practical WIRELESS

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QUERIES
While we will always try to assist readers in difficulties with a *Practical Wireless* project, we cannot offer advice on modifications to our designs, nor on commercial radio, TV or electronic equipment. Please address your letters to the Editor, Practical Wireless, at the above address, giving a clear description of the problem and enclosing a stamped self-addressed envelope. Only one project per letter please.

Components are usually available from advertisers. A source will be suggested for difficult items.

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☐ NEWS & VIEWS

☐ FOR OUR CONSTRUCTORS

☐ GENERAL INTEREST

○ EXTRA

Our March issue will be published on 2 February
(for details see page 33)

FABULOUS PROFESSIONAL DISCO SYSTEM

F.A.L. De Luxe PROFESSIONAL CONSOLE (Powered) Carr. etc. £15

Slide Fade Controls. Autofade with Music Overide on both mic. and jingle inputs. Headphone pre-fade monitor with 5 Push-button selector. Illuminated V.U. meters. Illuminated rocker switches. LED cue indicators. Tape or Jingle inputs, unity gain. Mic. channel with Bass & Treble. Slave outlet.

Treble Control (Music Channel)	Output into line (Slave)
Treble Control (Mic. Channel)	Autofade Recovery
Bass Control (Music Channel)	Microphone Input.
Bass Control (Mic. Channel)	Tape/Jingle. 1/P

£399

SAVE £100

DEPOSIT £28·88 and 38 weekly payments of £9.74 (Total £399)

TURNTABLES: Garrard 125SB Belt-drive with Low-Mass 'S' arm and Magnetic Cartridge.
POWER: 120 watts continuous RMS into 4 ohms
DECK LIGHTS: Fully adjustable flexi-beams over each turntable with independent switching.
CABINET: Solidly made to withstand the rigours of transporting. Covered in heavy duty leather cloth type material in attractive colour combinations Corner cap protectors Recessed carrying handles.

List £320.76

INTEREST FREE CREDIT on this system only

ALL THREE UNITS PRODUCED BY BRITAINS LARGEST MAKERS OF DISCO EQUIPMENT

PAIR MATCHING FULL RANGE De Luxe 80w LOUDSPEAKERS

Each inc. Pair of Powerful 12" Bass units (with aluminium centre domes), and High Frequency Horn unit to extend frequency range to above 17 kHz. Normally £89·95 ea.

Make your own Console with these DISCO MODULES

CONTROL UNIT (mains powered)

Vol. (Left) Vol. (Right) Tape input and volume control. Bass, Treble, ON/OFF switch for each Table. **£25·00** Carr. £1

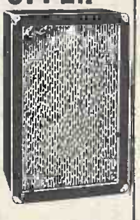
MONITOR UNIT With H/Phone Socket and Vol. Control Carr Free **£7·95**

FADER UNIT Carr Free **£7·95**

100w OUTPUT UNIT Mains powered Carr. £1·50 **£29·95**

FANTASTIC SPEAKER OFFER

TWIN 12" SPEAKER CABINET PLUS PAIR 12" SPEAKERS



of Robust vibration-proof construction. Fitted protective corner pieces, Removable Vynair covered front with silver effect trim. Sunken jack socket with escutcheon at the rear.
Pair 12" 20w speakers for wiring in series and front mounting in above supplied to complete a 40 watt unit for lead guitar or P.A.

While stocks last Three items

£19·95 Carr. £2·50

TITAN GROUP/DISCO SPKRS

	Value	RSC Price
T12/45R 12" 45w	£15·00	£12·95
T12/60R 12" 60w	£22·50	£14·95
T12/100 12" 100w	£36·00	£25·95
T15/60 15" 60w	£26·00	£17·95
T15/70 15" 70w	£28·00	£19·95
T15/100 15" 100w	£41·00	£29·95
T18/100 18" 100w	£51·00	£39·95

Rating RMS Imp 8-15 ohms

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

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

RSC 100 WATT DISCO SYSTEM

Consisting of (1) TWIN T/TABLE CONSOLE with PRE-AMP, and POWER OUTPUT STAGES (2) & (3) PAIR 50 WATT LOUDSPEAKERS including 12" UNITS

£169·95 Carr. £4·75

- ★ DISCOMAJOR POWER DISCO CONSOLE with integral Power Amplifier.
- ★ TWIN FULL SIZE BSR turntables with cueing device.
- ★ CARTRIDGES with Diamond Styli.
- ★ 3 SEPARATE VOLUME CONTROLS for each turntable and Mic.

CONSOLE COMPLETE WITH LID. FULL HEADPHONE MONITORING FACILITIES

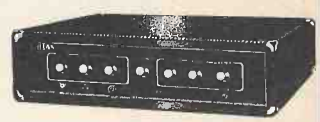
Terms: Deposit £30·00 and 18 fortnightly pymts. £9·80 (Total £206·40). Carr. £4·00.

Also available 200 WATT SYSTEM **£199·95**

ALL RSC PRICES INCLUDE VAT

50 WATT AMPLIFIER SACRIFICE

Limited stocks of **TITAN TA/50A** to be cleared to make way for a re-styled model.



Solid state, 3 sep. controlled inputs plus Master control. Bass. Treble & Presence Controls. Vynide covered cab. with corner protectives. Value £60. Terms: Dep. £7·95 & 8 monthly payments £4·72 (Total £45·71). Matching Cabinets 1 × 12" £29·95, 2 12" £49·95 Carr. £1 **£39·95**

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★LEEDS, ★LIVERPOOL & ★WOLVERHAMPTON

RSC

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TERMS C.W.O. or C.O.D. No. C.O.D. under £3. POSTAGE 60p PER ORDER OR AS QUOTED. Phone or Write for FREE CATALOGUE.

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RADIO EXCHANGE LIMITED

NEW ELECTRONIC MASTER KIT

With special V.H.F. Tuner Module to construct. A completely Solderless Electronic Construction Kit, with ready drilled Bakelite Panels, Nuts, Bolts, Wood Screws, etc. Also in the kit: Transistors, Capacitors, Resistors, Pots, Switches, Wire, Sleeving, Knobs, Dials, 5" × 3" Loudspeaker and Speaker Case, Crystal Earpiece, etc. Also ready wound Coils and Ferrite Rod Aerial. These are the Projects you can build with the components supplied with the kit, together with comprehensive Instruction Manual Pictorial and Circuit Diagrams.

Projects:
V.H.F. Tuner Module ★ A.M. Tuner Module ★ M.W. L.W. Diode Radio ★ Six Transistor V.H.F. Earpiece Radio ★ One Transistor M.W. L.W. Radio ★ Two Transistor Metronome with variable beat control ★ Three Transistor and Diode Radio M.W. L.W. ★ Four Transistor Push Pull Amplifier ★ Eight Transistor V.H.F. Loudspeaker Receiver ★ Variable A.F. Oscillator ★ Jiffy MultiTester ★ Four Transistor and Diode M.W. L.W. Radio ★ A.F. R.F. Signal Injector ★ Five Transistor Push Pull Amplifier ★ Sensitive Hearing Aid Amplifier ★ Three Transistor and Diode Short Wave Radio ★ Signal Tracer ★ Three Transistor Push Pull Amplifier ★ One Transistor Class A Output Stage to drive Loudspeaker ★ Sensitive Transistor Pre-Amp ★ Transistor Tester ★ Sensitive Three Transistor Regenerative Radio ★ Four Transistor M.W. L.W. and Diode Tuner ★ Five Transistor M.W. L.W. Trawler Band Regenerative Radio ★ Five Transistor V.H.F. Tuner ★ Three Transistor Code Practice Oscillator ★ Five Transistor Regenerative Short Wave Radio ★ Four Transistor and two Diodes M.W. L.W. Loudspeaker Radio ★ Seven Transistor M.W. L.W. Radio with Loudspeaker Push Pull output ★ One Transistor Home Broadcaster.

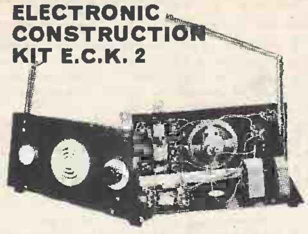
£14·99 + P & P £1·10

V.H.F. AIR CONVERTER KIT

Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to medium wave or the VHF band and operating as shown in the instructions supplied free with all parts.
Uses a retractable chrome-plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc. Size 5½"x1½"x3½". All parts including case and plans.

£4·95 + P & P and Ins. 60p

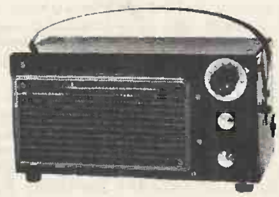
ELECTRONIC CONSTRUCTION KIT E.C.K. 2



Self Contained Multi-Band V.H.F. Receiver Kit.
8 transistors and 3 diodes. Push pull output. 3 in. loudspeaker, gain control, 7 section chrome-plated telescopic aerial, V.H.F. tuning capacitor, resistors, capacitors, transistors, etc. Will receive T.V. sound, public service band, aircraft, V.H.F. local stations, etc. Operates from a 9 volt P.P.7 battery (not supplied with kit).
Complete kit of parts

£7·95 + P & P and Ins. 90p

NEW MODEL R.K.1.



MultiBand A.M. Receiver. M.W.L.W. Trawler Band and Three Short Wave Bands. Seven Transistors and Four Diodes. Push Pull Output stage. 5" × 3" Loudspeaker. Internal Ferrite Rod Aerial. Kit includes all parts to build it up including Carrying Strap, Rubber Feet and ready-drilled Panels. Comprehensive Instruction Manual for stage by stage construction. Uses P.P.9 Nine Volt Battery.

