII	10 channel mono-graphic equaliser complete with sliders and knobs	£26.45
VPS30	Variable regulated stabilised power supply 2-30v 0-2 amps	£8.74

TRANSFORMERS

			P&P
2034	1.7 amp 35v suit SPM80	£6.21	£1.21
2035	2 amp 55v	£7.30	£1.47
2036	750mA 17v suit PS12	£3.68	
2040	1.5 amp 0-45v-55v suit SPM120/45, SPM120/55v	£5.98	£1.21
2041	2 amp 0-55v-65v suit SPM120/55, SPM120/65v	£7.82	£1.47
2050	1 amp 0-20v suit Stereo 30	£3.74	£0.75
1725	150mA 15-0-15v suit SG30	£2.04	

ACCESSORIES

139	Teak Cabinet suit Stereo 30, 320 × 235 × 81mm	£9.72
140	Teak Cabinet suit STA15 425 × 290 × 95mm	£8.97
FP100	Front Panel for PA100 & PA200	£2.07
BP100	Back Panel for PA100 & PA200	£1.84
GE100FP	Front Panel for one GE100MKII	£2.05
2240	Kit of parts including Teak Cabinet, chassis sockets, knobs to build 15 watt stereo amplifier	£22.94

SPECIAL OFFERS

MINIDRILL 12v hand held battery-operated mini drill. 7,500 r.p.m. Collet chuck. Ideal for drilling printed circuits or model making. No.1402. **£6.33**

TRANSFORMER 240v Primary 0-20v @ 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20v @ 2A is obtainable. Ideal for the experimenter. No.2042. **£1·50** + 86p. P & P

ANTEX MLX Soldering Iron. Sturdy 25 watt iron complete with: 4½ metres of 2-core cable. Works off a 12 volt battery. Ideal for Car, Boat, Caravan. No.1274. **£5·29**

METAL FOIL CAPACITOR PAKS

16204 – Containing 50 metal foil capacitor like Mullard C280 series – Mixed values ranging from 01uf – 2·2uf. Complete with identification sheet **£1·38**

TRIACS

2 amp	TO5 case		10 amp		
volts	No.	Price	volts		
100	TR12A/100	£0·36	100	TR110A/100	£0·88
200	TR12A/200	£0·59	200	TR110A/200	£1·06
400	TR12A/400	£0·82	400	TR110A/400	£1·29

6 amp			10 amp		
volts			volts		
100	TR16A/100	£0·59	400	TR110A/400P	£1·29
200	TR16A/200	£0·70	**DIACS**		
400	TR16A/400	£0·88	BR100	£0·23	D32 £0·23

SILICON RECTIFIERS

200mA

IS920 50V	£0.07
IS921 100V	£0.08
IS922 150V	£0.09
IS923 200V	£0.10
IS924 300V	£0.11

1 Amp

IN4001 50V	£0.05
IN4002 100V	£0.05
IN4003 200V	£0.07
IN4004 400V	£0.08
IN4005 600V	£0.09
IN4006 800V	£0.10
IN4007 1000V	£0.11

1.5 Amp

IS015 50V	£0.10
IS020 100V	£0.11
IS021 200V	£0.12
IS023 400V	£0.14
IS025 600V	£0.16
IS027 800V	£0.18
IS029 1000V	£0.23
IS031 1200V	£0.28

60 Amp

IS70/50 50V	£0.86
IS70/100 100V	£0.96
IS70/200 200V	£1.38
IS70/400 400V	£2.01
IS70/600 600V	£2.58
IS70/800 800V	£2.87
IS70/1000 1000V	£3.45

3 Amp

IN5400 50V	£0.16
IN5401 100V	£0.17
IN5402 200V	£0.18
IN5404 400V	£0.19
IN5406 600V	£0.24
IN5407 800V	£0.28
IN5408 1000V	£0.34

10 Amp

IS10/50 50V	£0.21
IS10/100 100V	£0.24
IS10/200 200V	£0.26
IS10/400 400V	£0.40
IS10/600 600V	£0.48
IS10/800 800V	£0.58
IS10/1000 1000V	£0.69
IS10/1200 1200V	£0.79

30 Amp

IS30/50 50V	£0.64
IS30/100 100V	£0.79
IS30/200 200V	£1.06
IS30/400 400V	£1.43
IS30/600 600V	£2.02
IS30/800 800V	£2.23
IS30/1000 1000V	£2.65
IS30/1200 1200V	£3.31

THYRISTORS

600ma — TO 18 Case

Volts	No.	Price
10	THY600/10	£0.17
20	THY600/20	£0.18
30	THY600/30	£0.23
50	THY600/50	£0.25
100	THY600/10	£0.29
200	THY600/200	£0.44
400	THY600/400	£0.51

1 amp — TO 66 Case

Volts	No.	Price
50	THY1A/50	£0.30
100	THY1A/100	£0.32
200	THY1A/200	£0.37
400	THY1A/400	£0.44
600	THY1A/600	£0.52
800	THY1A/800	£0.67

3 amp — TO 66 Case

Volts	No.	Price
50	THY3A/50	£0.32
100	THY3A/100	£0.35
200	THY3A/200	£0.38
400	THY3A/400	£0.48
600	THY3A/600	£0.58
800	THY3A/800	£0.75

5 amp — TO 66 Case

Volts	No.	Price
50	THY5A/50	£0.41
100	THY5A/100	£0.52
200	THY5A/200	£0.58
400	THY5A/400	£0.66
600	THY5A/600	£0.79
800	THY5A/800	£0.93

5 amp — TO 220 Case

Volts	No.	Price
400	THY5A/400P	£0.86
600	THY5A/600P	£0.79
800	THY5A/800P	£0.93

7 amp — TO 48 Case

Volts	No.	Price
50	THY7A/50	£0.55
100	THY7A/100	£0.59
200	THY7A/200	£0.66
400	THY7A/400	£0.71
600	THY7A/600	£0.90
800	THY7A/800	£1.06

10 amp — TO 48 Case

Volts	No.	Price
50	THY10A/50	£0.59
100	THY10A/100	£0.66
200	THY10A/200	£0.71
400	THY10A/400	£0.81
600	THY10A/600	£1.14
800	THY10A/800	£1.40

16 amp — TO 48 Case

Volts	No.	Price
50	THY16A/50	£0.62
100	THY16A/100	£0.67
200	THY16A/200	£0.71
400	THY16A/400	£0.89
600	THY16A/600	£1.04
800	THY16A/800	£1.60

30 amp — TO 94 Case

Volts	No.	Price
50	THY30A/50	£1.38
100	THY30A/100	£1.64
200	THY30A/200	£1.87
400	THY30A/400	£2.06
600	THY30A/600	£4.03

No.	Price
BT101/500R	£0.92
BT102/500R	£0.92
BT106	£1.44
BT107	£1.07
BT108	£1.13
2N3228	£0.81
2N3525	£0.89
BTX30/50L	£0.38
BTX30/400L	£0.53
C106/4	£0.69
BT116	£1.73

ZENER DIODES

400 mw (Bzy88) D007. Glass encapsulated range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v. **No. Z4 10p**

1w-1·5w Plastic and metal encapsulated. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z13 18p**

10w Metal stud type SO10 case. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z10 44p**

BRIDGE RECTIFIERS

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100v RMS	BR1/100	£0·25
200v RMS	BR1/200	£0·29
400v RMS	BR1/400	£0·41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2/50	£0·52
100v RMS	BR2/100	£0·55
200v RMS	BR2/200	£0·60
400v RMS	BR2/400	£0·67
1000v RMS	BR2/1000	£0·78

SILICON 10 amp

Type	No.	Price
50v RMS	BR10/50	£1·50
200v RMS	BR10/200	£1·70

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£1·90
200v RMS	BR25/200	£2·20

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Multiple Choice

FOLLOWING the first of the "new format" Radio Amateurs' Examinations in May 1979, several readers wrote to us complaining that some of the questions had been misleading, and asking that we put pressure on the City and Guilds of London Institute (the examining body) to get the problems sorted out. Unfortunately, none of these readers could provide any examples, and we felt we could not pursue the matter.

When the December examination came around, several members of *PW* 's editorial team were candidates, and, if the gods smile on us, there will be more callsigns appearing on the staff list shortly. What we saw then certainly confirmed what had been said about the May exam, and prompted us to write to the CGLI at some length. The points which we made can be summarised as follows:

1. Questions in a single-answer, multiple-choice examination paper must be ones having only one answer according to established and widely published knowledge, and that answer must be included as one of the options. If not, choosing an answer becomes at best a process of elimination, and at worst a lottery. *(I will be returning to this later.)*

2. It follows from "1" above, that in questions on subjects where knowledge is incomplete, or where opinions differ, the contentious parts of the subject must be avoided at all costs. *(A question on propagation asked for the highest reflecting layer in the UK at midwinter noon. On this point, textbooks tend not to agree even with themselves, let alone each other!)*

3. The language in which the questions are phrased must be easily understood by a competent candidate and must, above all, be good English. *(One question was not a complete sentence.)*

4. Any drawings must be accurately drawn if the candidate is not to be left wondering whether some particular feature is intentional (and therefore possibly important) or accidental. *(Some of the modulation waveforms were frankly weird!)*

The above were illustrated with a number of examples which we could recall from the exam (the question papers cannot be taken away by the candidates).

It also seemed strange to us that, while some questions demanded knowledge of two or three topics to arrive at an answer, penalising a candidate who was not familiar with one topic, other questions were almost duplicates, or virtually gave the answer to each other.

The initial reaction from City and Guilds has been, to say the least, disappointing. In answer to point "2" above, they comment that because the syllabus requires only an elementary knowledge of radio-communication, such as might reasonably be gained during a one-year course, a candidate should not infer more from the questions than is intended or expressed. This seems to be saying: (a) Don't read the questions too carefully, and (b) You could be penalised if you know too much; both of which are obviously nonsense.

On the point of overlapping questions, the CGLI's answer infers that the number of questions to be asked is too great for the breadth of the syllabus, and that overlap is inevitable.

We were interested to receive from an unknown reader, shortly before Christmas, a photocopy of a document which purports to be the May 1979 RAE question papers. This reinforces a feeling that the examiners have certain pet subjects. From the question topic and frequency, one might be forgiven for thinking that the average radio amateur likes little better than to operate a temporary or mobile station, using an indoor aerial and located within half a mile of an aerodrome boundary on the Isle of Man, transmitting nothing but recordings with s.s.b. modulation, and wondering all the while who might come along to revoke his licence!

In all this, it is important to remember just what the Radio Amateurs' Examination is supposed to achieve. It is to ensure that a successful candidate can safely be let loose on the air, designing, building and operating his own equipment if he so desires, with enough knowledge to avoid the wholesale wiping out of other radio-communication services. The subject area covered by the syllabus is not over-wide, but the past two exams have not, in our opinion, covered even that adequately.

continued opposite ▶

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

Mobile Rallies

The North Midlands Mobile Rally, organised by The Midland Amateur Radio Society and Stoke-on-Trent Amateur Radio Society, will take place on Sunday, 13 April 1980 at Drayton Manor Park near Tamworth, Staffs.

The rally opens at 11.30am and visitors will be made very welcome. There will be talk-in stations on 2m and 70cm.

Further details of the programme, car stickers etc. free on request from: *Norman Gutteridge G8BHE, 68 Max Road, Quinton, Birmingham B32 1LB. Tel: 021-422 9787.*

Simon Lloyd Hughes GW8NVN, Publicity Officer of the Barry College of Further Education Radio Society, informs me that the "Welsh Amateur Mobile Rally" will be held at the Barry Memorial Hall on Sunday, 20 April 1980.

Further details can be obtained from: *K. B. Hodge, 16 Claude Road West, Barry, South Glamorgan.*

2m Contest

Barking Radio & Electronics Society G3XBF/G8GPK, have organised a 2m contest to be held on 30 March 1980, between 1300 and 1700hrs GMT.

The contest will be divided into three sections: 1. All licensed operators residing in the county of Essex; 2. All licensed operators residing outside the county of Essex; 3. All short wave listeners.

For further details of scoring and contest rules contact: *A. Sammons G8IZN, 80 Lyndhurst Gardens, Barking, Essex IG11 9XZ. Tel: 01-594 2471.*

EDXC Conference in Paris, 1980

The 14th annual European DX Conference is to be held in Paris, between 23 and 26 May 1980. The conference is primarily aimed at short-wave broadcast band listeners as a forum for discussion.

Many well-known s.w. broadcasting stations will also be participating, creating a unique opportunity for broadcaster-listener dialogue.

Every effort has been made to keep the cost of participation as low as possible and it is estimated that the approximate cost of participation, including all meals and trips, will be 600 French Francs.

All s.w. listeners and DXers, regardless of experience, are invited. Conference registration is open now and the closing date for receipt of forms is 25 March 1980. A charter group from the UK to Paris may be organised if sufficient demand is shown.

For full conference details send a s.a.e. (or 2 IRCs outside UK) to: *EDXC, PO Box 4, St Ives, Huntingdon, England PE17 4FE.*

Television Exhibition

In March 1930, Baird's much-heralded "Televisor" was finally on sale, and the experimental 30-line transmissions from the BBC's Brookmans Park station were for the first time accompanied by sound. Television broadcasting, in fact, had arrived, and the fiftieth anniversary of this milestone is being marked by a special exhibition at the Science Museum, opening at the end of March 1980 for six months.

The title of the exhibition is "The Great Optical Illusion", and one of its aims is to reawaken the sense of wonder that is properly due to television but that our familiarity with it has inevitably dulled. An introductory exhibit will show what is involved in making a moving picture out of a single spot of light, and the "illusion" theme will be maintained with other demonstrations: "Chromakey", an electronic overlay technique, will make visitors appear to be performing a feat of aerial daring while actually just off the floor, while 'Front Axial Projection' will insert them optically into a projected scene. Nearby, visitors will be able to see each other on a reconstructed 30-line system, amidst relics of the low-definition era.

The exhibits outlining television's development since the opening of the 405-line service in 1936 will be punctuated by a series of period room-settings, in each of which it is hoped to show a montage of contemporary programmes on restored receivers of appropriate vintage; these will include a pre-war set with a five-inch tube, and a 'projection' set of the early 1950s. A display of videotape recorders will illustrate the dramatic fall in their size and price since they were first introduced, and there will be a working specimen of a type of British telecine machine that has been used with conspicuous success through three decades.

The final section of the exhibition will show how the television set is outgrowing its original function of receiving broadcast programmes, with items on TV games, teletext, viewdata, the video long-playing disc, and the domestic colour camera. This last, with the aid of two domestic videotape recorders and a tape loop, will enable visitors to make a short appearance before the camera and then, a minute or so later, see and hear themselves played back on a large-screen projection colour receiver.

The exhibition has been made possible by the collaboration and generosity of the BBC, the IBA and the ITV programme companies, and of the television industry, notably Philips Industries, Thorn Consumer Electronics, and Radio Rentals.

The exhibition (Admission Free) is open: From 10.00-17.45hrs weekdays; 14.30-17.45 Sundays, at: *Science Museum, South Kensington, London SW7 2DD. Tel: 01-589 3456.*

▶ We have no wish to bring the CGLI into disrepute, nor to reveal large sections of their question bank, but would quote the following, which we understand to have been included in the May 1979 examinations, as an example of a question which should never have got through the vetting and pre-test procedure.

Q Ohm's Law states that

a a current of one ampere flows in a circuit having a resistance of one ohm when one volt is applied to it

b $I = \frac{E}{R}$

c when one coulomb of electricity passes between two points there is a potential difference of one volt then one joule of work is done

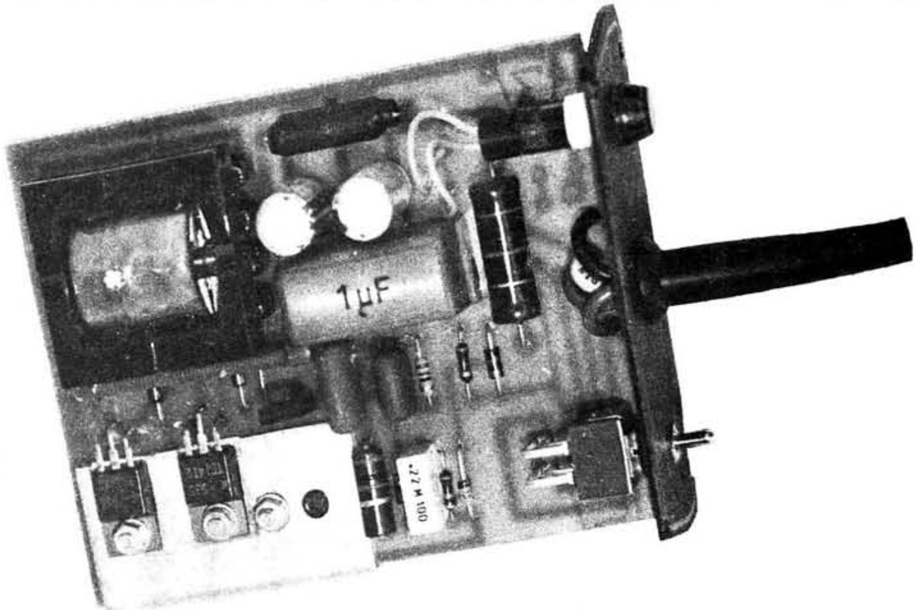
d the current flowing in a circuit is directly proportional to the applied e.m.f. and inversely proportional to the resistance of the circuit.

Well, remembering that the paper clearly states that "only ONE is correct", which would **you** choose as your answer? Turn to page 44!

SPECIAL PRODUCT REPORT

SUREFIRE

ELECTRONIC IGNITION SYSTEM KITS



Now that petrol prices seem to go up every few weeks, motorists have become more interested than ever in any improvement in fuel economy. This is one of the benefits claimed (somewhat extravagantly by some manufacturers) for electronic ignition systems, and has undoubtedly played a large part in their rise in popularity in recent years. It is interesting to note that Suretron Systems (UK) Limited do not claim increased fuel economy for their systems, other than as a result of the reduced wear on the Contact Breaker points, allowing them to remain in correct adjustment for longer periods.

Suretron have been involved in the manufacture of electronic ignition systems for some five years, and currently produce the Surefire ES1000, ES2000 and C3000 models, the first two being inductive systems, and the last a capacitive discharge system. In 1979 Suretron decided to launch kit versions of the ES2000 and C3000, called the ES200 and C300 respectively. These are electrically similar to their ready-built brothers, but differ mechanically in some ways, principally in that the p.c.b. module is no longer unpluggable for repair. The CONVENTIONAL-OFF-ELECTRONIC switch is retained as a useful "insurance" feature.

A sample of each kit was built and fitted to a *PW* staff-member's car, with the following results.

ES200

The ES200 proved reasonably simple to construct from kit form, once one had sorted out exactly what was what. The components list in the kit assembly instructions described nine separate "packs"; in fact, the box contained five polythene bags of parts, the lengths of wire, the extruded aluminium case and the bolt-on heat shunt, with no indication as to which bit belonged to which "pack"!

It was pleasing to find that all the lead-wires had been accurately trimmed and bent to suit, but it must be admitted that the shine was taken off by discovering that one of the resistors was missing! The lead spacing of one of the capacitors was incorrect for the p.c.b. drilling—otherwise, assembling the components onto the board was snag-free.

The assembly of the unit itself was a little more problematical, however. Persuading the four wires that connect the unit into the car's electrical system that they should fit through the sleeved grommet supplied, took several minutes, liberal applications of cable lubricant and a couple of words that you won't find in Chamber's Dictionary. At home one would, I suppose, use soap or washing-up liquid to ease things along but if a grommet of a slightly larger diameter were supplied, the task would be facilitated without making the unit any less water-resistant.

Fitting the p.c.b. into the case was frustrated by the heat shunt locating rather poorly, presumably due to inaccurate drilling. Some fairly energetic filing was necessary before a firm sliding fit could be achieved. The instructions confidently described the spade terminal-shrouds as being either clear or black when they were, in fact, all clear—the dif-

ference in dimensions between the two types was not really obvious from the drawing supplied.

Generally, though, there were no problems that anyone with even a modicum of common sense could not have rapidly sorted out. It took just on two hours to construct the unit—installing it into my ancient Austin 1300 was simplicity itself (15 minutes). Changing the contacts for a new set, and re-setting the timing and sparking plug gaps took about 45 minutes and I found the orange static-timing light, which is a feature of this unit, very handy in doing the job. This light is illuminated all the time when the engine is running on "electronic" (you do have a choice so that you are not immoblised if the unit fails) and, in view of this, it seems a pity that an l.e.d. or at least an easily replaceable lamp could not have been used. To replace the type supplied (which admittedly should last quite a time, being underrun) would involve dismantling the unit; rather a nuisance, I felt.

Certainly, the ES200 has had a marked beneficial effect on the cold starting of the car, which is kept permanently outside. Even when it has been left standing for a couple of days, it usually responds first time which was certainly *not* the case before the unit was fitted! Another immediate benefit appeared to be a marked improvement in fuel consumption but, feeling that this was probably more as a result of the timing being inaccurate *before* the unit was fitted, I decided to compare the fuel consumption and general performance during two almost identical weeks of driving, covering around 400 miles in each week. This seemed the fairest and most valid way of assessing the difference which the Surefire is making to the *economy* performance of the car while, at the same time, identifying any other effects.

My feeling that the timing was inaccurate before the unit was fitted (it was set by a garage) proved to be entirely justified, for the fuel consumption proved to be virtually identical during both weeks of the test (around 37 m.p.g.)—if anything, slightly better fuel economy was obtained with the ignition in the "conventional" mode! Each week contained a weekend round trip of 300 miles as well as the normal "drag" to and from the office and therefore my old workhorse can be considered to have run the full gamut of road conditions and usage, during the test period. In fairness, as already pointed out, the manufacturer does not claim that improved economy will result from the installation of an electronic system—the claimed advantages are those of improved and consistent cold starting, and improved contact wear leading to a reduction in maintenance.

At the conclusion of the test, I can certainly confirm both of these points with some enthusiasm; the car starts a lot better, runs well and the contacts are still very new and pristine-looking after 1000 miles or so of "electronic" motoring. The ES200 appears to be a worthwhile investment which can, as a matter of simplicity, be transferred from one vehicle to another and which should survive many miles and years of use. *JB*

C300

The comments on assembly of the ES200 kit apply equally to the C300, except that in this case, all components were present, but the invertor transformer, which is externally symmetrical, did not have the red dot on one corner as promised by the instruction sheet. Some 10-15 minutes detective work with test meter and circuit diagram was required to sort this one out. (*Suretron tell us that their procedures for component checking when packing the kits should have overcome this type of problem. Ours were taken from a small pilot run*).

The holes in the heatsink and p.c.b. did not correspond exactly, but by placing the two together in such a way as to distribute the errors evenly, no problems were experienced, and the completed assembly slid into the case perfectly.

The unit was fitted to an early Leyland Princess 1800 (patriotic lot, aren't we!) in about ten minutes. Regapping the sparking plugs took another ten minutes, the points were almost new so they were left alone. Starting of this car is very good in all conditions anyway (aided, no doubt, by its owner's obsessive attitude towards keeping the ignition system parts clean and coated in anti-damp compound), but the electronic system does seem to improve marginally even upon that.

There was no opportunity to carry out any extensive economy tests. Over a fairly short distance there was no noticeable difference in consumption, compared with conventional ignition. *GCA*

Prices

The kits are available by mail order from the manufacturers, who also offer a fault-finding and repair service for a standard charge of £5 including the cost of all parts used in the repair, VAT, carriage and insurance for the return of the unit. The prices for the kits are £13.95 for the ES200 and £17.95 for the C300, inclusive of VAT, postage and packing.

Suretron Systems (UK) Ltd., Piccadilly Place, London Road, Bath BA1 6PW. Telephone: Bath (0225) 23194.

KINDLY NOTE!

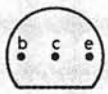
Burglar Alarms, Part 2. October 1979

It has been brought to our notice that uncorrected versions of the component layout diagrams (Figs. 4 and 9) were used in error. As a result, all diodes (with the exception of D10, which was drawn correctly) have been shown reversed. We apologise for any confusion that this may have caused.

Car Wiper Unit, February 1980

In Fig. 2, Tr3 and Tr5 have been drawn with the correct lead connections but with their case outlines reversed. The diagram shows the correct lead configuration for the BC182L, *viewed from below.* Note also that R1 and R2 are mounted on the terminals of VR1 and S2 respectively.

WRM235



BC182L

ICF-6800W Receiver Review, February 1980

In the Specification table, two items of information were omitted. The Frequency range on FM is: 87·5-108MHz. The Circuit system on FM/MW is: Single superhet.

STEREO AUTOMATIC FADER

R.A.PENFOLD

A stereo fader unit is a form of mixer which combines the signal from a microphone with a stereo music signal. However, it has an additional feature of automatically fading out the music signal to some predetermined level when there is a microphone signal of a suitably high amplitude.

The main use for this type of equipment is probably in the preparation of tapes to accompany slide or home movie shows. The unit is used to automatically fade out the background music during the commentary, and return it to its normal level during breaks in the commentary. This type of equipment can also be employed in disco systems, and there could well be other fields of application.

Block Diagram

The block diagram of Fig. 1 shows the general arrangement of the automatic fader unit. The microphone signal is fed to a high gain preamplifier which brings the signal up to a level of a few hundred millivolts r.m.s., before it is split into three parts. One part is mixed with the right hand channel music signal, and another is mixed with the left hand channel music signal. Each music channel is fed to its respective mixer stage via a v.c.a. (voltage controlled attenuator) which normally gives zero attenuation. However, in the presence of a reasonably high output from the microphone preamplifier, the third part of this signal causes the two v.c.a.s. to fade out the music signals.

This is accomplished by first rectifying and smoothing some of the preamplifier's output. The d.c. bias this produces is then fed to a level detector, and if the bias is of a suitably high level the output of the level detector falls from a high level to virtually zero volts.

The voltage change is used to drive the v.c.a.s via a buffer stage, and causes the music signal to fade out. A time constant is included between the level detector and buffer stages, with a characteristic which gives a fast attack and slow decay. This ensures that the music signal quickly fades out at the commencement of the voice signal, and then the music slowly returns to full level when the microphone signal has ceased, which gives the best effect in practice. The rectifier and smoothing network ahead of the level detector has a similar characteristic, and this again ensures that the music signal level rapidly diminishes at the commencement of the voice signal. The slower decay time prevents the music signal from starting to return to normal level during the brief pauses that occur during normal speech.

Opto-Isolator

As can be seen from the circuit diagram of Fig. 2, the v.c.a.s in this unit use an opto-isolator arrangement with a light emitting diode driving a cadmium sulphide photoresistor. D5 and PCC1 form the opto-isolator for the left hand channel, while D8 and PCC2 are the opto-isolator for the other channel. With its driving l.e.d. switched off and the photocell in total darkness, it exhibits a resistance of at least 200MΩ, but by switching on the l.e.d. this can be considerably reduced. The actual resistance with the l.e.d. fully on is about 50kΩ in this circuit.

It is obviously a quite straightforward matter to connect the photocell in an attenuator, and then control the attenuation level by varying the voltage fed to the l.e.d. and its series current limiting resistor. There are disadvantages to this system when compared to some others, and it is for instance more expensive than using a j.f.e.t. as the gain control element, and needs a far larger driving signal. It does have two important advantages over most alternative methods, the main one being the generation of negligible noise and distortion. The complete electrical isolation between the l.e.d. and the photocell makes this arrangement very convenient and versatile from the designer's point of view.

If we now consider the operation of one channel of the unit, PCC1 is connected to the negative feedback loop of an operational amplifier inverting mode circuit which utilises IC2. The closed loop voltage gain of the circuit is equal to R15 divided by the resistance between the input signal and the inverting (–) input of the operational amplifier.

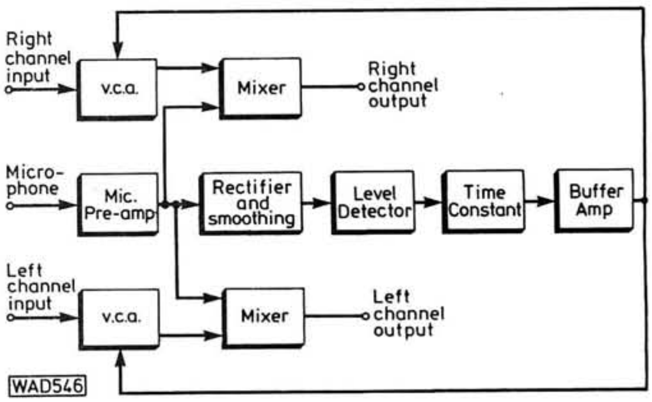


Fig. 1: Block diagram of the automatic fader

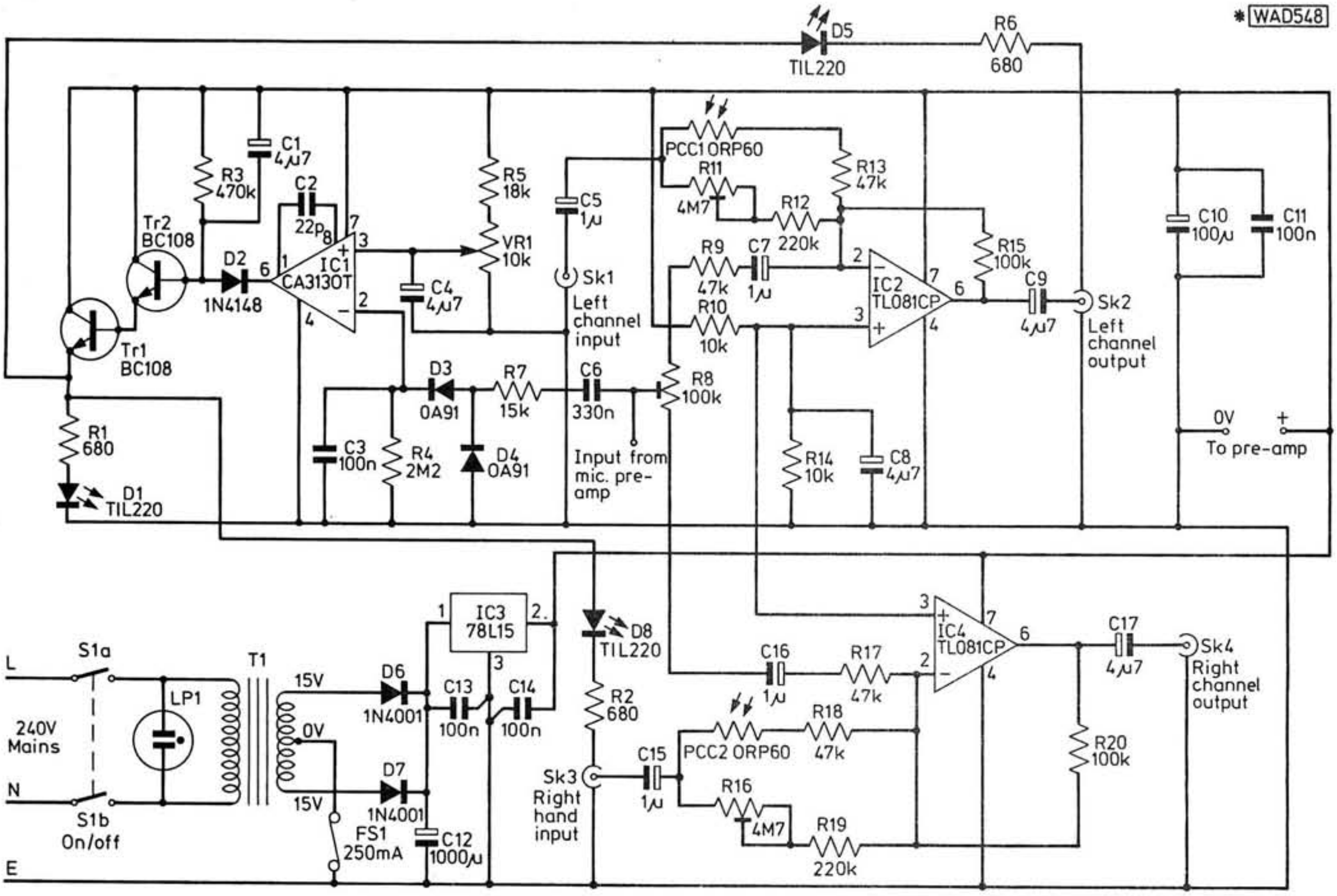


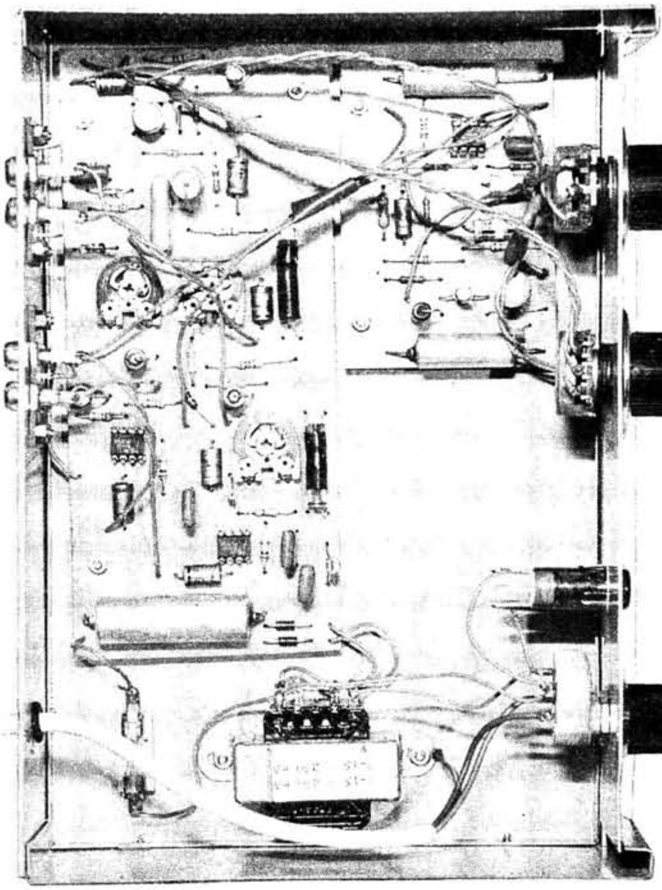
Fig. 2: Circuit diagram of the fader unit

This input resistance is comprised by the series-parallel combination of PCC1, R13, R11 and R12. Under quiescent conditions R3 will strongly forward bias the buffer amplifier formed by Tr1 and Tr2, and D5 will be switched fully on by the drive voltage from Tr1 emitter. This gives a series resistance of roughly 100kΩ through PCC1 and R13, and gives IC2 a closed loop gain of about unity. R11 and R12 have little effect on the circuit at this stage due to their relatively high resistance.

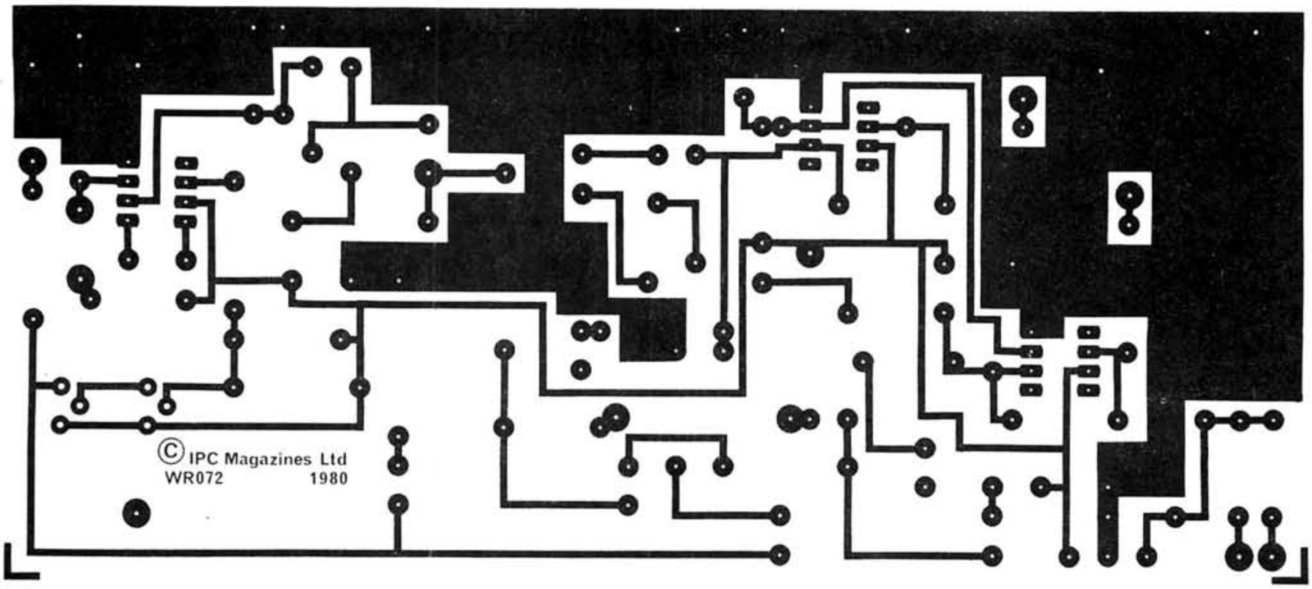
If the output of the level detector circuit (IC1 output) goes to a low voltage the base bias for Tr2 will be diverted through D2 and IC1 output, causing Tr1, Tr2 and D5 to turn off. The resistance of PCC1 then goes to a very high level, effectively cutting both it and R13 out of circuit. The voltage gain between the left hand input and output is then determined by the series resistance of R11 and R12, and varies from about −7dB, with R11 at minimum resistance, to approximately −34dB, when it is at maximum resistance. Thus the signal is faded out in the required manner, and by an amount which can be adjusted to suit individual requirements.

When the level detector's output returns to the high state the presence of D2 prevents D5 from immediately being switched fully on again. Instead it is slowly brought up to full brightness over a period of one or two seconds as C1 gradually discharges through R3, and the voltage at Tr1 emitter is increased back to maximum. This results in the music signal being smoothly brought back to its previous level.

The right hand channel uses IC4 in an arrangement that is identical to that employed in the left hand channel. D8 is driven in parallel with D5 from Tr1 emitter. There is a third l.e.d., D1, fitted as a panel indicator. This switches off when the music channels are faded out.



Interior view of the unit



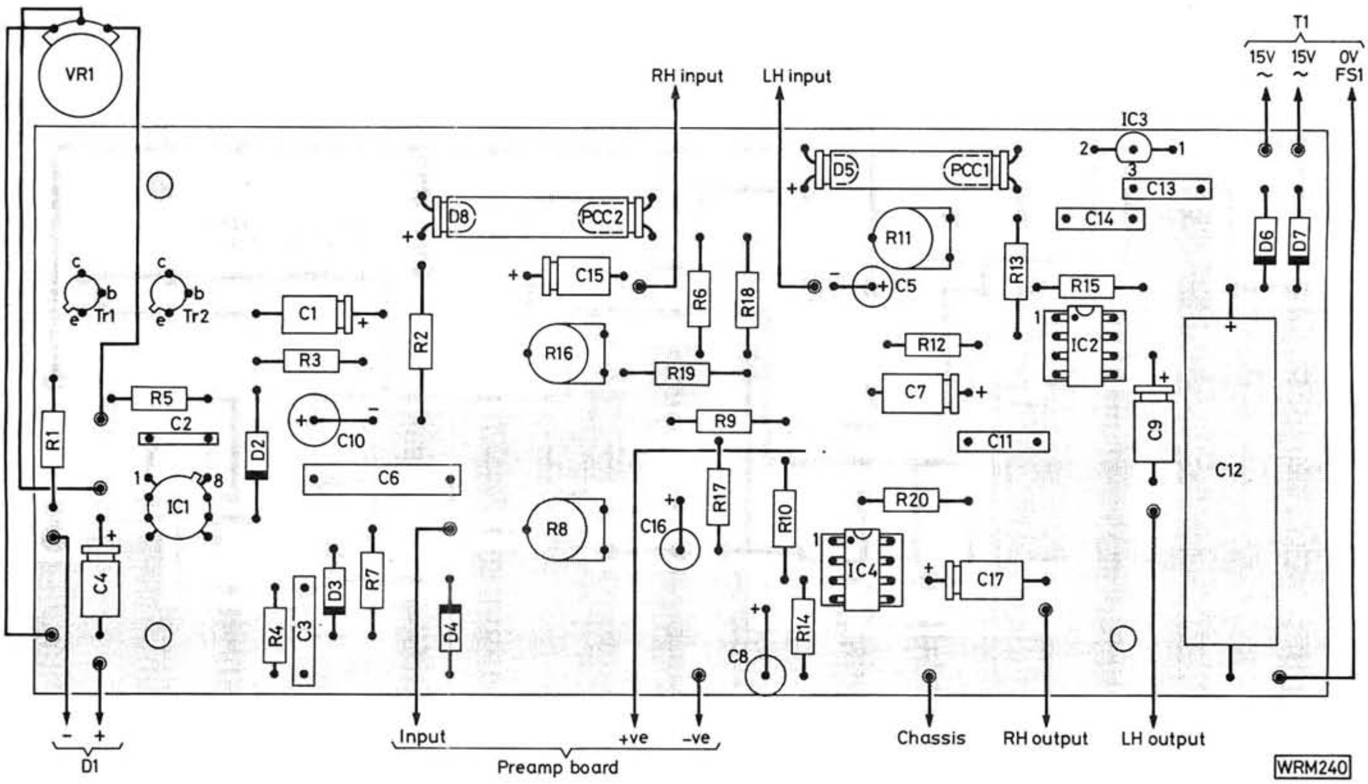


Fig. 3: (Top) copper track pattern shown full size for the main p.c.b.
Fig. 4: (Above) the component placement drawing for the main board

Level Detector

Some of the input from the microphone preamplifier is coupled via R8, R9 and C7 into the left hand channel, and IC2 acts as a conventional virtual earth mixer to combine this with the music signal. Similarly, some of the microphone signal is mixed into the right hand channel. R8 is adjusted for the correct channel balance of the microphone signal.

The rest of the microphone signal is coupled by C6 and R7 to the rectifier and smoothing network which consists of D3, D4, R4 and C3. This circuit has a fast attack time since C3 will quickly charge to virtually the peak signal level through the relatively low impedance path of R7 and D3. The much slower decay time is obtained as the only significant discharge path for C3 is through the quite high resistance of R4.

IC1 forms the basis of the level detector, and this is used as a comparator. Under quiescent conditions the inverting input of IC1 is at earth potential, and the voltage fed to the non-inverting input produces a fully positive output. A microphone signal takes the inverting input positive, and if it goes more positive than the non-inverting input the output goes almost down to the negative supply rail voltage. VR1 controls the voltage fed to the non-inverting input, and therefore sets the threshold level which the microphone signal must exceed in order to initiate the fading action.

Resistors
¼W 5% carbon

680Ω	3	R1,2,6
10kΩ	2	R10,14
15kΩ	1	R7
18kΩ	1	R5
47kΩ	4	R9,13,17,18
100kΩ	2	R15,20
220kΩ	2	R12,19
470kΩ	1	R3
2·2MΩ	1	R4

Potentiometers
Min. horizontal preset

100kΩ	1	R8
4·7MΩ	2	R11,16

¼ inch shaft

10kΩ lin.	1	VR1

Capacitors
Electrolytic

1μF 63V	4	C5,7,15,16
4·7μF 63V	5	C1,4,8,9,17
100μF 25V	1	C10
1000μF 25V	1	C12

Polyester

100nF	4	C3,11,13,14
330nF	1	C6

Ceramic Plate

22pF	1	C2

Semiconductors
Diodes

TIL220	3	D1,5,8
IN4148	1	D2
OA91	2	D3,4
IN4001	2	D6,7

Transistors

BC108	2	Tr1,2

Integrated Circuits

CA3130T	1	IC1
TL081CP	2	IC2,4
78L15	1	IC3

Photocells

ORP60	2	PCC1,2

Switches

Rotary Mains	1	S1

Miscellaneous
Instrument Case 230 × 152 × 76mm (Harrison Bros. Type HB1); Printed circuit board; Mains Transformer 15–0–15V 200mA (T1); 20mm chassis mounting fuseholder; 20mm 250mA fuse (FS1); Mains Panel neon indicator (LP1); Double phono sockets (2); Control knobs (3).

MICROPHONE PREAMPLIFIER

Resistors
¼W 5%

3·9kΩ	1	R24
12kΩ	2	R22,25
18kΩ	2	R23,26
68kΩ	1	R21
120kΩ	1	R28
150kΩ	1	R27
1·8MΩ	1	R29

Potentiometers

47kΩ log.	1	VR2

Capacitors
Electrolytic

10μF 25V	4	C19,21,23
100μF 25V	3	C18,22,24,26

Polyester

100nF	1	C25

Ceramic Plate

2·2nF	1	C20

Semiconductors
Transistors

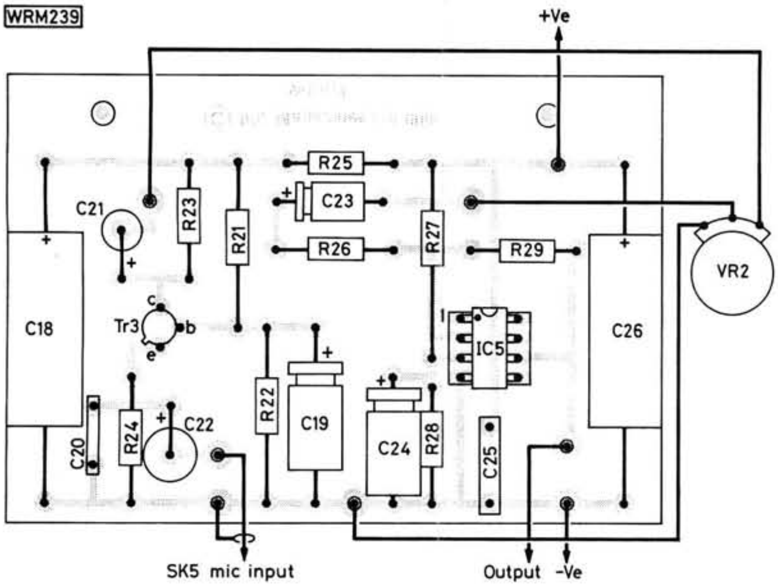
BC109C	1	Tr3

Integrated Circuits

TL081CP	1	IC5

Miscellaneous
Printed circuit board; 3·5mm jack socket (SK5).

The completed stereo automatic fader unit



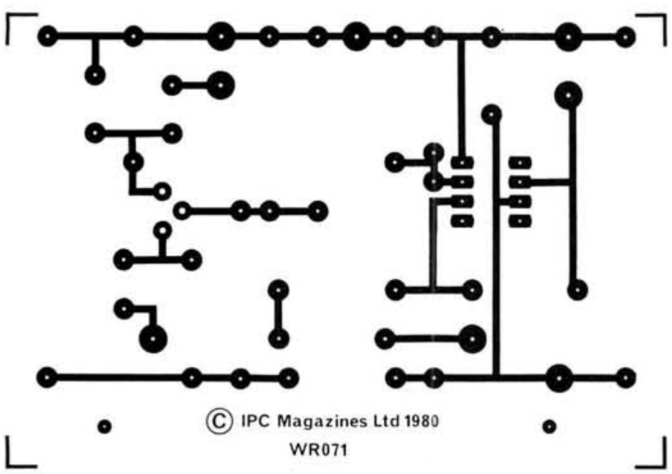


Fig. 5: (Top) the component placement drawing for the microphone preamplifier p.c.b. Fig. 6: (Above) the copper track pattern shown full size for the preamplifier board

Power for the unit is obtained from a simple mains power supply which feeds a 15 volt monolithic voltage regulator device (IC3).

Microphone Preamplifier

The circuit of Fig. 7 requires the music signals and the microphone signal to be at approximately equal levels, and since the music signals will presumably be at a few hundred millivolts r.m.s., a high gain amplifier must obviously be used ahead of the microphone. Fig. 3 shows the circuit diagram of the preamplifier used in the prototype, and this works well with 200Ω and 600Ω dynamic microphones. It should also give good results with electret types having a low impedance output, but other types of microphone will require a different preamplifier to be fitted.

A conventional common base stage is used at the input of the amplifier, and this gives the necessary low input impedance together with a reasonably high voltage gain. Good noise performance is obtained by using a low noise device run at a collector current of only about 500μA in the Tr3 position. Breakthrough of r.f. is often a problem with high gain microphone preamplifiers, and C20 is included at the input to act as an r.f. filter.

The output from Tr3 is coupled to a further stage of amplification via C21 and the gain control, VR2. This final stage uses UC5 in a standard operational amplifier inverting mode, and it gives a voltage gain of 40dB. Texas b.i.f.e.t. devices are used for IC5 as well as IC2 and IC4 as the audio performance of these devices is superior to the standard 741C.

With VR2 at maximum gain the preamplifier needs an input of only about 200μV for 1V r.m.s. at the output.

Construction

It is advisable to house the unit in a metal case which should be earthed via a 3-core mains lead. The general layout of the unit can be seen from the photographs and is not especially critical, although the mains wiring should be kept as far away from sensitive audio wiring as possible.

Most of the circuitry is assembled on a printed circuit board and this is shown in Fig. 4. The opto-isolators are made by taping each l.e.d. to its associated photocell, the two being placed end to end and as close together as possible. As the two are of the same diameter this is quite easily done, and apart from keeping the two components in the correct relative positions it will also exclude extraneous light which could otherwise prevent the unit from working if the lid of the case was removed, or when testing the board prior to installing it in the case.

The preamplifier is constructed on a separate printed circuit board, and details of this are given in Fig. 5. A screened lead should be used to connect the microphone socket to the preamplifier board, but it is not essential for any other connecting wires to be screened.

continued on page 51 ▶▶▶

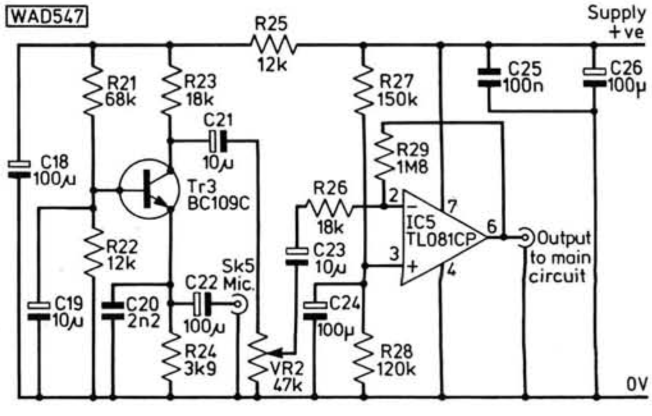
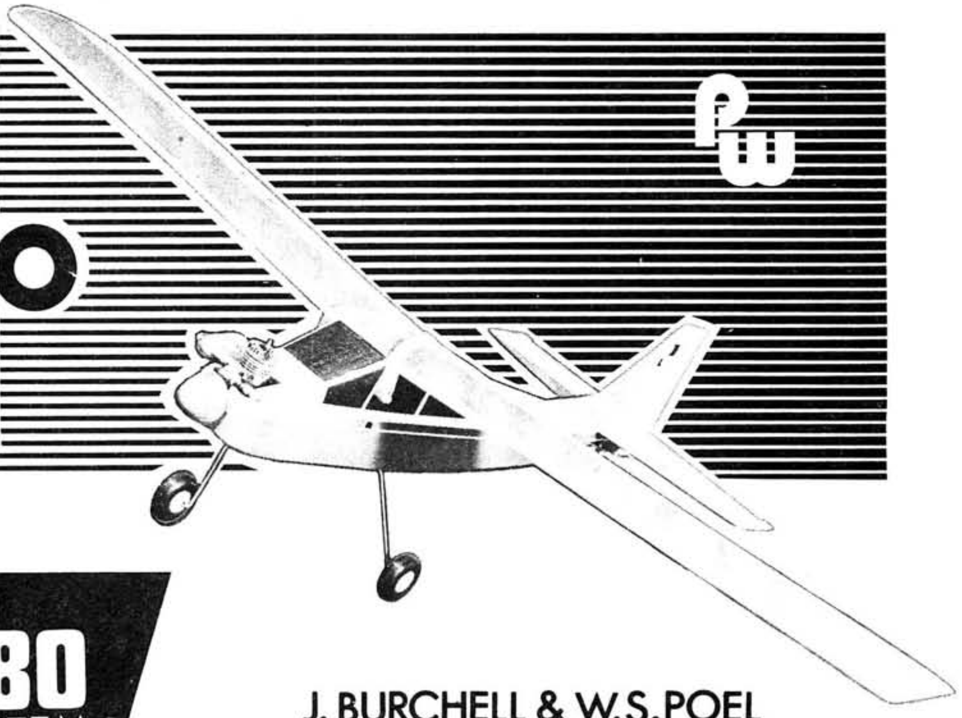


Fig. 7: Circuit diagram of the microphone preamplifier

Model Radio Control



Part 5

THE PW FM-80 SYSTEM

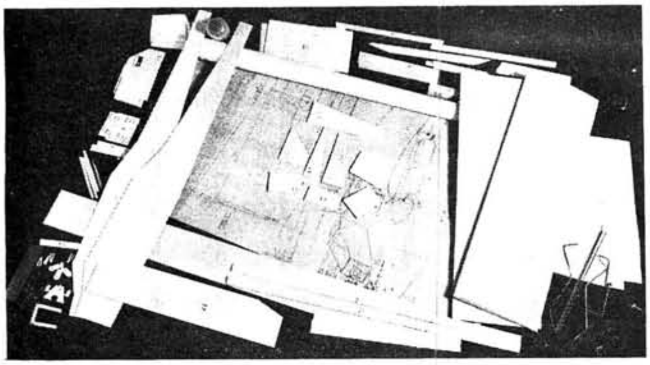
J. BURCHELL & W.S.POEL

The choice of a suitable model for radio control purposes is not so simple as most people imagine. The person attracted to radio control modelling for the first time imagines himself at the controls of a scale Spitfire performing aerobatics in the sky above his head. Unfortunately for him a lot of training on simpler models is needed before he can even think of flying such exotic models.

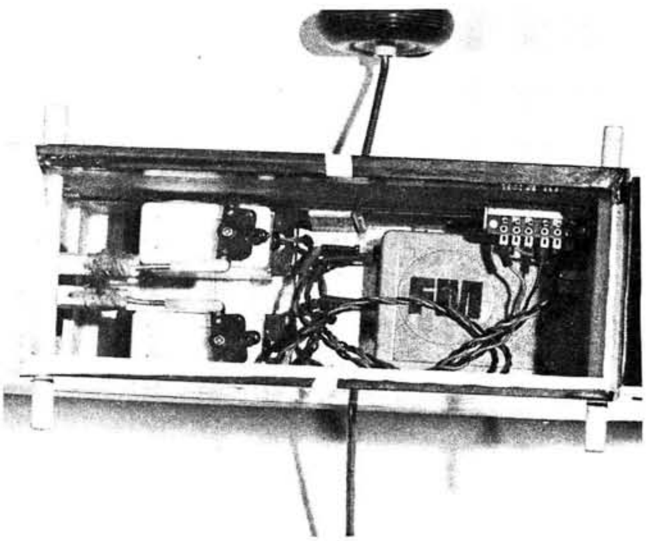
The beginner was kept very much in mind when designing the *PW* FM–80 system and in this article the installation of the system in a suitable training aircraft will be described. The boat and car enthusiasts have not been forgotten however, and simple installation hints are given for an electric powered boat and car.

Mini-Escort

The aircraft chosen to illustrate the FM–80 system is the Mini-Escort produced in kit form by Cloud Models. This is probably the least expensive model to get into the air and proved to be very simple to build, the fuselage being made from pre-cut balsa sheet and the wings from veneer covered plastic foam. No problems were encountered in putting together the model shown in the photographs.

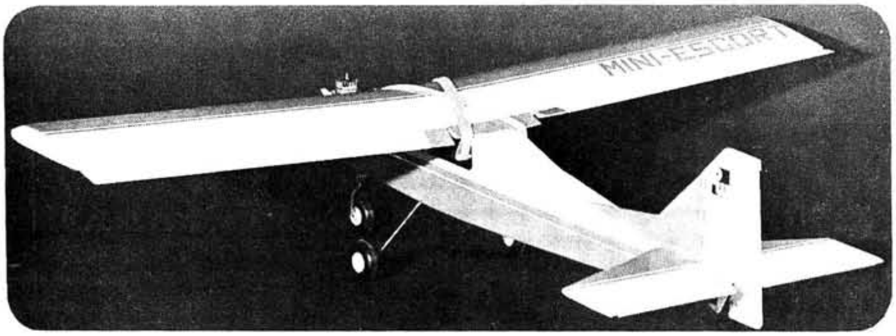


Some hints on the installation of the radio gear are given in the instructions provided with the kit. For our model we installed the NiCad battery pack in the front fuel tank bay ensuring that it was very firmly fastened in place and could not break loose in the likely event of a heavy landing. The picture shows the installation of the receiver and two servo units. The receiver would normally be packed in soft foam to absorb vibration from the engine and cushion the unit against landing shocks. Like the battery pack the receiver should not be free to wander around



The servos operating the elevator and rudder are mounted at the rear of the cabin space using double-sided adhesive foam tape. The FM-80 receiver is positioned ahead of the servos and should, of course, be wrapped with foam rubber.

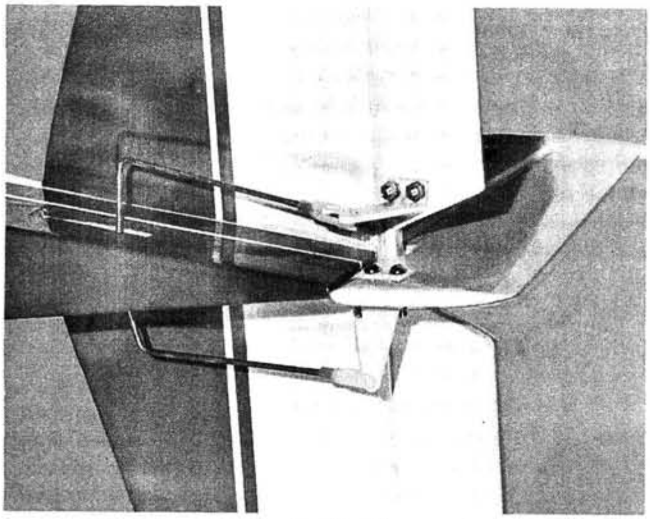
The kit for the Mini-Escort trainer is shown on the left and proved very easy to build



The aileron version of the Mini-Escort trainer. The wing is interchangeable with the plain version and can be built later. The engine fitted to our model is a Flash 15 R/C glow-plug which suits the Mini-Escort perfectly

the aircraft. The two servos shown operate the elevator and rudder by pushrods made up from soft balsa strip supplied with the kit. The clevises and threaded wire from which the push-rod ends are made are also supplied in the kit.

The servos can be mounted in a number of different ways. Micron make special servo mounting clips which allow you to remove servos easily. This is important if you have a number of models but only a limited number of servos. We took the easy way out and used a double-sided self-adhesive rubber tape, sold by model shops especially



The push-rods are attached to the control surfaces by plastic clevises. Careful fitting is essential to give smooth frictionless movement

for fixing servos. This allows the servos to be positioned easily without the need for very accurate placing of servo mounts or wooden bearers, but does have the disadvantage of making it difficult to remove the servos from the model.

Care must be taken to ensure that the control surfaces and linkages operate smoothly with the minimum of effort. Failure to acheive this will certainly impose extra loads on the servos resulting in poor control of the model.

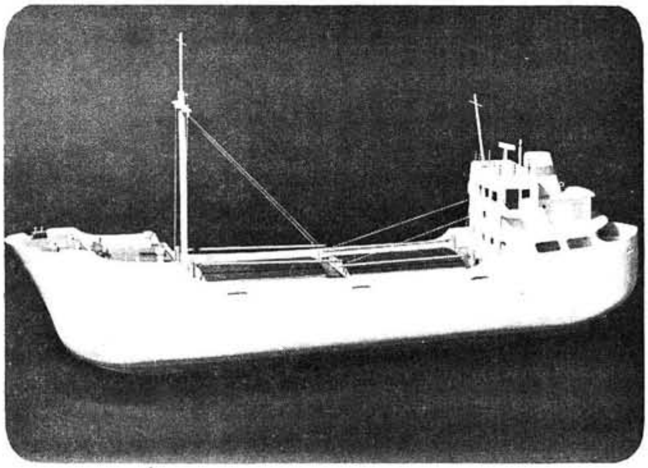
At a later date it is intended to fit a third servo for motor control and this will have to be fitted in such a position as to avoid the receiver and yet allow the control push-rod to pass easily through the fuel tank bay into the engine compartment.

The on-off switch is fitted in the fuselage side and if desired can be wired in such a way as to allow the battery pack to be charged via an SLM charger socket also mounted in the fuselage side.

Insurance

Before you launch your model into the blue sky please ensure that you are adequately insured. Even a simple trainer can wreak expensive havoc if anything goes wrong.

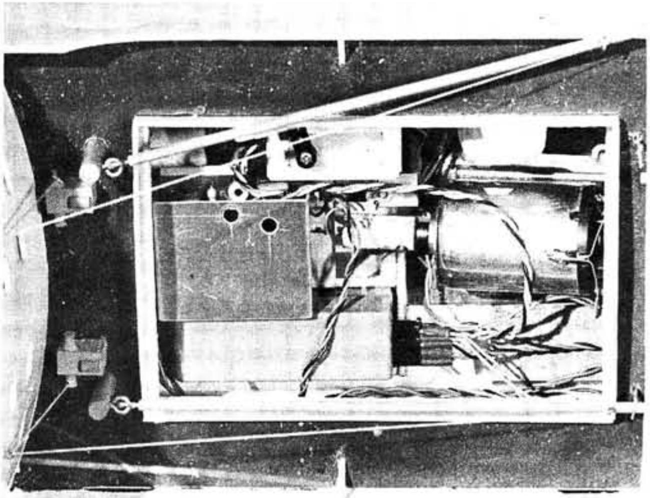
The Caribbean Coaster tramp steamer makes an ideal model for the newcomer to radio controlled boats



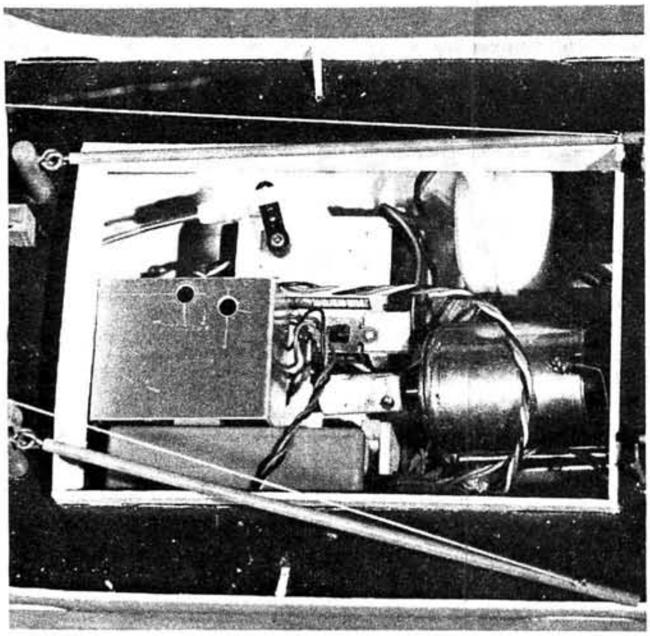
Caribbean Coaster

A model boat might seem to be a much simpler proposition than an aircraft but this is not necessarily the case. After all most aircraft come nowhere near water, and water, especially salt walter, is the arch-enemy of anything electronic. So the first requisite when planning the installation of your FM–80 system into a boat is to ensure that it will remain dry.

We fitted our FM–80 into a Veron Caribbean Coaster using one servo unit for the rudder and the electronic speed controller for motor control. The receiver, servo and speed controller were all mounted in the aft cargo hold along with the motor and propellor shaft. Suitable plywood compartments were fabricated to hold the



The speed controller and FM-80 receiver are simply mounted in plywood boxes in the aft hold of the Caribbean Coaster

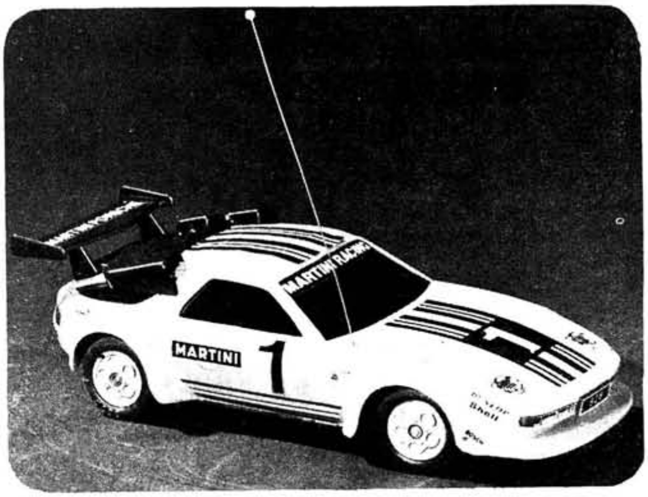


The servo used to operate the rudder is also mounted in a simple close-fitting ply box. Care must be taken to ensure smooth operation of the rudder assembly. The NiCad battery pack is fitted into a self-adhesive cable-tie attached to the side of the hold

receiver and the servo, and the speed controller was attached to a plywood cover over the propellor shaft by servo-tape.

The propulsion batteries were housed in the forward hold while the radio battery pack was held in a large cable tie attached to the hull side in the aft hold.

The model aerial, rigged in wire between the two masts, was actually used as the aerial for the receiver and this functioned very well in spite of its short length.



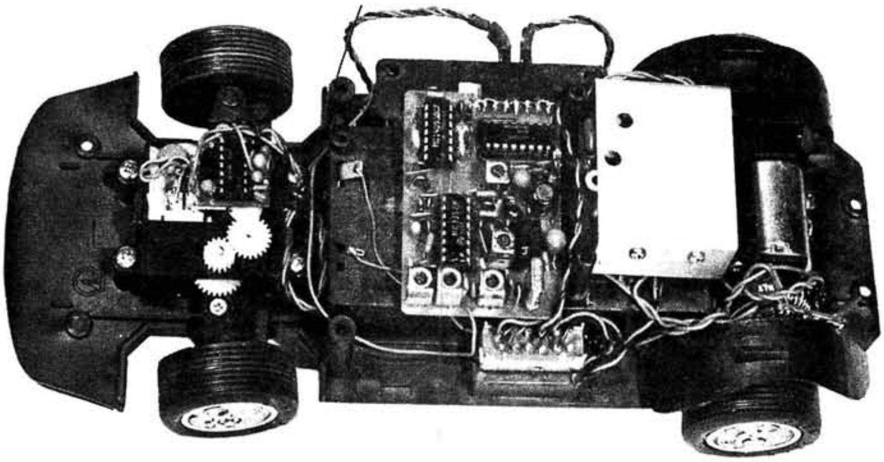
Porsche 928

The model car used was one of the cheap oriental imports which seem to have been popular as Christmas presents. The original crude radio system was removed to leave the basic model car with motor and servo mechanics for the steering.

A basic FM–80 servo amplifier is used to drive the steering motor with the feedback being obtained from the original potentiometer fitted to the steering unit.

The main motor is controlled by a speed controller unit which together with the receiver is mounted in place of the original radio equipment. The battery compartment is used to house the batteries which can be dry cells as originally intended or, with suitable modifications to the battery compartment, NiCads.

The next part of this series will describe a NiCad battery charger and servo tester.



The FM-80 system is a tight fit inside the "Oriental" Porsche. The receiver is used without its plastic case and could also be arranged without the seven way output socket. Both the receiver and speed controller are secured with "servo tape" to the floor of the model. The FM-80 servo amplifier is used in conjunction with the original steering motor and feedback pot. NiCad battery packs can be fitted if desired in the built-in battery compartments

The Mini-Escort trainer was supplied by Galaxy Models, 88 Catton Grove Road, Norwich NR3 3AA; The Flash 15 motor came from Neway Models, The Walnuts, The Street, Rickinghall, Diss, Norfolk; The Veron Caribbean Coaster was loaned by Mrs Marion Cottle; The Oriental Porsche came from Ambit International but could be by courtesy of Father Christmas

FM-80 Receiver

An error occurred in the component placement drawing of the receiver p.c.b., T3 was shown turned through 180°. This will prevent the local oscillator from working. T3 must therefore be turned round and an extra hole drilled in the board to take the centre tap connection. Alternatively this centre tap pin can be cut off.

A licence is required to operate radio control equipment. This costs £2.80 for five years. Application forms are available from: The Home Office, Radio Regulatory Dept., Waterloo Bridge House, Waterloo Road, London SE1 8UA

ON SALE 3RD. APRIL

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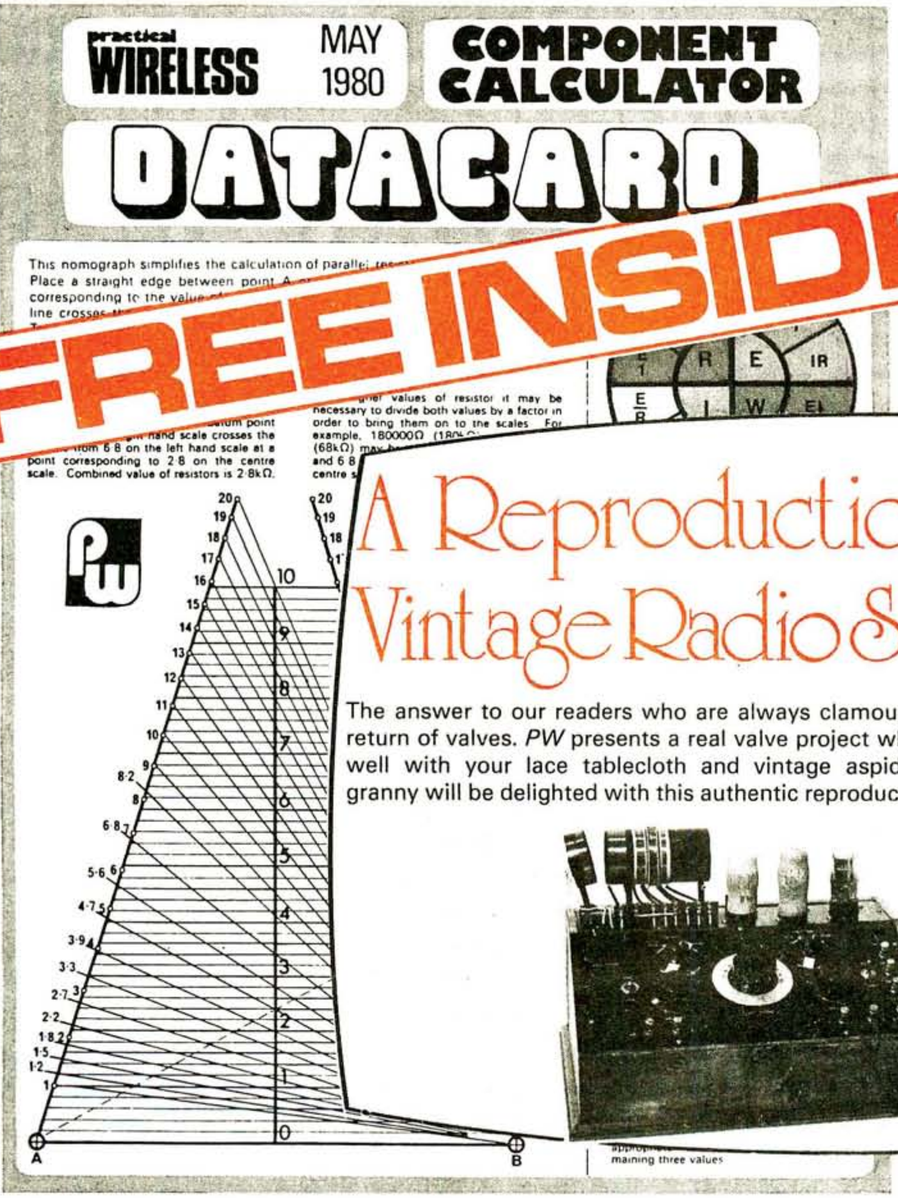
practical WIRELESS

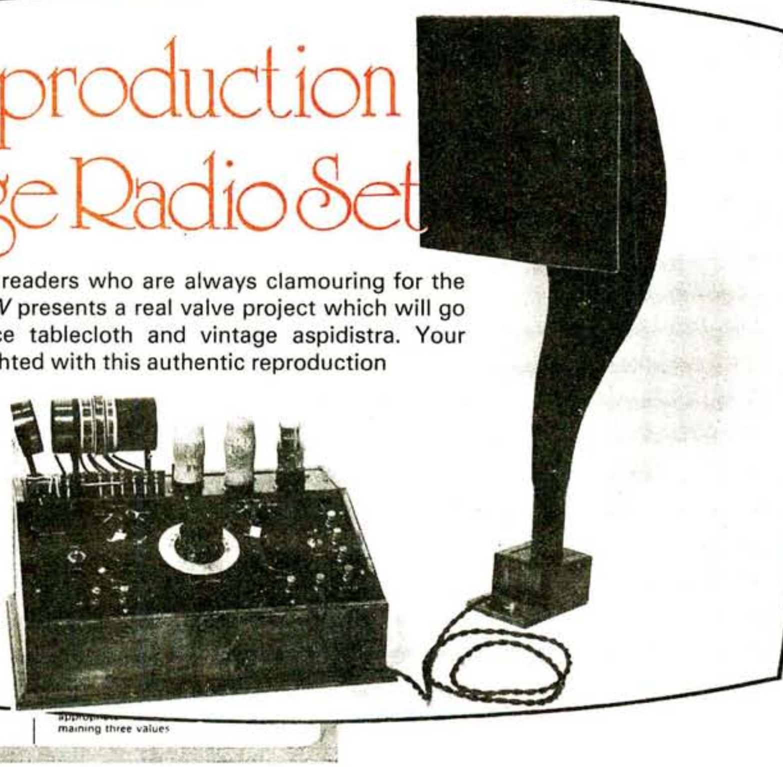


FREE INSIDE

The second in our series of useful reference cards, this Component Calculator enables you to work out parallel resistors and series capacitors. A handy nomograph simplifies power calculations for d.c. circuits. Other subjects covered are multipliers and the ubiquitous formula wheel

A Reproduction Vintage Radio Set

The answer to our readers who are always clamouring for the return of valves. *PW* presents a real valve project which will go well with your lace tablecloth and vintage aspidistra. Your granny will be delighted with this authentic reproduction



100 SECOND PHOTOGRAPHIC CLOCK

Accurate timing is essential in photography if consistently good results are to be achieved. The circuit of a two-digit seconds counter will be described using red l.e.d. display devices with reset and brightness controls

dual trace unit for the PW 'PURBECK'

Ian HICKMAN

Part 3

Using the Dual Trace Unit

You will of course already have used each of the two Y channels separately during the course of setting up and calibrating the instrument. Now we wish to familiarise ourselves with dual trace working in particular. As a start select as trigger source Y1 HF REJ, alternate mode, and set the Purbeck time-base controls to 5ms/div. Connect both Y inputs of the Dual Trace Unit (using two 10:1 probes if available) to the CAL output of the Purbeck. With suitable settings of the Y1 and Y2 input attenuators, VAR GAIN and SHIFT controls, two traces will appear alternately, each showing the approximately square 50Hz CAL waveform. As the repetition rate of the timebase will be 16·67Hz (each trace shows $2\frac{1}{2}$ cycles and therefore the timebase will retrigger every third cycle) each of the two traces will be repeated 8·33 times a second. This results in pronounced flicker, which will still be noticed but to a lesser extent when the time-base speed is set to 2ms/div. Now however, change the mode switch from ALT to CHOP, and the flicker will disappear. This is because instead of writing the two traces alternately the electron beam in the cathode ray tube is now writing part of one trace for 5μs, (about one four-hundredth of a horizontal division!) and then the other trace for the next 5μs, and so on.