£8·99 + P & P 90p

EDU KIT JUNIOR

Completely Solderless Electronic Construction Kit. Build these projects without Soldering Iron or Solder
- ★ Crystal Radio Medium Wave Coverage—No Battery necessary
- ★ One Transistor Radio
- ★ 2 Transistor Regenerative Radio
- ★ 3 Transistor Earpiece Radio Medium Wave Coverage
- ★ 4 Transistor Medium Wave Loudspeaker Radio
- ★ Electronic Noise Generator
- ★ Electronic Metronome
- ★ 4 Transistor Push/Pull Amplifier

All parts including Loudspeaker, Earpiece, M.W. Ferrite Road Aerial, Capacitors, Resistors, Transistors, etc. Complete kit of parts including construction plans.

£6·95 + P & P and Ins. 90p

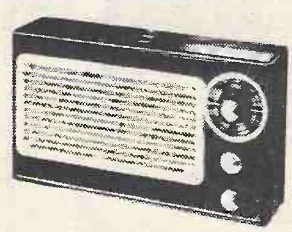
NEW ROAMER TEN MODEL R.K.3.

Multiband V.H.F. and A.M. Receiver. 13 Transistors and Six Diodes. Quality 6" × 3" Loudspeaker
With Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multiband A.M. section with Airspaced Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands S.W.1, S.W.2, S.W.3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc., Chrome-plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push-Pull output using 600mW Transistors. Gain. Wave-Change and Tone Controls. Plus two Slider Switches. Powered by P.P.9—9 volt Battery.

Complete kit of parts including carrying strap. Building Instructions and operating Manuals.

£14·79 + P & P £1·10

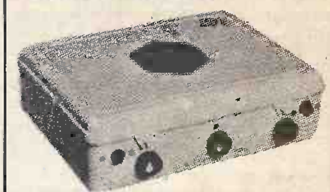
E.V.6 PLUS ONE



Build this exciting new design. Now with 7 Transistors and 4 diodes. MW/LW. Powered by 9V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in. loudspeaker. Attractive case with red speaker grille. Size 9in. x 5¼in. x 2¾in. approx. All parts including Case and Plans.
Total Building Costs:

£6·95 + P & P and Ins. 90p

EDU-KIT MAJOR



Completely solderless Electronic Construction Kit. Build fifteen projects including:— ● Signal Injector ● Transistor Tester NPN-PNP ● 7 Transistor Loudspeaker Radio MW/LW ● 5 Transistor Short Wave Radio.

Components include:
● 24 Resistors ● 21 Capacitors ● 10 Transistors ● 5" × 3" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc. Complete kit of parts including construction plans.
Total building costs:

£9·99 + P & P and Ins. £1·10

RADIO CONSTRUCTION KIT Q7

A compact small radio kit covering Medium Wave and Long Wave bands. Rugged Micanite construction and simple square design allows for easy carrying and positioning. Ideal for the Garage, Workroom, Kitchen, etc., has seven Transistors and four Diodes, quality Loudspeaker, ready wound Ferrite Rod Aerial and Carrying Strap. Size 4¾" × 4¾" × 4½". All parts and plans excluding 9v PP7 Battery.

£6·25 + P & P and Ins. 75p

POCKET FIVE

NOW WITH 2½" LOUDSPEAKER
3 Tuneable wavebands. M.W., L.W., and Trawler Band, 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive black and gold case. Size 5½" × 1½" × 3½" approx. All Parts including Case and Plans.
Total Building Costs

£4·95 + P & P and Ins. 80p

All prices include VAT

To: RADIO EXCHANGE LTD
61A High Street, Bedford MK40 1SA **Tel.: 0234 52367**
● Callers side entrance "Lavells" Shop.
● Open 10-1, 2.30-4.30 Mon.-Fri. 9-12 Sat.
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FEB 1979

Build the PW HYTHE marine band receiver

also:

12 Volt Fluorescent Lamp

&

Digital Audio Amplification

TTL ★★

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7403	10p	74121	25p
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7407	25p	74126	35p
7408	12p	74128	60p
7409	12p	74130	120p
7410	12p	74131	90p
7411	15p	74132	45p
7412	15p	74135	90p
7413	25p	74136	80p
7414	45p	74137	90p
7416	25p	74138	100p
7417	25p	74141	50p
7420	12p	74142	180p
7421	20p	74143	270p
7422	15p	74144	270p
7423	20p	74145	55p
7425	20p	74147	100p
7426	22p	74148	90p
7427	22p	74150	65p
7428	25p	74151	45p
7430	12p	74153	45p
7432	20p	74154	70p
7433	28p	74155	45p
7437	20p	74156	45p
7438	20p	74157	45p
7440	12p	74160	55p
7441	45p	74161	55p
7442	40p	74162	55p
7443	60p	74163	55p
7444	60p	74164	60p
7445	65p	74165	60p
7446	50p	74166	75p
7447	50p	74167	160p
7448	50p	74170	100p
7450	12p	74173	80p
7451	12p	74174	60p
7453	12p	74175	60p
7454	12p	74176	50p
7460	12p	74177	50p
7470	25p	74178	75p
7472	20p	74179	120p
7473	25p	74180	90p
7474	25p	74181	130p
7475	25p	74182	50p
7476	25p	74184	120p
7480	40p	74185	100p
7481	85p	74188	320p
7482	75p	74190	70p
7483	75p	74191	70p
7484	70p	74192	60p
7485	60p	74193	60p
7486	25p	74194	55p
7489	130p	74195	50p
7490	25p	74196	50p
7491	40p	74197	50p
7492	35p	74198	100p
7493	30p	74199	100p
7494	70p	74293	90p
7495	45p	7LS00	18p
7496	45p	74S112	80p
7497	120p	7805	100p
74100	80p	7812	100p
74104	40p	7815	100p
74105	40p	7818	100p
74107	25p	7824	100p
74108	100p		

LINEAR

AY38500	450p	NE556	90p
CA3039	70p	NE562B	400p
CA3046	60p	SAD1024	1500p
CA3060	225p	SL917B	650p
CA3065	200p	SN76003N	150p
CA3076	250p	SN76013N	110p
CA3080	75p	SN76013ND	125p
CA3084	250p	SN76023N	110p
CA3085	85p	SN76023ND	125p
CA3086	60p	SN76033N	150p
CA3088	190p	SN76227N	160p
CA3089	160p	SN766228N	180p
CA3090AQ	360p	SN7666DN	75p
CA3123E	130p	TAA300	100p
CA3130	100p	TAA350	190p
CA3140	60p	TAA550	35p
LF356	80p	TAA570	220p
LF357	80p	TAA661B	140p
LM211H	250p	TAA700	350p
LM300TR5	170p	TAA790	350p
LM301AN	30p	TAD100	150p
LM304	200p	TAD110	130p
LM307N	65p	TBA120S	60p
LM308TO5	100p	TBA120T	85p
LM308DIL	100p	TBA480Q	200p
LM309K	100p	TBA520Q	200p
LM310TO5	150p	TBA530Q	200p
LM311TO5	150p	TBA540	200p
LM317K	325p	TBA550Q	250p
LM324	70p	TBA560C	250p
LM339	60p	TBA641A12	250p
LM348N	90p	TBA700	180p
LM380	60p	TBA720Q	225p
LM381N	90p	TBA750Q	200p
LM382	90p	TBA800	80p
LM391	180p	TBA810	100p
LM555	25p	TBA820	100p
LM709C	40p	TBA920Q	280p
LM710TO5	69p	TCA270Q	220p
LM710DIL	65p	TCA270S	220p
LM723TO5	40p	TCA760	300p
LM723DIL	40p	TCA4500A	450p
LM733	120p	TDA1008	300p
LM741	20p	TDA1034	450p
LM748	40p	TDA2002	300p
LM1303N	100p	TDA2020	300p
LM1458	100p	TL084	120p
LM3080	75p	XR320	250p
LM3900	55p	XR2206	450p
LM3909N	65p	XR2207	450p
MC1310P	140p	XR2208	600p
MC1312P	150p	XR2216	650p
MC1314P	190p	XR2567	250p
MC1315P	230p	XR4136	150p
MK50398	650p	XR4202	150p
MM5314	380p	XR4212	150p
MM5316	480p	XR4739	150p
NE529K	150p	ZN414	100p
NE555	25p	95H90	700p