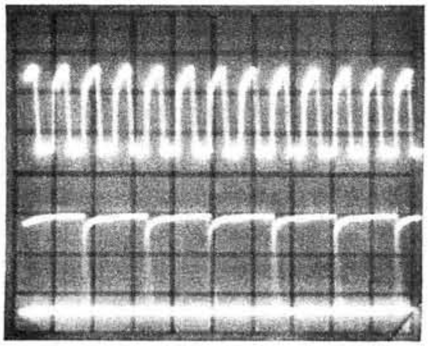
So far so good, but of course it is rather a waste of a Dual Trace Unit to display one waveform twice over. So now let's examine two different waveforms. However, a moments reflection will make it clear that they must be of the same frequency, or an exact multiple. Otherwise, if we trigger from one, the other will "run through" unsynchronised, and vice versa. An a.f. oscillator with both sine and square-wave outputs makes a handy source, and if you don't possess one, the circuit of Fig. 16 will provide both, plus a triangular wave to boot (the 'sine wave' is an approximation with $3\frac{1}{2}$% total harmonic distortion). Even simpler, use a low voltage secondary on a mains transformer to give you a 50Hz sine wave, and use the Purbeck CAL waveform for your squarewave. You will see that these are in phase (or antiphase according to which way round your secondary is connected), whereas the squarewave of the circuit of Fig. 16 is in "quadrature" (displaced one quarter of a cycle) to the triangular wave, and in antiphase to the sine-wave.

With input waveforms of a few kHz and higher, the "granular" effect of the traces in the chopped mode may be visible. In fact frequencies up to the chopping frequency or even higher can be displayed in the chopped mode, but the display may be unsatisfactory due to a stroboscopic effect. If the input frequency is carefully adjusted, the waveform can be seen to be traced out in dashes—the missing bits corresponding to the dashes where the other trace is being drawn. The sudden transitions of the beam between traces can also just be seen with care, but are not normally noticeable as they are so fast. On early double trace 'scopes in the CHOP mode, these transitions were not fast enough to be invisible, and blanking pulses were therefore fed to the cathode ray tube grid or cathode to dim the trace during the transitions. However the switching speed of the BSV81 f.e.t.s used in the Dual Trace Unit is so high as to render this unnecessary.

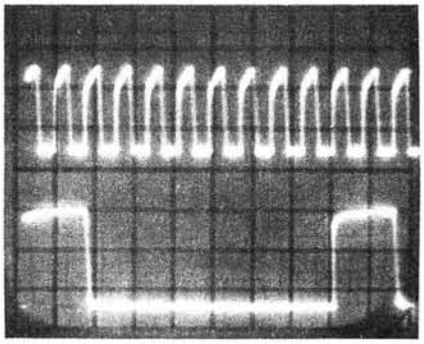
So far we have used the unit mainly in the CHOP mode, which is most suitable for lower frequencies—say from a few kHz down (though it can also often be used at frequencies in the MHz range). When displaying low frequencies in the CHOP mode, it is best if the trig. selector is at HF REJ, whether Y1 or Y2 channel is used as a trigger source. This is because the chopping action could possible superimpose spikes at the chopping rate on the outputs of the 733 amplifiers, albeit of very small amplitude. The HF REJ facility prevents these entering the trigger pick-off amplifier, thus they cannot interfere with the trigger function. If the HF REJ is not selected when in CHOP mode, then at low frequencies the trace may trigger on either the positive or the negative going slope of the waveform, whilst at higher frequencies the trace may tend to synchronise to the chopping frequency.

Having demonstrated both the Alternate and the Chopped modes with different waveforms of the same frequency, let's move on to something more meaty—a ÷10 counter. This demonstrates better the diagnostic value of the two traces, and also illustrates how it pays to give some

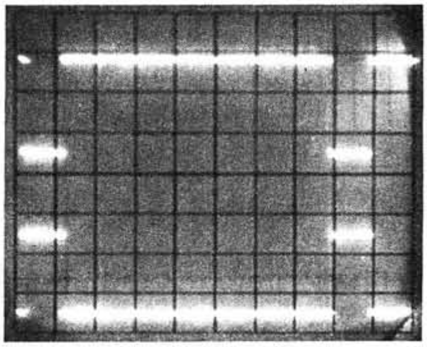
The set of traces shown on this page were all photographed from the screen of the author's prototype Purbeck oscilloscope. The inputs to the *PW* Dual Trace Unit were via commercial 10:1 passive probe units which had been adjusted to suit the inputs of the Dual Trace Unit



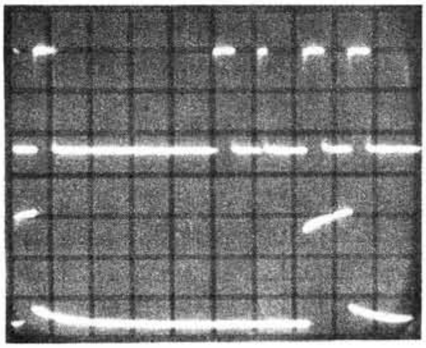
Photograph 1: This picture shows, at the top, the input to a 7400 series TTL decade divider. In this instance the Purbeck was being triggered from the divider input (upper trace) and as the timebase is set to display 13 pulses on the input trace the output trace (lower) will try to display 1·3 pulses. This accounts for the multiple and overlapping pulses on the lower trace



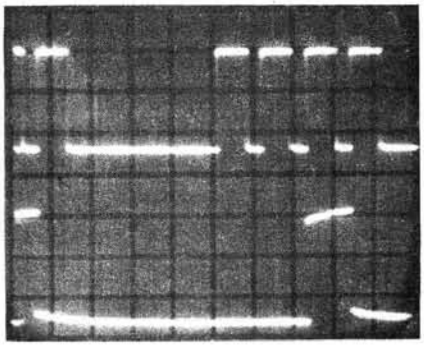
Photograph 2: Here we have the same basic information being displayed as in Photograph 1. However the oscilloscope is now being triggered from the lower trace with the result that both the input and output pulse trains are now displayed correctly on the screen and can be studied and measured without difficulty



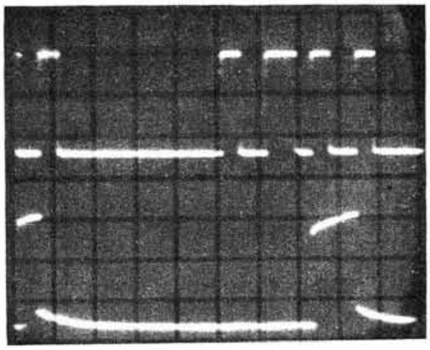
Photograph 3: This photograph shows how a twin beam oscilloscope can be used to indicate the differences between two pulse trains. The two traces shown are taken from the input and output pins of a TTL inverter and the display shows very clearly that when one trace is at 0V the other is at +5V. (Each trace is set to show 0V as its lower level and +5V at its higher position;



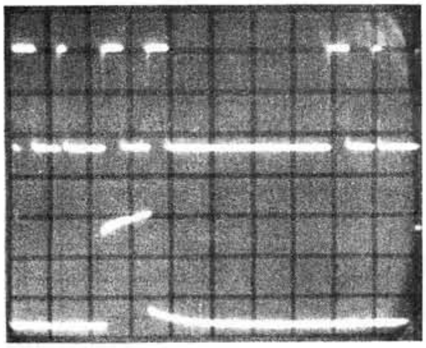
Photograph 4: A dual trace oscilloscope is extremely useful when dealing with digital proportional radio control equipment such as the advanced *PW* FM–80 system currently being described in these pages. This photograph, along with the next four show the outputs of the FM–80 encoder circuitry contained in the transmitter.



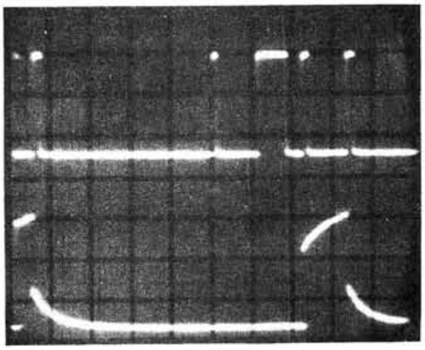
Photograph 5: The preceding photograph showed the FM–80 encoder output with Channel 2 set to 1·0ms pulse width (equivalent to full left at the servo output). This picture shows the same set up but with all channels set to 2·0ms pulse width (all servos full right). In these photos the lower trace is used as the triggering input, and is looking at the reset



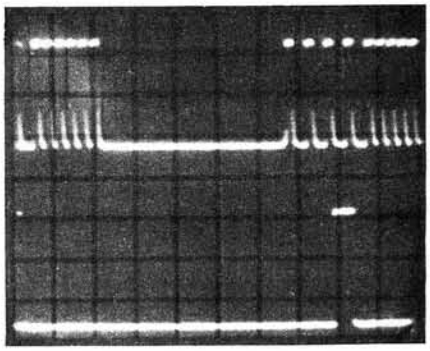
Photograph 6: Here we have Channel 2 set to 2·0ms (full right at the servo arm). The encoder can be set up so that with the control stick centred the pulse width for that particular channel is 1·5ms and with the stick at each end of its travel the pulse width changes from 1·0ms to 2·0ms. Comparing this picture with Photograph 9 the differences in operation of the FM–80 encoder can be seen



Photograph 7: This is basically the same display as Photograph 4 but the triggering arrangements are slightly different. In Photograph 4 the scope is triggered from the lower trace on the positive going edge. This picture has the traces triggered from the upper trace. The Dual Trace Unit was set to CHOP with the HF REJ switched in for all the r.c. trace pictures



Photograph 8: The output of the FM–80 encoder again but this time with all the channels set to 1·0ms except Channel 2 which is set to 2·0ms. From these pictures it will be seen that the Dual Trace Unit adds an extra dimension to the Purbeck oscilloscope enabling the operator to study pulse trains in particular with an ease that is not possible with a single beam



Photograph 9: Here we have the output of a more conventional radio control digital encoder circuit. This one is Micron's PL7–D f.m. system and shows how each channel pulse is formed. Again the Dual Trace Unit is set to CHOP with HF REJ in circuit. The lower trace shows the output associated with Channel 4 reset

Fig. 16: (Right) circuit diagram of a useful waveform generator. This will produce sine, square and triangular waveforms. The three outputs are all at the same frequency, making the circuit useful in checking out the Dual Trace Unit

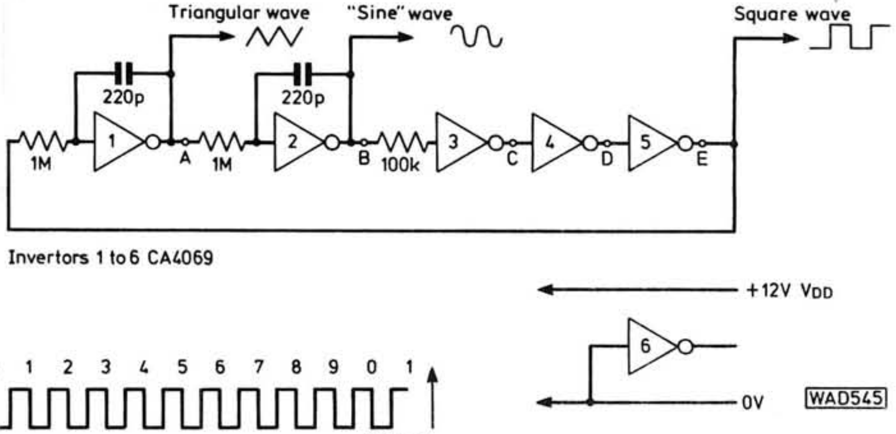
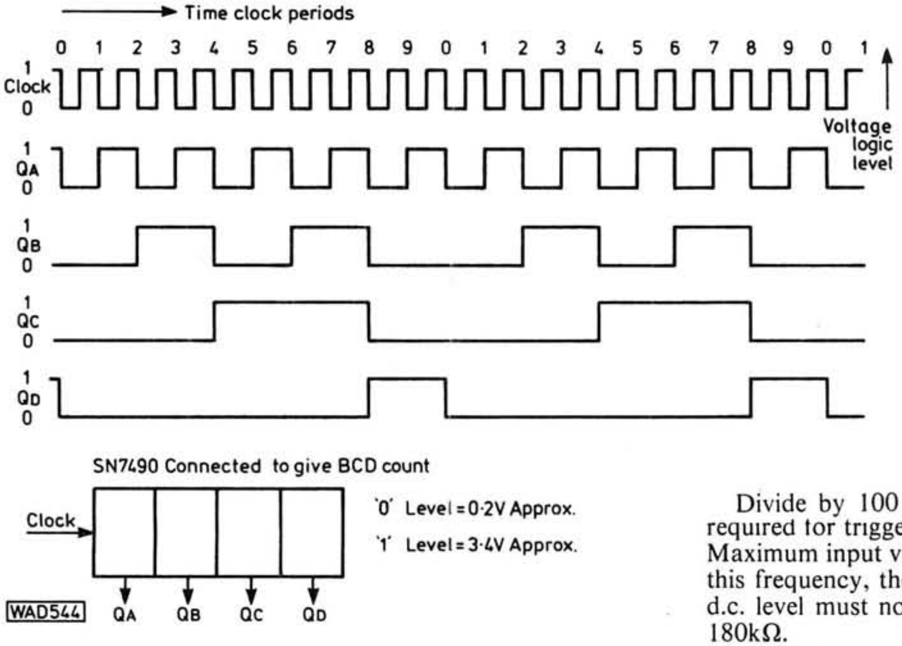


Fig. 17: (Below) the various waveforms of a t.t.l. decade divider of the 7490 type



Having tried out all the foregoing, you will now feel much more at home when driving a dual trace oscilloscope. However the following points relating to the Purbeck plus its Dual Trace Unit in particular are well worth noting. Firstly, following the modifications described in Fig. 15, the external trigger facilities of the basic Purbeck oscilloscope now typically meet the following specification.

Divide by 100 input; a minimum of 3V peak-to-peak required for triggering, frequency response down to 10Hz. Maximum input voltage 250V r.m.s. down to 10Hz. Below this frequency, the sum of the peak a.c. voltage plus any d.c. level must not exceed 160V. The input impedance is 180kΩ.

Direct input, a minimum of 30mV peak-to-peak required for triggering, frequency response −3dB at 80Hz. Maximum input voltage 10V a.c. peak-to-peak, any associated d.c. level not to exceed 160V. Input impedance 2kΩ. (Note that at frequencies below about 100Hz, the phase shift associated with the falling amplitude response will result in the TRIG LEVEL control producing triggering over part of the other slope of the input waveform in addition to the slope selected by the TRIG POLARITY switch.)

Secondly, with the Y input controls of the Purbeck set to 100mV/div., the Dual Trace Unit provides exactly the same range of Y input sensitivities as the basic Purbeck. However, by setting the Purbeck Y input to 10mV/div. instead, the sensitivity of the Dual Trace Unit is increased by a factor of 10. (If the Purbeck Y input is d.c. coupled, the traces will probably be driven off screen, but can be returned by adjusting the Y1 and Y2 SHIFT controls on the Dual Trace Unit. However, it is easier simply to set the Purbeck Y input to a.c. coupled, as one is unlikely to *want* to make d.c. coupled measurements at this sensitivity.)

There will be noticeable thickening of the trace when working at this sensitivity, i.e., 500μV/div., due to the wide bandwidth, but with a ×1 probe (a screened lead) and a reasonably low source impedance for the measured waveform, useful measurements can still be made. The trigger facilities in the Dual Trace Unit are sensitive enough to work at 500μV/div., provided the input waveform is large enough to produce 1 division vertical deflection, i.e., is at least 500μV peak-to-peak. In fact, the Purbeck can even be set to 10mV/div., with the variable gain control selected and set at maximum gain, giving a sensitivity at the Dual Trace Unit input of around 100μV/div. Using triggering via the Dual Trace Unit would require 4 or 5 divisions of vertical deflection to lock

continued on page 59▶▶▶

thought as to which channel it is best to trigger from. Fig. 17 gives the waveforms at the outputs of the four stages of a t.t.l. counter type SN7490: these are generally designated QA, QB, QC and QD; the clock waveform is also shown. The photograph shows the Purbeck displaying the clock waveform on the Y1 channel, (top trace) and the output of QD at one tenth the frequency on Y2. The TRIG selector switch of the Dual Trace Unit is set to Y2, ensuring a unique display of the QD waveform. Now switch the TRIG selector to Y1 and you will still have a clean display of the clock waveform, but most likely the Y2 trace will show the QD waveform at several different overlapping positions in the X direction. If however the X timebase variable is adjusted so that the 'scope retriggers after exactly 10, 20 or 30 clock pulses, a clear display of the divide by 10 QD output will again be obtained—but at the expense of having the timebase uncalibrated. This illustrates the reason for retriggering the oscilloscope from the lower frequency waveform when displaying two waveforms of different frequencies.

The QB waveform is a little more tricky, it can be seen that this spends two clock periods high, then two low, two high again and then four low. Consequently, depending on the clock frequency, it is quite likely you will get a split display when triggering from this waveform. One can always display the QD waveform on the other trace and trigger from that, but if it is particularly desired to display the QB and clock waveforms without having the timebase speed uncalibrated, the dodge is to connect the QD waveform direct to the EXT TRIG input of the Purbeck in place of the trigger output from the Dual Trace Unit. We now effectively have a three channel system, although only two of them are actually being displayed, and of course a single QB waveform will be obtained.

PRODUCTION LINES

alan martin

Latest from Casio

We recently received for review three of the very latest products from Casio.

On the left of our photograph is the MQ-6, a micro-card watch/calculator, which features a watch, stopwatch, calendar and an 8-digit calculator. The MQ-6 measures only 68 × 44 × 5mm thick.

In the centre is the ML-81, which offers the following functions, a clock, calendar, two alarms, timer, stopwatch, 8-digit calculator and a new musical instrument function.

Using the novel music function, the calculator keyboard doubles as the tonic sol-fa plus three octave notes. The timer, alarm 1 and 2 can be selected (when set) to operate a buzzer for 20 seconds or play its own programmed tune for 24 seconds. The three tunes are Frülingslied, Träumerei and Moments Musicaux No. 3.

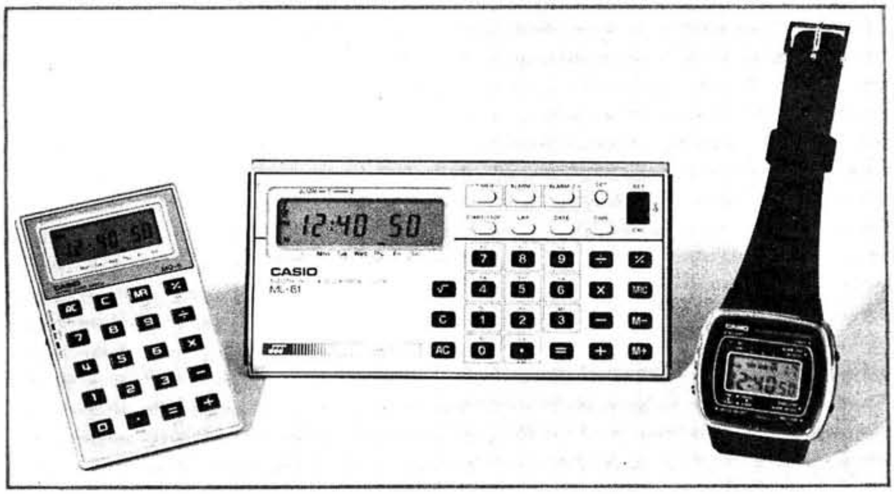
Finally, on the right is the F-80, an alarm chronograph. The regular timekeeping function has two optional displays; hour/minute/day/date or hour/minute/second/date.

Also featured is a three mode stopwatch, alarm and time-signal facility.

The F-80 is powered by one BR-2320 lithium battery which should run the watch for approximately three years.

These three products are available from Tempus at a discounted price, which includes VAT and P&P (the RRP is shown in parentheses). MQ-6 £19.95 (£24.95), ML-81 £22.95 (£27.95) and the F-80 £19.95 (£24.95).

Tempus, The Beaumont Centre, 164-167 East Road, Cambridge CB1 1DB. Tel: (0223) 312866.



Mini f.m. Handy

The very latest from Icom is the IC2E, a hand-held two metre f.m. transceiver, which is probably the smallest available.

The IC2E measures 116 high (without battery pack) × 65 wide × 35mm deep and weighs only 450 grams including power pack and antenna. Other features are; fully synthesised, covering 144–145·995MHz in 400 5kHz steps; BNC antenna socket; transmit/battery state indicator; frequency selection by thumbwheel switches which indicates the tuned frequency; +5kHz switch; duplex simplex switch; hi-low switch which reduces power output from 1·5W to 150mW; external microphone jack and external speaker jack.

This little beauty is supplied ready to go, complete with NiCad battery pack, charger and antenna. Although the price has as yet, not been confirmed, I understand it will be highly competitive.

The IC2E will be available during March, for further details contact: *Thanet Electronics, 143 Reculver Road, Herne Bay, Kent. Tel: (02273) 63859.*

Safety Microphone

A very useful item for the amateur, operating a mobile rig is the MM–202 mobile microphone.

The "mini" capacitor-microphone weighs only five grams and is fitted with a lightweight clip enabling the microphone to be attached to the coat lapel or shirt front of the operator.

The p.t.t. switch unit incorporates a microphone pre-amp with preset gain control, a long-arm switch toggle, an l.e.d. transmit indicator and is also fitted with a sturdy clip for mounting on the vehicle's gear change lever.

With the microphone attached to the operator and the p.t.t. switch mounted on the gear change lever should facilitate a much safer operating condition, when considering the more usual handheld microphone with p.t.t. switch incorporated.

The MM–202 costs £20.95 inclusive of VAT, plus 50p P&P. When placing an order or making further enquiries please quote the make of transceiver on which the microphone is to be used. Connectors and wiring diagram are available.

The MM–202 is obtainable from: *Waters and Stanton Electronics, 18–20 Main Road, Hockley, Essex. Tel: (03704) 6835.*

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

Memorial Lecture

The Verulam Amateur Radio Club will be holding the 1980 G3PAO Memorial Lecture in the Jubilee Centre, Catherine Street, St. Albans, Herts, on Thursday, 27 March at 7.30 for 8.00 p.m. This event is held to remember their former Chairman and Founder Member, George Slaughter, who passed away in 1977.

The Lecture this year entitled "Frequency Synthesis and Receiver Design" will be delivered by William Poel, G8CYK.

All radio amateurs, short wave listeners and other interested parties are invited to attend. Further details may be obtained from: *The Hon. Secretary G8MAE QTHR. Tel: Hemel Hempstead (0442) 64751.*

RNARS

The Royal Naval Amateur Radio Society will be operating an amateur radio station GB2RN aboard the preserved cruiser HMS BELFAST, moored in London's Upper Pool, opposite the historic Tower of London, commencing 0001 GMT Friday, 4 April 1980 and ending 1800 GMT Sunday, 13 April 1980.

Primary operating frequencies as follows: c.w. 1828 (QSX 1802), 1838, 1858, 3520, 7020, 14052, 21052, 21120, 28052, 28152; s.s.b. 1875, 3660, 3780, 7070, 14140, 14245, 14340, 21175, 21433, 28470, 28933.

Schedules are welcomed—especially with other stations of special interest—and can be arranged via *Don Walmsley, G3HZL, 153 Worple Road, Isleworth, Middlesex TW7 7HT. Telephone: 01-892 3239,* or via *RNARS, Bridge Wireless Office, HMS BELFAST, Symons Wharf, Vine Lane, London SE1 2JH. Telephone: 01-407 6434 extension 39.*

Home Radio

Due to problems arising from a planning permission refusal, Home Radio (Components) Ltd. have been compelled to move to new premises.

Their new address for callers is: *269A Haydons Road, Wimbledon, London SW19 8TY. Temporary telephone number: 01-648 3077.* Mail order correspondence should be sent to: *P.O. Box 92, 215 London Road, Mitcham, Surrey.*

Club Diary

Harlow and District Amateur Radio Society meet at 8pm every Tuesday at their club house, Marks Hall Barn, First Avenue, Harlow, Essex.

On Tuesday, 1 April 1980 at the club house, they are holding an "All Fools Junk Sale". Payment of the £1 entry fee, permits the taking and carrying away of any of the "junk" displayed and the right to sell your own "junk". Sorry no dealers!

Further details from: *Hon. Sec., A. C. Keeble G4HPU, 4 Manor Cottages, Debden, Saffron Walden, Essex CB11 3JY.*

Irish Agents

Vero Electronics Ltd. have recently signed agreements for the distribution of their products throughout Ireland.

Vero products in Northern Ireland will be available from: *Hill Electronic (N.I.) Ltd., 4 Deerpark Parade, Oldpark Road, Belfast. Tel: Belfast 742371.*

In the Republic the agency will be handled by: *Electronic Manufacturing Co. Ltd., 17 Blessington Street, Dublin. Tel: Dublin 309044, 309188 and 309552.*

New Electronic Security for Hotels

A new ultra-secure electronic door locking system which speeds hotel guest check-ins and overcomes the problem of lost or stolen keys, is being introduced onto world markets by British Relay Electronics Limited.

This locking system, named the "AccessMaster", has an almost unlimited number of key combinations which are preset by a central control unit in the hotel. The low-cost disposable keys are made from virtually unbreakable plastic.

When each guest checks in, a key is selected at random from a storage pool and allocated to the room number. This information is fed into the hotel's central control unit which recognises the new combination and allows access to the room, only when, the correct key is inserted into the door lock.

The same key is used throughout a guest's stay. However, should the key be lost or stolen, another is issued at random, a new combination is allocated by the central control unit and the previous combination is cancelled.

When a guest checks out, the key is returned to the storage pool and the lock combination is deleted from the system.

Should an invalid key be inserted into any door lock, the system prevents the door from opening and immediately signals to the central control unit that an illegal key is being used.

In the event of a door being forced, or burst open, an alarm system is immediately activated.

For extra security, the door locking system is linked to a memory bank which records the exact time and key identification of the last two entries into a room.

The system also allows one key to be programmed to give access to a number of rooms during specific periods of time. The key is then allocated to one member of the hotel staff responsible for cleaning a series of rooms. At the end of the predetermined cleaning period the key combination is cancelled.

Similarly, one key can be programmed to open one or more storage rooms or cellars, and then invalidated when no longer required.

Other facilities include a security key for the central control unit and storage pool, and a buzzer system which signals whenever a door lock is opened.

The central control unit

The central control unit can be interfaced to the hotel's computer system to give automatic morning call, message waiting and room status information. Furthermore, the central control unit continues to operate in the event of a power failure.

British Relay Electronics Ltd., 41 Streatham High Road, London SW16 1EP. Tel: 01-677 2511.

Low frequency signal generator

P. LEAH

Signal generators which employ discrete components in their construction commonly suffer from the problem of ensuring that the output waveform remains pure and stable over their frequency range. Either the mark-to-space ratio becomes irregular or the signal becomes distorted at the extremities of the range.

However, with the aid of microelectronics, most of these problems can be overcome by simply concentrating all the complex control circuitry into a single chip; the designer has then merely to select a handful of components to programme an integrated circuit which has been developed expressly to meet his needs.

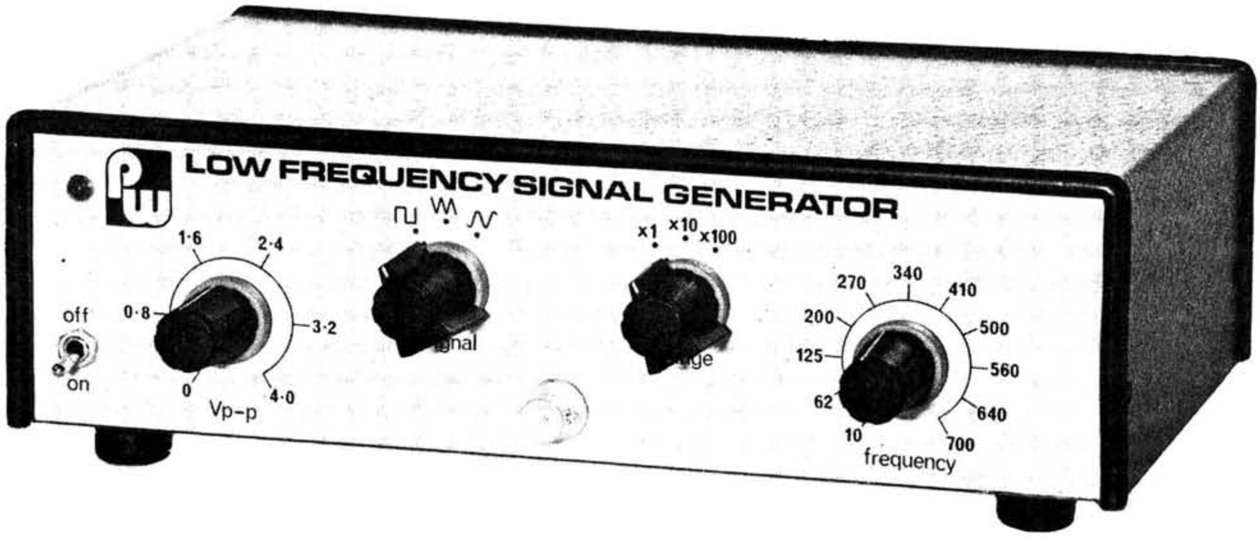
One of the most versatile of the commercially available devices is the Intersil 8038 waveform generator. It produces simultaneous sine, square and triangular output waveforms and forms the basis of this constructional project. With additional circuitry for the power supply, the low impedance output buffer stage and the range selection and purity adjustment circuitry, this relatively simple l.f. generator has an output frequency range of 10Hz to 70kHz arranged in three stages: 10–700Hz; 100–7000Hz; 1–70kHz. It is also possible to extend the range to 500kHz.

The output voltage is variable up to 4V peak-to-peak and the instrument is therefore suitable for both digital and analogue applications (it can be used to direct-drive either TTL or CMOS) and is a useful tool for testing audio or other low-frequency equipment.

Power Supply

The circuit of the power supply section is shown in Fig. 1; it produces a stabilised +11·3V and −11·3V from the 240V mains input. These particular voltages were chosen in order to combine optimum performance with minimum temperature drift.

The mains input is applied to the primary winding of T1. The output from the centre-tapped secondary of this 24V transformer is full-wave rectified by D1–D4 and then smoothed by C1 and C2 to produce unregulated voltages of approximately +17V and −17V at the collectors of Tr1 and Tr2 respectively. These transistors are used in the common base configuration, their base current being supplied via R2 and R3 and the base reference voltage being determined by the 12V Zener diodes D6 and D7. The out-



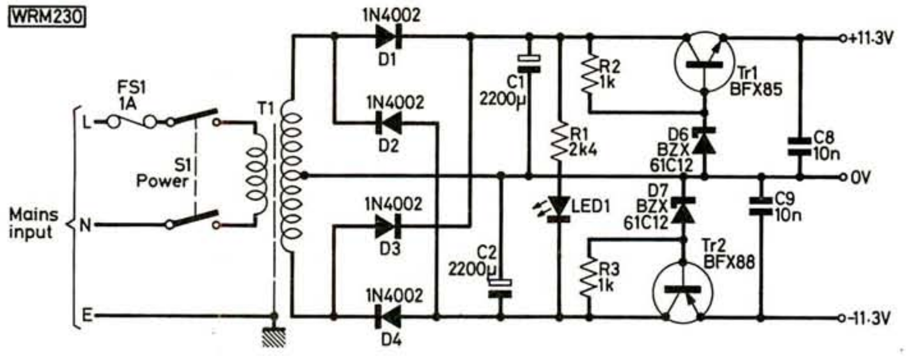


Fig. 1: Power Supply circuit diagram

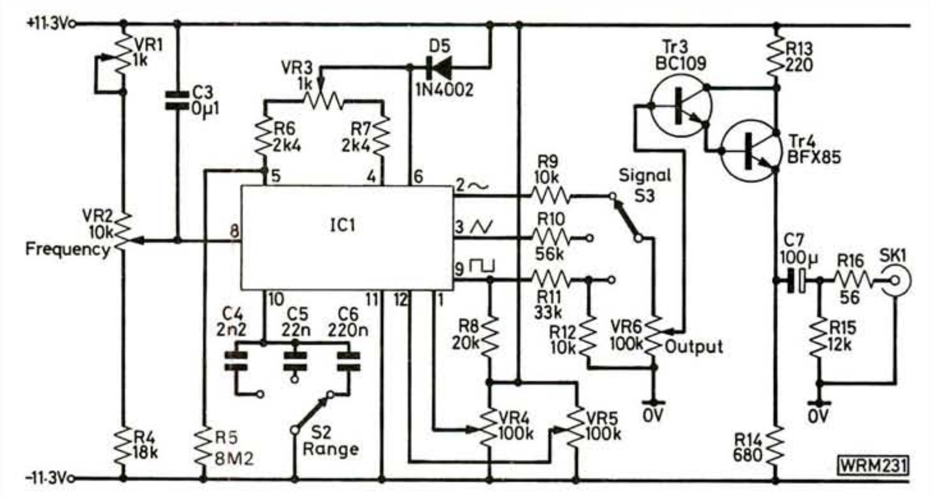


Fig. 2: Main circuit

put voltages from the emitters of Tr1 and Tr2 are stabilised at +11·3V and −11·3V with respect to the 0V line. An on-off indication is provided by LED1 which is connected across the unregulated output of the rectifier bridge (D1–D4) and which, like the power switch S1, is mounted on the front panel. The current through the l.e.d. is limited to approximately 12mA by R1.

Main Circuit

Figure 2 shows the 8038 with its associated range selection and waveform purity circuitry. The output impedances and amplitude of these waveforms vary considerably and the series resistors R9, R10 and R11 are included to produce waveforms equal in amplitude at approximately 4V peak-to-peak. The squarewave output is floating and must be connected to the supply voltage via R8; all of these output waveforms are balanced about 0V. The desired waveform is selected by means of S3 which is mounted on the front panel and the amplitude of the output is varied by VR6, also mounted on the front panel. The output from the i.c. is buffered and amplified by two transistors Tr3 and Tr4 which are connected as a common-collector Darlington pair—this configuration provides maximum current gain but negligible voltage gain. Resistors R13 and R14 provide d.c. bias to Tr3 and Tr4. Capacitor C7 provides d.c. insulation for the output waveform which is referenced to 0V by R15. Resistor R16 protects the instrument against damage should the output become short-circuited.

In the configuration shown, the output impedance of the instrument is approximately 100Ω.

Construction

With the exception of those which are mounted on the front panel, all components used in the construction of the l.f. signal generator are mounted on a single-sided printed circuit board. This is housed in a metal instrument case measuring 225 × 64 × 134mm. The main body of the case is drilled only to mount the 6BA bolts which support the p.c.b.; the location of the mounting holes is not critical but be sure to leave enough space between the front panel and the p.c.b. If you don't, the panel-mounted items will tangle

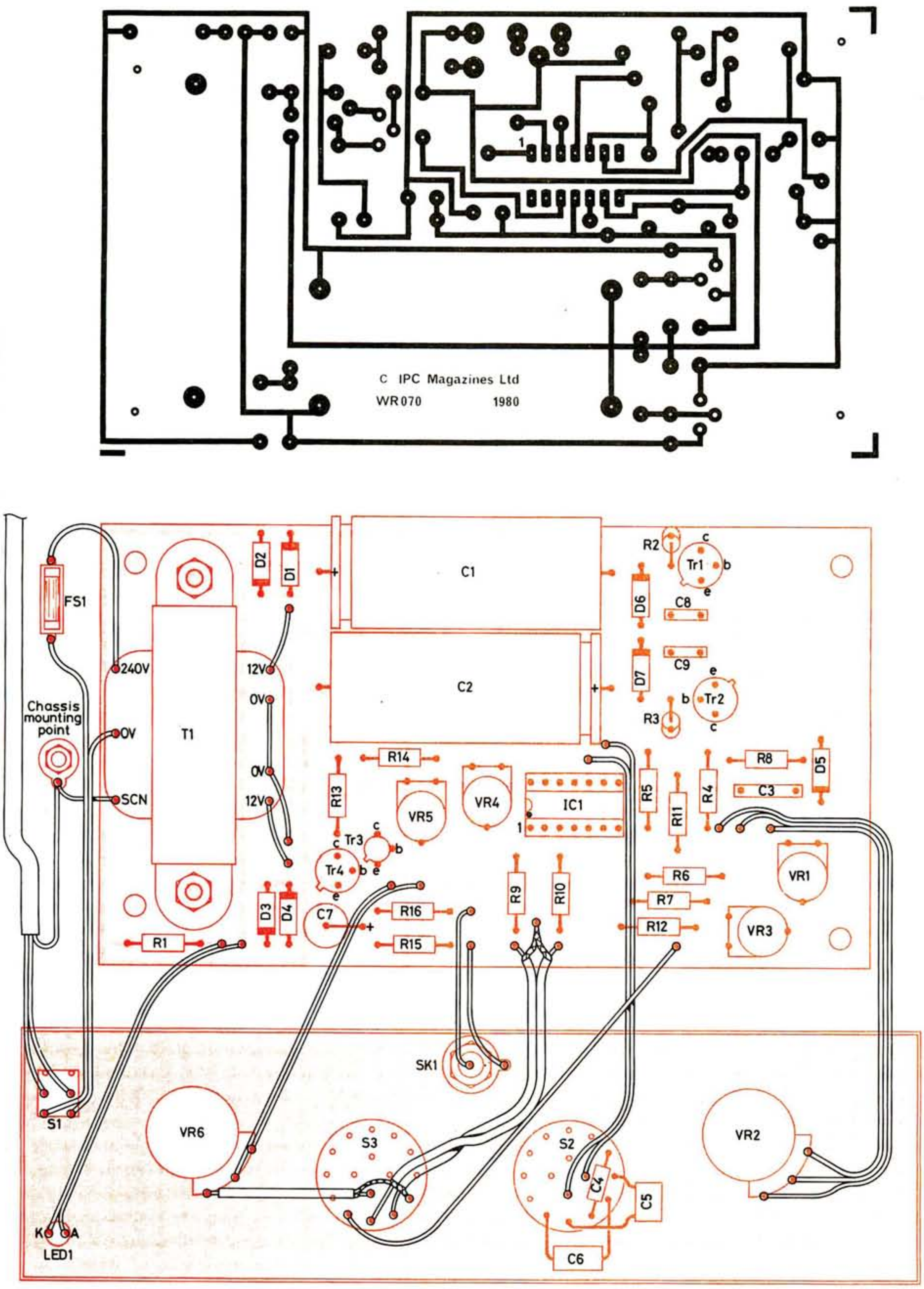


Fig. 3: Copper foil pattern, component layout and connections to front panel, shown full size

WRM229

★ components

Resistors

¼W 5%			
56Ω	1	R16	
220Ω	1	R13	
680Ω	1	R14	
1kΩ	2	R2,3	
2·4kΩ	3	R1,6,7	
10kΩ	2	R9,12	
12kΩ	1	R15	
18kΩ	1	R4	
20kΩ	1	R8	
33kΩ	1	R11	
56kΩ	1	R10	
½W 5%			
8·2MΩ	1	R5	

Semiconductors

Diodes			
1N4002	5	D1,2,3,4,5	
BZX61C12V	2	D6,7	
Transistors			
BC109	1	Tr3	
BFX85	2	Tr1, 4	
BFX88	1	Tr2	
Integrated circuit			
8038CC	1	IC1	Intersil
Light emitting diode			
Min. indicator type	1	LED1	

Switches

Midget rotary 4p3w	2	S2,3
Min. toggle d.p.d.t.	1	S1

Capacitors

Ceramic			
10nF	2	C8,9	
0·1μF	1	C3	
Polystyrene 5%			
2·2nF	1	C4	
22nF	1	C5	
Polycarbonate 5%			
220nF	1	C6	
Electrolytic 16V			
100μF	1	C7	P.c.b. type
Electrolytic 25V			
2200μF	2	C1,2	

Potentiometers

Min. preset, horizontal mounting, 0·1W		
1kΩ	2	VR1,3
100kΩ	2	VR4,5
Midget, linear track		
10kΩ	1	VR2
100kΩ	1	VR6

Miscellaneous

12–0–12V 6VA mains transformer (1); instrument case (Bazelli) 225 × 64 × 134mm (1); 50Ω BNC coaxial socket, Type UG1094/U (1); 14-pin d.i.l. integrated circuit mounting socket (1); knobs, Sifan, 15mm collet type with wing (2), plain with white line (2); *PW* transparent panel overlay (1); mains cable entry clamp (1); 1A fuse and holder (1); printed circuit board (1); 50Ω coaxial cable, equipment wire, etc.

with those mounted on the p.c.b!