TRANSISTORS

AA113	10p	BC171	12p	BDX42	50p	BU208	220p
AA217	30p	BC172	12p	BDY10	100p	BY100	25p
AC121	30p	BC177	15p	BF115	20p	BY126	15p
AC126	20p	BC178	15p	BF120	50p	BY127	15p
AC127	20p	BC182	10p	BF121	45p	BY133	25p
AC127/01	25p	BC182L	12p	BF123	45p	BY164	50p
AC128	20p	BC183	10p	BF125	45p	BYX94	8p
AC151	25p	BC183L	12p	BF127	50p	C1120	30p
AC153	30p	BC184	10p	BF137	35p	C1164	20p
AC153K	40p	BC184L	12p	BF154	18p	E100	42p
AC154	30p	BC186	20p	BF160	18p	E300	47p
AC187	20p	BC204	12p	BF161	18p	E310	60p
AC188	20p	BC205	12p	BF173	20p	E420	180p
ACY17	35p	BC207	12p	BF178	25p	E430	120p
ACY19	35p	BC212	11p	BF179	25p	MJE340	45p
ACY20	35p	BC212L	12p	BF180	30p	MPSA05	30p
ACY22	40p	BC213	12p	BF181	30p	MPSA06	32p
ACY40	50p	BC213L	15p	BF182	30p	MPSA56	32p
ACY41	50p	BC214	15p	BF183	25p	TIP29	35p
ACY42	50p	BC214L	18p	BF184	20p	TIP29A	40p
AD130	150p	BC237	10p	BF186	25p	TIP29C	40p
AD143	150p	BC237B	15p	BF194	10p	TIP30	35p
AD149	80p	BC268	16p	BF195	10p	TIP30A	40p
AD161	30p	BC294	30p	BF196	10p	TIP30B	40p
AD162	30p	BC300	25p	BF197	10p	TIP30C	45p
AD161/2MP	70p	BC301	25p	BF198	25p	TIP31	40p
AF114	25p	BC303	30p	BF199	25p	TIP31A	45p
AF115	25p	BC307	15p	BF200	30p	TIP31B	50p
AF116	25p	BC308	15p	BF224	20p	TIP31C	55p
AF118	80p	BC317	12p	BF225	20p	TIP32	40p
AF178	95p	BC318	12p	BF241	16p	TIP33	60p
AF139	35p	BC323	30p	BF244B	35p	TIP34	70p
AF239	45p	BC328	18p	BF255	25p	TIP35	200p
AF279	50p	BC337	20p	BF257	25p	TIP35C	225p
AU110	180p	BC338	18p	BF258	25p	TIP41A	70p
BA114	12p	BC348	20p	BF259	25p	TIP41B	75p
BA121	12p	BC461	35p	BF271	25p	TIP41C	80p
BA154	12p	BC516	35p	BF274	30p	TIP42A	80p
BA157	15p	BC517	35p	BF324	30p	TIP42B	85p
BA173	15p	BC547	12p	BF336	35p	TIP42C	90p
BAX13	5p	BC547B	13p	BF337	35p	TIP2955	70p
BAX16	5p	BC548	12p	BF451	25p	TIP3055	50p
BAW21	20p	BC548C	14p	BF367	20p	TIS90	25p
BB105	35p	BC549B	13p	BF394	35p	TIS91	25p
BB110	35p	BC549C	14p	BF458	50p	IN914	5p
BC107	10p	BC557	13p	BF594	50p	IN3754	20p
BC108	10p	BC557B	15p	BF596	50p	IN4001	5p
BC108C	15p	BCY34	80p	BF597	50p	IN4002	5p
BC109	10p	BCY38	100p	BFR40	30p	IN4003	5p
BC109C	15p	BCY42	25p	BFR80	30p	IN4004	5p
BC113	12p	BCY43	25p	BFW58	20p	IN4005	5p
BC114	15p	BCY58	18p	BFW60	25p	IN4006	6p
BC115	15p	BCY59	25p	BFW88	30p	IN4007	7p
BC116	15p	BCY70	15p	BFW89	30p	IN4148	4p
BC117	18p	BCY71	20p	BFW91	30p	2N456A	90p
BC118	12p	BCY72	15p	BFX29	25p	2N929	20p
BC119	25p	BD115	45p	BFX34	25p	2N930	20p
BC125	16p	BD121	85p	BFX38	25p	2N1302	25p
BC125B	20p	BD131	35p	BFX44	35p	2N1303	30p
BC126	20p	BD132	35p	BFX48	45p	2N1305	30p
BC134	15p	BD133	45p	BFX81	100p	2N1306	38p
BC136	16p	BD135	35p	BFX85	30p	2N1308	50p
BC137	16p	BD136	35p	BFX87	25p	2N1711	22p
BC138	30p	BD137	40p	BFX88	25p	2N2219A	25p
BC140	30p	BD139	40p	BFY10	30p	2N2483	30p
BC141	30p	BD140	40p	BFY18	100p	2N2906	16p
BC142	30p	BD144	160p	BFY19	100p	2N2907	20p
BC143	30p	BD181	100p	BFY50	20p	2N3053	20p
BC147	10p	BD182	100p	BFY51	20p	2N3054	50p
BC148	10p	BD188	130p	BFY52	20p	2N3055	60p
BC148C	14p	BD207	70p	BFY53	25p	2N3702	11p
BC149	10p	BD220	65p	BFY90	125p	2N3703	12p
BC153	16p	BD222	65p	BR101	35p	2N3704	12p
BC154	18p	BD233	50p	BRY39	35p	2N3705	12p
BC157	10p	BD238	50p	BRY56	35p	2N3706	12p
BC158	10p	BD252	50p	BSX20	20p	2N3708	12p
BC159	10p	BD263	65p	BSY40	25p	2N3715	300p
BC167A	12p	BD607	80p	BSY95	20p	2N3819	25p
BC168	14p	BD608	80p	BT100A	80p	2N3866	95p
BC169	15p	BD609	80p	BU105	200p	2N3904	15p
		BD610	80p	BU133	180p	2N6027	50p
		BDX32	200p			2SD234	50p
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4011	12p	4056	120p
4012	12p	4060	100p
4013	30p	4066	35p
4015	50p	4069	12p
4016	30p	4070	12p
4017	50p	4071	12p
4018	55p	4072	12p
4019	40p	4081	12p
4020	50p	4082	12p
4022	50p	4093	70p
4023	12p	4510	60p
4024	40p	4511	70p
4025	12p	4516	65p
4026	80p	4518	65p
4027	30p	4520	65p
4028	45p	4528	80p
4029	50p	4583	70p
4030	30p		
4032	80p		
4033	100p		
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2·2/35	7p	100/10	8p
3·3/25	7p	100/16	8p
4·7/10	7p	100/25	8p
4·7/16	7p	100/50	8p
4·7/25	7p	100/63	16p
4·7/50	7p	220/16	12p
6·8/25	7p	220/25	14p
10/10	7p	220/50	22p
10/16	7p	330/25	17p
10/25	7p	330/35	18p
10/50	7p	330/50	20p
22/6V3	7p	470/10	14p
22/10	7p	470/25	19p
22/16	7p	470/35	20p
22/25	7p	470/50	24p
22/35	7p	1000/16	27p
22/50	8p	1000/25	30p
33/6V3	7p	1000/35	35p
33/16	8p	1000/40	40p
33/25	8p	1000/63	50p
33/40	8p	1200/63	60p
33/50	9p	2200/10	30p

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1000 PF	5p	0·1 uF	6p
2200	5p	0·22 uF	7p
3300	5p	0·33 uF	9p
4700	5p	0·47 uF	12p
6800	5p	1·0 uF	20p
0·01 uF	5p	2·2 uF	25p
0·022 uF	5p	4·7 uF	35p
0·033 uF	5p	6·8 uF	40p
0·047 uF	5p	10 uF	60p

TANT. BEADS

0·1/35V	14p	3·3/16V	14p
0·15/35V	14p	4 7/16V	14p
0·22/35V	14p	4·7/25V	14p
0·33/35V	14p	4·7/35V	14p
0·47/10V	14p	6·8/6V3	14p
0·47/35V	14p	6·8/35V	14p
0·68/35V	14p	1·0/35V	14p
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LP1400	400p
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EP9002	280p
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Production of the new catalogue has been held up for a few weeks - since we have just been appointed as distributors for two of the most exciting ranges of radio components products yet : The Micrometals range of iron dust torroids cores and formers, and the OKI range of VLSI for digital frequency displays for receivers. We apologize for any inconvenience, but these two ranges are really worth the wait, and include some products you will find hard to believe, like the MSM5523 IC, an IC with less than ten external components that gives AM frequency readout to 1kHz from LW to 39.999MHz, FM frequency readout in 100kHz steps - (all usual IF offsets programmable by diodes), a 24 hour format clock with 12 hour display, independent on and off timers, time signals on the hours, stopwatch facility and a sleep timer. This costs £14 with its timebase crystal, and makes all that has gone before an expensive and time wasting excercise. Rather like the way the Intersil ICM7216 has revolutionized the instrument counter market. (See the OSTS ad.) And those of you familiar with Amidon and IG dust torroids, favoured in many new RF designs, will be pleased to know Ambit will be stocking a broad range of the Micrometals types for applications from EMI filters to RF PA stages.

OKI frequency counter ICs: details in cat2

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

Other new semiconductor additions:

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

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

Price reduction on CA3189E ....now £2.20

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

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

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

208BLR series, individual per channel with a 26/38kHz version for pilot cancel decoder applications. Flat to 15kHz £0.90

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

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

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

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

A brief summary of some of our range of ICs:

TDA1062/1.95; TDA1083/1.95; HA1197/£1.40 CA3123E/£1.40; TBA651/£1.81; CA3089/1.94 HA1137/£2.20; MC1310/£2.20; HA1196/£3.95 KB4424/£2.75; KB4423/£2.53;SD6000/£3.75 KB4412/£2.55; KB4413/£2.75; KB4417/£2.55 MC1495L/£6.86*; MC1496P/£1.25 LM381N/£1.81; LM1303/£0.99; ULN2283B/ £1.00; LM380N/£1; TBA810AS/£1.09 TCA940E/£1.80; TDA2002/£1.95; ICL8038CC/£4.50*; NE566/£2.50*; NE567/ £2.50*; NE5608/£3.50; NE561B/£3.50; NE562B/£3.50*; NE565A/£2.50*

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

Some transistors for RF specifically:

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

PIN and other Varicap diodes:

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

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

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

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

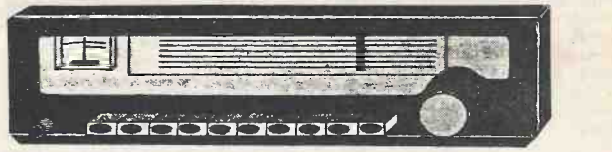
That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that,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

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

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

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

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



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

The tuner board - with "on board" PCB mounted switching, all components etc : £33.00
The case/cabinet with PSU, meter and mechanics etc £25.00
An SAE for full details please. See the feature article in Practical Wireless (Dec/Jan)

2 Gresham Road, Brentwood, Essex.

FF1 WALL MOUNTING KIT FOR HI-FI SPEAKERS

Fidelity Fastenings FF1 is a precision made, vibration damped wall fastening for Hi-Fi and Stereo Speakers of up to 50lbs weight each. Almost undetectable when fitted, the FF1 allows easy adjustment of speaker angle, and the rubber mounting ensures that they do not move accidentally. Speakers can also be quickly and easily lifted off for dusting, cleaning and redecorating.

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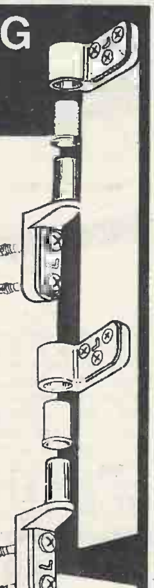
in case of difficulty, direct from the manufacturer at £6.89 inc P & P



- ★ Holds up to 50lbs weight per speaker.
- ★ Precision cast mounting brackets.
- ★ Rubber friction mounting for complete stability.
- ★ Easy adjustment of angle for precise stereo image.

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SINCLAIR PRODUCTS microvision tv £90. PDM35 £27·25. mains adaptor £3·24. case £3·25. DM235 £48·30. rechargeable battery units £8. adaptor/charger £3·70. case £8·50. cambridge prog calculator £13·13. prog library £3·45. mains adaptor £3·20. enterprise prog calculator £21·95. DM350. DM450 p.o.a.
COMPONENTS send sae for full list. 1 lb FeCl £1·05. dalo pen 73p. 60 sq ins pcb 55p. laminate cutter 75p. small drill 20p. zn414 £1·05. pcb and extra parts for radio £3·85. case £1. 1N4148 1·4p. 1N4002 2·9p. 723 29p. 741 15p. NE555 23p. bc182b, bc183b, bc184b, bc212b, bc213b, bc214c 4·5p. plastic equivs bc107, bc109 4·8p. ¼W 5% E12 resistors 10R to 10M 1p, 0·8p for 50+ of one value. 16v electrolytics ·5/1/2/5/10/22mf 5p, 100mf 6p, 1000mf 10p. polyesters 250v ·015, ·068, ·1mf 1½p. ceramics 50v E6 22pf to 47n 2p. polystyrenes 63v E12 10pf to 10n 3p. zeners 400mW E24 2v7 to 33v 7p.
TV GAMES send sae for data. AY–3–8500 + kit £8·95. AY–3–8600 + kit £12·50. tank battles chip £6·90, kit £7·05. stunt cycle chip £6·90, kit £5·60. rifle kit £4·95.
TRANSFORMERS 6–0–6v 100ma 74p, 1½a £2·35. 6·3v 1½a £1·89. 9–0–9v 75ma 74p, 1a £2, 2a £2·60. 12–0–12v 100ma 90p, 1a £2·49.
IC AUDIO AMPS with pcb JC12 6W £1·60. JC20 10W £2·95. JC40 20W £2·95.
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BATTERY ELIMINATOR KITS send sae for data. 100ma radio types with press-studs 4½v £1·40, 6v £1·40, 9v £1·40, 4½+4½v £1·80, 6+6v £1·80, 9+9v £1·80. stabilized 8-way types 3/4½/6/7½/9/12/15/18v 100ma £2·80, 1Amp £6·40. stablilzed power kits 2–18v 100ma £3·60, 2–30v 1A £6·95. 2–30v 2a £10·95. 12v car convertor 6/7½/9v 1a £1·35.
T-DEC AND CSC BREADBOARDS s-dec £3·17, t-dec £4·02, u-deca £4·40, u-decb £6·73.16 dil adaptor £2·14. exp300 £6·21, exp350 £3·40. exp650 £3·89. exp4b £2·48.
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AAZ13	0·18
AAZ15	0·34
AAZ17	0 27
AC107	0·60
AC125	0·20
AC126	0·20
AC127	0·20
AC128	0·20
AC141	0·25
AC141K	0·35
AC142	0·20
AC142K	0·30
AC176	0·20
AC187	0·20
AC188	0·20
ACY17	0·85
ACY18	0·80
ACY19	0·75
ACY20	0·70
ACY21	0·75
ACY39	1·50
AD149	0·70
AD161	0·45
AD162	0·45
AF106	0·45
AF114	0·35
AF115	0·35
AF116	0·35
AF117	0·35
AF139	0·40
AF186	1·20
AF239	0·45
AFZ11	2·75
AFZ12	2·75

ASY26	0·40
ASY27	0·40
ASZ15	1·25
ASZ16	1·25
ASZ17	1·25
ASZ20	1·50
ASZ21	2·00
AU110	1·70*
AU113	1·70*
AUY10	1·70*
BA145	0·13*
BA148	0·13*
BA154	0·09
BA155	0·10
BA156	0·09
BAW62	0·05
BAX13	0·06
BAX16	0·09
BC107	0·12
BC108	0·12
BC109	0·13
BC113	0·12*
BC114	0·13*
BC115	0·14*
BC116	0·15*
BC117	0·17*
BC118	0·10*
BC125	0·16*
BC126	0·20*
BC135	0·14*
BC136	0·15*
BC137	0·15*
BC147	0·09*
BC148	0·08*
BC149	0·09*
BC157	0·09*
BC158	0·08*

BC159	0·10*
BC167	0·12*
BC170	0·11*
BC171	0·10*
BC172	0·10*
BC173	0·12*
BC177	0·15
BC178	0·14
BC179	0·16
BC182	0·11*
BC183	0·10*
BC184	0·11*
BC212	0·13*
BC213	0·12*
BC214	0·15*
BC237	0·09*
BC238	0·12*
BC301	0·25
BC303	0·24
BC307	0·10*
BC308	0·10*
BC327	0·20*
BC328	0·18*
BC337	0·18*
BC338	0·17*
BCY30	1·00
BCY31	1·00
BCY32	1·00
BCY33	0·90
BCY34	0·90
BCY39	3·00
BCY40	1·00
BCY42	0·25
BCY43	0·25
BCY58	0·16
BCY70	0·15
BCY71	0·17

BCY72	0·13
BCZ11	1·50
BD115	0·45
BD121	1·20
BD123	1·20
BD124	1·30
BD131	0·35
BD132	0·38
BD135	0·34*
BD136	0·34*
BD137	0·35*
BD138	0·40*
BD139	0·43*
BD140	0·44*
BD144	2·00
BD181	1·10
BD182	1·18
BD237	0·40
BD238	0·55
BDX10	0·91
BDX32	2·00
BDY20	1·25
BDY60	0·50
BF115	0·25
BF152	0·18
BF153	0·20
BF154	0·17
BF159	0·23
BF160	0·16
BF167	0·20
BF173	0·20
BF177	0·24
BF178	0·24
BF179	0·25
BF180	0·30
BF181	0·30
BF182	0·30
BF183	0·25
BF184	0·25
BF185	0·25

BF194	0·09*
BF195	0·09*
BF196	0·10*
BF197	0·12*
BF200	0·27
BF224	0·20*
BF244	0·28*
BF257	0·24
BF258	0·26
BF259	0·32
BF336	0·20*
BF337	0·30*
BF338	0·31*
BFS21	3·96
BFS28	2·23
BFS61	0·20*
BFS98	0·20*
BFW10	0·65
BFW11	0·65
BFX84	0·22
BFX85	0·23
BFX87	0·21
BFX88	0·21
BFY50	0·26
BFY51	0·26
BFY52	0·26
BFY64	0·26
BFY90	1·25
BSX19	0·21
BSX20	0·20
BSX21	0·20
BT106	1·25
BTY79/400R	3·19
BU205	1·75*
BU206	2·25*
BU208	2·00*
BY100	0·45
BY126	0·14
BY127	0·15

BZX61 Series	0·18
BZY88 Series	0·13
CRS/105	0·45
CRS/140	0·60
CRS/305	0·45
CRS/340	0·75
CRS/360	0·90
GEX66	1·50
GEX541	1·75
GJ3M	0·75
GJ5M	0·75
GM0378A	1·75
KS100A	0·45*
MJE340	0·80
MJE370	1·17
MJE371	0·61
MJE520	0·52
MJE521	0·55
MJE2955	1·25
MJE3055	0·75
MPF102	0·30*
MPF103	0·30*
MPF104	0·30*
MPF105	0·30*
MPSA06	0·24*
MPSA56	0·26*
MPSU01	0·36*
MPSU06	0·46*
MPSU56	0·49*
NE555	0·45
NKT401	2·00
NKT403	1·73
NKT404	1·73
OA5	0·95
OA7	0·55
OA10	0·60
OA47	0·14

OA70	0·30
OA79	0·30
OA81	0·30
OA85	0·30
OA90	0·08
OA91	0·08
OA95	0·08
OA200	0·09
OA202	0·09
OA211	1·00
OAZ200	1·00
OAZ201	1·00
OAZ206	1·00
OAZ207	1·00
OC16	2·90
OC20	2·50
OC22	2·50
OC23	2·75
OC24	3·00
OC25	0·90
OC26	0·90
OC28	2·00
OC29	2·00
OC35	1·50
OC36	1·50
OC41	0·80
OC42	0·75
OC43	2·25
OC44	0·60
OC45	0·55
OC71	0·55
OC72	0·55
OC73	1·00
OC74	0·65
OC75	0·65
OC76	0·55
OC77	1·20
OC81	0·65
OC81Z	1·20