Only one hole is required in the rear panel—for the mains cable entry. In accordance with normal good practice (i.e., common sense), we recommend that you use a cable entry clamp (such as RS Components Type 544-263 or similar) in preference to an ordinary plain grommet. Fuse FS1 is easily accommodated within the case.

The front panel overlay (see Fig. 4) provides the necessary drilling information for the front panel. All the mounting holes for the switches and potentiometers are 9·5mm dia. (0·375in). The hole for the BNC output socket (SK1) should, however, be drilled to 10mm dia.; this hole is intentionally oversized as SK1 *must be isolated from the chassis* in order to avoid undesirable earth-loop effects. Figure 5 shows in detail how this may be achieved. A BNC socket was chosen for the output as this is the type most commonly used in test instrument applications—the individual constructor may, of course, vary the choice to suit his own requirements. Indicator LED1 is mounted in a 4mm dia. hole.

Full details of the p.c.b. and the connections between it and the front panel are shown in Fig. 3.

Constructors should note that the sine and triangular outputs from the i.c. are high impedance and are therefore susceptible to crosstalk from its squarewave output. Consequently, the connections from the p.c.b. to S3 must use coaxial cable; the same applies to the connection between the common contact of S3 and VR6. Keep the lengths of these coaxial connections as short as possible; note that a spare tag on S3 is used in order to common together the earth screens.

The frequency selection capacitors C4, C5 and C6 are all mounted directly onto the back of S2—a twisted pair is all that is necessary to make the connection between these components and the p.c.b. The remaining interconnections are made with normal stranded equipment wire.

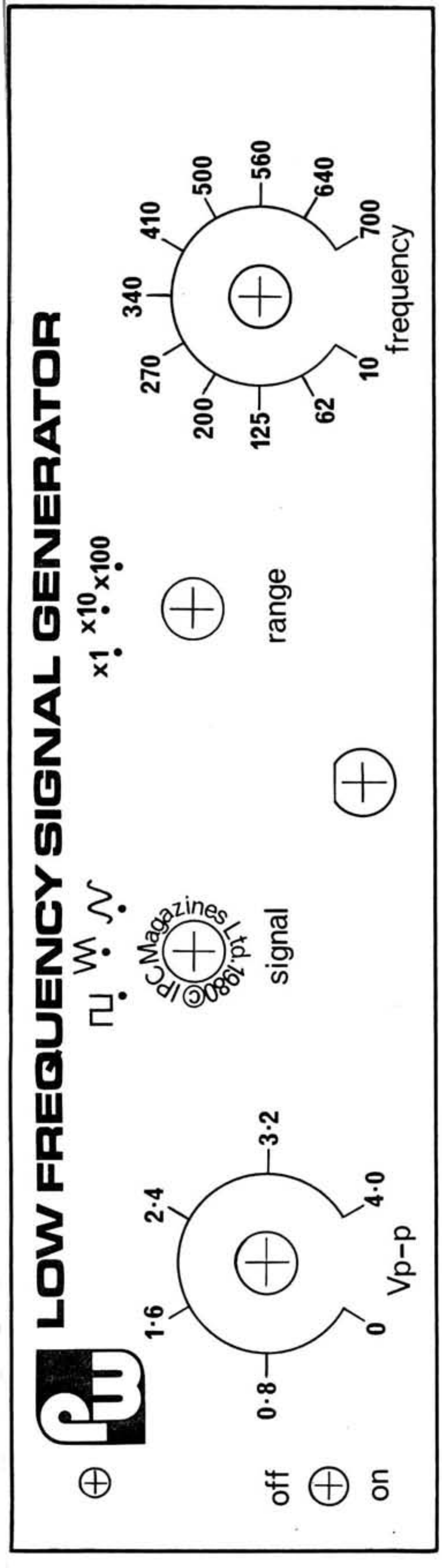


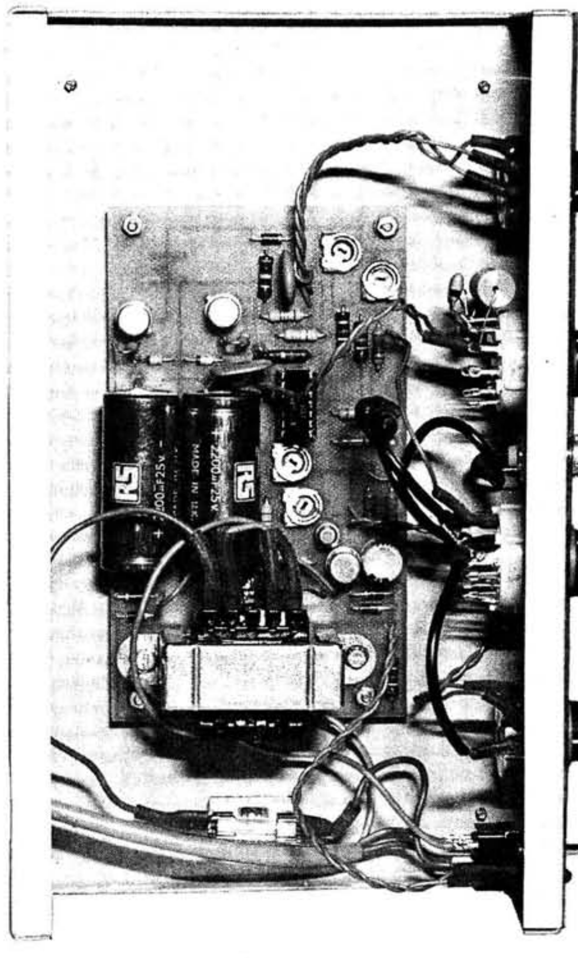
Fig. 4: Front panel (full size)

Testing

An oscilloscope is essential for calibrating the instrument and, if available, a frequency counter and an electronic voltmeter would also be very useful. Check first that the supply voltages (+11·3V and −11·3V) are correct to within 0·2V; the 8038 used in the prototype was socket-mounted and the i.c. was not placed into the socket until these voltages were verified as being correct.

The next step is to set all potentiometers and pre-sets to mid-travel and monitor the output waveforms from pins 2, 3 and 9 of the i.c. using the 'scope. The approximate peak-to-peak amplitudes of the waveforms should be 20V for the squarewave, 6·5V for the triangular output and 4V for the sinewave output. Changing ranges (S2) should alter the frequency by a factor of ten, of course.

Once you are satisfied that all is well with the i.c., test the output buffer by comparing the waveform at the wiper of VR6 (waveforms of up to 4V peak-to-peak should be available on all signal selections) with that emerging from the output socket (SK1). In all cases, the waveforms should be virtually identical at both points.



Interior view of the prototype unit

Calibration

A frequency counter is obviously the best instrument to use for calibration, although an oscilloscope may also be used if its timebase is known to be accurately calibrated. The l.f. generator range switch (S2) should be set to the × 1 position, and VR2 should be turned fully anti-clockwise (frequency at a minimum). Now adjust VR1 until the output frequency is 10Hz. Changing ranges should now result in output frequencies of approximately 100Hz and 1kHz. Repeating this procedure with VR2 set to its maximum frequency position (fully clockwise) should produce output frequencies of approximately 700Hz, 7kHz and 70kHz.

The purity of the sinewave output should be adjusted by using VR4 and VR5—do this with the output frequency set to approximately 1kHz on the ×10 range. The adjustment is correct, of course, when the trace on the oscilloscope most closely resembles the classic sinewave shape!

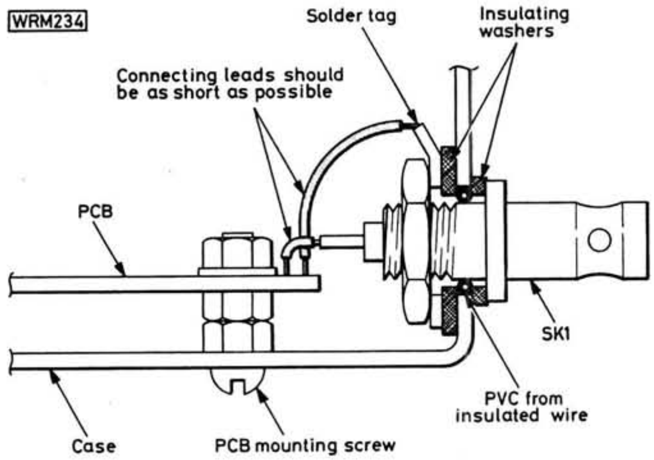


Fig. 5: How to mount SK1. The insulating washers should be cut from semi-rigid plastic sheet, such as the celluloid used in shirt-packaging, etc. The "O" ring is made by cutting pvc sleeving to length and then trapping it in position as shown

Accuracy

After calibration of the frequency scale, it is worth pointing out that the frequency set will be accurate only to ±3%. This is due partly to the frequency drift of the i.c. with change in temperature (it does run fairly hot and therefore calibration is best performed after the instrument has been switched on for some time), and partly to the tolerance on the absolute values of the capacitors in the tuning circuit. The accuracy could probably be improved by adding extra trimmer capacitors in parallel with C4/C5/C6, but these additional components and the extra calibration required were not thought to be justified in this simple construction. This particular generator was never intended to achieve laboratory standards of accuracy!

Distortion

Distortion occurs at the low frequency limit, caused by variations in the mark-space ratio, and also at the high frequency limit—due to a reduction in the amplitude of the output waveform. The distortion is, however, within 4% over 95% of the frequency range.

Unfortunately, the distortion is a function of the i.c. itself and varies according to the waveform selected. The triangular output is the most affected as its amplitude reduces above 40kHz. If you decide to extend the range of the instrument as described below, it should be pointed out that the squarewave becomes distorted above 120kHz and the amplitude of the sinewave output becomes reduced above 75kHz.

Extension

If an extension of the output frequency range is desired (and you can stand the reduced amplitude of the output!), substitute a 3-pole 4-way wafer switch for the S2 specified in our components list and add a capacitor in similar fashion to C4/C5/C6. This should be 150pF in value with a polystyrene dielectric and will provide a further sinewave output range from 10kHz to 500kHz.

The reduction in the peak-to-peak output voltage is approximately 50% at the highest frequency. ●

The transparent front panel overlay for this project is available from the PW *Editorial Office, price £1.60 including post and packing.*

Multiple Choice—*continued (see page 21)*

Actually, none of the answers is correct. Ohm's Law states:

If the temperature of a conductor is kept constant, the current through it is proportional to the potential difference across it.

Note that the term "resistance" does not enter into the statement of the law as originally given.

"But", I hear you protest; "So what? In practical terms, Ohm's Law relates voltage, current and resistance." And so it does, but if you go back to the options offered, "d" expresses that relationship in words, "b" expresses it algebraically, and "a" gives a numerical example. So you must decide between them.

If I had encountered this question in an exam, knowing that none of the options is correct (or even if I hadn't known), I would have argued as follows: "c" is not relevant. It is probably a true statement but it is not a complete sentence (read it again if you don't believe me), so I cannot be sure. "a" is relevant and true, but not adequate as a definition, and laws are not usually expressed numerically, so it can be eliminated. "b" is relevant and true and adequate, being answer "d" turned into an equation. To choose between the two, I would argue that laws are more often stated in words than symbols, and plump for "d". I don't know if that's "right", but in any case, the decision doesn't seem relevant to my suitability to become a radio amateur, or does it?

Geoff Arnold

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

New Catalogues

Greenweld's latest 1980 catalogue is now available.

Many new products have been added, and surprisingly a great many prices have been reduced, giving even greater value.

Included with every catalogue is a first-class reply paid envelope, an order form, their latest bargain list and inside the back cover will be found five 12p discount vouchers.

As soon as the new Vero catalogue becomes available (early 1980), this will be included as well.

The catalogue costs 40p plus 20p P&P from: *Greenweld Electronics Ltd., 443 Millbrook Road, Southampton SO1 0HX. Tel: (0703) 772501.*

Transformers

Barrie Electronics Ltd. have extended their range of transformers, all available from stock.

In addition to their existing ranges of miniatures, output and mains input types are auto transformers, isolating transformers (with screens), low voltage ranges and low-cost split bobbin types.

Barrie also provide a specialist winding service for types not covered by standard ranges stocked, a catalogue is available for 20p stamps.

Barrie Electronics Ltd., 3 The Minories, London EC3N 1BJ. Tel: 01-488 3316/7/8.

Club News

A new AR society has been formed, The Eden Valley Radio Society. Meetings are held every third Thursday of the month at 7.30pm in the Two Lions Hotel, Penrith, Cumbria.

A comprehensive programme has been arranged for 1980, which includes field day stations.

A welcome is extended to all, who can obtain further details from: *David Shaw G8TXJ, 2 Low Wiend, Appleby-in-Westmorland, Cumbria CA16 6QP.*

North Devon Radio Club meets twice a month. On the 2nd Wednesday at Pilton Community College, Choddiford Lane, Barnstable, and on the 4th Wednesday at 38 Clovelly Road, Bideford. All meetings start at 7.45pm.

Further details from: *The Secretary, H. G. Hughes G4CG, "Crinnis", High Wall, Sticklepath, Barnstaple EX31 2DP.*

Garrard Sold

The Plessey Company Limited announced recently that the worldwide business of its Swindon-based consumer electronics subsidiary, Garrard Engineering Limited, is to be sold as a going concern to Gradiente Electronica Limitada of Sao Paulo, Brazil, for £1 million cash.

Gradiente is a major audio products company with five factories in Brazil and one in Mexico. The Company employs 2,800 people and last year had a turnover of approximately £35 million. It markets a complete range of hi-fidelity audio products and presently manufactures Garrard products under licence in Brazil.

It is intended that Gradiente products and the existing Garrard range will both be marketed in future under the Garrard trade name throughout the world. The combination of the Garrard name and products and the Gradiente range will present an attractive, comprehensive and unified group of audio products.

Gradiente expects that Garrard with a wider range of products will trade profitably in the future.

Hi-Fi Homework

Building the power stage of a hi-fi amplifier awaits students starting the Open University's new second-level course on Introductory Electronics. The home experiment kit for the course also contains a dual-trace oscilloscope with its own power supply.

"Introductory Electronics" uses a systems approach concentrated on circuit design and offers a modern, practical way of teaching digital electronics, for example in focussing on the use of read-only memories specified by truth tables. It brings students to the point where they can begin to tackle work on microprocessors, as in "The Digital Computer", a related course from the Open University.

Equally, though, the new course is useful for people who simply want to find out what electronics is about.

It does, however, assume a basic knowledge of some mathematical concepts: sine and cosine functions, elementary differentiation and integration. Students could get to this stage by taking the Open University's course, "Modelling by Mathematics".

There are eleven television programmes associated with the course, and a joint summer school with the Open University's course on Instrumentation.

At present, "Introductory Electronics" is available to existing undergraduates of the Open University, but in 1981 will be introduced for Associate Students undertaking a "one off" period of study. (Applications from Associate Students will be invited in May this year.)

Nearly 1400 students have applied to start "Introductory Electronics" in January and, overall, more than 4000 people have applied to enrol on one of the Open University's four electronics courses: "Introductory Electronics", "Instrumentation", "Telecommunication Systems" and "The Digital Computer".

Open University students learn from study booklets sent through the post, from associated radio and television programmes, summer school and tutorials.

If you would like to become an undergraduate of the Open University, write to: *The Admissions Office, PO Box 48, Milton Keynes MK7 6AB.* No formal educational qualifications are required—entry is on a "first come, first served" basis. Applications are invited before May 30, to start studying in 1981, but apply early to stand the best chance of being accepted for next year.

Can You Help BAEC?

The British Amateur Electronics Club, formed in 1966, has its base at Penarth, S. Glamorgan. Members in other parts of the country have tried to start local meetings, but have run into many problems, principally that of finding a suitable room at a reasonable charge.

If you run an Electronics Group or Radio Club, the BAEC would greatly appreciate, if suitable arrangements could be made, for local BAEC members to attend your meetings. Naturally, those members would be prepared to pay an affiliation fee.

Can you help? If so, please contact: *The Chairman, BAEC, Cyril Bogod, "Dickens," 26 Forrest Road, Penarth, S. Glamorgan. Tel: (0222) 707813.*

NIMBUS

Modular 2m Transceiver System (Part 2)

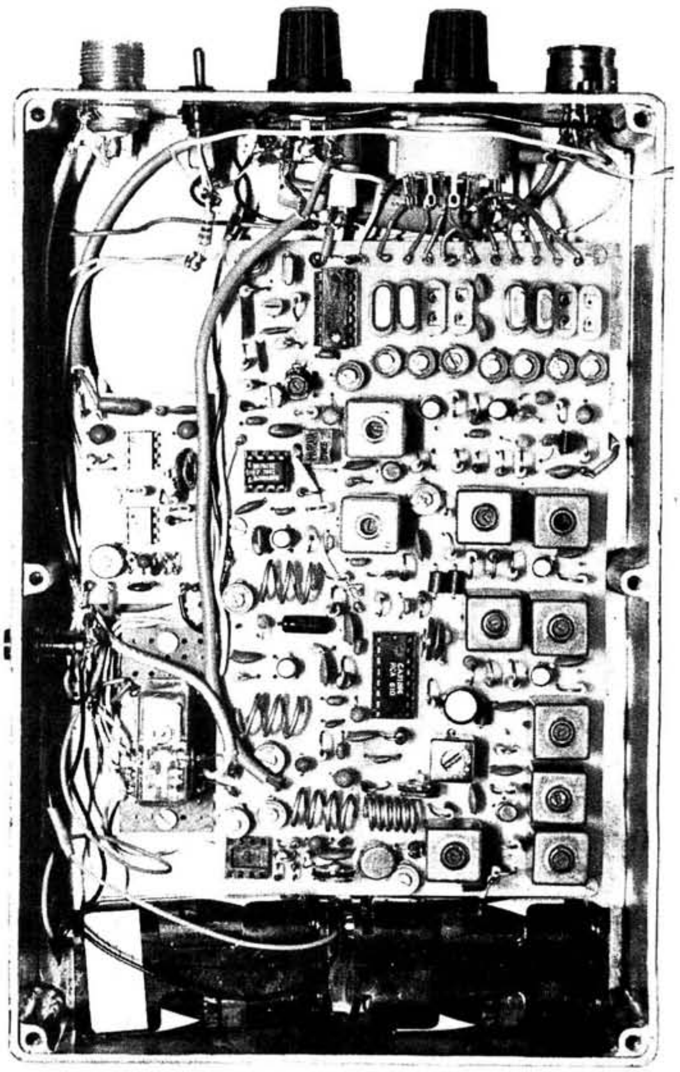
Michael TOOLEY BA G8CKT
&
David WHITFIELD BA MSc G8FTB

Construction of the transceiver should not be attempted without the use of the recommended printed circuit design for the main transmitter/receiver module. No other form of construction will give satisfactory results, and even a small departure from the recommended layout may cause severe problems. Whereas a double-sided p.c.b. (with an extensive earth plane on the component side of the board) could have been used for this project, the obvious advantage of simplified track layout was considered to be outweighed by the comparatively high cost and fabrication problems when compared to a single-sided design. In particular, the requirement for accurate registration between the masks for the two sides of the board would have rendered it difficult, if not impossible, for the average amateur to manufacture.

The result (after many hours spent in playing a mind-bending version of three-dimensional jigsaw puzzles) was to produce a single-sided printed circuit design. The track layout is shown in Fig. 7, and the following section contains some notes for constructors who wish to manufacture their own p.c.b. for the transmitter/receiver module. The ensuing sections contain some specific constructional notes for the three basic circuit modules, but first a number of other general points which apply to all the modules. Assembly details for the transmitter and receiver tuned circuits are essentially the same and are therefore described together in a separate section.

It was mentioned in Part 1 that the basic transceiver could be built for around half the cost of an equivalent commercial unit. The economy achieved, however, is the result of careful design, rather than by the use of low cost surplus type components and the use of full-specification components is, in fact, essential to ensure good performance; surplus components should, therefore, be avoided. For example, surplus transistors may function quite adequately in many respects and in many applications, but their performance in terms of noise, gain and cut-off frequency is often impaired, to the detriment of the overall circuit performance. Another important consideration is that the components used should fit into the spaces allocated to them on the printed circuit board. In particular, this is true of the electrolytic capacitors, which should be tantalum bead types. These are more expensive than other types, but represent the most compact way of achieving the required capacitance.

All the connections between the printed circuit boards and external controls, sockets, etc., are made to terminal pins on the p.c.b. the pins being employed are those used for standard 0·1in Veroboard. The various test points are also fitted with pins to allow measurements to be made easily from the top side of the board. When the component assembly has been completed a further visual examination is recommended and all protruding connections on the foil side of the board should be cut off as close to the board as possible to avoid any stray capacitance effects between connections. This side of the board may then be cleaned using a solvent cleanser and then treated with a light protective coating of printed circuit lacquer.



Internal view of the transceiver

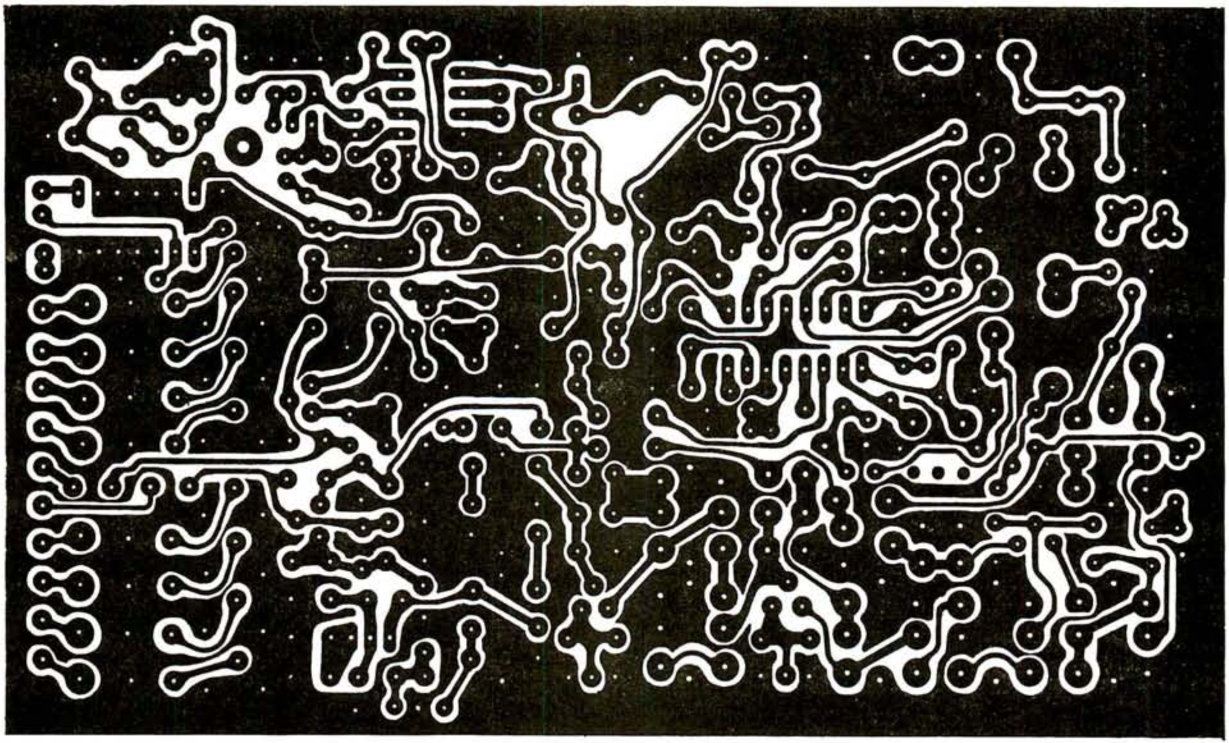


Fig. 7: Main printed circuit board track pattern shown full size

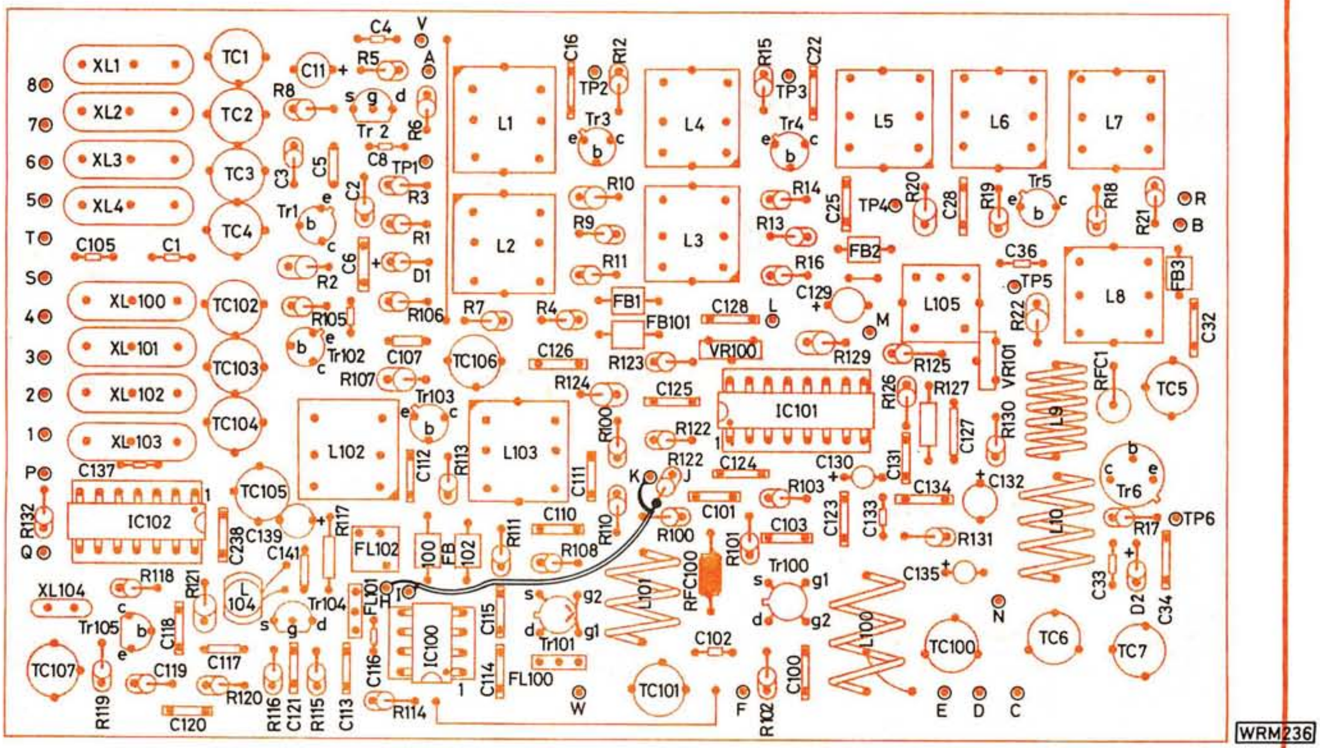


Fig. 8: Component layout on the main printed circuit board

Printed Circuit Board

The manufacture of the p.c.b. for the transmitter/receiver module is a relatively straightforward undertaking provided that the necessary materials and facilities are available. The whole process can be completed in approximately 2 to 3 hours, including the time to drill the holes.

The first stage in the process is to make a transparent mask from the 1:1 p.c.b. layout shown in Fig. 7. This may be done photographically or with the aid of a suitable proprietary copying process. A piece of copper-clad single-sided fibreglass board of at least 160mm × 90mm should be coated with positive photo-resist using one of the proprietary sprays available, alternatively, pre-coated board is available from several sources. The mask is then laid over the coated board and the board is exposed to ultra-violet light through the mask. The directions supplied with the board indicate suitable exposure times and the exposed board is then immersed in developing solution (this is typically sodium hydroxide). After developing is complete, the board should be carefully washed.

It is worthwhile at this stage to subject the board to a careful visual examination. The developed resist pattern should be checked to ensure that there are no unwanted bridges between tracks. Any such extraneous resist should be removed with a fine scriber. When the pattern is considered to be satisfactory the board may be etched in the usual way. After etching and cleaning, the board should again be checked for unwanted copper bridges. The importance of such checking cannot be over emphasised; a few minutes well spent at this stage may save many hours of frustration later on!

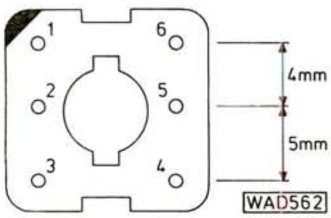


Fig. 9: Coil base connections viewed from above

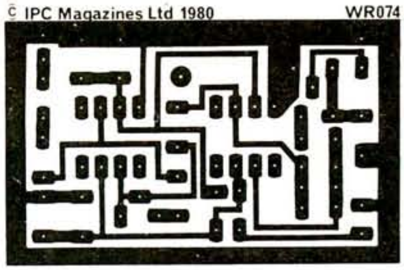


Fig. 11: Modulator printed circuit board (full size)

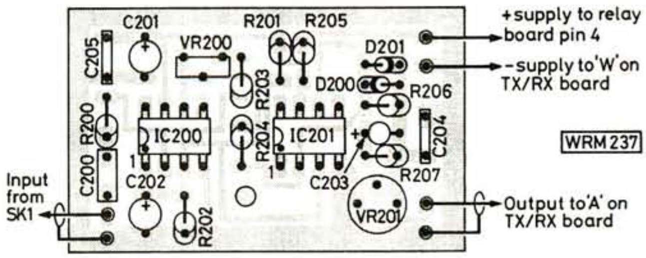


Fig. 12: Modulator board component layout

The board is now ready for drilling and it is recommended that initially all holes are drilled out with a No. 60 (1mm) drill. In view of the number of holes involved, it is likely that a quantity of such drill bits will be required; it is essential that sharp drills are used to ensure clean, burr-free holes. After all the holes have been drilled, specific holes should be enlarged where appropriate as follows:

1mm	All test points, all wiring points (both to accept terminal pins as used on 0·1in Veroboard), all preset resistors and for the centre pins of the crystal sockets.
1·5mm	All trimmer capacitors, end terminals of the crystal sockets, the coil bases (including the holes for the cans), L9, L10, L100, L101, and earth tags for L105.
3mm	For mounting the board in the case.
6mm	For the base of L104.

The board is now ready for the components to be assembled onto it.

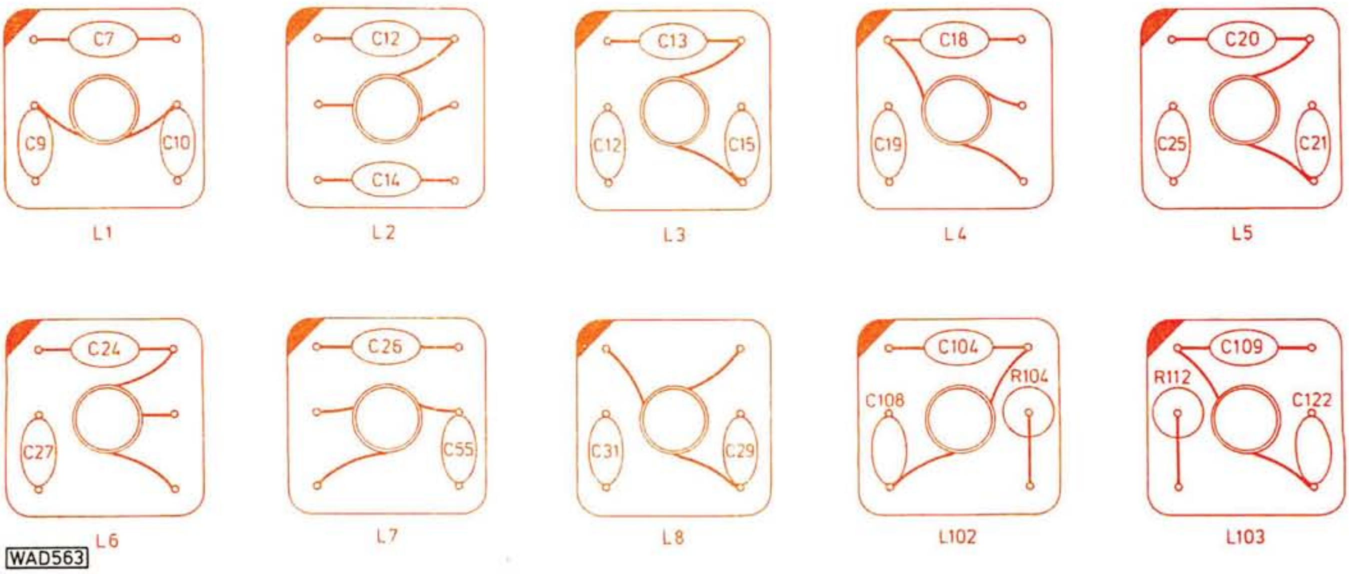


Fig. 10: Coil base connections viewed from above showing components

Table 1: Tuned circuit coil winding details

Coil	Base and Can	Former	Tuning Slugs	Turns	Wire		Winding Length mm	Tap Details	Pins			Notes
					s.w.g.	Type			Top	Bottom	Tap	
L1	√	√	√	18½	36	enam.	close	—	2	5	—	
L2	√	√	√	20	36	enam.	close	4½T from pin 5	6	5	2	
L3	√	√	√	12	36	enam.	close	—	4	6	—	
L4	√	√	√	12½	36	enam.	close	3T from pin 5	1	5	4	
L5	√	√	√	6	22	t.c.	7·5	—	6	4	—	
L6	√	√	√	7	22	t.c.	10	2T from pin 5	5	6	4	
L7	√	√	×	3½	18	t.c.	7·5	½T from pin 2	2	5	3	
L8	√	√	×	4	22	t.c.	7·5	1T from pin 6	4	6	1	
L9	×	×	×	6	18	t.c.	12·5	—	—	—	—	6mm i.d.
L10	×	×	×	4	18	t.c.	15	—	—	—	—	7·5mm i.d.
L100	×	×	×	3	18	t.c.	15	1T from chassis	—	—	—	7·5mm i.d.
L101	×	×	×	3	18	t.c.	12·5	—	—	—	—	7·5mm i.d.
L102	√	√	√	8½	36	enam.	close	—	6	3	—	
L103	√	√	×	3½	22	t.c.	7·5	—	1	4	—	
L104	×	√	√	30	36	enam.	close	—	—	—	—	

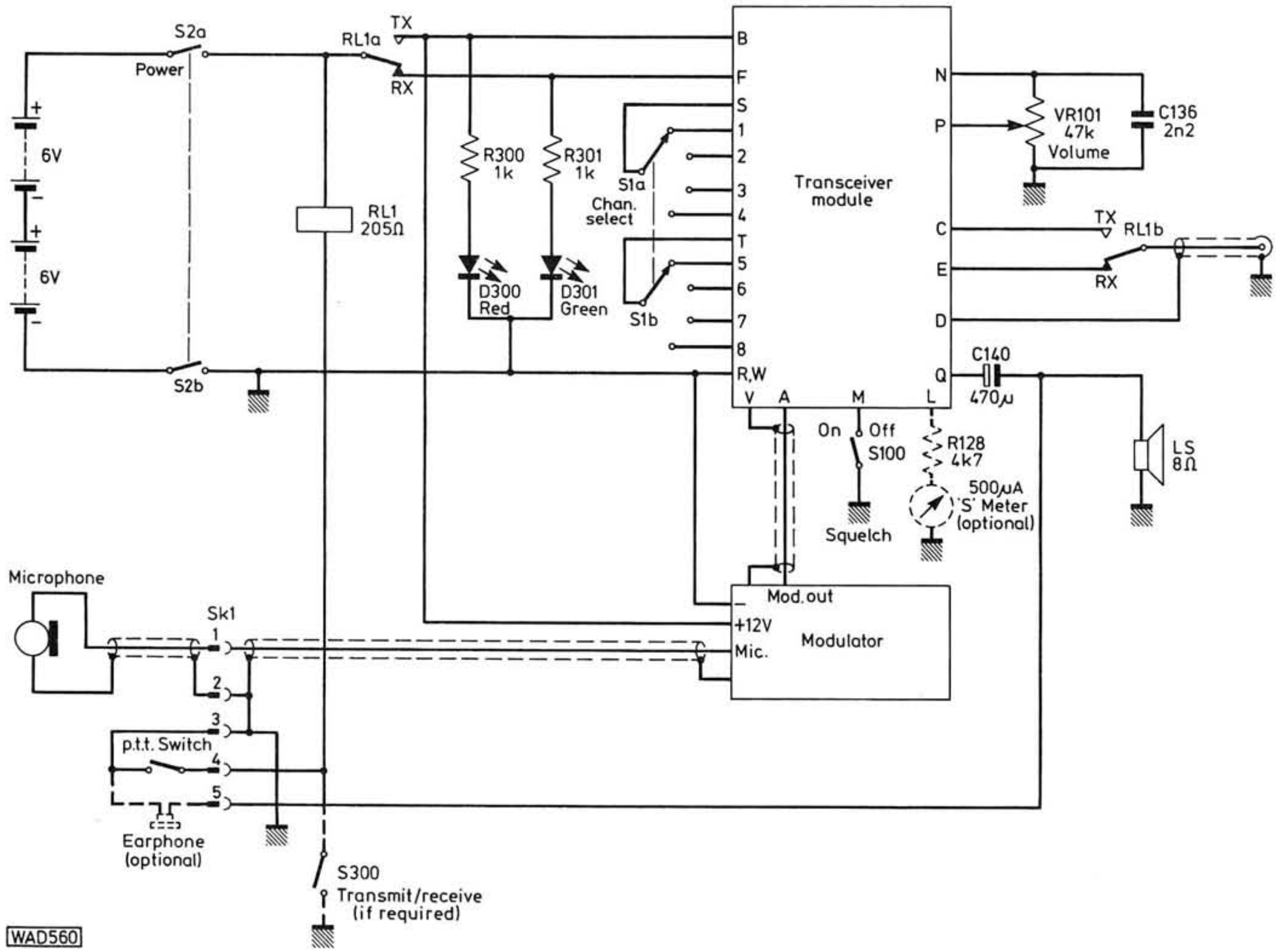


Fig. 13: Circuit diagram of interconnection wiring

Tuned Circuits

The construction of the various tuned circuits as described below depends on the use of the components as specified in detail in the parts lists. All but four of the coils used in the tuned circuits are wound on 4·8mm formers, the remainder (L9, L10, L100, L101) being self-supporting, air-spaced windings. The coil formers, with the exception of L104, are mounted on bases inside the screening cans; L104 uses a former mounted directly on the printed circuit board.

The convention which will be adopted to identify the base connections is illustrated in Fig. 9. The "flag" marker is used in the various illustrations to identify pin 1 of the base as viewed from the top side (the base itself carries no such marking in practice). The coils which are mounted in screening cans also have a number of passive components wired to the coil former base and the component layouts associated with these coils are shown in detail in Fig. 10, the coil windings themselves being specified in Table 1. It is recommended that the components on each coil base are all fitted before the completed unit is mounted on the printed circuit board. The windings themselves may be secured to their formers with a drop of polystyrene impregnant to prevent subsequent performance degradation arising from vibration-induced value changes.

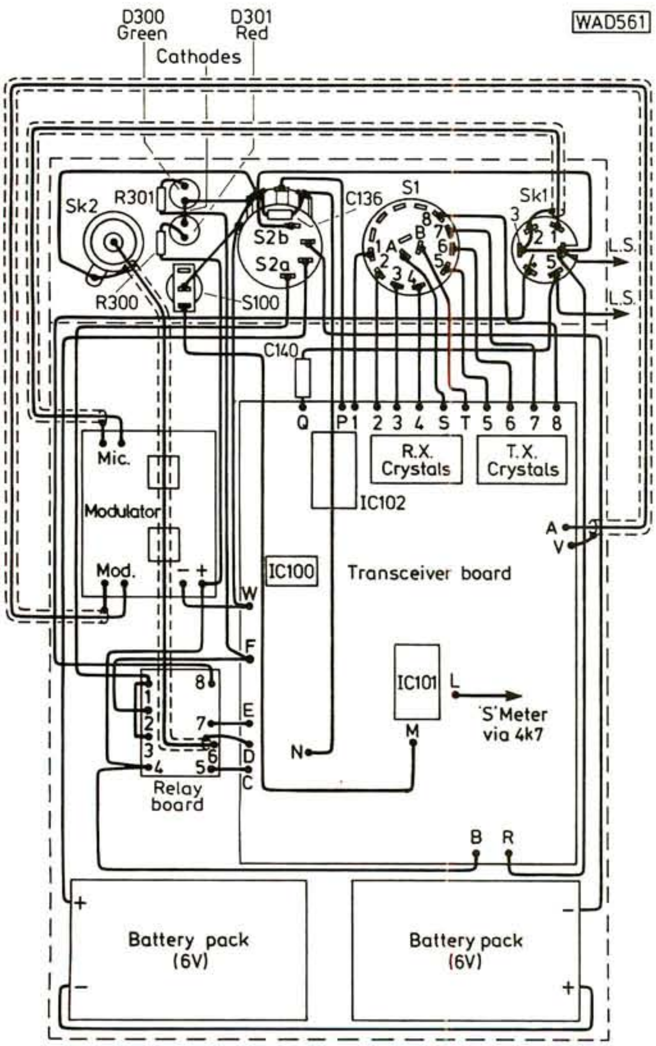


Fig. 14: Wiring and interconnection details

Transmitter Construction

The construction of the tuned circuits for the transmitter module should now be complete with the exception of L9 and L10 which are easily wound on the shank of a twist drill of the appropriate diameter and the winding length then adjusted while still on the drill. It is recommended that the tuned circuits and coils should not be fitted to the p.c.b. until after the remainder of the components are in place because this facilitates the insertion of the smaller components with much greater ease.

The component layout for the transmitter module is shown in Fig. 8. The use of fine insulated wire is recommended for the link adjacent to L1 and L2. The ferrite beads, FB1-3, are fitted and held in place by wire links through their centres as shown. The choke, RFC1, is constructed by close-winding turns of 30–36 s.w.g. enamelled copper wire along the length of a $\frac{1}{2}$ watt 1kΩ resistor, the ends of the winding being soldered to the resistor leads close to the body.

Receiver Construction

In most respects the construction of the receiver follows closely the pattern of the transmitter described in the previous section. However, there are a number of differences and additional considerations to be borne in mind. The receiver makes use of three integrated circuits and these may, if desired, be mounted in dual-in-line

Fig. 15(a): Copper foil layout of the relay board shown full size

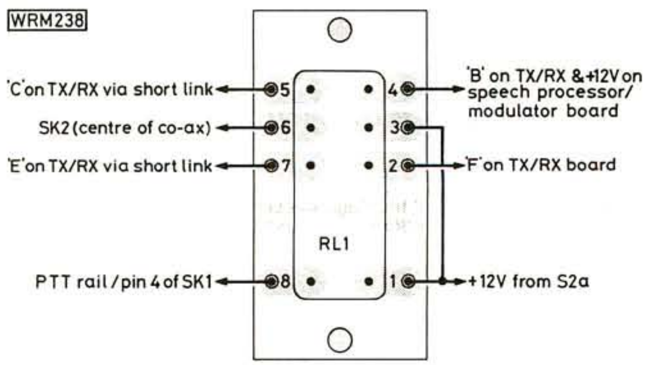


Fig. 15(b): Relay orientation and pin connections

sockets. In any event, the orientation of the integrated circuits should be very carefully checked before power is applied to the circuit.

The component layout for the receiver module is shown in Fig. 8, but this diagram has a link omitted for reasons of clarity. A coaxial connection is required between pins H and I, J and K, respectively. It should be noted that pin J is in fact one end of R133 which stands vertically in the position shown, i.e., the bottom of R133 is soldered to the p.c.b. while the top end acts as pin J.

The construction of the choke, RFC100, is similar to that of RFC1 described earlier, the difference is that the value of resistor used is 100kΩ. The inductor for the "trap" circuit, L104, is wound on a 4·8mm former which mounts directly onto the p.c.b. This should be a tight fit, but the former may be secured with a drop of adhesive taking care not to get any in the threads of the former.

Other points which may not be immediately obvious from Fig. 8 are as follows. The second local oscillator crystal, X104, is soldered in place without any socket. The gate connections of Tr101 cross over and so must have insulated sleeves. Choke RFC100 should be mounted horizontally on the p.c.b. The filters which define the performance of the first i.f. amplifier, FL100 and FL101, are Toko Type CFS10.7 which were designed for use in wideband f.m. receivers and are used here to provide broadband selectivity. The standard filters are available with 300kHz ± 50kHz bandwidth (−3dB), and attenuation of better than 20dB at ±600kHz. It is advisable to order filters in pairs to ensure matching characteristics, and filters with a narrower bandwidth (±150kHz at the 3dB points) are available from Ambit International under the description CFS10.7(150). All types are electrically symmetrical, and may be inserted either way round, with the centre pin always earthed.

The second i.f. filter is available in two forms. The CFU455H has a bandwidth of 6kHz (−6dB), while the CFU455F has a bandwidth of 12kHz (−6dB), both being ceramic filters in the same encapsulation. The filter used depends on the application, but the CFU455F is probably more suitable for general purpose applications.

Modulator Construction

The simple modulator circuit is built on its own single-sided p.c.b., the component layout for the board not being critical, but a good earth is desirable for decoupling purposes. A suitable p.c.b. track layout is shown in Fig. 11 with the corresponding layout in Fig. 12.

Constructors wishing to manufacture their own p.c.b. for the modulator should follow the same procedure as described for the main transmitter/receiver module. Alternatively, a suitable piece of 0·1in Veroboard may be used in place of a formal p.c.b. The two integrated circuits may be mounted in dual-in-line sockets if desired, but otherwise no special considerations apply to the mounting of the components.

Wiring and Internal Layout

The circuit diagram of the interconnecting wiring is shown in Fig. 13, the actual layout employed being very much a question of individual preference and the wiring diagram of Fig. 14 shows only one possible interpretation. In any layout, however, the following points should be borne in mind:

1. The aerial and microphone sockets should be physically separated. (Ideally at opposite ends of the front panel.)
2. Controls should be easily accessible and logically placed.
3. Controls and sockets should all be located on the front panel thus allowing the transceiver to be used in either the upright or the horizontal position. (The former is appropriate for "hand-held" use and the latter for dash mounting in a car.)
4. Links from the transceiver board to the crystal switch should be kept as short as possible, and 50Ω coaxial cable should be used for all signal connections including linking the relay board to the aerial socket.
5. The relay board should not be placed in close proximity to the p.a. transistor, Tr6 and associated components.
6. The relay board can be located immediately beside points E, D and C on the transceiver board. In this case coaxial links are not required and short lengths of 22 s.w.g. tinned copper wire will be adequate. A suitable layout for the relay board is shown in Fig. 15. Constructors may, however, mount the relay on a small piece of 0·1in matrix Veroboard if preferred.
7. The printed circuit boards should be mounted so that all test points and preset components are readily accessible.

In Part 3 we will deal with the alignment of the transmitter and receiver, setting up the modulator controls and finishing the completed project. Also included will be information on the crystals required for the most popular of the v.h.f. f.m. channels.

Please note that Tr105 was incorrectly shown as BC458 in the receiver components list. It should read BC548 as shown on the circuit diagram.

STEREO AUTO FADER

►►►*continued from page 28*

Adjustment

With the input connected to a programme source and the output coupled to a tape deck or amplifier, the deck or amplifier controls are adjusted for the correct channel balance. VR2 is set to give a microphone signal of the appropriate level, and R8 is adjusted to correctly balance this signal. VR2 is set for the highest threshold level that gives reliable operation of the automatic fader circuitry. It is not advisable to use a lower setting as this could result in accidental operation of the fader action and could also considerably extend the decay time of the circuit. R11 is adjusted for the desired level of fade out in the left hand channel and then R16 is used to balance the two channels with the automatic fade in operation.

If desired, a higher level of fade can be achieved by increasing R12 and R19 in value. The time taken for the signal to return back up to its non-faded level is proportional to the value of C1, and can be altered by changing the value of this component should a different decay time be preferred. Similarly, the time that elapses before the signal begins to return to its normal level is proportional to the value of C3, and can easily be changed if a different delay time is considered to be desirable. ●

RADIO SPECIAL PRODUCT REPORT

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YAESU

PART 2

Mobile HF TRANSCEIVER

In Part 1, last month, we looked at the circuit arrangements, and gave details and results of the transmitter section tests. The marine transmitter specifications were used as a "yardstick" for some of these, but it should be remembered that amateur equipment is designed to much less rigorous standards. Just as well, otherwise few amateurs could afford it! We now continue the receiver section tests and measurements.

Table 6 lists the internal whistles, and is produced by tuning carefully through each band in turn looking for the whistles, and then measuring the frequency and equivalent level. Table 7 lists external spurious, a much longer task. For this, the receiver is tuned to a frequency, and then the signal generator is set to a level of 10mV and swept, manually, from 500kHz to about 50MHz. Each whistle is then measured in level and frequency, and those above 100mV are ignored. This test is very laborious, but a signal generator of the type required for accurate measurement by sweeping costs about £16 000, and the authors employers haven't yet found sufficient justification for it!!

Table 8 lists the intermodulation performance. For this test, two equal signals spaced 20kHz apart are fed into the receiver, which is tuned 20kHz away from one of the signals. The levels of the signals are then adjusted, while maintaining equality of level, until the resultant received signal is equivalent to a 1μV input signal. For 2nd order intermodulation distortion, signals are chosen such that their sum or difference is equal to the frequency of tune. This test is very important in determining the receiver capabilities on an aerial.

Reciprocal mixing again uses two frequencies, and this test measures the noise sidebands of the local oscillator(s) in a receiver. It is especially important in synthesised receivers, and those using pre-mixed oscillators. Cross modulation is one of the most misunderstood terms in amateur radio, and rarely occurs in modern receivers—other effects mask it, and lead to operator intervention first! As can be seen from the results, cross modulation is masked by reciprocal mixing, and this seems a fairly common feature of modern receivers.

Finally, it may be noted that no measurements are made of selectivity as such. Because the equipment uses a com-

Table 6. Internal Spurious. Equivalent Input Levels

Band MHz	Frequency	Level μV
3·5	—	—
7·0	7·4155	0·07
14	14·165	0·1
	14·502	0·4
21	21·200	0·07
28·5	28·799	0·15

Table 7. External Spurious

Tune Frequency MHz	Spurious Frequency MHz	Spurious level for equivalent to 1μV i/p
3·7	3·915	87dB
	4·050	86dB
	4·500	80dB
	6·869	67dB
	9·000	90dB
	14·289	73dB
7·2	6·870	80dB
	7·808	78dB
	9·000	70dB
14·2	13·857	78dB
	32·212	80dB
21·2	39·202	70dB
28·7	23·400	58dB
	30·800	55dB
	33·200	75dB
	34·000	43dB
	39·300	65dB
	41·400	60dB
	46·700	50dB

Note: Spurious signals appearing at a level greater than 10mV have been disregarded.
No explanation is offered for the 10m band spurious being on multiples of 100kHz.

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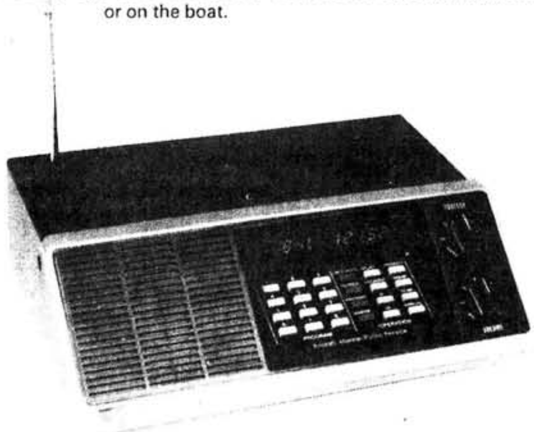

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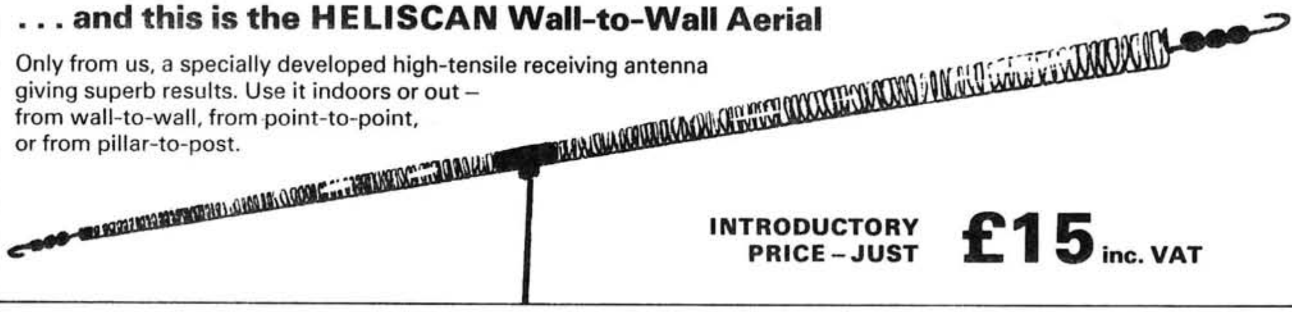

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Table 8. Receiver Intermodulation

3rd Order

Band MHz	Level for 1μV equivalent
3·7	59
7·2	57
14·2	55
21·2	58
28·7	65

2nd Order

Tune Frequency MHz	Frequency 1	Frequency 2	Level for 1μV equivalent
3·7	2·0	5·7	61dB
28·7	15·0	42·7	70dB

With the Aerial Attenuator in use, the improvement is about 15dB on 3rd Order, and 20dB on 2nd Order.

Table 9. Reciprocal Mixing

An input signal on tune is adjusted in level for a 13dB SINAD ratio. An unwanted signal separated by 10kHz and in the unwanted sideband is increased in level until the SINAD is degraded to 10dB.

Frequency MHz	Level for 3dB degradation dB rel. 1μV
3·7	69dB
7·2	60dB
14·2	65dB
21·2	65dB
28·7	66dB

Cross Modulation

At 3·7MHz. A signal with 20dB SINAD is degraded to 17dB SINAD, with 10kHz separation, a 1kHz tone being the wanted signal, and the unwanted signal modulated at 400Hz.

Level for 10% c.m. 75dBμV

Using the Aerial Attenuator 95dBμV

On other bands, the cross modulation is not measurable, being masked by the effects due to reciprocal mixing.

Blocking. This is limited by Reciprocal mixing.

CW Filter Selectivity

Bandwidth Hz	Rejection dB
80	3
267	10
600	20
1153	30

Clarifier Range

At 14·000MHz: plus 4·800kHz minus 2·735kHz
At 14·500MHz: plus 3·783kHz minus 2·132kHz

Table 10. Drift

Time from switch on minutes	Frequency Hz
0	14 214 800
5	14 215 001
10	14 215 265
15	14 215 373
20	14 215 567
25	14 215 660
30	14 215 720
35	14 215 773
40	14 215 837
45	14 215 889
50	14 215 932
55	14 216 003
60	14 216 052
65	14 216 097
70	14 216 138

Dial Error

The dial is calibrated in 1kHz increments. When calibrated at the centre of the band (14 200kHz), the dial error did not exceed 500Hz at any point.

mon s.s.b. filter for receive and transmit, quite accurate information on the s.s.b. filter is derived from the transmitter modulation/frequency characteristic. Without making connections inside, it is not easy to actually measure the filter response, and as a fair amount of information can be deduced from the transmitter measurements, and the effectiveness of the filter from the reciprocal mixing measurements, it is not considered worthwhile to attempt these measurements. After all, if the rejection of the filter is 80 or 90dB at 10kHz off tune, it scarcely matters which if reciprocal mixing means that a signal 60dB higher than the wanted one drowns it out with noise!

The final measurements are drift from cold, c.w. filter response, and transmitter key characteristics and clarifier range. The result of all these measurements is a pretty daunting set of figures, most of which can be meaningless without some standards of comparison. However, they can be boiled down fairly easily, and the comments on the results should put them into perspective.

Comments

The results obtained from the FT-7B were, in the reviewers opinion, somewhat disappointing. Working through the results in order, and starting with the transmitter, it can be seen that the output power is around the 45 watt level. This can give a respectable mobile signal, and is about what should be expected from a 100 watt input transmitter. The intermodulation products are reasonably well reduced, while the spurious output levels (including harmonics) are at a level which can only be described as very satisfactory. Indeed, for a mobile rig, these levels are about 20dB lower than is required for interference-free use! The modulation frequency response gives a very good indication of the filter characteristics, and the results are very good when looked at in terms of unwanted sidebands. The out-of-channel radiation is reasonable, but not good enough to meet the usual commercial specifications, and the relative levels can be seen from Fig. 4. The carrier suppression and hum and noise levels are very satisfactory.

In view of the above comments, it may be wondered why the equipment was disappointing. This disappointment lies mainly in the receiver, but one item of the transmitter measurements needs mentioning, and this is the c.w. keying. At 25 bauds (approximately 30 w.p.m.), the distortion of the keying was about 75% when an equal mark-space ratio at the key was used. To reduce the distortion to a reasonable amount it was necessary to reduce the keying speed to about 15 w.p.m., because of the lengthening of the dots. At this speed, however, the signal does not suffer from clicks, although the rounding of the characters accounts for this. To what extent this distortion will effect the readability of the Morse is hard to say, but is unlikely to help, especially at reasonable speeds.

The receiver performance was notable for its extreme sensitivity—so much so that the measurements were repeated because of disbelief. The 10m band sensitivity could be improved, while the 80m performance really requires the attenuator in circuit at all times. The ultimate SINAD is not very good, representing around 5% equivalent distortion. However, the limitation was not distortion, but noise, indicating that the distribution of r.f. gain control could be improved. The a.f. output power is adequate for mobile use—3 watts makes a very loud noise, even overpowering the car noise in a rather old and noisy estate car! The a.g.c. performance is reasonable for signals above the 5 to 10μV level, but the threshold seems to be very high—most receivers would give somewhere around a 6dB increase for levels from 1μV to 10mV, and so overall, weak signals have a tendency to sound weak. Especially on 10m, the loss of gain is very noticeable.

Receivers using pre-mixed injection and a 5·0–5·5MHz v.f.o. are usually well provided with a number of internal spurious whistles, especially at 21·2MHz, where the 4th harmonic of the v.f.o. is on the tune frequency. The lack of internal spurious is surprising, and laudable, there being only three of them in band. External receiver spurii are quite acceptable, but as to why those appearing on the 10m are at multiples of 100kHz, no explanation can be offered.

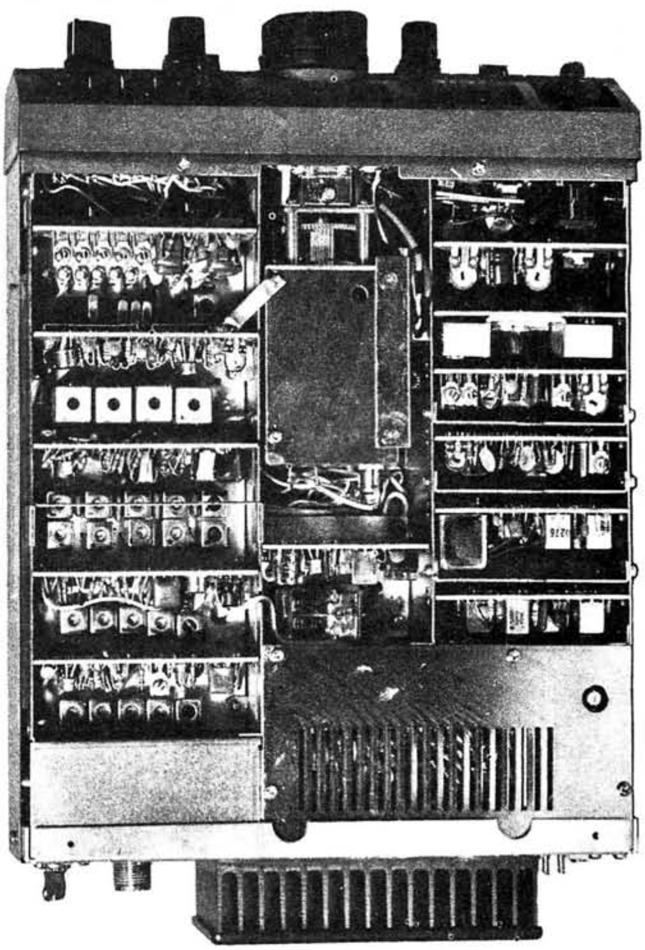
Intermodulation is very disappointing. It is interesting that the 10m band, where the sensitivity is falling off, is also where the intermodulation is improving. This suggests that the step-up to the r.f. amplifier is rather less on this band. From a design point of view, the number of stages between the aerial and the main selectivity of the equipment is enough to cause large problems of intermodulation, and this is shown by the results. The 2nd order performance is just as disappointing, and the effects of introducing the aerial attenuator are completely at odds with the effects that are usual and predicted by theory. At signal levels below the point where overload takes place, the reduction of the input signal by 20dB by using the aerial attenuator should require an increase in signals from the generators of 20dB each to produce the same equivalent intermodulation product level. The increase was definitely less than 20dB, and was about 15dB on 3rd order IMD, and 20dB on 2nd order IMD.

It is possible that the switching of the aerial attenuator is responsible for this effect, but this is considered unlikely. A more probable cause is the number of diode switches in the signal path, and the diodes coupled to the aerial output for a.l.c. Nevertheless, a thorough explanation of this effect is difficult to find. Checks with the spectrum analyser show that signals at a level of +90dBμV can be achieved with an intermodulation ratio of 90dB, so it is felt that the test set up can be considered innocent. However, the general level of intermodulation in the receiver was distinctly poor, and although the lower signals available in a mobile installation may reduce the importance of IMD in the receiver, the results are not very good. From a design point of view, there is just too much gain, and too many stages, between the aerial and the crystal filter. Reciprocal mixing is a very real test of the receiver performance capabilities in a real world of interfering signals, and here again the figures are not outstanding. More surprising is the fact that cross modulation is masked by reciprocal mixing.

There is a definite mathematical relationship between intermodulation and cross modulation, and this relationship is generally found to be borne out in practice, but not in this case. Taken with the intermodulation results, the reviewer suspects that the signal handling capability of the large number or pre-filter stages is insufficient, and that the compression point of the system is too low. The reciprocal mixing is noticeably better on 80m where the injection is not premixed, but it should be noted that on 40m, for example, the noise sidebands were some 77dB down on the wanted signal. On 80m, the ratio was about 90dB, which is very acceptable when using a 6-pole filter. Blocking was not measurable, being well masked by reciprocal mixing—a strange result when considering the IMD performance and compression.

The other parameters—c.w. selectivity, clarifier range, and drift are satisfactory, although the clarifier may be considered by some to have excessive range.

The YC-7B digital readout unit was used at the same time as the equipment. For those desiring digital readout, it is doubtless a useful accessory, but is by no means necessary to be able to get on to frequency with reasonable accuracy—especially as the one tested had a 600Hz error! However, the connecting cable could well be made rather longer, as this was found somewhat annoying in its short length.



On the Air

The FT-7B was tried mobile, and was carefully set up as per the instruction book. The MIC GAIN was advanced to the point where the output was not rising, and the reports were of high distortion and almost unreadable signals. By reducing the MIC GAIN to the point where a whistle led to a p.a. current about two thirds of that achieved on two-toned test led to acceptable results. However, reports on speech quality were not as complimentary as on other rigs, and reports from stations knowing the reviewer were that the modulation was harsh. The noise blanker made little difference on 80m, but noise blankers are an area where results seem to be more than usually subjective, and the reviewer has been present at tests where one listener, equally experienced, found a major improvement while the reviewer couldn't tell the difference! Further tests then produced the opposite results, so the matter is one for further experiment.

On 80m, the aerial attenuator was vital at night, and on 40m, most of the time. Nevertheless, the number of strange signals that could be identified as due to intermodulation were considered excessive, and the change in noise levels when additional attenuation was used in the aerial lead was educational.

The final points that were found were that the jack sockets for phones and key were the small size, and the provision of standard 0·25in sockets would have been an advantage, although adaptors are apparently supplied normally. The knobs are of convenient size, although the concentric DRIVE and TUNE knobs suffer from mutual undesired mechanical coupling.

continued on page 60 ▶▶▶

A GERMAN WARTIME RECEIVER

Ron HAM

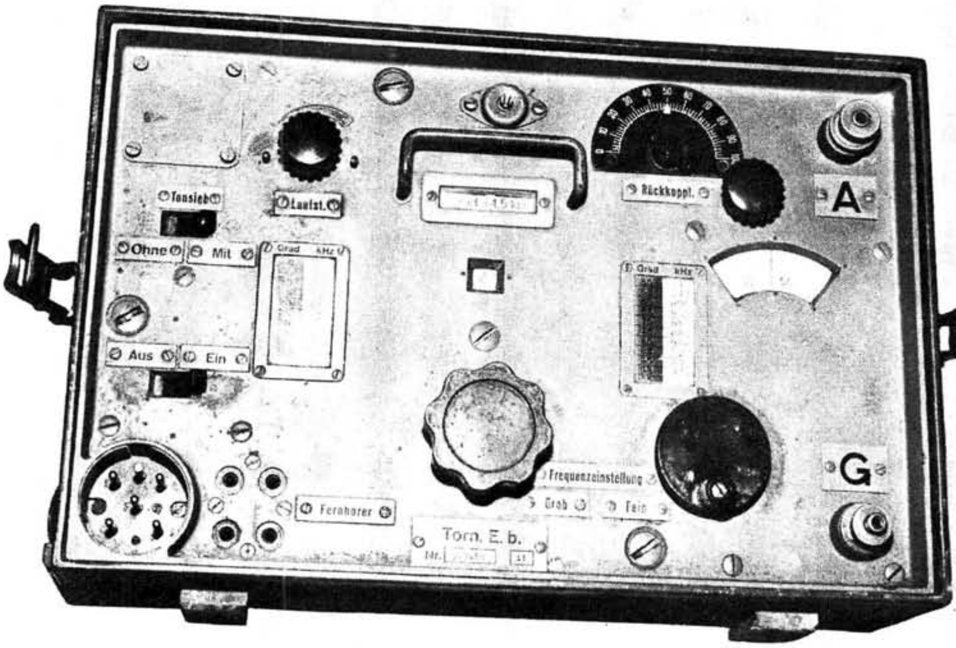


Fig. 1: Telefunken receiver made in 1941 for the German military

Although, after World War II, tons of military radio equipment used by the Allied forces was sold, almost at scrap prices, only a relatively small amount of German equipment was available. Therefore, any of the wireless sets used by the Luftwaffe and the Wehrmacht that appear today are sought after by collectors.

A recent addition to the author's collection is a Telefunken receiver (Fig. 1) in excellent condition, labelled Torn. E.b. and dated, 1941.

Like all military equipment, this set is beautifully engineered and is housed in a strong metal case, with carrying handle and the Eagle and Swastika emblem stamped inside. The complete unit measures 330 × 210 × 222mm, weighs 26lb and covers 96·6 to 7095kHz. The frequency range is divided into eight wavebands by a magnificent turret range selector which is 152mm diameter and occupies the centre of the main chassis (Fig. 2).

After rotation, the selected range is retained by a detent wheel under pressure from a 152mm long, 6-segment leaf spring visible behind the cable harness above the turret in Fig. 2.

There are three sections to each of the eight turret coil assemblies mounted on the rotatable frame, and each one, measuring 146 × 57mm (Fig. 3) is secured to the rotator by four screws and has 10 brass rings about 5mm wide,

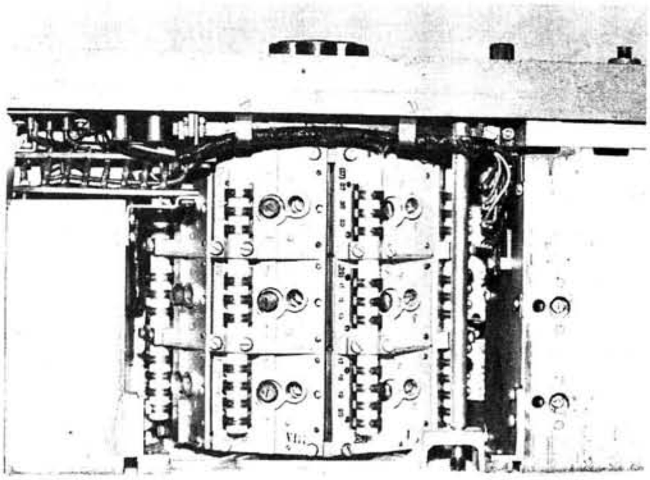


Fig. 2: Underside of the receiver, showing the turret range selector

(A somewhat similar turret, but with four sections to cope with two tuned r.f. stages, frequency changer and local oscillator, was used in the B21B h.f./d.f. ("huff-duff") receiver used by the Royal Navy—Editor).

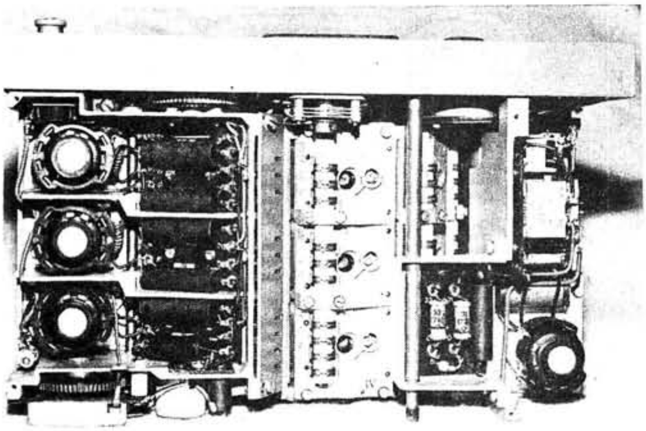


Fig. 3: Top side of the receiver, showing the valves in position and coils about to engage in the contact block on the left

which make contact with the receiver circuitry. The main tuner is built from three separate variable capacitors, each with an 8mm shaft supported by two 22mm ball races and all mounted in a sectionalised diecast box. The large tuning knob, seen on the right in Fig. 1, the ganged capacitors, and the scale marked 0–100 are coupled together by a series of gear wheels to avoid backlash and to give accuracy of tuning.

Although the four RV2P800 valves are themselves screened (Fig. 4), each one plugs into a long metal container with a ceramic insulated contact at the bottom for the pin, and side contacts at the top (Fig. 3), for the other valve connections.

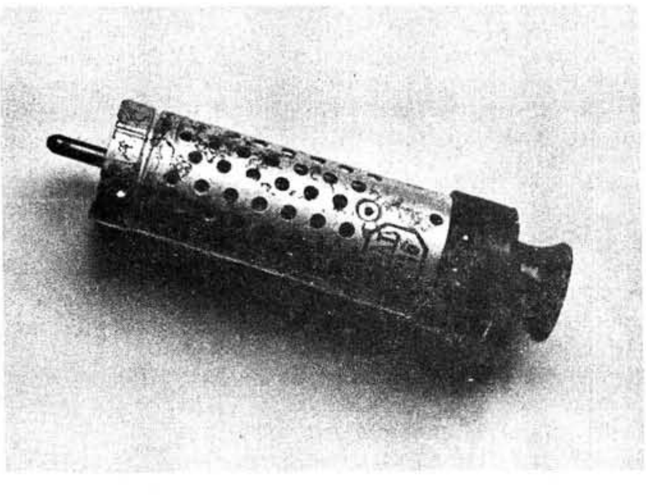


Fig. 4: One of the RV2P800 valves made for the German government by Telefunken

These directly-heated pentode valves, made by Telefunken for the German government, require 1·9 volts at 180mA for the filament, 120 volts on the anode and 80 volts on the screen grid. The set is supplied with power via the 6-pin plug on the left of the front panel (Fig. 1), and the headphones are connected to the four adjacent sockets.

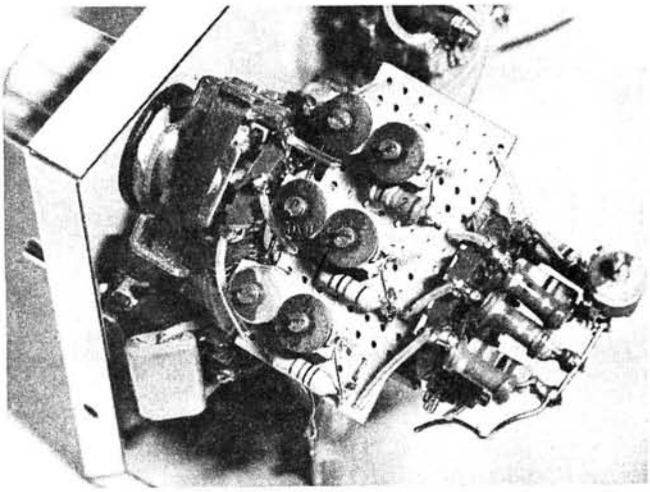
Every part of this set, including the aerial and earth terminals, marked A and G, is very robust and more than adequate for the job to be done. ●

DUAL TRACE UNIT

▶▶▶ *continued from page 36*

the picture, but if Y1 only is selected, then the Purbeck can be set to Internal trigger thus avoiding this problem. Alternatively a larger version of the waveform under investigation may be available at some other point in the circuit, in which case the Y2 input can be connected to this and the Dual Trace Unit triggered from the Y2 channel. These very high sensitivities are of course mainly of use at audio frequencies, and in these circumstances, triggering stability can be improved by setting the TRIG selector switch of the Dual Trace Unit to LF REJ, thus limiting the bandwidth of the trigger channel. In fact, a simple but useful accessory for limiting the bandwidth of the signal channel itself, with a choice of cut-off frequencies, will be described in a future article.

Note that when working at these high sensitivities, great attention must be paid to earthing and screening arrangements, otherwise the signal it is desired to view may be swamped with hum pick-up. ●



Close-up detail of the input attenuator for one channel of the Dual Trace Unit. The other attenuator is built in the same way

Components

Several minor errors crept into the components list. R658 appears twice in the circuit diagrams and component overlay. The resistor shown on Fig. 11 as R658 and placed at an angle below C623 and to the top left of IC607 should be 100Ω and is the R658 associated with Fig. 3. The other R658, shown next to C625, is 100kΩ and is the one associated with Fig. 6.