OC82	0·65
OC83	0·65
OC84	0·65
OC122	1·50
OC123	1·75
OC139	2·25
OC140	2·75
OC141	3·25
OC170	1·00
OC171	1·00
OC200	1·50
OC201	1·75
OC202	1·75
OC203	1·75
OC204	2·50
OC205	2·50
OC206	2·50
OC207	1·75
OCP71	1·25
ORP12	0·75
R2008B	1·75*
R2009	2·25*
R2010B	1·75*
T1C44	0·30
T1C226D	1·20
T1L209	0·20
T1P29A	0·41*
T1P30A	0·44*
T1P31A	0·45
T1P32A	0·48
T1P33A	1·69
T1P34A	1·73
T1P41A	0·63
T1P42A	0·70
T1P2955	1·67
T1P3055	0·56
T1S43	0·45*
ZS140	0·25*
ZS170	0·21
ZS178	0·54*

ZS271	0·23*
ZS278	0·57*
ZTX107	0·11*
ZTX108	0·10*
ZTX109	0·12*
ZTX300	0·12*
ZTX301	0·13*
ZTX302	0·15*
ZTX303	0·17*
ZTX304	0·19*
ZTX311	0·12*
ZTX314	0·20*
ZTX500	0·13*
ZTX501	0·14*
ZTX502	0·16*
ZTX503	0·17*
ZTX504	0·20*
ZTX531	0·20*
ZTX550	0·16*
1N914	0·05
1N916	0·07
1N4001	0·06
1N4002	0·06
1N4003	0·07
1N4004	0·07
1N4005	0·08
1N4006	0·08
1N4007	0·09
1N4009	0·06
1N4148	0·06
1N5400	0·13
1N5401	0·13
1S44	0·04
1S920	0·07
1S921	0·07
2G301	1·00
2G302	1·00
2G306	1·10
2N404	1·00
2N696	0·25

2N697	0·25
2N698	0·30
2N705	1·20
2N706	0·15
2N708	0·20
2N930	0·20
2N1131	0·26
2N1132	0·26
2N1302	0·35
2N1303	0·35
2N1304	0·45
2N1305	0·45
2N1306	0·50
2N1307	0·50
2N1308	0·55
2N1309	0·55
2N1613	0·25
2N1671	1·50
2N1893	0·25
2N2147	1·75
2N2148	1·85
2N2218	0·25
2N2219	0·24
2N2220	0·18
2N2221	0·18
2N2222	0·18
2N2223	2·75
2N2368	0·17
2N2369A	0·21
2N2484	0·20
2N2646	0·55
2N2904	0·25
2N2905	0·25
2N2906	0·21
2N2907	0·21
2N2924	0·21*
2N2925	0·22*
2N2926	0·14*
2N3053	0·25
2N3054	0·50

2N3055	0·70
2N3440	0·60
2N3441	0·80
2N3442	1·10
2N3525	0·80
2N3614	1·50
2N3702	0·11*
2N3703	0·13*
2N3704	0·13*
2N3705	0·13*
2N3706	0·13*
2N3707	0·13*
2N3708	0·10*
2N3709	0·13*
2N3710	0·10*
2N3711	0·10*
2N3771	1·75
2N3772	2·00
2N3773	3·00
2N3819	0·36*
2N3820	0·45*
2N3823	0·55*
2N3866	0·72
2N3904	0·13*
2N3905	0·13*
2N3906	0·13*
2N4058	0·14*
2N4059	0·10*
2N4060	0·12*
2N4061	0·12*
2N4062	0·13*
2N4124	0·15*
2N4126	0·15*
2N4286	0·20*
2N4288	0·22*
2N4289	0·24*
2N5457	0·35*
2N5458	0·35*
2N5459	0·35*

VALVES

AZ31	1·10*
CBL31	1·50
CL33	2·00*
CY31	1·00*
DAF91†	0·40*
DAF96	1·00*
DF91†	0·40*
DF96	1·00*
DK91	1·05
DK92	1·25*
DK96	1·10*
DL92	0·75*
DL94	1·20*
DL96	1·10*
DY86/7†	0·55*
DY802	0·80*
E88CC†	1·00
EABC80	0·55*
EAC91	0·50
EAF42	1·25*
EAF801	1·75*
EB41	2·00*
EB91†	0·40*
EBC33	1·75*
EBC41	1·25*
EBC81	1·10*
EBC90	0·75*
EBF80	0·50*
EBF83	1·25*
EBF89†	0·45*
EBL31	2·50*
ECC40	1·25*
ECC81†	0·50*
ECC82†	0·47*

ECC83†	0·55*
ECC84†	0·60*
ECC85†	0·55*
ECC88†	0·75*
ECC91†	0·55*
ECC189	1·66*
ECF80†	0·60*
ECF82†	0·70*
ECH35	2·00*
ECH42	1·15*
ECH81†	0·55*
ECH83	1·25
ECH84†	0·85*
ECL80†	0·60*
ECL82†	0·60*
ECL83	1·50*
ECL86†	0·85*
ECLL800	7·00*
EF37A†	2·50*
EF39†	1·60*
EF40	1·15*
EF41	1·20*
EF42	2·00*
EF50†	0·60*
EF80†	0·50*
EF83	1·75*
EF85†	0·50*
EF86†	0·60*
EF89	1·60
EF91†	0·70*
EF92†	0·75*
EF98	1·25*
EF183†	0·70*
EF184†	0·70*

EH90	1·28*
EL32	1·50*
EL33	3·50*
EL34 (Thorn)	1·60
EL34(Mullard)	2·24
EL41	1·25*
EL42	1·75*
EL81	1·10*
EL84†	0·45*
EL86†	0·75*
EL91	4·35*
EL95†	0·80*
EL360	2·75*
EM80	1·10*
EM81	1·00*
EM84	1·00*
EM85	1·25*
EM87	1·50*
EN91†	2·24*
EY51†	0·75*
EY86†	0·50*
EZ40	1·25*
EZ41	1·25*
EZ80†	0·50*
EZ81†	0·50*
EZ90†	0·60*
GZ32	1·25
GZ33	4·00*
GZ34†	1·52*
KT61	3·50*
KT66	5·00*
KT88	6·25*
KTW61	1·75*
KTW62	1·75*
KTW63	1·75*

MU14	1·00*
N78	9·00*
OA2†	0·55
OB2†	0·60
OC3†	0·75
OD3†	0·75
OZ4	1·60
PC86†	0·85*
PC88†	0·85*
PC97	1·08*
PC900†	1·00*
PCC84†	0·50*
PCC88	0·65*
PCC89†	1·05*
PCC189†	1·00*
PCF80	0·96*
PCF82†	0·50*
PCF86†	0·75*
PCF87†	1·10*
PCF200†	1·15*
PCF201†	1·10*
PCF801†	0·60*
PCF802†	0·88*
PCF805	1·44*
PCF806	1·44*
PCF808	1·44*
PCL82†	0·80*
PCL83†	0·92*
PCL84†	0·75*
PCL85†	0·96*
PCL86†	0·85*
PCL805/85†	0·96*
PD500	3·60*
PFL200	1·12*
PL36†	1·12*

PL81	1·12*
PL81A†	1·12*
PL82	0·60*
PL83†	0·55*
PL84†	0 75*
PL504/500†	1·20*
PL508†	1·60*
PL509†	2·72*
PL519†	3·60*
PL801	1·10*
PL802	3·46
PY33	1·10
PY81	0·92
PY82	0·80
PY83	0·70*
PY88†	1·16*
PY500A†	1·60*
PY800/81†	0·92*
PY801	0·92*
QQV02-6	9·90
QQV03-10†	2·00
QQV03-20A†	10·50*
QQV06-40A†	13·00*
R17	1·65
R19	1·00
R20	1·44
U18-20	2·50*
U25	1·16*
U26	1·44*
UABC80†	0·58*
UAF42	1·25

UB41	1·25*
UBC41†	1 00*
UBF89	0·60
UCC84	1·10
UCC35†	0·55*
UCF80	1·15
UCH42	1·20*
UCH81†	0·65*
UCL82†	0·75*
UCL83	1·44*
UF41	1·00*
UF80†	0·50*
UF85†	0·65*
UF89†	0·55*
UL41	1·60
UL84†	0·85*
UM80	1·00*
UY41†	0·75*
UY85†	0·65*
1B3GT†	0·65*
1R5†	0·55*
1S5†	0·40*
1T4†	0·40*
2AS15	10·00
2D21†	0·80
3A5	1·35
3CX100A5	20·00
3S4†	0·75*
3V4†	1·00*
4CX250B	17·50
5R4GY†	1·10*
5U4G	1·52*
5U4GB	2·26*
5V4G†	0·65*
5Y3GT	0·85*
5Z3	1·50*

5Z4G	1·12*
5Z4GT	1·00*
6-30L2	1·56*
6AB7	0·75*
6AC7	0·75*
6AF4A†	0·70*
6AG7	0·75*
6AH6†	0·95*
6AK5†	0·50*
6AK6	0·95*
6AL5†	0·40*
6AM4	2·30*
6AM5	3·85*
6AM6†	0·70*
6AN5	2·50*
6AN8A†	0·70*
6AQ5†	0·85*
6AR5	0·70*
6AS6†	0·80*
6AS7G†	1·50*
6AT6†	0·75*
6AU5GT	4·26*
6AU6†	0·55*
6AV5GT	3·74*
6AV6†	0·75*
6AW8A†	1·00
6AX5GT	3·10*
6B7	0·75
6B8	0·75
6BA6†	0·50*
6BA7	5·12*
6BA8A	3·75
6BC4	3·71
6BE6†	0·48*
6BH6†	1·20*
6BJ6†	1·20*
GBK4	4·21*