R660 is 7·5kΩ not 1·5kΩ as shown in the caption to Fig. 6.

The twelve tantalum decoupling capacitors should be 47µF 16V not 17µF as shown in the components list. In most instances not all of these will be needed.

Three 4·7nF polyester capacitors are required, C521, 522, 523 and these, as with all components numbered in the 500 series are mounted on the front panel components.

The fourth 22kΩ resistor in the components list should be R659 not R657 and R644 is 47kΩ not 47Ω.

FT-7B REVIEW

►►►*continued from page 56*

The handbook is remarkably detailed, and contains the necessary information for servicing the equipment. However, as mentioned earlier, without the card extenders, maintenance is very difficult, if not impossible, so the information may not be of as much help as at first envisaged. A large amount (for an amateur) of test equipment is required for alignment, including r.f. and a.f. signal generators, an oscilloscope, valve voltmeter and sweep generator. Possibly the skilled technician could improvise for many measurements, but it seems a pity that the bandpass filters could not be set up by a method not requiring a sweeper—for example, by Dishal's method. However, the famous Japanese English clangers seem noticeable by their absence, although there may be some that were overlooked.

The specifications given in the handbook are the usual meaningless ones. For example, the transmitter specifications list carrier suppression, sideband suppression, spurious and distortion products as being so many dB down, without saying whether the measurements are relative to p.e.p. or one tone of a two-tone signal, which give answers different by 6dB! Antenna output impedance is even more meaningless—the output impedance of a transmitter, like any power generator, should be as low as possible, and the correct term is design load impedance, which, it should be noticed, is not always the optimum load impedance achieved in practice! The receiver specification suffers similarly when it talks about audio output impedance, while the sensitivity is not defined as either e.m.f. or p.d., which again gives a 6dB difference. Spurious responses, other than image and i.f. rejection, with multiple signal tests see the handbook being extremely reticent, although this is unfortunately not uncommon.

Most of the semiconductor devices can either be replaced with near equivalents, or are readily obtainable European or American types, with the exception of two Toshiba i.c.s. For equipment destined for export to the USA or Europe, the use of more readily available i.c.s in these positions would possibly be welcome, and there is no shortage of suitable devices. This is however a fairly minor point, unless one has a rig out of use while spares are obtained. Apart from these two i.c.s and the r.f. power devices, however, the average largish town with some sort of electronic components shop could probably provide replacement devices for all of the semiconductors in the set from stock, which is more than can be said for many equipments!

Summing up, the results obtained from the transmitter are very good, with the exception of the speech quality and c.w. keying, while the reviewer rates the receiver performance as definitely very poor. The handbook is good, but the maintainability terrible, and Joe Q. Average Ham relies on the dealer with a well equipped workshop and well qualified staff for maintenance. A previously published review on the FT-7 did not investigate the receiver performance in any detail, and although there are a number of amateurs who can be heard praising the equipment very highly, there are a remarkable number of sets available second hand.

The reviewer's opinion is thus somewhat in conflict with many others, but it is a regrettable fact that analysis of receiver performance on the air is by no means as easy as some amateurs would like to believe. ●

Costing £431.25 including VAT (plus £69.00 for the YC-7B digital readout), the FT-7B reviewed was kindly loaned by South Midlands Communications Limited, S.M. House, Osborne Road, Totton, Southampton SO4 4DN. Tel: 0703 867333, and we would like to thank them for their invaluable assistance in this respect.

by Eric Dowdeswell G4AR

With several h.f. communications receivers now on the market intended for amateur radio listening, the potential customer will try to evaluate their various facilities and equate them to the cost, trying, naturally, to get the best value for money. If one is sufficiently knowledgeable the best way is to list the requirements for an acceptable receiver and see how the proposed set matches up to the list.

At the moment some of the features, usually listed under the assinine heading of "state-of-the-art technology" are of doubtful value and, indeed, some run contrary to good receiver design. But, first of all, let us look at the receiver used by **Bill Rendell** of Truro in Cornwall, who has an old valved Heathkit AR3 to which he has added numerous bits and pieces until he has, at the last count, some 18 different controls! But, he is able to copy s.s.b. and c.w. signals at signal levels which, I venture to suggest, cannot even be heard on some present-day receivers.

Why should this be so? Because every circuit on the r.f. side is separately tuned "on the nose" for the particular frequency concerned, by having fine tuning on the individual sections of the ganged tuning capacitor. Thus there is maximum rejection of all signals on both sides of the required frequency and cross modulation effects are at a minimum.

I am not going to suggest that we all make carbon copies of the Rendell Wonder but the basic principles of good receiver design ought to be followed in commercially produced sets. Regretfully, this does not always happen. Certain controls and functions are sometimes omitted, ostensibly to make our lives easier but, in reality, to make the life of the manufacturer simpler, and these changes are thrust upon us as "progress".

Years ago the output stage of an amateur transmitter had two controls, tuning and loading, enabling the stage to be matched to a quite wide range of aerial feed impedances. The loading capacitor was then replaced by a fixed one, much cheaper, for a fixed output impedance of 50 ohms, immediately reducing the versatility of the stage. Now it is common to replace the tuning control too, replacing it with a fixed tuned band-pass filter that offers much reduced rejection of unwanted harmonics and spurii that now get radiated.

This band-pass filter now finds itself at the front end of receivers, switched in automatically with operation of the band switch in the r.f. and mixer stages. Consequently every signal within the passband is being applied to the transistors or devices in these stages and cross modulation is inevitable, and some of those signals can be pretty hefty, running into many millivolts. Weak signals stand little chance of being resolved even if they can be heard.

The cross modulation problem, having been created, is ostensibly overcome by fitting an "r.f. attenuator" which, while reducing the input level of strong signals, also reduces the strength of the wanted weak one! The attenuator will improve the situation in some circumstances but why create the problem in the first place? The separate "pre-selector" tuning used on receivers for a long time past is infinitely superior to the band-pass filter idea, and when combined with separate r.f. and i.f. gain controls, offers the best possible chance of resolving that weak DX.

Receiver manufacturers naturally have to use all reasonable marketing techniques to further the sale of their products, hence the continuous flow of "innovations" which may sometimes be plain gimmicks or old ideas rejuvenated under another title. But it does seem wrong when the performance of a receiver suffers in the process.

How lovely it would be if a manufacturer could produce a receiver that met the requirements of good design at a reasonable price, leaving out all the fancy bits, and using a valve in a particular stage if it can be shown to perform better there than its solid-state counterpart. It would mean a few more controls on the front panel but we would, at least, get back to a receiver that did the job it is supposed to do. Namely, produce a signal with a minimum of noise and free of interference from other signals.

General Notes

In West Wickham, Kent, **John Dainty** is wisely spending more time swotting for his RAE than listening on his FRG-7. He is thinking of putting up a G5RV aerial which will serve as an all-band job when he gets his ticket and will perform well in the meantime. John had occasion to take his FRG-7 with him on jaunts to East Anglia and Newcastle, only to find the cold of the QTH's affecting the receiver to the extent that he could not resolve s.s.b., not an entirely unknown trouble with this set, he says. I suppose one could fix in a small heater to keep the temperature more or less constant on such occasions. No such troubles with valved sets! *(Not my experience! Ed.)*

Jim Rowland (Tetbury, Glos) says he is way out in the country where man-made noise, electrical that is, is at a very low level so he promptly noticed that something was wrong recently when an electric fence started to give trouble. Seemed the 6V system uses a transistorised unit run from dry batteries and someone decided it would be economical to use a 12V car battery! All was well, fortunately, when 6V was applied again. Jim comments that some cows seem to enjoy the "kicks" they get from the fence.

D. A. Day writes from 46A Seaside, Eastbourne, Sussex, to ask if anyone has any info on the old Hallicrafters Super Skyrider, as he has one he'd like to get back into working order. A circuit diagram or service information would be most welcome. In Aisby, near Grantham, Lincs, **Arthur White** is also keen on putting vintage equipment to rights, but at the moment would like any info on the Cossor 339A 'scope so if you can help I will gladly pass the gen on.

While on the subject of 'scopes, **F. Dickenson,** 5 Farmfields, Sanderstead, Surrey is also seeking assistance, on the Tektronix valved 561A oscilloscope where a manual would be of great help. In both cases cost and postage would be refunded with pleasure. Final appeal this month is from **Ian Haggart** G3JQL, 22 Alnwick Road, Newton Hall, Durham, who'd like to beg, borrow or steal a manual on the Eddystone S750 receiver. Ian, to use his own words, "has returned to the fold" after being QRT for eight years and asks "where have all the home-built stations gone"? Every station describes its equipment with a string of numbers! Too true Ian, and if you don't know what they mean an inferiority complex can develop! Ian likes the increased amateur radio content of *PW* compared to a few years ago. Don't we all!

Top to Ten

Dave Coggins in Knutsford, Cheshire, has parted with his old faithful DX160 and bought an FRG-7 so it's a log for all bands from 10 to 160m and very nice too. I do notice that a few readers with this set seem to ignore the fact that there are bands other than 20m so do try them. They can be a pleasant surprise if you can get on at the right time. With a 66ft aerial and a.t.u. Dave heard VP2MCK and SAX plus VU2USE on 10m, J3AAG (Grenada), VP1KS and 3D6BP on 15m. 40m produced AA7A/VP2A on Antigua and J6LOO on St Lucia and a rare one 5T5JW. Down in frequency and it was VP2MCK, again, and OX5AP on 80m with top band 160m revealing UQ2GBU, N4ASV and W8JI in an early morning session. Later Dave mentions VK2AVA most evenings around 1900 on 3680kHz.

Just to prove what I was saying earlier about **Bill Rendell** of Truro he found XE1UF on 40m, J3AH on Grenada, KG6RN and TN8AJ on 20m, the latter being a seldom heard call, while 15m came up with FG7AR/FS7 and J6LOO on St Lucia. Bill didn't knock off his task of hearing VK/ZL on successive days until he'd reached the 201 mark but it was dodgy on some days with stalwart VK3MO always there in the end, sometimes better than Radio Australia! Ha, ha! that means you sometimes sneak on to the BC bands! Shame on you.

Our RTTY king **Dennis Sheppard** (Sheerness, Kent) has been off work and feeling pretty grim to the extent that he has not been listening all that much. That must be bad so get well soon OM. Latest aerial is a 66ft top with feeder from the centre so being a top-loaded vertical it ought to be fine for the low angle DX stuff. 10m proved best this time with EA3BQQ, LU4EGE, VE1TX, W5ZNN, WD8IUP, YO2IS, 4U1ITU and 9H1ET all on RTTY with just JA1ACB on 15m. SSB reported includes HP3FL and 3V8AA on 80m plus VP9BO and W2HCW on 160m.

Allan Stevens of Crowthorne, Berkshire, was pretty disgusted to hear A7XA in Qatar say that he was using 30kW, yes kilowatts! I feel it was someone playing around with a BC transmitter in his time off rather than some exasperated DXer trying to work that final, final country! Pick of the bunch for Allan was VP9JR on 15m, 6W8FZ on 20m and EA8AK and JA9UX on 40m, all s.s.b. Allan, like many more around the country, is champing on the bit waiting for the December RAE results!

Arthur White, mentioned previously, is not satisfied with his 265ft long wire, 80m inverted dipole and dipoles for 15, 20 and 40m but wants to put up a Beverage about a 1000ft long! He has a field adjoining his QTH and hopes the birds won't mind! They will welcome the extra perch OM! But seriously, I too would welcome information on a practical Beverage aerial with details of matching transformers, etc. Plenty of basic circuits in the books but nothing practical. Any ideas, anyone, of a source of info?

15-year-old **Sean Richards** of Maidenhead, Berkshire, has been listening for the last six months and decided to stick to the amateur bands after joining the Maidenhead and District ARC. He has an SX28 plus a 66ft wire. RAE is taking up some of his time and, optimistically, he is talking of taking it in May! I'm glad to hear that he has no interest in a G8 call and will take the code test as soon as possible. Quite a programme, but good luck all the same, Sean. Working down from 80m where he heard CN8AK, EA6CP, EA8FG, FM7WS, G2ACK/VP2M, JA6IEF, YV3AZL, ZS6HP, 4X4VL, 5B4CR and 7X4MO, 40m provided EA8JS and ZL4BO. On 20m it was 6W8GC, 9Y4VP, FM7BUL and VP2AZG with C6ANU, FR7RC, FM7AX, VQ9PC (QSL K9KLR), VP8SB, ZD7SO, 3B8CF, 3C1AC (QSL EA7FY) on 15m. Ten metres came up with AP2P, EA9GD, FG7AR/FS7, HP7XRK and K1CO/PJ7.

Club Time

Propagation is the subject of a talk by G3LEQ at the **Bury RS,** G3BRS, on March 11 at the Mosses Youth Centre, Cecil St., Bury, while one to note for next month is a TVI Seminar on April 8. These meetings on second Tuesdays are interspersed with informal meetings on the remaining Tuesdays where code practice and construction projects are the order of the day. Newly-elected PRO for the society Chris Marcroft says membership is now over 100 for the first time. Write him at 24 Lancaster Avenue, Ramsbottom, Bury or try Ramsbottom 2168.

Liverpool and District ARS also meets on Tuesdays, at the Conservative Rooms, Church Road, Wavergate at 8pm with a bring and buy sale on March 11, More Magic with G3SIW on the 18th and a constructional contest on the 25th. Thursdays 8.30pm sees G3AHD, the club station, on 144·250MHz with slow Morse practice. More from: Al Neilson G4CVZ, 78 Ackers Hall Avenue, Liverpool or 051-220 5470 after 6pm.

Northern Heights ARS will be glad to see you at 8pm any Wednesday at the Bradshaw Tavern, Illingworth, Halifax, with March 12 being construction contest night and the 26th devoted to microcomputer basics by three of the members G3TQA, G8CHN and G8SDE. NHARS News is a well produced newsletter and it is a pity that others do not follow this example. Believe it or not some newsletters I get aren't even readable! No information on where the club meets or its officers or, at least, the secretary's QTH. A pity, because if a job is to be done then it is worth doing well and it doesn't take a lot of effort to see that copies are readable and to scrap them if they are not.

The Watling Community Association, 145 Orange Hill Road, Burnt Oak, Edgware, Middx is the venue for the **Edgware and District RS** on March 13, when G3TDR talks on s.s.b. transceiver construction and that ought to draw the crowds. On the 27th the club station G3ASR will be on the air. Write to: Howard Drury G4HMD, 39 Wemborough Road, Stanmore, Middx for more info.

Ken Crouch G8KEN, chairman of the **Dover RC** and

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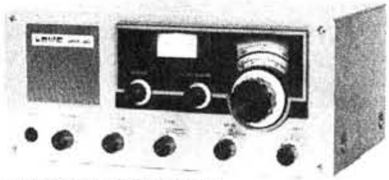

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the RSGB's SE Kent area rep, keeps me in touch with events in the club, like G8EGT on test equipment on March 12, activity night on 20m with the club station G3YMD on the 19th, and constructional competition judging on the 26th. The club station is also available at other times. Contact: Ken Crouch, 14 Victoria Road, Capel-le-Ferne, Folkestone, Kent, or ring 55241.

Two big events for the **Ipswich RC** in 1979 were the club callsign G4IRC, for which they had obviously been waiting, and the first club magazine, and a fine effort it is too. QUA (have you any news?) is an 18-page job and one only hopes they can keep it up. It even includes info on other clubs in the area! March 12 has a talk from the PO Radio Interference department and on the 26th it's RAE question night with answers to candidates' problems. Meetings second and last Wednesday of the month during school term, at Handford House, Ranelagh Road, Ipswich but ring: Jack Tothill G4IFF, 76 Fircroft Road, Ipswich on 0473 44047.

Ian Daniels has taken it upon himself to talk of home-made colour TV cameras and 10GHz links on March 12 for the **West Kent ARS** at the Adult Education Centre, Monson Road, Tunbridge Wells, where they meet alternate Tuesdays with informal meetings at the Drill Hall, Victoria Road. You'll have to work it out from March 12! Or write/ring: Brian Castle G4DYF, 6 Pinewood Avenue, Sevenoaks, tel 0732 56708.

North of the border it is the **West of Scotland RS** GM4AGG that should interest readers in the Glasgow area. Meet every Friday at 22 Robertson, Glasgow where gear for h.f. and v.h.f. is in operation, but contact: Ian McGarvie, 3 Kelso Avenue, Paisley PA2 9JE.

Briefly

Lincoln SW Club, second and fourth Wednesday, 8pm, Lincoln Corporation Social Club, Waterside South. Mike Wells G8PNU, 4 Horner Close, Brant Road, Lincoln. **Stevenage and District ARS,** first and third Thursdays, Senior Staff Canteen, British Aerospace Site B, Gunnels Wood Road, Stevenage at 8.15pm. Peter Byrne G8MCV, 21 High Plash, Stevenage, 0438 64624. **St. Helens and District ARC,** Wednesday evenings YWCA HQ, 107 Corporation Street, St Helens at 7.45pm as there is code practice before getting down to business. Try Paul Gaskell G8PQD, 131 Greenfield Road, St.H. or ring 25472. Finally, **Maidenhead and District ARC** first Thursday and third Tuesday, 7.45pm, Red Cross Centre, The Crescent, M'head or contact John Patrick G3TWG, Bedford Lodge, Camden Place, Bourne End, Bucks or Bourne End 25275.

Do write to me direct and not via *PW*. My address is in the box in *On the Air* every month.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

The Regional Radio Conference of the Western Hemisphere, which meets in Buenos Aires this spring, has a proposal on its agenda that could have far-reaching consequences for the medium wave DXer. The United States is pressing for 9kHz separation between stations, in line with the Geneva Plan which applies to the rest of the world. If adopted, it will mean that the DX slots that currently exist in between European stations will disappear, since the m.w. band will be divided into a number of world-wide channels. Not a bad idea from some points of view but it would certainly make medium-wave DXing even more difficult than it is at the moment.

Reception Reports

"Can you tell me how to obtain QSL cards from the stations I log—" is a question often asked. Writing to a long- or medium-wave station requires quite a different approach than on the short-waves. You are outside the

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service area of your DX and consequently you are not one of that station's intended listeners. So always send return postage, either unused postage stamps of the country concerned or an International Reply Coupon obtainable from main post offices for 25p each. The one illustrated was issued in Reykjavik and sent to me by a *PW* reader in Iceland.

Since you are relying on goodwill for a reply then write a more personalised report than usual. Tell the station your hobby is DXing, that you are using a — receiver and give the date and time and some programme details so that they can confirm that you did actually receive them. Ask for a verification of reception and if you receive one from a distant station then write back and thank them for it. An airletter form is not expensive and you will be enhancing the reputation of the hobby among m.w. broadcasters. The addresses of most stations are to be found in the *World Radio and TV Handbook* which had full page adverts in the January and February issues of *PW*.

Beginners' Corner

West Africa is not too difficult to pick up on the medium waves. Tune to 765kHz and when the French speaking station (Sottens in Switzerland) signs off, usually around 2300, then Radio Senegal in Dakar should be audible. It transmits on this channel well into the night and can easily be recognised by its African music, drums and singing. The station announcements are in French as well as in local languages and you will get a QSL if you send them an IRC along with the reception report. The address is Radio Senegal, Boîte Postal 1765 Dakar, Senegal.

Now tune to 702kHz and at 2330 you should hear more African style music and singing until 2350 when the programme changes to readings from the Koran prior to close down at midnight. You are listening to Sebaa Aioun in Morocco which carries the Berber programmes of Radiodiffusion Television Moroccaine, whose address is Rue el Brihi, Rabat, Morocco.

I have picked up Dakar and Sebaa Aioun with my Vega 204 (which is an earlier version of the 206) using its internal aerial, so both stations should be audible on most receivers. Remember the slow cyclic fading that is characteristic of a DX signal on the medium waves. It lasts a minute or two and is quite regular so it is very easy to miss DX if you only pause momentarily on a frequency.

Ougadougou

If you have been successful in picking up Radio Senegal then why not try for something a little more difficult? Tune down to 747kHz. The Dutch station on this channel closes down at 2315 and Radio Sofia goes off at 2330 leaving the frequency clear for DX. You may then pick up a weakish signal from the 100kW transmitter at Ougadougou in Upper Volta, a country located inland between Ghana and Mauretania. It is on the air until midnight, usually with African music. The announcements are in French, the slogan is "La Voix de la Renouveau" and the address for reports is B.P. 7029, Ougadougou, Upper Volta. This station QSLs if you send an IRC along with your report.

Ougadougou comes in quite well when I use the BRT400 and loop and I did once manage to hear it on the Vega 204 though not strongly enough to resolve it. There are times though when it is not audible at all, but then this is real DX and you have to be patient and persistent on the medium waves.

Filters

Reader **J. Radford** is puzzled by the different types of filter that are available, and he wonders if there is any literature that covers the subject. Try the *ARRL Handbook* but a few examples may help.

A 2MHz high-pass filter attenuates signals below 2MHz but allows frequencies above 2MHz to pass through it. A 2MHz low-pass filter does the opposite, it passes frequencies below 2MHz and would be useful between aerial and receiver when DXing on the medium waves. A band-pass filter allows through frequencies within its passband. One covering 463kHz to 467kHz would make a good 465kHz i.f. transformer with a passband of 4kHz.

A crystal filter uses one or more quartz crystals as resonators while a ceramic filter is a piezoelectric device that is used these days in place of the traditional i.f. transformer. The term mechanical filter is not a misnomer. The r.f. signals are actually converted into mechanical vibration in metallic discs and after passing through a number of them the mechanical vibrations are reconverted into electric signals. A passband with steep sides is the result.

Readers' Letters

A new navigation beacon has appeared on the medium waves. **Geoff Halligay** (Hitchin, Herts) writes to say that "WCO" on 730kHz is located near Aylesbury, Bucks. Geoff first heard WCO while listening for the new BBC Radio 4 relay for the London area on 720kHz which is located at Lots Road Power station in Chelsea. The Radio

Free Europe jammers operate on 719kHz which makes reception rather difficult at Geoff's QTH.

Local Radio DXing interests **John Radford** of Nottingham who used his FRG-7 and 65ft random wire (indoor) to pull in 18 local stations including Manx Radio IOM on 1368kHz, Radio Blackburn on 855 and R. Merseyside on 1484. **J. W. Boyd**, Kaitaia, New Zealand is building the *PW* loop to try to eliminate QRM from Australia. (I wish I had QRM from Australia!)

From Birmingham comes an interesting letter from **John Dennis Court** who uses a Vega 206 which he reckons is far superior to any transistor Rx he has used. DX heard included CJYQ in St John's Newfoundland on 930kHz and WINS in New York City on 1010. I do not have the address of the Volmet station you ask about John and it is, I suspect, illegal to listen to it anyway.

North American DX

Two useful logs of North American DX have been received. **A. C. Jacklin** managed to pick up 12 North Americans last December using his Realistic DX160 and 60ft loft aerial, the best of them being WCBS in New York City on 880kHz, WTOP Washington DC on 1500, WITS in Boston on 1510, WQXR NYC on 1560 and CKLM Laval in Quebec on 1570, all heard between 0000 and 0300. Yes, the unidentified on 940 is most likely to be CBM in Montreal. Reader **D. R. Mayhew** uses a portable receiver (type not mentioned) at Yapton in Sussex coupled to a 40 inch loop. He reports hearing CFRB on 1010 and CHUM on 1050, both stations being in Toronto, plus WABC on 770 and WHN on 1050 both in NYC. A number of Latin Americans were also logged including Radio Oriental Montevideo in Uruguay on 770, La Voz de Mexico on 730 and WLVV, the missionary station in Puerto Rico on 1370kHz. All heard between midnight and 0400.

BROADCAST BANDS

SHORT-WAVE BROADCASTS

by Charles Molloy G8BUS

The inexperienced short wave listener (s.w.l.) may wonder how it is that DX is ever heard at all amid the powerhouses, jamming, interference, etc., that is prevalent on the international broadcast bands today. The answer is of course that it depends on which band and what time of day you listen, whether any DX will be heard.

The high frequency bands, i.e. 13 metres (21MHz), 16m (17MHz) and 19m (15MHz) only propagate radio waves when the path between transmitter (Tx) and receiver (Rx), or most of it, is in daylight. If you listen at sunrise you will have a path of daylight to the east for DXing and one of darkness towards the west which will eliminate interference (QRM) from that direction.

Sunrise on the h.f. bands is the time to listen for Japan, India, Pakistan, Sri Lanka, Australia and New Zealand. Start DXing a couple of hours before sunrise, since the path opens up when the sun's radiation strikes the ionosphere some 2000km to the east of the UK. If you want to hear something exotic then listen on 15 170kHz at 0800 on a Sunday for Radio Tahiti. Try also on 11 825 kHz on the 25 metre band (11MHz). The interval signal is the Tahitian flute plus drums and reception is quite good in spite of the distance and low transmitter power which is only 20kW. Announcements are in French.

Radio New Zealand

A number of readers have tried without success to pick up RNZ in the UK. Certainly the stations are only 7·5kW and are not beamed to Europe which doesn't help much, but the main reason for failure is, I suspect, listening at the wrong time of day. Although reception of RNZ has been reported at all hours of day it is in the early morning that success is most likely.

Retired reader **George Lee** of Osset in West Yorkshire has rigged up an HRO receiver at his bedside. When used with a 75ft long wire it picked up RNZ on three successive Sunday mornings recently on 15 345kHz and also on December 9 on 17 860kHz. Exact times were not given. **Bryan Roberston** (Oxford) also heard RNZ on December 9 on 17 860 at 0505 SIO232 with QRM from Radio Moscow, the receiver being a Realistic DX300 used with a 60ft long wire.

BRT400

Reader **S. Wade** of Meonstoke, Hants says he "picked up a BRT400 from a junk shop for a few quid and after many hours of chipping away the rust, etc., it goes well on all bands". He wonders how many of these old receivers are still around.

Well, the BRT400 is not all that old. I first heard of it as a result of a short article in *Wireless World* in the early 1950s when they were being installed at BBC receiving stations. The receiver came onto the surplus market about ten years ago. The version I have is the BRT400D which is the basic table model (some are rack mounted), without crystal calibrator or 9kHz audio rejector filter. The date on the handbook is July 1952.

It is a 14-valve, single-conversion job covering 150 to 350kHz plus 510kHz to 30MHz in five bands. The i.f. is 455kHz and variable selectivity is provided by six switched bandwidths between 0·5kHz and 13kHz. A crystal filter is in use on the three narrowest positions together with a phasing control which can attenuate a signal 1kHz off tune by some 40dB. There are 16 switches and knobs on the front panel which include separate r.f. and i.f. gain controls, aerial trimmer, noise limiter, a.g.c. on/off, and speech/music which attenuates audio below 400Hz when in the speech position. The modern equivalent to this receiver would be beyond the means of most of us, but of course there are snags.

The receiver weighs 37kg, measures 500 × 430 × 305mm, spares including some of the valves are difficult to come by and it would, I think, be difficult to find anyone to repair or service it. Like many older receivers, the BRT400 is really for the technical DXer who can adjust, align, repair and modify it to suit his own requirements.

Get the Best Out of a Vintage Receiver

This is the title of a six-page article in the 1980 edition of the *World Radio and TV Handbook*. It takes the reader through a valve receiver, starting at the loudspeaker and finishing at the aerial socket, outlining on the way the various faults that might occur due to age, use or even lack of use. Anyone contemplating the overhaul of an old valve receiver should read this article. To quote from it: "There

are few specifications possessed by contemporary receivers that could not be found in sets well over a quarter of a century ago." which agrees with my own experience with the BRT400. Apart from a slight change to the alignment on the medium waves the only "mod" I have done is to fit an external commercially made digital readout, which turned out to be quite a simple job.

QSLs

Some readers like to display their QSLs on the walls of their "shack". **Julien Smith** is one of them and he thinks it is a pity that some cards do not have the name of the station and reception details printed on the front. I know how you feel Julien, as I keep mine in photographic albums and it is a nuisance having to take them out. **Lee Humphreys** has another problem which is encountered by many DXers, and that is with stations that do not reply to a reception report. Some like return postage, an IRC for example, while others take a long time to reply and there are a few that just do not QSL at all.

Sometimes there is a change of policy and a non-verifier suddenly begins to QSL. This seems to be the case with the Voice of Chile as a number of readers report receiving a verification from that station. **Bryan Robertson** enclosed a photo-copy of the QSL folder he received, while **Rhys Thomas** had his report translated into Spanish by a teacher at the local school and when sent with an IRC it brought a reply. Some DX clubs have Spanish report forms which enable members to concoct their own using a standard type letter and a DX vocabulary.

Radio Canada International's QSL policy is raised by **W. Semmens,** who mentions that a do-it-yourself QSL card is issued once a year only and then only to listeners who are on their mailing list.

The Voice of the Andes

HCJB is the callsign of the Voice of the Andes, which is a station in Ecuador in South America owned and operated by the World Radio Missionary Fellowship. On Mondays, Thursdays and Saturdays a programme in English for DXers, called DX Party Line, is on the air at 2130 in the 16m and 19m bands, according to the current schedule. HCJB is generally a good signal in the UK.

A new steerable multiband antenna has come into use recently and there is a photo of it on page 349 of the current *WRTH*. HCJB will QSL on receipt of a complete reception report. Their latest QSL card shows a piece of sculpture from an early civilisation in Ecuador and the address for reports is HCJB, Casilla 691, Quito, Ecuador.

Readers' Letters

Radio New Zealand crops up again in a note from **A. D. Scholifield** who has sent me a rather pretty QSL card from this station. He reports hearing RNZ on 11 945kHz in the 25m band between 0730 and 0900, and he would like to hear from any reader who has listened regularly to the programmes from this station. Replies direct to 43 Fellside, South Shields, Tyne and Wear, NE34 8QX.

Thirteen-year-old **Andrew Harpur** of East Kilbride in Scotland has started the All Round DXers Course with Radio Nederland, which he says is very informative. Anyone interested in this or any of the other courses run by this station should write to Radio Nederland, 1200 JG Hilversum, Holland. I can thoroughly recommend this course as I followed it when it was broadcast in instalments a few years ago.

VHF BANDS

by Ron Ham BRS15744

Pictures from across the Atlantic, contributions from new young enthusiasts and reports of DX through meteor scatter, out of season sporadic-E and a super high atmospheric pressure. What more could a v.h.f. columnist ask for?

Solar

Although **Ted Waring,** Bristol, reported counting 30 sunspots on December 7, 31 on 11th, 21 on 20th, 24 on 29th, 14 on 31st, 20 on January 2, 25 on 4th, 37 on 6th and 55 on 13th, neither **Cmdr Henry Hatfield,** Sevenoaks,

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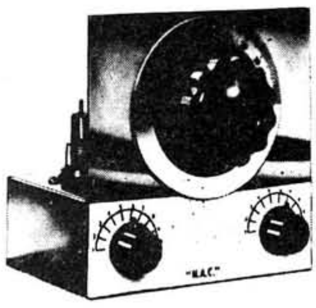

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nor myself recorded any significant radio noise at metre wavelengths throughout the period.

Cross Band, 10m to 6m

Between November 20 and December 16, **Mike Allmark,** Leeds, logged VE1AVX, who has been predominantly strong in the UK when 6m is open, eight Ws and six Ks. Up to mid-December **John Branegan** GM4IHJ, Saline, Fife, has worked 75 stations, crossband, 10m to 6m, as far west as New Mexico and South Dakota. I noticed that when I heard strong s.s.b. signals from Canada and the USA on 6m, at midday on December 14 and 16 and January 7 and 8, signals from the north American continent were very strong on 10m.

The 10 Metre Band

It appears that my report of hearing the Norwegian beacon signal LA5TEN, was the first from outside Norway to reach the beacon keeper, **Paul Justnaes** LA5PN, who modified one of his own QSL cards to acknowledge the report (Fig. 1), many thanks Paul. LA5TEN is situated near Oslo and operates on 28·2375MHz. Paul also had a report from LA2PH/MM, near Florida, USA and said he would like more reports, his QTH is PO Box 10, N-1410 Kolbotn, Norway.

Ted Waring received signals from LA5TEN at midday on December 11, 12 and 13, at 549 and I heard it again, 569, at 1334 on the 16th. Ted heard the Canadian beacon VE3TEN, around 539, almost daily from December 4 to January 14 and, unlike me, only detected the Cyprus beacon, 5B4CY, occasionally. I received signals from the beacons in Bahrain A9XC and Germany DK0TE and DL0IGI, on each of the 38 days between December 14 and January 20, 5B4CY on 34 days and the Bermuda beacon VP9BA on 28 days. Although DL0IGI hit 599 at 1355 on January 4, all other beacon signals were well below 549. **Harold Brodribb,** St Leonards-on-Sea, Sussex, using an AR88LF and inverted "V" loft aerial, logged strong harmonics at several spots in the 10m band, from lower frequency broadcast stations, on December 15, 18, 20, 24, 26 and January 1, 5, 6 and 10. Generally speaking, the band was well open throughout the period with signals from Russian stations predominant in the early morning and from the USA at midday.

Slow Scan Television

Sam Faulkner received SSTV pictures, mainly around 28·680MHz, from WA4UUV on December 2, WB4ROY on the 5th, three Ws and two Ks 6th, WA7WOD 7th, OH2KM 8th, K1BZ 15th, KP4YD 25th, WA2YJD and W5ZR 26th, I7PQD 30th and KA1AQM, PA3API and KA5EJX on January 9 (Fig. 2). During the big tropospheric opening on November 28 and 29, **Richard Thurlow** G3WW, March, Cambs, had two-way SSTV QSOs with one Belgian, two Dutch, three French, six German and two UK stations in the 2m band, and his pictures were also received by ON1AFJ and ON5MK who, like Sam, have monitors only. Several times a week Richard has breakfast-time SSTV QSOs with Mel Shalveson W6VLH (Fig. 3), who has a 6ft monitor screen, and LA, W0, W9, W8, and W7. During 1979, Richard worked 247 first-time, two-way contacts to bring his SSTV total, by January 7, to 1423 stations worked. Among the awards Richard has earnt is *CQ Magazine's* DX SSTV Certificate No. 3 (two-way contacts, 101 countries), and their Master SSTV Awards Certificate No. 1, for five two-way contacts on each of the five amateur bands, 80, 40, 20, 15 and 10m and six ditto in six bands, including 2m.

Fig. 1: The QSL Card received from the Norwegian beacon keeper in response to the author's report

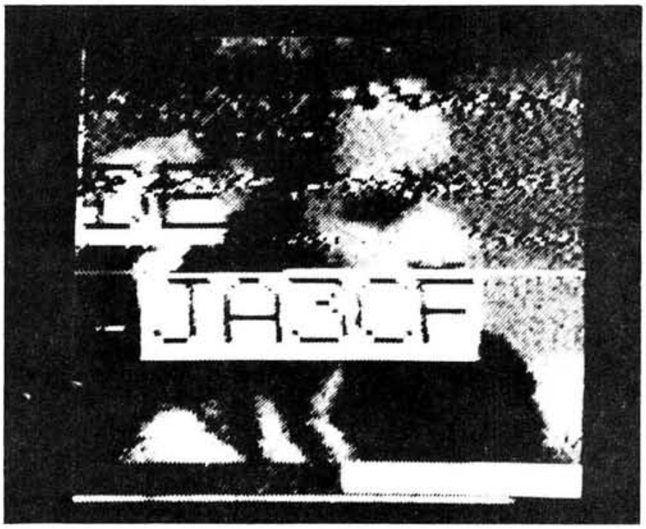


Fig. 2: SSTV picture received by Sam Faulkner from Japan

Fig. 3: The SSTV picture of W6VLH received by Richard Thurlow at 1633 on January 15

DXTV

Cyril Willis, Ely, Cambs, received Russian pictures on channel R1, 49·75MHz, for a short time at 1000 on

December 25, and again at 1615 on the 27th when he watched a news programme, followed by a ballet for about an hour. Cyril began TV DXing in June 1979 and has seen pictures from Austria, Czechoslovakia, Holland, Hungary, Iceland, Italy, Norway, Poland, Portugal, Russia, Sweden and Yugoslavia, in Band I, via sporadic-E. He has received, Belgium, Denmark, Holland, and W. Germany in Band III, and Belgium, France, Holland and W. Germany at u.h.f. via tropospheric openings. Cyril's converted Bush TV receiver is fed with a Vorta 14-element aerial for Band III, and a Maxiview, 4-element aerial for Band I, mounted on an Antiference rotator.

Nicholas Brown, Rugby, also began TV DXing last June and has received pictures in Band I from the same countries as Cyril. Nicholas uses a dual-standard receiver directly on u.h.f., and a v.h.f.-u.h.f. up-converter with a vertical dipole and a horizontal, omnidirectional, "X" array for the lower bands. He also tells me that the Bulgarian news is called, PO CBETAN Y HAC. **M. J. Wood,** Mablethorpe, Lincs, suggests that TV DXers should have a copy of the Russian alphabet which can be found in the *Teach Yourself . . .* series of books; this could be very useful when monitoring Band I. **George Grzebieniak** RS41733, London, is setting up television gear using a combined 5-element array for Bands I and III and a dual-standard HMV 2660 receiver. George's first target is to receive Southern Television and is considering giving the RS Components, Hybrid RF Amplifier module a try. This looks good George, I see that its recommended frequency range is 40 to 860MHz, it has a gain of 27dB, works on 24V and has an input and output impedance of 75Ω.

Fifteen-year-old **Alistair Dupres,** Cardiff, uses a Rigonda portable receiver, and with its own loop aerial he received the Dutch u.h.f. station Nederland-2, during the tropospheric opening on November 29 and watched the evening news programme *Nos Journaal.* Alistair then borrowed his father's Minolta camera, set it at f8 and 1/30th and photographed some of the DX (Fig. 4).

Sporadic-E

A sporadic-E disturbance, extending into Band II, occurred mainly during the afternoon of January 5. While I was trying to sort out a news programme from a cartoon and an American war film around channel E2 in Band I, **David Appleyard,** Uppsala, Sweden, sitting in his car outside Stockholm's International Airport, received signals of "unbelievable strength" on his car radio at 1650 from BBC Radio-2 on several adjacent frequencies between 88 and 88·6MHz and a further English station, which he could not identify, around 96·8MHz. "These conditions persisted until just after 1800 when, alas, the BBC faded out", writes David.

Andrew Rogers, Bristol, received pictures from Sweden, on E2 at 1800; by 1815 he was getting the same programme on E3, but it all faded out at 1915. During the event Andrew heard full stereo from Spain on 96·4MHz. It was beginner's luck for 15-year-old Andrew, because he only purchased an up-converter for his 12in Ferguson portable TV earlier in the day and was delighted to see his first DX so soon. **P. M. Farrugia,** also in Cardiff and another recent starter in TV DXing, was very excited on the 5th, because for the first time he saw the Austrian test card, ORF-FS1 (Fig. 5) at 1120 and, like me, the American war film plus Czechoslovakian and Russian test cards. P. M. Farrugia uses a JVC 3040 receiver fed with a wideband array on a rotator for Band I.

Sam Faulkner watched news and cartoons on R1 from 1750 to 1845 on the 4th and a Ballet from Russia around 1600 on the 5th. At 1630, Sam also received pictures and sound on E2 and E3 from Sweden. "The video and audio from Sweden at 1700 was fantastic, often equal to local level and the signals on both channels (transmitting the same programme) were excellent until 1900," writes Sam. "The first programme, a documentary about the fishing industry, was followed by the news headlines and weather forecast. The YL announcer then introduced a religious programme, which featured a very beautiful church. *A Comedy of Errors* from essentially serious films followed, then a film about a young Swedish family. *James at 15*, an American children's programme, began the early evening's viewing; by this time I was no longer alone in the shack having been joined by the rest of the family."

TV Across the Atlantic

Around 1600 on December 11 and 12, Mike Allmark received pictures from the USA on channel A2, 55·25MHz, via F2, and from 1430 to 1700 on the 13th, he saw *NBC News, Sesame St, Flintstones, Beverly Hill Billies* and weak sound, copied at times on 59·75MHz. He

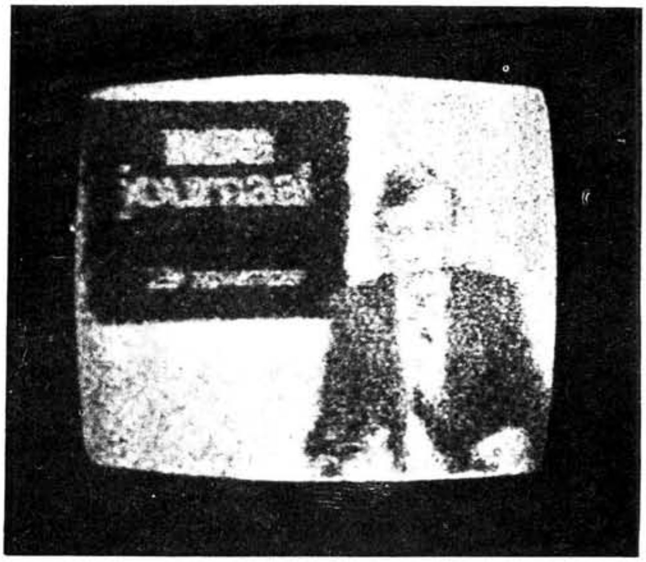


Fig. 4: Dutch TV programme *Nos Journaal,* received on u.h.f. by Alistair Dupres

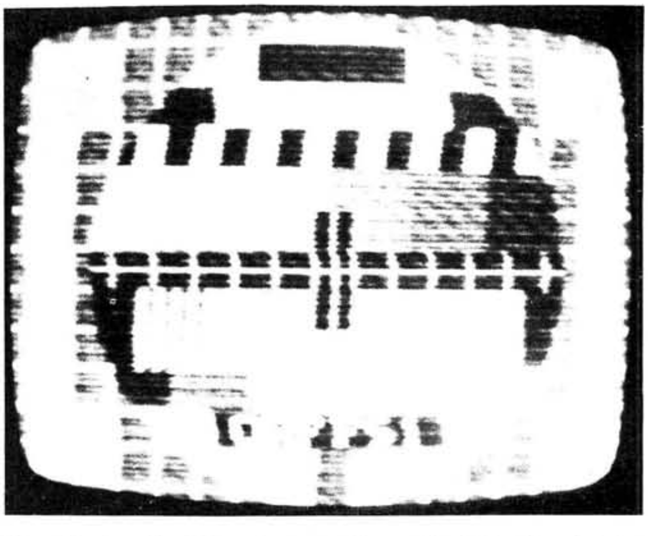


Fig. 5: An Austrian test card received in Band I by P. M. Farrugia at 1120 on January 5

again received pictures on A2 around 1300 on the 14th and during the afternoon of the 15th. Sam Faulkner received Canadian TV signals around 1300 on the 13th and 14th and writes: "I could see the newscaster and the programme format was similar on both days." A2 signals were received again briefly on the 15th and from 1320 he saw the Saturday morning children's programmes. With two transmitters coming up on the channel, Sam had some difficulty sorting out the *Muppets* from a craft programme. John Branegan received pictures on A2 at 1622 on the 14th and Mike Allmark recorded the sound of *CBS News* during the same afternoon.

Back on this side of the pond, on December 17 Mike received strong pictures on R1, E2 and E3 until about 1400. On E3 the PM5544 test card had what looked like UAE, a Gulf State, in the bottom identification panel. I found it impossible to identify anything from the mixture of pictures on R1, via F2, around 0930 on December 14 to 19 and January 16 and 17.

Meteor Scatter

"The Quadrantids meteor shower was good this year; 144MHz was alive, especially around 0200 on January 4," writes Mike Allmark, who heard signals from at least 10 countries. Among them was IT9FEJ at over 2000km, bouncing off the trails of ionised gas left by the meteor particles as they burnt up in the earth's atmosphere. Mike also identified bursts of picture from European and Scandinavian television stations in Band I, during the event. Between December 1 and 14, which includes the Geminids meteor shower, Mike heard signals on 144MHz from France, Germany, Italy, Scandinavia and Switzerland. Sam Faulkner monitored Band I between 0700 and 0750 throughout the period November 14 to December 11 and saw a multitude of "pings" of test cards from Czechoslovakian, Scandinavian and Russian TV stations.

At 1007 on January 4, I received strong bursts of test cards from Finland and Russia.

Tropospheric

The atmospheric pressure rose from 30·0in on January 10 to a real high of 30·7in at midday on the 12th. True to form, as it fell through the 13th and 14th, there was a tropospheric opening. During this time I heard signals through the 2m repeaters in Birmingham GB3BM (R5), and Bristol Channel GB3BC (R6), and at 1413 on the 13th the 70cm beacon at Emley Moor, GB3EM was 589, on my dipole! **Alan Baker** G4GNX, Newhaven, Sussex, worked through the new Dorset repeater GB3SC (R1) and heard signals through the Leicester repeater GB3CF.

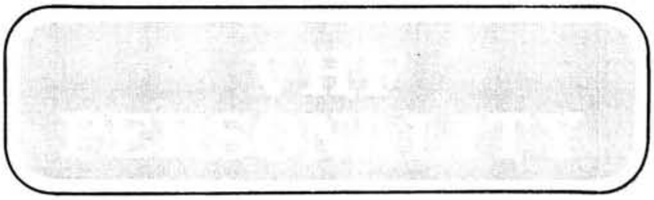
Mike Allmark heard 2m signals from stations in DL, ON, OZ, PA0 and SM on the 13th along with u.h.f. TV pictures from Belgium, France, Holland and West Germany.

News Items

Within two days of **Eric Arnold,** Brighton, formerly G8OUK, receiving his new call, G4JDJ, he worked a VK on 10m s.s.b. and another new call, **Paul Corrigan** G8TJS, Bradford, was on the air 20 minutes after his licence dropped through his letter box. At present Paul has a Trio TR2300, a 4-element quad and Slim Jim aerials for 2m and a DX160 receiver with a 66ft long wire aerial for the h.f. bands. By January 4, Paul had made 775 contacts on 2m. **John Trimmer,** Brighton, formerly G8TMX is now G4JDM.

There has been a change to the 2m repeater system in London. GB3LO (R7) has been replaced by a network of repeaters at the compass points, GB3NL, north London (R7), GB3SL (R2), GB3EL (R0) and GB3WL (R1).

I hope to see some of you at the RSGB VHF Convention at Whitton, Twickenham, Middx, on March 8.



Roy BANNISTER G4GPX

Although Roy Bannister did not get his G8 licence until 1976, his interest in radio dates back more than 30 years to a time when he was a regular visitor to and transmitted from, (as one could under supervision in those days) the shacks of G2CSV, G3BRU and many others.

When Roy and his wife Joyce moved from Redcar to their present home in Lancing, Sussex in 1960, they developed a deep interest in tape recording. Since then they have won several national tape recording contests, in addition to making tapes for the Blind and Audio programmes transmitted by BBC Radio Brighton.

Through tape recording they met John Kuipers, who took the RAE with Roy. John attended college and Roy studied at home with Braille literature and tape recordings. Since getting his licence, Roy has worked a great deal of v.h.f. DX, using an FT221 and an 8-element Yagi from his home QTH, situated at sea level. He is usually very active during an aurora or tropospheric disturbance.

In 1977, Roy passed the Morse test and with his present callsign, G4GPX, has made many c.w. contacts using his FT101E and a Hustler vertical or a trapped inverted "L" aerial.

Both Roy and Joyce are members of the Worthing and District Amateur Radio Club and are frequently seen at mobile rallies and use an FT7 from their car. In addition to earning his living as a piano tuner, Roy has just completed forty years of playing the organ or piano in dance bands.

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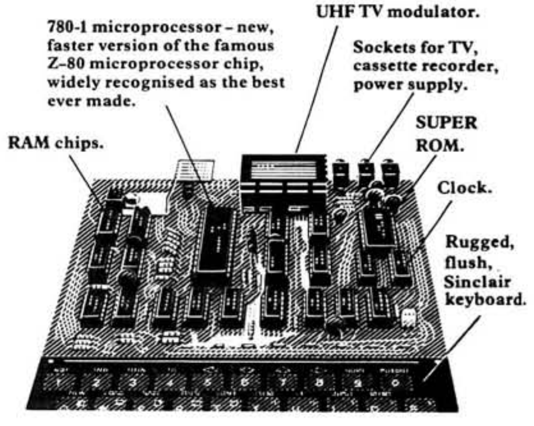

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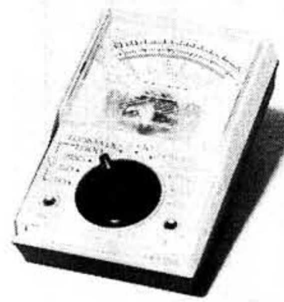

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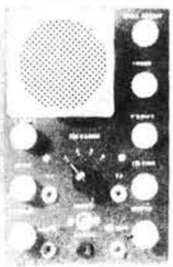

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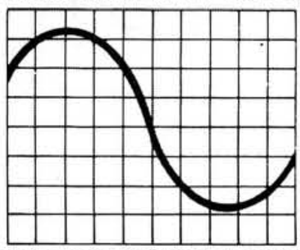

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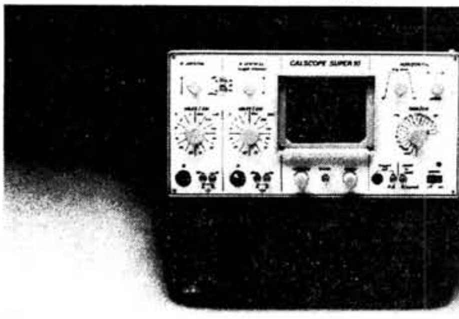

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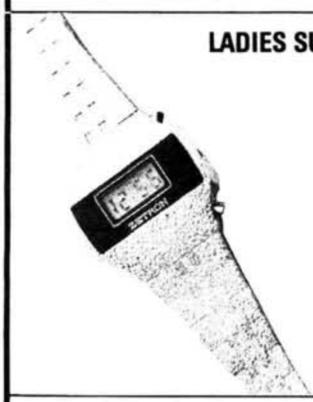

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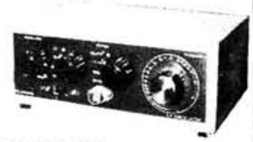

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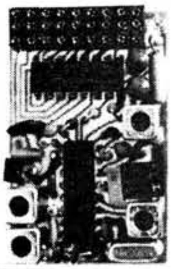
FM radio control RX kit



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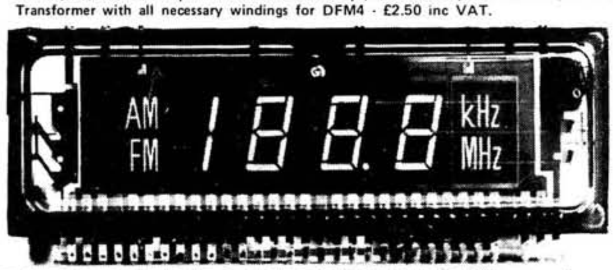

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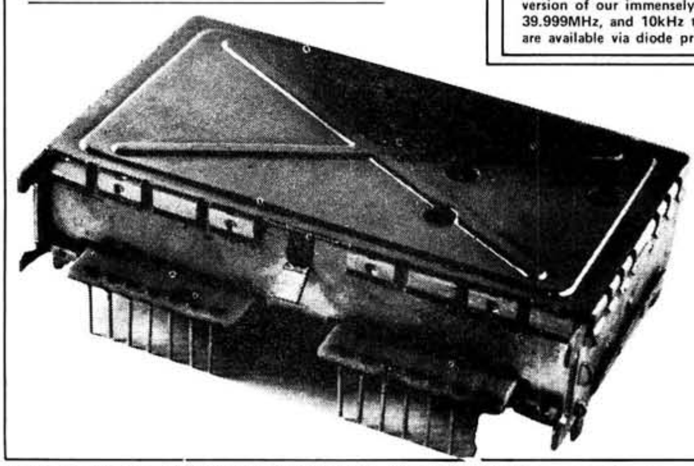

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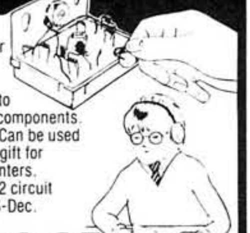

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Continuous Ratings + VAT 15%

30 VOLT RANGE

Pri 220/240 sec 0-12-15-20-24-30V Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V and 15V-0-15V.

Ref	Amps	Price	P & P
112	0 5	**2·90**	0·90
79	1 0	3.93	1·10
3	2 0	**6·35**	1·10
20	3 0	**6·82**	1·31
21	4 0	**8·79**	1·31
51	5 0	**10·86**	1·52
117	6 0	**12·29**	1·67
88	8 0	**16·45**	1·89
89	10·0	**18·98**	1·89
90	12·0	**21·09**	2·24
91	15 0	**24·18**	2·39
92	2·0	**32·40**	O.A.

50 VOLT RANGE

Pri 220/240V Sec 0-20-25-33-40-50V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V and 25V-0-25V.

Ref	Amps	Price	P & P
102	0 5	**3·75**	0·90
103	1 0	**4·57**	1·10
104	2 0	**7·88**	1·31
105	3 0	**9·42**	1·52
106	4 0	**12·82**	1·73
107	6 0	**16·37**	1·89
118	8 0	**22·29**	2·39
119	10·0	**27·48**	O.A.
109	12 0	**31.89**	O.A.

MAINS ISOLATORS (SCREENED)

PM 120/240 Sec 120/240V CT

Ref	VA	Price	P & P
•07	20	**4·84**	0·91
149	60	**7·37**	1·10
150	100	**8·38**	1·31
151	200	**12·28**	1·31
152	250	**14·61**	1·73
153	350	**18·07**	2·12
154	500	**22·52**	2·47
155	750	**32·03**	O.A.
156	1000	**40·92**	O.A.
157	1500	**56·52**	O.A.
158	2000	**67·99**	O.A.
159	3000	**95·33**	O.A.

•Pri 0-220-240V Sec 115 or 240V. State sec. volts required.

CASED AUTO TRANSFORMERS

240V cable in 115V USA flat pin outlet

VA	Price	P & P	Ref
20	**6·55**	1·03	56W
75	**8·50**	1·31	64W
150	**11·00**	1·31	4W
200	**12·02**	1·67	65W
250	**13.88**	1·67	69W
500	**20·13**	1·89	67W
1K	**30·67**	2·65	84W
1 5K	**42·82**	O.A.	93W
2K	**54·97**	O.A.	95W

60 VOLT RANGE

Pri 220/240V sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24V-0-24V or 30V-0-30V.

Ref	Amps	Price	P & P
124	0·5	**4·27**	1·10
126	1·0	**6·50**	1·10
127	2·0	**8·36**	1·31
125	3 0	**12·10**	1·31
123	4·0	**13·77**	2·12
40	5·0	**17·42**	1·89
120	6·0	**19·87**	2·12
121	8·0	**27·92**	O.A.
122	10·0	**32·51**	O.A.

END OF LINE OFFERS

Ref				Price	P · P
30-Isolator	240V:240V	200VA		**£4·62**	£1·10
62-Isolator	240V:240V	250VA		**£5·72**	£1·10

M616 – 0-240V: Screen 1) 13-0-13 1A. 2) 12V 150ma **£2·10** 60p

M489 – 0-240V: 1400V × 150ma, 6·3V × 4A **£5·50** £1·04

M708 – 6K to 3KΩ matching trans. 5 watt **90p** 40p

M679 – 0-120V × 2; 36V 1·6A **£3·00** 78p

M865 – 100V Line to 4Ω 10 watts **£1·90** 60p

M973 – 100V Line to 8Ω 40 watts **£2·90** 60p

M1020 – 0-240V 12-0-12V × 50ma **75p** 30p

M1126 – 120/240V: 9-0-9V × 1A **£1·79** 71p

M1130 – 0-240 4500V × 10ma **£4·86** £1·08

M1165 – 0-115-240V: 14V 50ma **75p** 30p

Metal Oxide Resistors ¼W 5% TR4 (Electrosil)

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P.W. Purbeck osciloscope transformer 250-0-250; 6·3V; 12·9V **£7·51** £1·04

12 OR 24V OR 12-0-12V

Pri 220-240 volts

Ref	Amps 12V	Amps 24V	Price	P&P
111	0 5	0 25	**2·42**	0·52
213	1 0	0 5	**2·90**	0·90
71	2	1	**3·86**	0·90
18	4	2	**4·46**	1·10
85	0 5	2 5	**6·16**	1·10
70	6	3	**6·99**	1·10
108	8	4	**8·16**	1·31
72	10	5	**8·93**	1·31
116	12	6	**9·89**	1·52
17	16	8	**11·79**	1·52
115	20	10	**15·38**	2·39
187	30	15	**19·72**	2·39
226	60	30	**40·41**	O.A.

SPECIAL OFFER

Multimeter 20KΩ B/V – with combined audio/I.F. test oscillator at 1 KHz and 465 KHz AC/DC to 1000 volts DC current to 500mA resistance to 1KΩ. Size 160×97×40mm **£8·50** P & P £1·00 VAT 15%.

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	**2·83**	0·63
212	1A, 1A	0-6, 0-6	**3·14**	0·90
13	100	9-0-9	**2·35**	0·44
235	330, 330	0-9, 0-9	**2·19**	0·44
207	500, 500	0-8-9, 0-8-9	**3·05**	0·85
208	1A, 1A	0-8-9, 0-8-9	**3·88**	0·90
236	200, 200	0-15, 0-15	**2·19**	0·44
214	300, 300	0-20, 0-20	**3·08**	0·90
221	700 (DC)	20-12-0-12-20	**3·75**	0·90
206	1A, 1A	0-15-20-0-15-20	**5·09**	1·10
203	500, 500	0-15-27-0-15-27	**4·39**	1·10
204	1A, 1A	0-15-27-0-15-27	**6·64**	1·10
239	50	12-0-12	**2·88**	0·37

AVO TEST METERS

AVO 8 MK5	**£91·50**
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AVO MM5 minor	**£35·95**
Wee Megger	**£76·28**
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DA116 Digital	**£110·90**
BM/ Megger	**£53·76**
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All Avos Meggers and accessories available. **P & P £1·32 VAT 15%**

20,000 ohm/V Multimeter, mirror scale Ranges AC DC to 1000V DC current to 250mA Resistance to 3 Mohms 5" × 3½" × 1¼" **£14·36** P&P £1.00 VAT 15%

U4315 Budget Meter. 20KΩ/V Ranges to 1000V, 2·5A AC/DC 500KΩ Res. In steel case **£15·85.** PP £1·15 VAT 15%

NEW RANGE TRANSFORMERS

2 windings 0-36V-48V/36V-0-36V 48V-0-48V 72V or 96V.

Amps	Ref	Price	P & P
½	430	**4·88**	0·76
1·0	431	**8·12**	0·99
2·0	432	**13·35**	1·31
3·0	433	**16·17**	1·40
4·0	434	**20·65**	2·11
5·0	435	**29·30**	2·47
6·0	436	**36·69**	O.A.
8·0	437	**40·03**	O.A.

PANEL METERS

43mm × 43mm		82mm × 78mm	
0 50μA	**6·20**	0 50μA	**6·70**
0 500μA	**5·95**	0 500μA	**6·70**
0 1mA	**5·95**	0 1mA	**6·70**
0 30V	**5·95**	0 30V	**6·70**

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100V	25A•	**£2·10**
200V	2A	**£0·45**
400V	4A	**£0·85**
400V	6A	**£1·25**
500V PM7A6	12A•	**£2·85**

P & P 17p VAT 15%

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12 or 24 hour display also alarm. Hour, minute, second, day, AM/PM on constant display. Month data day backlight lighting at the press of a button, 24 hour mode reading if required (useful for travel) Chronograph to 1/10th sec + laptime with attractive stainless steel adjustable bracelet and case **£13.48.** P&P 50p + VAT 15%.

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0-12-15-20-24-30V
Ref 009 1 Amp **£2·98** P & P £1·10
Ref 010 2 Amp **£4·62** P & P £1·10

15V RANGE (7·5-0-7·5V) 0-CT 15V

Ref			P & P
171	500 mA	**2·30**	0·52
172	1A	**3·26**	0·90
173	2A	**3·95**	0·90
174	3A	**4·13**	0·99
175	4A	**6·30**	1·10

Power Unit input 240v-output 15v. 5amp AC/12v. 3amp DC. In Plastic case with mains lead size 2¼×2¼×2" **£1.50.** P&P 50p.

Mains Eliminator fits into 13A Skt 3-6-9-12V multiplug outlet 300ma **£4·60** P & P 55p VAT 15%

Electronic Construction Kit
Home electronic starter. Start simply and progress to a TRF radio or electronic organ No soldering All parts included in presentation box. Full instructions. **£8·29.** P & P £1·10 VAT 15%

AUTO TRANSFORMERS

Ref	VA (Watts)		£	P&P
113	15	0-115-210-240	**2·73**	0·81
64	75	0-115-210-240	**4·41**	1·10
4	150	0-115-200-220-240	**5·89**	1·10
67	500	0-115-200-220-240	**12·09**	1·91
84	1000	0-115-200-220-240	**20·64**	2·39
93	1500	0-115-200-220-240	**25·61**	OA
95	2000	0-115-200-220-240	**38·31**	OA
73	3000	0-115-200-220-240	**65·13**	OA
80S	4000	0-10-115-200-220-240	**84·55**	OA
57S	5000	0-10-115-200-220-240	**98·45**	OA

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POLYESTER RADIAL LEAD CAPACITORS: 250V; 10n, 15n, 22n, 27n **5p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1μ **22p**; 1μ5 **30p**; 2μ2 **34p**.

ULTRASONIC TRANSDUCERS **350p** per pair

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF). **500V:** 10 **40p**; 47 **68p**; **250V:** 100 **65p**; **63V:** 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22 **8p**; 32, 47, 50 **12p**; 63, 100, **27p**; **50V:** 1.0 **7p**; 50, 100, 220 **25p**; 470 **32p**; 1000 **50p**; **40V:** 22, 33μF **8p**; 100 **12p**; 2200, 3300 **85p**; 4700 **98p**; **35V:** 10, 33 **7p**; 330, 470 **32p**; 1000 **50p**; **25V:** 10, 22, 47 **6p**; 80, 100, 160 **8p**; 220, 250 **13p**; 470, 640 **25p**; 1000 **27p**; 1500 **30p**; 2200 **45p**; 3300 **62p**; 4700 **74p**; **16V:** 10, 40, 47, 68 **7p**; 100, 125 **8p**; 220, 330 **14p**; 470 **16p**; 1000, 1500 **20p**; 2200 **34p**; **10V:** 100 **6p**.

TAG-END TYPE 450V: 100μF **180p**; **70V:** 4700 **165p**; **64V:** 3300 **130p**; 2500 **98p**; **50V:** 3300 **105p**; 2200 **99p**; **40V:** 15,000 **399p**; 4700 **120p**; 4000 **92p**; 3300 **93p**; 2500 **85p**; 2200 **85p**; 2000+2000 **120p**; **30V:** 4700 **90p**; **25V:** 6400 **105p**; 4700 **85p**; 3300 **80p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0.1μF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2μF, 3.3, 4.7, 6.8. **25V:** 1.5, 10. **20V:** 1.5μ . **16V:** 10μF **13p** each.
16V: 15μ, 22 **25p**; 47, 100, 220 **40p**.
10V: 15μ, 22, 33 **20p**; 100 **35p**; **6V:** 47μ, 68, 100 **30p**; **3V:** 100 **20p**.

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Carbon Track, 0.25W Log & 0.5W Linear Values. Rotary Type.

470Ω, 680Ω 1K, 2K (Lin only) Single	27p
5KΩ to 2MΩ Single gang	27p
5KΩ to 2MΩ Single with D/P switch	65p
5KΩ to 2MΩ Dual gang	78p

POLYESTER (MYLAR) CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01μF **6p**
0.015, 0.02, 0.03, 0.04, 0.05, 0.056μF **7p**
0.1μF **8p**, 0.2 **10p**. **50V:** 0.47μF **12p**

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm track

5KΩ 500KΩ Single gang	60p
10KΩ 500KΩ Dual gang	80p
Self-Stick graduated Alum. Bezels	30p

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10nF **4p**
15nF, 22nF, 33nF, 47nF **5p** 100nF **7p**

PRESET POTENTIOMETERS

0.1W 50Ω-2.2M Minl. Vert. & Horiz.	7p
0.25W 100Ω-3.3MΩ Horiz. larger	10p
0.25W 250Ω-4.7MΩ Vert.	10p

POLYSTYRENE CAPACITORS:
10pF to 1nF, **6p**. 1.5nF to 47nF **10p**.

RESISTORS–5% carbon, High Stab. Miniature, Low Noise

Range		Val.	1-99	100+
¼	2Ω2-4M7	E24	2p	1p
0.5W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-10M	E12	5p	3p
2% Metal Film	10Ω-1M		6p	4p
1% 0.5W	51Ω-1M	E24	10p	8p

N.B. 100+ price applies to Resistors of each type not mixed values.

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TIL209 Red	13	4 LCD	975
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TIL212 Yel	18	ORP12	63
.2" Red	15	2N5777	45
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Square LED, Red		LD271	40
Grn, Yel	36	TIL32 Detector	58
7 Seg. Displays		SFH205	98
Red		TIL78	70
.3" C Cath	99		
.3" C Anod	99	**CRYSTALS**	
.4" C Cath	120	100KHz	385
.4" C Anod	120	455KHz	385
.5" C Cath	115	1MHz	323
.5" C Anod	115	1.008M	323
.6" C Cath	180	1.6MHz	395

VEROBOARD

Pitch	0.1 (copper clad)	0.15	0.1 (plain)	0.15
2½ × 3¾	46p	39p	31p	24p
2½ × 5	55p	50p	—	31p
3¾" × 3¾"	55p	50p	—	—
3¾ × 5	62p	67p	50p	43p
3¾ × 17	218p	180p	141p	120
4¾ × 17	280p	—	—	183p

Pkt of 36 pins	20p	VQ Board	90p
Spot face cutter	85p	DIP Board	268p
Pin insertion tool	120p	'S' Board	1270p

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	Fibre Glass Single-sided	Double-sided	SRBP 9.5" × 8.5"
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16 pin	13p	46p
18 pin	16p	52p
20 pin	22p	65p
22 pin	25p	70p
24 pin	36p	78p
28 pin	39p	85p
36 pin	—	105p
40 pin	50p	109p

EDGE CONNECTORS

		1	·156
2	10 way	—	85p
2	15 way	—	99p
2	18 way	115p	120p
2	22 way	130p	135p
2	25 way	149p	160p
2	30 way	170p	—
2	36 way	194p	—
2	40 way	210p	—
2	43 way	232p	—

DENCO COILS

Dual Purpose 'DP' VALVE TYPE		B9A Valve Base	25p
Ranges: 1-5 Bl, Yl, Rd, Wht.	92p	RDT2	98p
6-7 B, Y, R	82p	RFC 5 chokes	104p
1-5 Green	100p	RFC 7(19mH)	120p
'T'-type (Transistor Tuning).		1FT 13/14/15/16/17	110p
Ranges: 1-5 Bl, Yl, Rd, Wht.	105p	1FT 18/1 6	104p
		1FT 18/465	114p
		TOC1	92p
		MW 5FR	88p
		MW/LW 5FR	112p

JACKSONS VARIABLE CAPS.

Dielectric 100/300pF	160p	0 2 365pF with slow motion Drive	345p
500pF	185p	00 208/176	285p
6:1 Ball Drive 4511/DAF	115p	.. .. with slow motion drive	345p
Dial Drive 4103 6:1/36:1	650p	C804: 5pF; 10; 15; 25pF	175p
Drum 54mm	30p	50pF	195p
0-1-365pF	245p	100; 150pF	235p
00 2 365pF	275p	C 3: 310pF	595p
00-2-500pF	525p	00-3 · 25pF	430p

TRANSISTORS

	p
AC125	20
AC126	20
AC127	20
AC128	20
AC141	24
AC142	24
AC176	24
ACY17	40
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
AD149	70
AD161	42
AD162	42
AF114	50
AF115	50
AF116	50
AF117	50
AF118	65
AF139	35
AF178	70
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC140	35
BC142	30
BC143	30
BC147	8
BC147B	10
BC148	8
BC148B	10
BC148C	10
BC149	8
BC149C	10
BC153	27
BC154	27
BC157	10
BC158	11
BC159	11
BC160	42
BC167A	11
BC168C	12
BC169C	14
BC170	18
BC172	11
BC173	12
BC177	18
BC178	16
BC179	18
BC181	20
BC182	9
BC183	9
BC184	9
BC182L	11
BC183L	10
BC184L	11
BC187	28
BC212	10
BC212L	11
BC213	10
BC213L	12
BC214	10
BC214L	13
BC236	10
BC237	10
BC307B	20
BC308B	20
BC327	15
BC328	15

	p
BC338	12
BC441	36
BC461	36
BC477	25
BC516	20
BC517	20
BC547	12
BC548	12
BC549C	13
BC557	15
BC558	20
BC559	20
BCY70	18
BCY71	20
BCY72	20
BD131	45
BD132	45
BD133	43
BD135	38
BD136	36
BD137	36
BD138	50
BD139	40
BD140	36
BD144	198
BD145	198
BD205	110
BD214	115
BD245	50
BD378	65
BD434	42
BD517	65
BD695A	65
BD696A	65
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BF259	30
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OC28	150
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ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
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40603	65
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2N3772	195
2N3773	288

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2N3866	90
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2N3904	18
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2N4037	52
2N4058	17
2N4061	17
2N4062	17
2N4427	75
2N4859	65
2N4871	50
2N5172	25
2N5179	60
2N5191	70
2N5305	40
2N5457	32
2N5458	32
2N5485	35
2N5642	750
2N5777	45
2N6027	40
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74LS673	1050
74LS674	1450

VOLTAGE REGULATORS
1A +ve 5V, 12V, 15, 18, 24V **65p**
1A -ve **85p**
100mA +ve 5V, 6, 8, 12, 15V **30p**
100mA -ve **65p**
LM309K **135p**
LM317K **350p**
LM323K **635p**
LM723 **38p**
78H05 **595**

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12A/800V	130
16A/100V	95
16A/400V	105
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25A/800V	250
T2800D	120

DIAC ST2 **25p**

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702	75
709C 8 pin	35
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753 8 pin	150
810	155
AY-1-0212	580
AY-1-1313A	660
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AY-1-5050	190
AY-1-5051	145
AY-1-6721/6	195
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AY-3-8500	390
AY-5-1224A	260
AY-5-1230	450
AY-5-1315	560
AY-5-1317A	630
AY-5-3500	510
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CA3011	110
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CA3020	186
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CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	71
CA3048	214
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CA3081	190
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	85
CA3140	48
ICL7106	795
ICL7107	975
ICL8038CC	340
ICM7205	1150
ICM7215	1025
ICM7216A	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7555	89
LD130	452
LF365	98
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LM318H	205
LM324A	45
LM339	70
LM348	90
LM349	125
LM379	375
LM380	80
LM381N	145
LM381AN	248
LM382	125
LM386	99
LM387	150
LM389	93
LM733	125
LM1458	40
LM3900	60
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LM3911	125
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MM5303	635
MM5307	1275
MM57160	620
MSM5526	850
NE518	210
NE543K	210
NE544	185
NE555	20
NE556DB	55
NE560	325
NE561	395
NE562B	410
NE564	425
NE565A	120
NE566	160
NE567V	170
NE570	395
NE571	420
RC4136D	110

SAD1024	1350
SG3402	295
SN76003N	210
SN76013N	170
SN76013ND	130
SN76018	148
SN76023N	170
SN76023ND	130
SN76033N	195
SN76115N	215
SN76131	110
SN76227N	95
SN76477	200
SN76660	120
SP8629	299
TAA621AX1	250
TAA661A	155
TAA960	320
TAD100	159
TBA120S	70
TBA540	220
TBA550Q	330
TBA990Q	270
TBA641-A12/BX1 or BX11	250
TBA651	190
TBA800	90
TBA810S	95
TBA820	70
TBA920Q	260
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TL061C	54
TL062CP	125
TL064CN	159
TL071	45
TL072CP	90
TL074CN	140
TL081CP	42
TL082CP	70
TL083CP	95
TL084CP	120
TMS2716	1750
UAA170	150
UAA180	150
ZN414	80
ZN424E	130
ZN425E	415
ZN1034	200
ZN1040E	685

COMPUTER IC'S

2102-2	225
2111	195
2112	110
2112-2N	250

2114	435
2708	675
4116 16K	1025
4047	750
6502	995
745288	210
74S00	60
74S04	73
74S132	00
74S138	250
74S158	00
74S188	185
74S189	158
74S194	00
74S195	00
74S241	195
74S262	895
74S287	325
74S470	325
74S472	1150
74S475	825
81LS95	125
81LS96	125
81LS97	137
AY-5-2376	980
CP1610	920
MC1488	85
TMS2716	1650
TMS4035	250
TMS4039	250
MC1489	90
MK4027 4K	325
MK4118	2099
Z80 CPU2	5 990
Z80 4M	1099
Z80 P10	660
Z80 CTC	595

VDU IC'S

AY-3-1015	550
AY-5-1013	450
RO-3-2513	650
SFF96364E	1050
SFC71301	820
SFS80102	205
SN74265	63
SN74LS163	118
SN74S262	895
SN75450	120
SN75451	70
SN75452	70
SN75454	225
TMS6011	355

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
03	12
04	12
05	18
06	28
07	28
08	17
09	17
10	11
11	20
12	17
13	30
14	45
16	30
17	30
20	16
21	29
22	17
23	27
25	27
26	36
27	28
28	35
30	17
32	25
33	40
37	30
38	33
40	15
41	74
42	68
43	115
44	112
45	94
46	94
47	57
48	56
50	17
51	17
53	17
54	17
60	17
70	28
72	25
73	32
74	38
75	36
76	48
80	37
81	86
82	69
83	72
84	95
85	77
86	31
89	140
90	30
91	75
92	38
93	32
94	78

95	65
96	57
97	189
100	119
104	62
105	62
107	29
109	54
110	54
111	68
112	125
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147	175
148	109
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159	185
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167	200
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173	120
174	87
175	87
176	75
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178	153
180	85
181	165
182	88
184	135
185	135
188	275

190	95
191	95
192	98
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194	98
195	98
196	93
197	80
198	150
199	150
221	132
246	204
247	204
248	240
249	204
251	125
265	63
273	320
278	220
279	119
298	185
75108	00
75150	175
75491	92
75492	92
75450	120
75451	50
75454	225

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4001	18
4002	15
4006	87
4007	18
4008	82
4009	38
4010	38
4011	28
4012	18
4013	42
4014	80
4015	82
4016	45
4017	82
4018	87
4019	48
4020	99
4021	95
4022	85
4023	22
4024	66
4025	19
4026	180
4027	45
4028	81
4029	99
4030	58
4031	205
4032	100

4033	145
4034	116
4035	111
4036	335
4037	100
4038	108
4039	320
4040	105
4041	80
4042	75
4043	94
4044	95
4045	145
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4053	72
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4160	109
4161	109
4162	109
4163	109
4174	110

4175	99
4194	108
4408	720
4409	720
4410	720
4411	958
4412V	1380
4415F	795
4415V	795
4419	280
4422	545
4433	995
4435	825
4440	1275
4450	295
4451	295
4452	
4490F	695
4490V	525
4501	19
4502	120
4503	69
4535	75
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98
4513	206
4514	265
4515	299
4516	120
4517	382
4518	102
4519	55
4520	108
4521	228
4522	149
4526	149
4527	152
4528	99
4529	145
4530	85
4531	135
4532	115
4534	575
4536	365
4538	142
4539	105
4541	135
4543	155
4549	375
4550	398
4554	150
4556	72
4557	451
4558	105

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OA9	75
OA70	12
OA79	12
OA81	15
OA85	14
OA90	7
OA91	7
OA95	8
OA200	9
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003/4	5
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1N4148	4
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3A/400V	20
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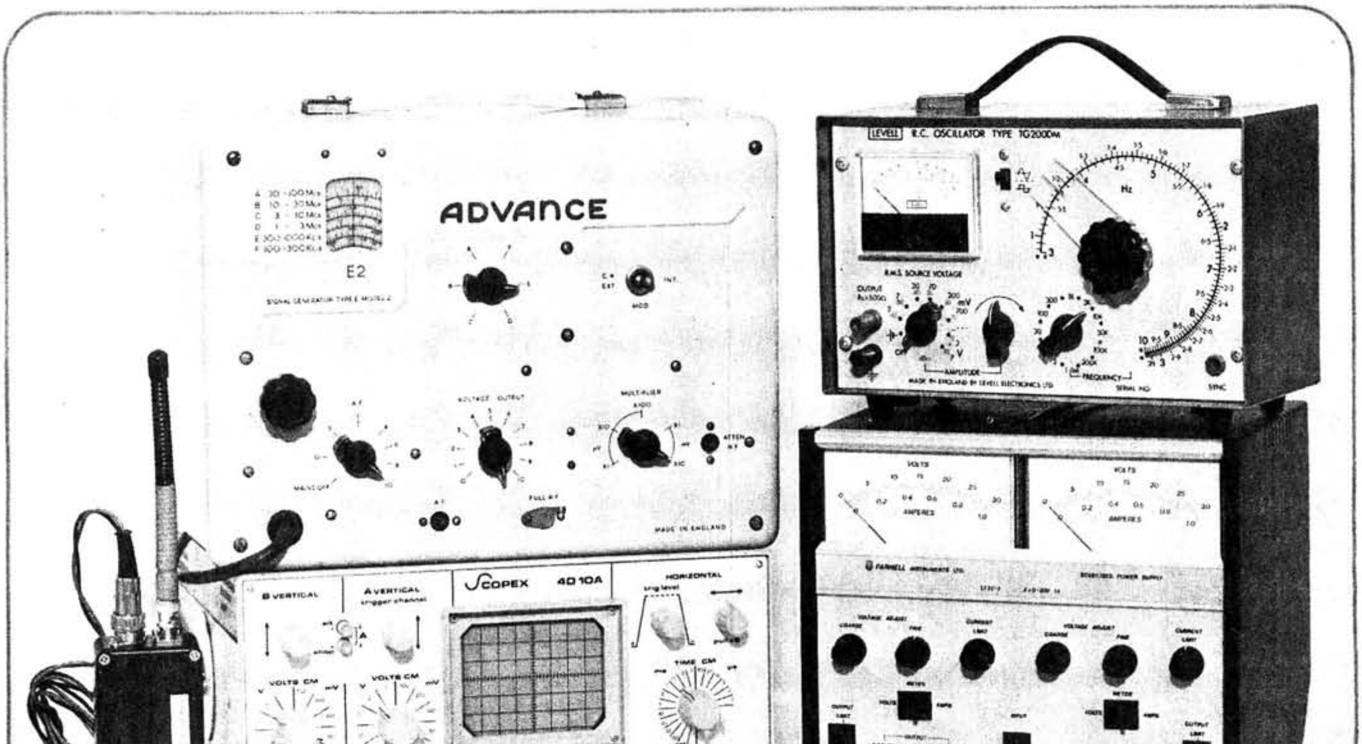

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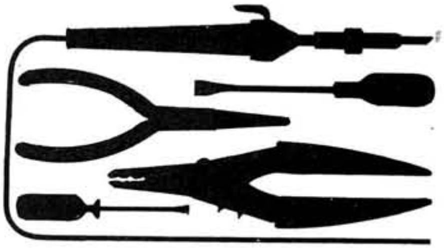
The first thing to realise when faced with a defective piece of equipment is that there is no magic formula for putting it right. What is required is a little knowledge, a logical approach, the correct tools for the job in hand, a reliable test meter and infinite patience. One needs to regard oneself as a detective, finding and acting on the clues presented, sorting out the red herrings and eventually arriving at the point where the fault is apparent.