6BL6	85·06
6BL7GT	3·86*
6BN6	0·80*
6BQ7A	1·55*
6BR7	4·00*
6BR8†	1·20*
6BS7	4·00*
6BW6	3·75*
6BW7	1·40*
6BX7GT	4·96*
6BZ6	1·78*
6C4†	0·55*
6CB6A†	0·55*
6CD6GA	4·90*
6CG7	1·72*
6CH6	4·42*
6CL6†	0·75*
6CW4	7·24*
6D2†	0·40*
6DK6	2·49*
6DQ6B	3·90*
6EA8	2·21*
6EB8	2·12*
6EW6	1·50
6F6	1·75
6F23	1·60*
6F28	1·16*
6H2N	1·05
6H3N	1·05
6H6	1·50
6J4†	1·20*
6J6†	0 55*
6J7	0·80*
6K4N	1·25
6K6GT	1·30
6K7	1·50
6K8	1·75

6KD6	4·79*
6L6G	2·50*
6L6GA	1·50*
6L6GT	0·85*
6L6GC	1·95*
6L7	2·00
6N2P	1·05
6N3P	1·05
6N7	1·05
6P25	3·60*
6Q7	2·20
6R7	1·80
6SA7	1·45
6SC7	1·50
6SF7	1·60
6SH7	1·50
6SJ7	1·60
6SK7	1·30
6SL7GT†	0·70*
6SN7GT†	0·70*
6SQ7	1·30
6SR7	1·50
6SS7	1·80
6U5G	2·00*
6U8†	0·55*
6U8A†	0·55*
6V6GT†	0·65*
6X4†	0·60*
6X5GT†	0·60*
7B7	1·70
7C5	1·75*
7C6	1·25*
7H7	2·00
7R7	1·50*
7S7	2·25*

7Y4	1·60
7Z4	1·85
12AT6	1·20
12AT7†	0·50*
12AU6	0·65*
12AU7†	0·47*
12AV6	0·85*
12AV7	3·46*
12AX7†	0·55*
12AY7†	0·85*
12B4A†	1·00*
12BA6	0·65*
12BE6	1·60*
12BH7†	0·65*
12BY7†	0·80*
12E1	7·10
30C15	1·56*
30C17	1·56*
30C18	1·44*
30F5	1·60*
30FL1/2	1·12*
30FL12	1·72*
30FL14	1·44*
30L1	0·84*
30L15	1·72*
30L17	1·72*
30P4	0·92*
30P19	1·12*
30PL1	1·32*
30PL13	1·72*
30PL14	1·68*
30PL15	1·72*
35W4	0·60*
50C5	0·70*
85A2	1·50
90AG	7·96
90AV	7·96

90C1	1·50
90CG	13·78
90CV	13·30
92AG	7·26
92AV	7·16
150B2	1·80
150C2	1·50
150C4	2·30
211	5·00
723AB†	8·00
807†	1·20
811A†	3·80
812A	8·35
813†	10·00
833A	30·00
866A	8·85
872A	13·75
931A	12·24
2050	2·50
5642	5·26*
5654	3·61*
5651	1·80*
5670	2·86*
5814A	2·60*
6080†	6·85*
6146A	5·12
6146B	5·58
6159	6·00
6442	15·00
6973	3·52*
7586	11·38*
7587	19·60*
7868	3·94*
8068	5·50
8136	2·44*

INTEGRATED CIRCUITS

7400	0·16
7401	0·16
7402	0·16
7403	0·16
7404	0·17
7405	0·16
7406	0·40
7407	0·40
7408	0·20
7409	0·20
7410	0·16

7412	0·26
7413	0·32
7416	0·32
7417	0·32
7420	0·17
7422	0·20
7423	0·32
7425	0·30
7427	0·30
7428	0·43
7430	0·17

7432	0·30
7433	0·36
7437	0·32
7438	0·32
7440	0·18
7441AN	0·85
7442	0·72
7447AN	1·90
7450	0·18
7451	0·18
7453	0·18

7454	0·18
7460	0·18
7470	0·35
7472	0·33
7473	0·36
7474	0·40
7475	0·54
7476	0·40
7480	0·55
7482	0·75
7483	0·90
7484	1·00
7486	0·35
7490	0·52

7491	0·80
7492	0·60
7493	0·60
7494	0·80
7495	0·72
7496	0·80
7497	3·00
74100	1·50
74107	0·45
74109	0·70
74110	0·50
74111	0·86
74116	1·75

74118	1·00
74119	1·50
74120	0·83
74121	0·40
74122	0·60
74123	1·00
74125	0·55
74126	0·55
74128	0·60
74132	0·70
74136	0·55
74141	0·80
74142	2·30
74143	2·50

74144	2·50
74145	0·90
74147	2·00
74148	1·75
74150	1·60
74151	0·85
74154	1·75
74155	0·85
74156	0·85
74157	0·75
74159	2·10
74170	2·30
74172	4·40

74173	1·40
74174	1·50
74175	0·90
74176	1·20
74178	1·25
74179	1·25
74180	1·15
74190	1·50
74191	1·50
74192	1·35
74193	1·35
74194	1·25
74195	1·00

74196	1·20
74197	1·10
74198	2·25
74199	2·25
76013N	1·75*
LM309K	1·50
TAA570	2·30*
TAA630S	3·50*
TAA700	3·91
TBA480Q	1·84*
TBA520Q	2·30*

TBA530	1·98*
TBA540Q	2·30*
TBA550Q	3·22*
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TBA673	2·19*
TBA700	1·52*
TBA720Q	2·30*
TBA750Q	2·07*
TBA800	1·20

TBA920	2·90
TBA9200	2·99
TBA990Q	2·99*
TCA270Q	2·99*
TCA760A	1·38*

DIL Sockets

8 PIN	0·15
14 PIN	0·15
16 PIN	0·17

BASES

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

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1CP31	31·00
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2BP1*	9·00
3BP1	8·00
3DP1*	5·00
3EG1*	7·00
3FP7	6·00
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3JP1*	8·00
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3JP7*	10·00
3KP1*	15·00
3RP1*	35·00

5ADP1	35·00
5BP1*	10·00
5CP1*	5·00
5CP1A	40·00
5FP15A	15·00
5UP7	14·00
DG7-5	25·00
DG7-32	36·00
DH3-91	31·00
DH7-11	68·00
VCR97*	5·00
VCR138*	10·00
VCR138A*	12·50
VCR139A*	8·00
VCR517A*	10·00

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VCR517C*	6·00
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* = Surplus
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SPECIFICATIONS

AMPLIFIER	Nominal
Power Output:	2 × 25 watts RMS.
Distortion:	THD @ 2 × 20 watts 0·7%
Frequency Range:	@—1·5dB 30Hz-15KHz
Tone Control Range:	
VC-20dB	18dB
Basic Electrical centre	@ 100Hz-14dB
Treble Electrical centre	@ 10KHz+8dB —14dB
Loudness Control:	
VC30dB	@ 100Hz+14dB @ 10KHz+11dB
Filters:	
VC30dB	@ 10KHz—6dB
Controls:	5 rotary: volume, balance, bass, treble tuning.
Switches:	9 push button: phono, tape, radio, aux. input, mono/stereo, loudness, filter, speaker switching, separate mains switch.
Meters:	2 signal strength: FM tuning
Sockets:	Headphones: 5 pin DIN Aux: AM aerial (ext) FM aerial (co-axial): 4 × 2 pin DIN L/S

Intermediate Frequency:	
AM	475KHz
FM	10·7KHz
Aerial input:	
AM (internal)	Ferrite Rod
AM (external)	2 pin DIN
FM (external)	Co-axial 75 ohm unbalancedl
AGC:	
For 6dB audio change	46dB
IF Bandwidth	
@ max sensitivity	± 1·5KHz @ 6dB
RF Sensitivity:	
@ 20dB S/N Ratio	
200KHz	1500μV/m
600KHz	500μV/m
1400KHz	200μV/m
FM:	
RF Sensitivity	
@ 26dB S/N (mono)	2·5μV
88MHz	
100MHz	
@ 46dB S/N (mono)	16μV
@ 46dB S/N (stereo)	125μV
Distortion:	
@ Decoder O/P	0·9%
Frequency Response:	
@ ± 1·5dB	30Hz-15KHz
Stereo Separation:	40dB
Audio Filter	Flat to 55KHz 50dB @ 130KHz

SUITABLE SURPLUS MODULES. Fully Wired

Stereo power amp 25w rms P/channel	£7·50
Low noise pre amp. Full freq correction	£5·99
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Selector Board 8 way	£3·99
Complete chassis massive 22 inches	£8·50

AU10

A Radio Record Player Kit which has everything you need to make a first class three band STEREO unit. Can be assembled in modular form or from scratch. A professional finish is guaranteed.

SPECIFICATIONS

Amplifier	
Output	2 × 10W RMS, both channels driven
Distortion:	1% ± 2 × 5 watts
Controls:	Four rotary 1. OFF/ON/VOLUME 2. Balance 3. Treble 4. Bass
Tone Control Range:	Bass @ 100 Hz ±9dB Treble @ 10 kHz ±9dB
Outputs:	2 × 2-pin DIN for 8 ohm loudspeakers 1 switched stereo headphone socket 1 5-pin DIN Aux. Tape in/out socket
Stereo Performance:	Frequency response @ ± 1·5dB 30 Hz—15kHz Separation 40dB Audio Filter—flat to 55 kHz—50dB @ 130 kHz
Controls:	7 Push Button: Phono, Tape, Mono, FM, MW, LW, AFC 1 Rotary: Tuning
Radio Tuner	
Waveband Coverage:	Medium Wave 525—1620 kHz Long Wave 155—280 kHz FM VHF 88—108 kHz

Price Hardware Kit	8·90	RF Board	21·95
Amplifier & Pots	8·75	Record Deck	13·95
PSU & Transformer	3·99	Dust cover	6·00

TU020

A Hi Fi tuner amplifier

This unit can be built from our modules or as a complete kit. Input for mag cartridge, tape record/playback, MW/LW/VHF stereo, tuner. Uses the same R F Board as does the Wimborne with birdie filters, multiplex filter, varicap tuning on MW and LW.