This is half the job completed; the next step being to correct the fault, possibly by replacement of one or more components; fitting and soldering to be done to the highest standard possible and finally testing the completed job to make sure there are no further faults and that the equipment operates in a satisfactory manner.

Speed and efficiency in fault finding will not be achieved overnight; it takes a number of years for the professional to reach the standards required in the trade, but this should not deter the "amateur" from attempting to put things right himself, particularly where time is of no great consequence. For the author, fault finding presents a different challenge for each successive fault found and hence can never be boring. The feeling of elation and satisfaction when a totally defunct receiver bursts into life is hard to describe



and has never diminished over the passing years.

Equipment

At least 80% of general faults can be found with the equipment shown in Fig. 1. The meter is an Avo 8, but any multirange meter will suffice provided it has suitable voltage, current and ohms ranges and a resistance of no less *than* 20 000Ω/V. The hand tools shown have done sterling service for the author for many years and I can only reiterate the point that money spent on quality tools is never a waste.

In Fig. 2 is shown a set of test equipment generally used by the more advanced fault finders to enable the remaining 20% of difficult faults to be cured. This equipment is also necessary for accurate alignment of receivers, but whilst desirable it is not essential for general broadcast receivers of the ordinary tran-

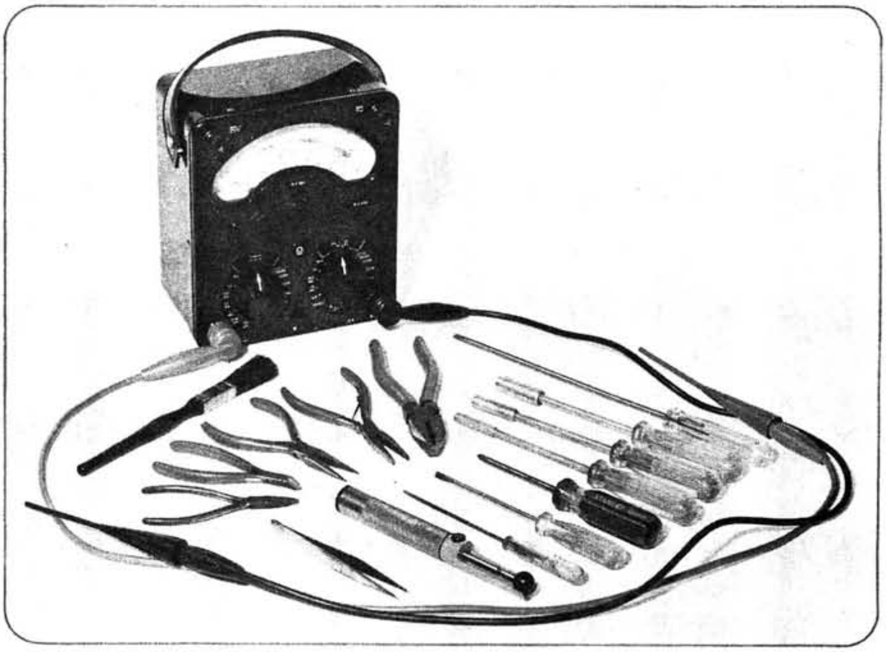


Fig. 1: The basic tools of the trade

sistor portable variety. With practice, a reasonably good job can be done on these without the use of this test gear.

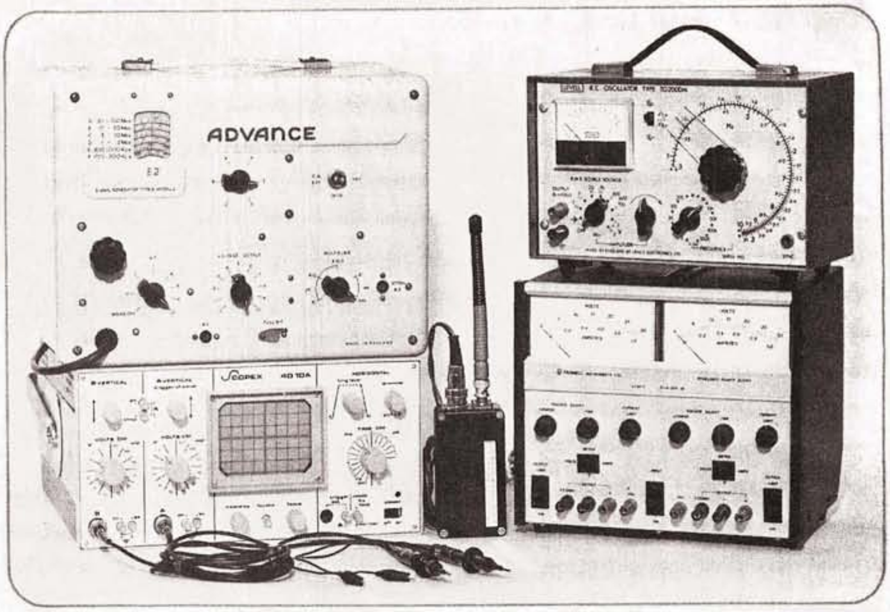


Fig. 2: Common test equipment used for more advanced fault finding

Knowledge

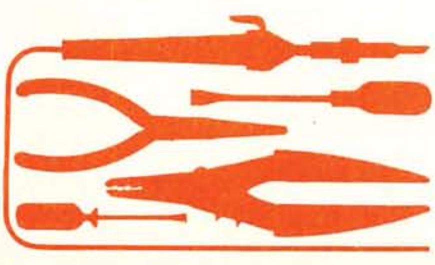
The basic requirement is a fundamental understanding of the properties of electronic components and the ways in which they can be exploited to fulfill our requirements in a circuit. From this statement it can be seen that in any circuit diagram the function of any particular component can be deduced with reasonable accuracy and hence what the effect on the circuit would be if the component should suddenly go faulty.

Most basic faults will revolve around two major fault conditions, open circuits or short circuits and partial stages between these two limits. Resistors can go open-circuit or high or low value compared to their designated markings, whereas a capacitor can go either open-circuit or short-circuit; and inductors can go open-circuit or partial short-circuit depending on the type of inductor or transformer.

Any electronic circuit will possess capacitance, inductance and resistance, these being the three basic building blocks in electronics, apart from valves and transistors. Anything which causes a dramatic change in any of these three design conditions will constitute a fault and the circuit will therefore operate incorrectly. This is the area with which this article is concerned.

Fault Finding Procedures

There are two basic methods of fault finding which may be employed, one being to start at the output and work back to the input, the other preferred way being the half-split method. This involves applying a signal at approximately half way through the circuit and depending on whether there is an output or not, deciding in which direction from the point of injection the fault will be.



Having found in which direction the fault lies, the half-split method can now be repeated and the faulty stage will eventually be isolated. In Fig. 3 is shown the block diagram of a basic superhet receiver and if a fault occurs in any one of these blocks this will give rise to a certain set of symptoms. In block diagrams of this type, a power unit is assumed and is not shown diagrammatically.

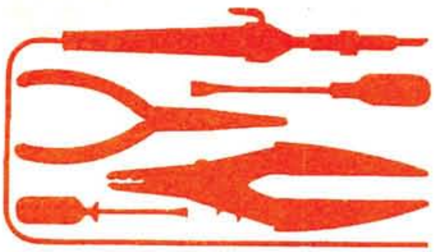
The first thing that must be realised about fault finding is that components under large electrical stress are more likely to go faulty than components under little or no stress. With reference to Fig. 3 it will be obvious that the largest signals and hence voltage and currents will be present in the audio amplifier and output stage, it therefore follows that most of the electrical stress is concentrated in this area. Assuming Fig. 3 to be representative of a practical receiver, whether valve or solid-state is unimportant, and when switched on does not produce any sounds whatsoever, then the first checks should be concerned with the controls, e.g., volume control turned up, speaker connected, aerial connected, etc. If all is satisfactory then the next logical step is to check mains connections and or battery connections and indeed battery voltage on load; again, if all appears correct, then it is safe to assume that the fault will be in one of the blocks shown in Fig. 3.

With practice, this seemingly long winded procedure can be accomplished up to this point in a matter of a few minutes, but could save a considerable amount of wasted time looking for a fault that was not really there in the first place. It will now be necessary to have to hand the circuit diagram of the equipment before proceeding further.

Method

The next step is to listen carefully with the ear near to the speaker to ascertain if there is any noise of any sort present, albeit of a low level. If nothing is heard at all, then it is safe to assume that the fault must lie in either the power supply to the audio amp. and output stage, or indeed the actual stage itself. Voltage checks with a meter comparing them to voltages marked on the circuit diagram should next be carried out and this should reveal the fault.

Alternatively, if something can be heard in the speaker such as a slight hum or hiss, then we should immediately go for the half-split method and inject a signal at i.f. frequency, either from a signal generator or a squarewave signal injector, to a point A in Fig. 3. Again,



there will be two results, either an output from the speaker, or nothing.

If there is an output then the fault must be somewhere to the left of point A, if no output, then the fault must be to the right of point A. Assuming in this case no output was obtained, then the same frequency signal would now be injected at point B, the input to the detector, resulting again in either an audible signal or nothing. If still nothing is heard then the fault is most likely to be in the audio amp. stage; if an output was obtained, then the fault must be in the i.f. amp. stage.

Assuming now that we had an output when injecting a signal at point A; this means that the fault must be to the left of point A and we would inject a signal again at i.f. frequency to point D to check the operation of the mixer stage. If no signal resulted, then the mixer stage would be suspect, but if a signal was obtained then the fault may be in the local oscillator stage or the r.f. amplifier stage.

Quick d.c. voltage checks round the local oscillator stage should prove adequate to ascertain operation and the output can be checked with a frequency counter if available. If all is normal here, then the fault must be to the left of point D and a signal from a generator tuned to the same frequency as the receiver should be injected at the aerial socket. Voltage checks on the r.f. amplifier stage should now reveal the fault. It must be pointed out that a large number of receivers do not have a separate r.f. amplifier stage and the aerial input would therefore go direct to point D via the input tuning assembly, obviating the need for the last step in the checks above.

All the steps now referred to represent the general plan of action in dealing with a fault in a receiver and to isolate the faulty section in a quick and efficient manner. It should be realised that this method is also applicable to all types of electronic circuits when broken down to their basic building blocks and we will now look at a simple circuit in detail to consider the effects caused and the results of failure of its various constituent components. This is the point at which some knowledge of the electrical properties of components used in a circuit is essential.

The Multirange Meter

Before any interpretation of meter readings can be made, it must be understood that any multirange moving coil meter of the AVO type will draw current when making a reading. In other words, across the meter leads will be present a certain resistance which will depend on the range selected. With a meter of 20 000Ω/V sensitivity switched to the 10V d.c. range, the resistance between the meter leads will be $20\,000 \times 10 = 200\,000\Omega$.

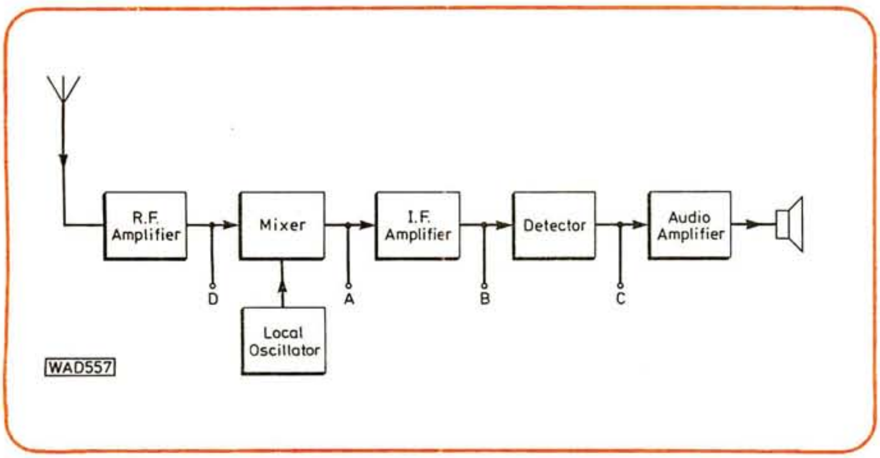


Fig. 3: Block diagram of basic superhet receiver

It follows that when making voltage checks, the resistance of the meter must be taken into account when interpreting readings otherwise an incorrect set of clues may be the result. When taking voltage readings across high source impedance points use a range which gives the highest internal resistance, having regard to the probable voltage that is to be measured.

The Simple Amplifier

The circuit shown in Fig. 4 is a simple, single stage audio amplifier. When the circuit is operating normally with 12V applied to the points indicated, then with a signal input applied to the negative side of C1 an amplified output of that signal would be expected to appear at the negative side of C3. Resistors R1 and R2 form the base bias supply circuit, R3 is the collector load resistor and R4 is the emitter stabilising resistor. Capacitors C1 and C3 are d.c. blocking capacitors coupling the signals into and out of the amplifier respectively. Capacitor C2 holds the emitter potential of Tr1 constant against signal level variations at the base, which would otherwise cause the base/emitter bias to change. We will now proceed to investigate the effect of specific faults, one at a time, as applied to the circuit in Fig 4.

Faulty Resistors

If R1 becomes open-circuit there will be no base voltage applied to Tr1, hence no forward bias, no collector current and no emitter potential. The transistor will be switched off and the collector potential will be 12V.

With R2 open-circuit, the base potential will be high, causing Tr1 to conduct very hard. Emitter current will be very high, giving rise to low collector volts and high emitter volts. This fault will give distortion and the transistor may run warm to the touch.

If R3 becomes open-circuit, there will be no collector voltage, but the emitter/base junction will still be forward biased. Base current increases as there is no emitter/collector current flowing and the base voltage will be reduced. The emitter voltage follows the base voltage so that the difference between the two is the turn-on voltage. A point to remember is that when a meter is connected to the

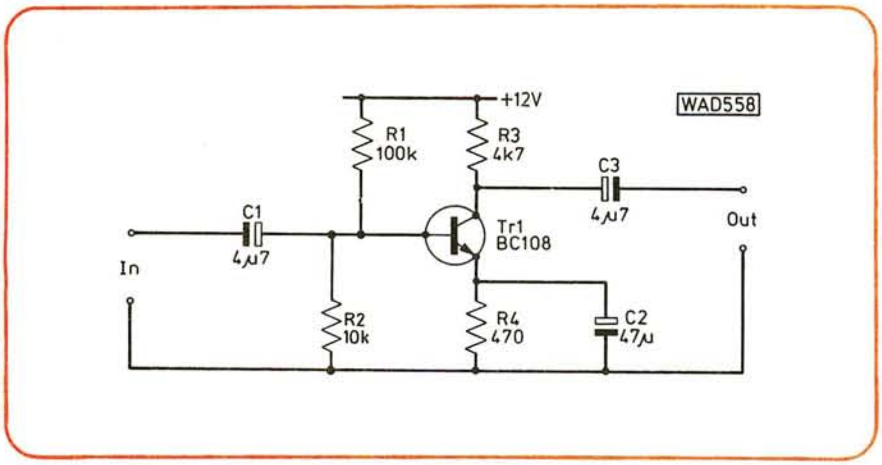


Fig. 4: Circuit diagram of simple audio amplifier

collector to read volts, it will not read 0V as expected since the collector/base junction will be forward biased via the meter and R1.

With R4 open-circuit, there will be no base/emitter current or collector/emitter current. The base voltage will be high and the collector voltage will be at supply potential. The transistor will be completely switched off, but when a meter is connected to read emitter voltage, then the emitter is connected to chassis via the resistance of the meter and a reading will be shown. Depending on the resistance of the meter, the circuit will be switched on and may partially function while the meter remains connected.

Faulty Capacitors

If C2 becomes short-circuit, then the emitter will be connected directly to chassis. The base current will increase and the collector current increases to a high value. Consequently, collector voltage will be very low and the transistor will be running warm to the touch giving bad distortion of any signals.

With C2 open-circuit, all d.c. voltages will be correct and transistor action will be as normal. What will be noticed is a marked lack of gain due to the ability of the emitter voltage to change in sympathy with the signal and hence altering the bias level. This capacitor has a large value giving a very low reactance at the operating frequency.

Capacitors C1 and C3 are d.c. blocking and are input and output coupling capacitors, respectively. If either of these go open-circuit, then the d.c. conditions of the circuit will remain unaltered, but of course, there will be no signal coupling either in or out of the amplifier.

If either were to become short-circuit, then any effect on the amplifier would depend on the impedance of the coupling into, or out of, the amplifier. If d.c. voltages were present, e.g. coupling into the amplifier from the collector circuit of a previous stage, then this voltage would be passed on unhindered and consequently upset the working conditions of the circuit.

Transistor Faults

With the collector/base junction of Tr1 short-circuit, then current will flow via R2, the s/c junction and R3 to the supply. There will be a larger voltage drop across R3 and R4 and the collector voltage will be reduced. The result will be base and collector at the same potential.

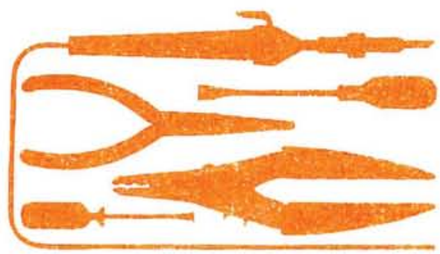
If the base/emitter junction were to go short-circuit, then current will flow through R4 and R1 via the faulty junction. There will be increased base current with a consequent larger voltage drop across R1 and the base voltage will be of a very low value. There will be no collector current, therefore the collector voltage will be at the supply potential and the base and emitter voltages will, of course, be equal.

With the base/emitter junction open-circuit, there will be no base current flowing and less voltage drop across R1, giving rise to a higher base potential. Also, there can be no emitter/collector current flowing so the emitter will be at chassis potential and the collector at supply potential.

With the collector/base junction open-circuit, there can be no collector/emitter current. Base current will flow but will be larger than normal. As only the base current will flow through R4, then the emitter potential will be low and the collector will be at supply potential.

This concludes the fault finding section which the author hopes will have dissipated some of the fears and the old wives tales concerning the processes involved.

It was not intended that this should be a complete fault finding manual, but rather a guide as to the best way to set about the job using ones own knowledge and abilities but hopefully guided in the right direction.



Receiver Alignment

No receiver however complicated or simple will perform satisfactorily without being correctly aligned; indeed, a badly mis-aligned superhet receiver can cause severe interference to other receivers over a large area and thus may bring down the wrath of the Home Office round ones head. To align any receiver is basically a simple process, but involves a large number of steps if the receiver is a complicated one. All these steps must be completed in the correct sequence as laid down in the service manual, otherwise it will never work correctly.

Generally speaking, the correct service manual for the receiver must be available because some adjustments may be very critical and if completed in the wrong sequence, will give rise to all manner of spurious effects. Most adjustments in modern receivers are by ferrite dust cores and it is IMPERATIVE that the correct type of

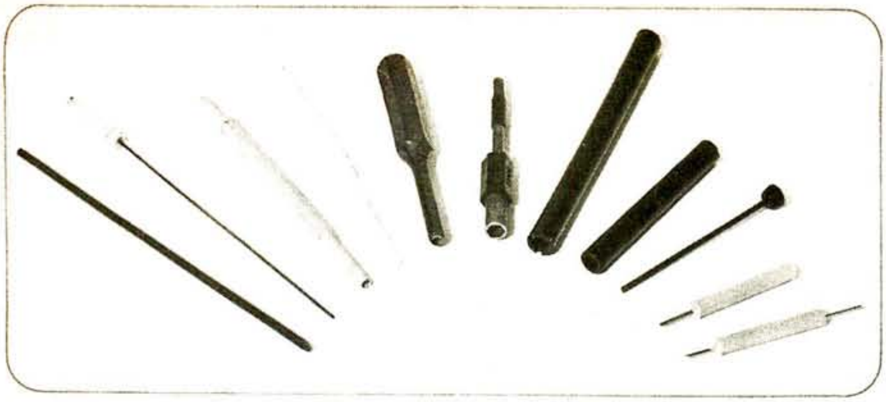


Fig. 5: A selection of trimming tools

trimming tool is used for adjustment of these. The use of an incorrect trimming tool or too much force will only result in a broken core, which will be very difficult to remove without extensive damage to the coil.

A wide selection of trimming tools is shown in Fig. 5 some of which can be purchased as a complete kit or built up from individual items bought separately. Poor quality plastic tools should be avoided, only good quality nylon types are worthy of the professional's tool box.

General

With any superhet receiver the first step in the alignment procedure is to align the i.f. strip. In ordinary receivers, most i.f. strips will be aligned to a frequency between 450 and 470kHz, commonly the latter, and in the majority of simple cases transistor receivers will have three tuned circuits and valve receivers four tuned circuits to adjust. They must be set EXACTLY to the frequencies stated in the manual, or the bandwidth and gain of the receiver will be seriously affected. Provided the alignment is not drastically out, then the signal would be injected at point D in Fig. 3. With the volume control turned full up and the aerial disconnected, the signal generator input level should be increased until an audible signal is heard in the loudspeaker.

Alignment of I.F. Stages

We start by aligning the last tuned circuit first and proceed until all tuned circuits are brought into line, repeating the process at least three times because there will be a pulling effect between mutually coupled tuned circuits when approaching resonance. It must also be borne in mind that the type of modulation from the generator must be the same as the detector in the receiver is designed to demodulate and as alignment proceeds, the signal generator output level should be continuously reduced as the circuits come into line to avoid undue damping caused by a.g.c. action.

From the block diagram in Fig. 3 it will be seen that the local oscillator is the major driving force behind the operation of the receiver and it is this which controls the actual frequency coverage. All other circuits, except the i.f. amplifier stages, are subordinate to this section and unless the l.o. is correct, then the receiver will track across the dial receiving frequencies other than that indicated. It is therefore essential that in all cases the local oscillator is the section which must be aligned next for each band covered by the receiver.

The Local Oscillator

In a standard type of receiver, this section will contain an oscillatory circuit the heart of which will be a tuned circuit of the type shown in Fig. 6. It should be appreciated that there are many different variations on this theme, but all are designed to fulfill the same purpose and that is to provide a signal which, when mixed with the imcoming r.f., will produce a constant frequency signal from the mixer which is the resultant i.f.

In most broadcast and h.f. band receivers covering up to 30MHz, the local oscillator is normally the i.f. above the incoming r.f. in frequency. For example, if we tuned to 1MHz on the receiver dial, then the corresponding local oscillator frequency would be 1MHz + 470kHz = 1·470MHz for an i.f. of 470kHz. Throughout the receiver's tuning range the correct i.f. must always be maintained, so a two section ganged tuning capacitor must be used, one section to tune the incoming r.f. and the other section to tune the local oscillator. If the receiver has an r.f. amplifier stage, then a three gang tuning capacitor must be used.

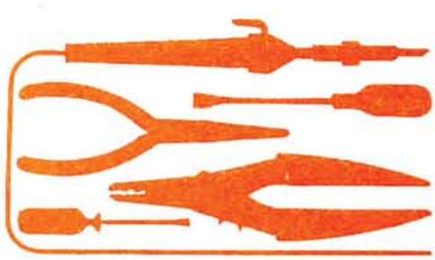
At this point it should be appreciated that the tuning gang sections are normally manufactured with all sections identical, having maximum values commonly up to 500pF and will thus give rise to a major alignment problem.

Because the local oscillator must track at a higher frequency than the incoming r.f. and uses the same value of tuning capacitor, it follows that the tuning inductance must of necessity be smaller in value than the inductance of the coil used for tuning the incoming r.f. If this arrangement resulted in the correct i.f. with the tuning capacitors at minimum value, then at maximum value the local oscillator frequency would be wildly out, in no way would it remain correct with the tuning dial. We must, therefore, resort to the type of circuit shown in Fig. 6.

Padding And Trimming

Capacitor C1 and coil L1 are the normal tuned circuit, but with the addition of Cp and Ct. Capacitor Cp is called a padding capacitor and is effectively in series with C1, the main tuning capacitor; Ct is called a trimmer capacitor and is in parallel with C1.

The value of Cp will depend upon the frequency range covered and the value of Ct will be approximately equal to the



minimum capacitance of C1; sometimes being part of the tuning gang assembly. Each frequency range of the receiver will involve switching a different L1 and Cp into circuit as well as switching coils in the mixer input stage and the r.f. stage if used.

The effect of Cp on the operation of the circuit is as follows. Depending on its value, its reactance will change with frequency over a certain range. This reactance, in conjunction with the reactance of C1, being in series with it, causes the maximum capacity effect of C1 on the coil L1 to be reduced, but at the h.f. end of the band the reactance of Cp will have fallen to a value such as to have little effect on the capacity of C1. Hence Cp, or in most cases the core of L1, is adjusted at the l.f. end of the band where the tuning capacitor, C1, is exerting maximum influence on L1. Either Cp or the coil can be made adjustable as the net effect is the same, but it is far more convenient to adjust a coil and have the capacity fixed.

The trimmer, Ct, being of small value will have very little effect with C1 at maximum capacity; but when C1 is at minimum capacity it has the maximum effect, hence Ct is adjusted at the h.f. end of the band.

Local Oscillator Alignment

With the receiver tuned to the l.f. end of the band, inject a signal, tuned to the same frequency as shown on the receiver dial, via the aerial socket and adjust the coil core for maximum output.

Tune the receiver to the h.f. end of the band and inject a signal of the same frequency as that shown on the dial. Adjust the trimmer capacitor for maximum output. This process will need repeating a number of times until the tracking becomes correct. It is then useful to tune the receiver to the centre of the band and check again with the signal generator to see if tracking at the centre is correct. If it is not, then mechanical adjustment of the tuning mechanism is indicated and then repeat the full alignment process.

These two adjustments will then be made for each band the receiver covers, in turn, starting with the l.f. bands and finishing with the h.f. bands. This now completes the alignment of the local oscillator circuits.

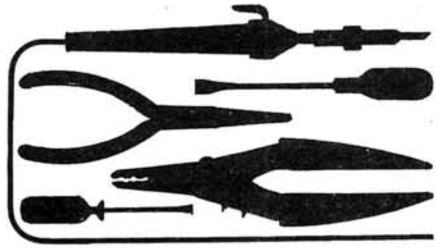
Mixer Alignment

This section is concerned with the adjustment of the r.f. input coils to the mixer. There will be padding and trimming adjustments to be made for each band covered by the receiver; again, padding or coil core adjustments at the l.f. end first, followed by trimmer capacitor adjustments at the h.f. end of the band. In these circuits there will be no fixed padding capacitance such as Cp in Fig. 6.

It should be noted that these adjustments should be carried out at the same tuning points that the local oscillator was set up to, unless stated otherwise in the receiver manual. Unless the receiver is fitted with an r.f. stage preceding the mixer, then this completes the alignment of the receiver.

Alignment of R.F. Stage

The only coils which usually require alignment in this part of the receiver are again the input coils to the stage, the output generally being broadbanded using either an r.f. choke as a load or just simple CR coupling to the mixer input. The tuning points selected for alignment should be those used for the oscillator and mixer input circuits previously described. Again, the coil core padding adjustment should be completed first followed by the trimmer adjustment and again note that there will be no fixed padding capacitance used. There will be one coil for each band in use and should



be aligned in the usual order, namely, l.f. bands first finishing with the highest h.f. band.

It will be noticed that during alignment of this stage, the signal generator output will have had to be progressively reduced, possibly to its lowest output level, to facilitate easy peaking of the circuits. If the receiver being aligned is a sensitive type communications receiver, then an external attenuator will probably be necessary if using a cheaper type signal generator, to reduce the generator attenuator output to 1µV or less. The use of good quality coaxial cable is recommended for connection of the signal generator to the receiver to reduce r.f. leakage which could cause erroneous readings. This completes the alignment of the receiver and it should now perform in a most satisfactory manner.

Beat Frequency Oscillator

The majority of communications type receivers are fitted with a b.f.o. to enable the listener to copy either s.s.b. or Morse code transmissions. A small trimmer type capacitor is usually brought out to the

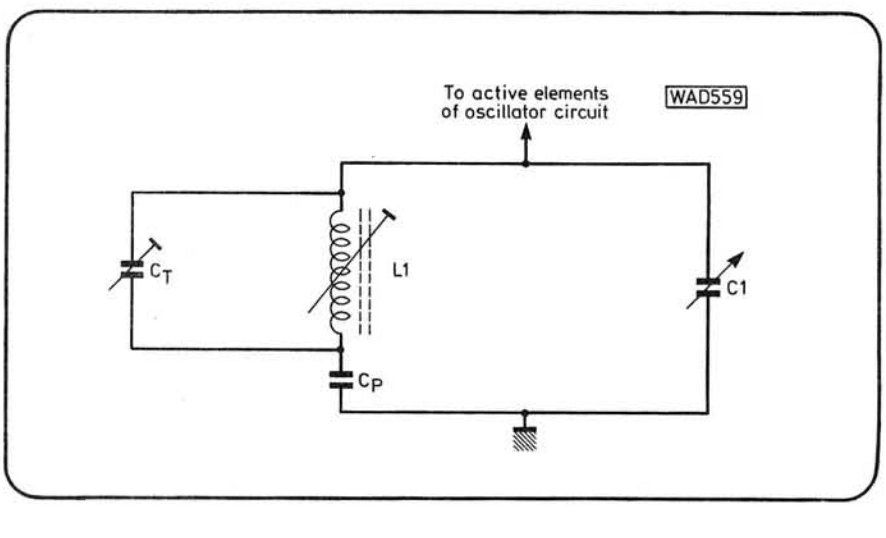
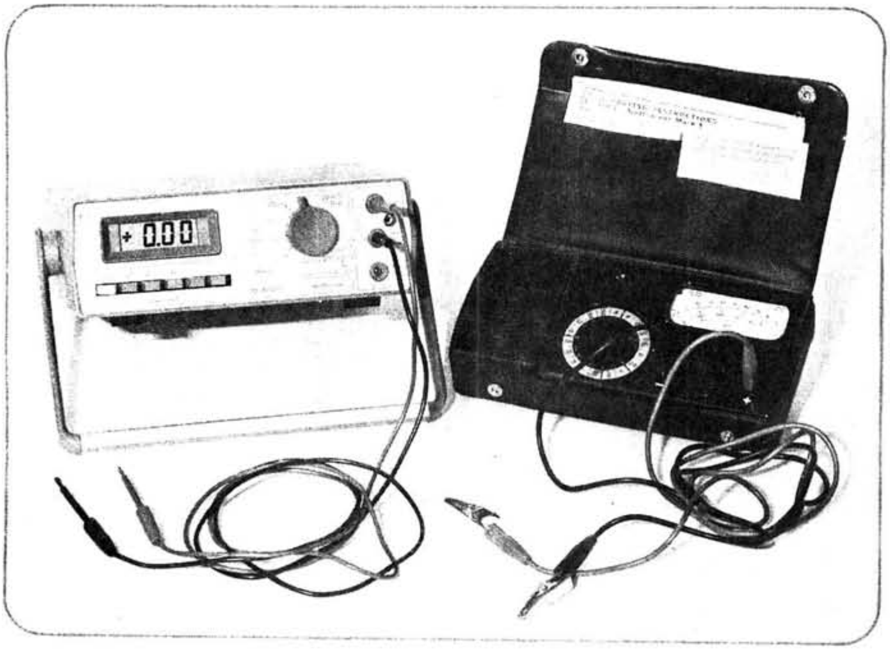


Fig. 6: Local oscillator tuned circuit



Two other commonly used meters

single conversion superhet. The triple conversion receiver goes a stage further and can give superior narrow i.f. bandwidth performance over the previous examples, by using a third i.f. stage of the order of 85kHz following the 470kHz amplifier stage and sometimes incorporating a mechanical filter.

In these receivers, only the first local oscillator is tuned by the main tuning control, the other oscillators will be preset and in some cases will be crystal controlled. The maker's manual is absolutely essential when aligning these receivers and must be adhered to in every detail during alignment, otherwise the receiver will never work satisfactorily. Also, alignment of these receivers should never be attempted unless essential and certainly not without the use of a device for measuring accurately the output frequency of the signal generator to be used.

front panel to enable the frequency to be adjusted in the range ± 5kHz. The main adjustment is by ferrite core in the b.f.o. coil assembly.

To align the b.f.o. correctly, set up the test equipment as for i.f. alignment, but without any modulation present. Set the signal generator to exactly the correct i.f. frequency, preferably with a counter, and then switch on the b.f.o. With the panel control set to zero, or mid-scale, depending on marking, adjust the coil core to zero beat with the generator input. When adjustments are completed, make sure the front panel trimmer swings the frequency of the beat note equally in both directions. This completes the alignment of the b.f.o.

Final Points

Although alignment can be performed reasonably well by ear alone, a more exact method to indicate maximum output is to connect a multimeter, switched to the 2·5V a.c. range across the speaker speech coil, taking care not to cause the meter to go beyond full scale deflection during the alignment process.

In those cases where the receiver is fitted with a ferrite rod aerial and no separate external aerial socket is provided, then injection from the signal generator should be via a coil of about 5 or 6 turns and 25mm diameter made from stout insulated wire placed over one end of the ferrite rod aerial. When actually adjusting the position of the coils on the ferrite rod, this sometimes being the r.f. input padding adjustment, then the injection coil should be kept well away from the coil being adjusted, otherwise coupling effects will reduce the Q of the tuned winding and alter the tuning point.

This guide is intended to give a general impression of the method employed for carrying out alignment and it must be realised that receivers vary considerably both in physical makeup, sensitivity and bandwidth and in all cases but the most simple, the steps in the maker's manual should be followed to the letter!

Double And Triple Superhets

These types of receiver are in common use and have distinct advantages in the way of bandwidth and rejection of unwanted signals, both internally generated and coming in via the aerial circuit.

The double superhet will have two conversion frequencies; probably a first i.f. of 1·6MHz and a second i.f. of 470 kHz to give superior image and second channel rejection performance over the

Conclusions

Realignment of any receiver can usually be relied on to give a good indication of that receiver's general condition. During alignment, various faults may become apparent which would otherwise not be noticed and these faults should be dealt with prior to completing the alignment process.

When the job is completed, do not forget to reassemble the cabinet correctly as this forms the major screening device for the receiver; very important if of the solid-state type. Finally, do not forget to wipe off all the dirty fingermarks from the dial assembly, control panel and knobs. A useful tip for cleaning knobs is to use a stout toothbrush and some methylated spirit to scrub the dirt from the depths of the knurled parts, finishing off with a soft cloth. Do remember, please, NO SMOKING whilst this operation is in progress! A clean and tidy receiver is always a pleasure to look at as well as to operate. ●