Items from the Wimborne numbers 2 and 3 can be used for different performance specifications.

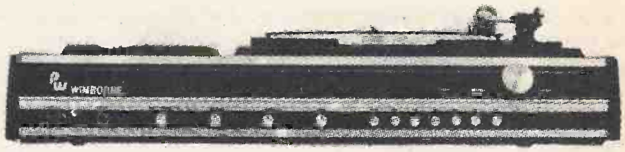
SPECIFICATIONS

Power output 25 Watts RMS per channel (both channels driven)
Total harmonic distortion 0·05%
Bass 100 Hz ± 12 dB
Treble 10 KHz ± 12 dB
Frequency response ± 1·5 dB 30 Hz—20 KHz

FM sensitivity 1·0μV for 26 dB S/N ratio
IF rejection 60 dB image rejection 60 dB
Stereo separation 40 dB
AM sensitivity 200μV at 1600 KHz 20 dB S/N ratio.

Fully wired modules, Preamplifier,	£6·99
Power amplifier	£9·50
RF Board	£33·95
Power supply unit	£3·99
Transfomer	£4·50
Magnetic PU amp	£2·99
Hardware kit	£7·99

PLEASE ADD £1 for postage and packaging for each item except the mag PU amp which is 30p.



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7401	£0·09	7428	£0·25	7473	£0·22	74110	£0·35	74166	£0·75
7402	£0·09	7430	£0·08	7474	£0·22	74111	£0·55	74167	£2·00
7403	£0·09	7432	£0·20	7475	£0·27	74118	£0·75	74174	£0·60
7404	£0·09	7433	£0·28	7476	£0·22	74119	£1·10	74175	£0·60
7405	£0·09	7437	£0·20	7480	£0·40	74121	£0·22	74176	£0·55
7406	£0·22	7438	£0·20	7481	£0·80	74122	£0·35	74177	£0·55
7407	£0·22	7440	£0·10	7482	£0·65	74123	£0·38	74180	£0·80
7408	£0·12	7441	£0·45	7483	£0·55	74136	£0·50	74181	£1·25
7409	£0·12	7442	£0·38	7484	£0·82	74141	£0·50	74182	£0·55
7410	£0·09	7443	£0·68	7485	£0·65	74145	£0·54	74184	£1·00
7411	£0·15	7444	£0·68	7486	£0·22	74150	£0·65	74190	£0·68
7412	£0·14	7445	£0·64	7489	£1·60	74151	£0·45	74191	£0·68
7413	£0·22	7446	£0·60	7490	£0·30	74153	£0·45	74192	£0·65
7414	£0·45	7447	£0·45	7491	£0·60	74154	£0·80	74193	£0·60
7416	£0·22	7448	£0·52	7492	£0·32	74155	£0·48	74194	£0·55
7417	£0·22	7450	£0·09	7493	£0·28	74156	£0·48	74195	£0·55
7420	£0·09	7451	£0·09	7494	£0·70	74157	£0·48	74196	£0·60
7421	£0·19	7452	£0·09	7495	£0·45	74160	£0·55	74197	£0·58
7422	£0·15	7453	£0·09	7496	£0·48	74161	£0·60	74198	£1·00
7423	£0·20	7454	£0·09	74100	£0·80	74162	£0·60	74199	£1·00
7425	£0·18	7460	£0·09	74104	£0·35	74163	£0·60	74279	£1·00
7426	£0·21	7470	£0·24	74105	£0·35	74164	£0·65		

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CD4009	£0·40	CD4023	£0·13	CD4043	£0·78	CD4081	£0·15
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CD4011	£0·13	CD4025	£0·13	CD4045	£1·15	CD4510	£0·80
CD4012	£0·14	CD4026	£1·00	CD4046	£0·95	CD4511	£0·80
CD4013	£0·35	CD4027	£0·45	CD4047	£0·75	CD4516	£0·85
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No. 16140	25 PNP trans. like 2N2905 TO39	40p
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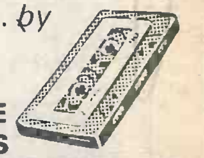

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STA25 25 watts per channel amplifier kit
Consists: 2 × AL60: 1 × PA100: 1 × SPM120/45 – 1 × 2040: transformer: 1 × reservoir capacitor: 2 × coupling capacitors. **£41·45** inc. VAT. £1·16 P&P.

STA35 35 watts per channel amplifier kit
Consists: 2 × AL80: 1 × PA100: 1 × SPM120: 1 × 2041: transformer: 1 × reservoir capacitor: 2 × coupling capacitors. **£48·45** inc. VAT. £1·16 P&P.

STA50 50 watts per channel amplifier kit
Consists: 2 × AL120: 1 × PA200: 1 × SPM120/65 – 1 × 2041: transformer: 1 × reservoir capacitor: 2 × coupling capacitors. **£58·20** inc. VAT. £1·10 P&P.

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AC126	14p	BC178	12p	BF195	*9p	TIP32B	35p	2N1711	15p
AC127	16p	BC179	12p	BF196	*12p	TIP32C	36p	2N1893	28p
AC128	16p	BC182	*9p	BF197	*12p	TIP41A	34p	2N2218	15p
AC128K	24p	BC182L	*9p	BF200	25p	TIP41B	35p	2N2218A	18p
AC176	16p	BC183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	BC183L	*9p	BFX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	BC184	*9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	BC184L	*9p	BFY51	12p	TIP42C	38p	2N2221A	16p
AC188	16p	BC212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	*10p			TIP3055	42p	2N2222A	16p
AD161/		BC213	*10p	MPSA05	*22p	ZTX107	*6p	2N2369	10p
162 MP	80p	BC213L	*10p	MPSA06	*22p	ZTX108	*6p	2N2904	14p
AF139	30p	BC214	*10p	MPSA55	*22p	ZTX109	*7p	2N2904A	15p
AF239	30p	BC214L	*10p	MPSA56	*22p	ZTX300	*7p	2N2905	14p
BC107	6p	BC251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
BC108	6p	BCY70	12p	OC45	12p	ZTX302	*9p	2N2906	12p
BC109	6p	BCY71	12p	OC71	9p	ZTX500	*8p	2N2906A	14p
BC118	*10p	BCY72	12p	OC72	12p	ZTX501	*10p	2N2907	12p
BC147	*8p	BD115	40p	OC75	10p	ZTX502	*12p	2N2907A	13p
BC148	*8p	BD131	*35p	OC81	14p	2N696	10p	2N2926G	*8p
BC149	*8p	BD132	*37p			2N697	10p	2N2926Y	*7p
BC154	*16p	BF115	17p	TIP29A	35p	2N706	7p	2N3053	12p
BC157	*9p	BF167	19p	TIP29B	36p	2N706A	8p	2N3055	35p
BC158	*9p	BF173	20p	TIP29C	38p	2N708	8p	2N3702	*7p
BC159	*9p	BF180	25p	TIP30A	36p	2N1302	12p	2N3703	*7p
BC169	*10p	BF181	25p	TIP30B	37p	2N1303	15p	2N3704	*6p
BC170	6p	BF182	25p	TIP30C	38p	2N1304	15p	2N3903	*11p
BC171	*6p	BF183	25p	TIP31A	32p	2N1307	18p	2N3904	*11p
BC172	*6p	BF184	25p	TIP31B	33p	2N1308	22p	2N3905	*11p
BC173	7p	BF185	25p	TIP31C	34p	2N1309	22p	2N3906	*11p

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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AAZ13	4p	OA202	5p	BYZ17	28p	OA90	6p		
BA100	6p			BYZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	BYZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	*10p					IN5402	12p
BA148	10p	BYZ10	32p	OA47	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA70	5p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA79	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p	OA81	7p	IN4148	4p	IN5408	19p

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Our Role

OBVIOUSLY, with a title like *Practical Wireless,* our main aim in life must be to impart practical information—working designs, with instructions on building and using them. We don't see that as the whole story, though. We think we're here to educate you too, and this side of things takes many forms.

First there is the item which is straight theory, though often incorporating practical hints such as the *Introduction to Logic* series which concludes in this issue. This sort of article is intended to help you to understand text-books or manufacturer's data sheets, which often assume a fairly advanced level of knowledge and tend to be somewhat obscure in their treatment, or simply to keep you up to date with developments.

A second type of article is typified by the *"FM Receivers—Devices and Circuits* series, and by its predecessor on a.m. receivers. These present outline circuits and explain how they work, but do not give constructional information. Their intention is to provide a basis for further experimentation by interested readers.

Of course, the constructional articles also have quite a big teaching role, too, either in "learning by doing" or "learning by reading". This last category is particularly important, as some part of a circuit will often trigger off an idea for another project in someone's mind, or will provide a solution to a design problem that has been bugging them. And it is the reason that we sometimes publish articles which will, we think, only have direct appeal to a limited number of readers, but where the principles involved are of wider interest. The *Videowriter* project published in *PW* in 1976 was rather in this category, though as it turned out, it was built in quite large numbers and used in applications which we never foresaw.

As already hinted at above, we want to help you to understand text-books etc., and part of that understanding is the ability to take in the various abbreviations and symbols used. This is part of the reason for our decision to change, over the next few issues, to a new but now widely-adopted convention for quoting component values on circuit diagrams. This involves using the unit multiplier instead of the decimal point, so that for example 4·7kΩ becomes 4k7, and 2·2μF becomes 2μ2. The decimal point, being just a small dot on the paper, is so easily missed, and this new method is intended to overcome the problem. Note also that the unit, which is obvious anyway, has been dropped, thus saving space on congested circuit diagrams. More details will be given in our next issue, for the benefit of those unfamiliar with the scheme.

PW PERSONALITY

Alan Martin—News & Production Editor

Following technical college, Alan began his working life as a draughtsman. His first contact with *PW* was as a technical artist in the latter days of F. J. Camm—the founder. After a spell in the technical publications dept. of a large electronics firm, Alan started his own company, specialising in the preparation of technical literature. He joined the staff of *PW* in 1973.

Having lived in West London for most of his life the move to Poole proved quite an upheaval for himself, wife and two daughters. However, the move has been a great success and the family have settled very happily in Christchurch.

Alan's interests include darts, swimming, the countryside and lately gardening, mainly the labouring aspect!

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

New Battery

Chloride Silent Power Ltd. has received a £1·9 million grant from the Government to support the continued development of a revolutionary new battery in which Britain has a world lead.

This is the sodium sulphur battery, which has been under development by Chloride Silent Power, at its Runcorn research establishment, since the formation of the company—jointly owned by the Electricity Council and the Chloride Group—in 1974.

With at least three times the energy of the lead acid batteries now used in battery-operated vehicles, the new battery would give road vehicles a range of well over 100 miles compared with the 60-mile range of the present advanced Silent Karrier vehicles.

Among the many advantages of this new battery is that it uses two materials which are relatively cheap and plentiful throughout the world—sodium and sulphur. Demand for this battery will accordingly not affect supply or cost of these raw materials.

The £1·9 million grant is from the Department of Industry, under the Science and Technology Act 1965, from funds being made available under the Government's new Product and Process Development Scheme.

To date, £2·6 million has been spent by Chloride Silent Power Ltd. on sodium sulphur development, and the DOI grant is a contribution towards further development expenditure over the next four years, including the building of a pilot manufacturing plant. *Chloride Group Ltd., 52 Grosvenor Gardens, London SW1W 0AU. Tel: 01-730 0866.*

New Catalogues

Greenweld Electronics, the wholesale/retail suppliers of electronic components and equipment, have recently published their new 64 page catalogue. Also provided is an order form and reply paid envelope, five 10p discount vouchers and a bargain list. The catalogue costs 30p plus 15p P&P and is obtainable from: *Greenweld Electronics, 443 Millbrook Road, Southampton SO1 0HX. Tel: (0703) 772501.*

Crellon Electronics announce the publication of their largest stock list ever. This 30 page edition covers over 8000 different items and is available free of charge from: *Crellon Electronics, 380 Bath Road, Slough, Berkshire. Tel: (06286) 4300.*

Electronic Brokers' latest catalogue is the largest the company has ever produced, with 86 pages devoted to second user electronic test equipment, computers and peripherals, plus new electronic products. Copies of the catalogue are available, free, to bona fide companies writing in on their letter heads. For private individuals, the charge is £1, and overseas enquiries £2—to cover P&P. From: *Electronic Brokers Ltd., 49/53 Pancras Road, London NW1 2QB. Tel: 01-837 7781.*

Heathkit have their latest 40 page catalogue ready, containing scores of electronic kits dealing with radios, digital clocks, test instruments, metal locators, car tune-up systems—and a new range of personal computers. Also available is their 16 page computer brochure. Both the catalogue and brochure are obtainable for 20p each, from: *Heath (Gloucester) Ltd., Dept. PW, Bristol Road, Gloucester GL2 6EE. Tel: (0452) 29451.*

Club news

Ormskirk Amateur Radio Club will be holding their A.G.M. on Wednesday 17 January 1979. The club meets on Wednesday evenings at members' homes; often there is a talk-in on 145.000MHz at about 2000 GMT. New members are very welcome. For further details contact: *Peter J. Kay G4GCB, Hon. Sec. OARC, 24 Laurel Avenue, Burscough, Ormskirk, Lancs. Tel: Burscough 89 2416.*

Verulam Amateur Radio Club will be holding the 1979 G3PAO Memorial Lecture in the Ex Civil Defence Hall, Chequers Street Car Park, St Albans, Herts on Thursday 25 January at 7.30 for 8.00 pm. This event is held in memory of their former Chairman and Founder Member, George Slaughter, who passed away in 1977. The lecture entitled "EME Transmissions" will be delivered by Peter Blair G3LTF, and will be illustrated with slides and tape recordings. Interested parties are welcome to attend. Further details from: *Hon. Sec. G4DUS QTHR. Tel: Rickmansworth 77616.*

Microprocessor Courses

Bleasdale Computer Systems in conjunction with Texas Instruments Ltd. is expanding its existing range of Microprocessor courses to cover the TI9900 family of microprocessors and TI990 microcomputers.

The courses are run by consultants who are actively involved in designing and building m.p.u. based systems. They are designed to give the participants in-depth practical experience in designing and building such systems. To achieve this, Bleasdale has designed and developed a range of Input/Output devices which can readily interface with microprocessors.

Currently available there is a one-week course for people with little or no previous microprocessor experience entitled "The Fundamentals of the 9900". Also a 2-week workshop entitled "Designing Systems with 9900", which is an advanced workshop for people with knowledge of microprocessors and their operation. For further information contact: *Bleasdale Computer Systems Ltd., 7 Church Path, Merton Park, London SW19. Tel: 01-540 8611.*

Sound and Video 79

Arrangements for Sound and Video 79, the North West's Audio, Hi-Fi and Video exhibition are now well under way and more exhibitors than last year have agreed to participate.

The exhibition will be held for the 3rd year at the Excelsior Hotel, Manchester Airport from Thursday, 18 January until Sunday, 21 January and entrance will be free. For further information: *R. J. Taylor, Advertising & Promotions Manager, Hardman Radio Ltd., Head Office & Accounts, 26 Exchange Street East, Liverpool L2 3PH. Tel: 051-236 2828.*

RAE Reprint

A reprint of the complete series—So You Want to Pass the RAE?—including details of the new examination format being introduced this year, is now available.

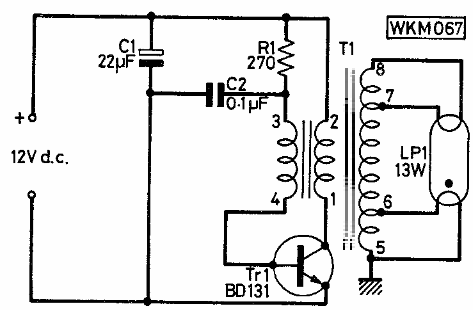
Order your copy by completing and returning the coupon on page 71.

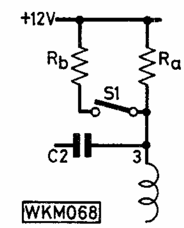
12V FLUORESCENT LIGHT

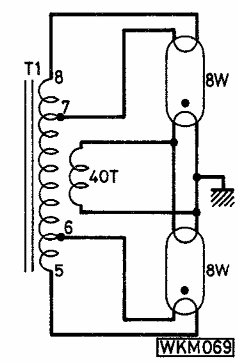
Low-voltage fluorescent lamp fittings have many applications. For boats and caravans, where often the only power supply is an accumulator, they form a permanent light source. For emergency or other intermittent use, the scope is even wider: in the home, when power failures or cuts occur; in the car, for breakdowns and punctures; when camping.

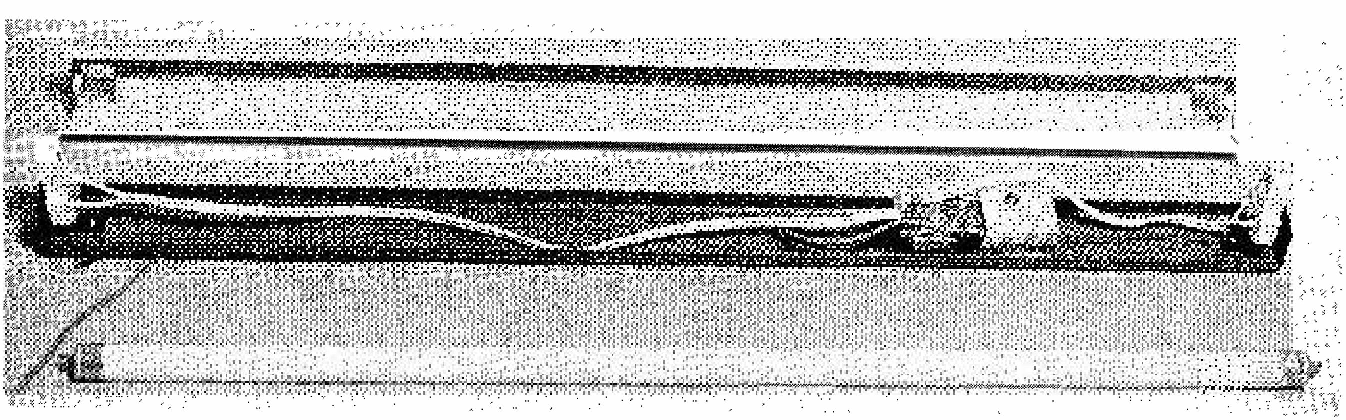
A 13 watt, 21 inch tube will provide a very useful level of lighting for a consumption of about 1 ampere from a 12 volt battery, when driven via a suitable invertor circuit such as that shown in Fig. 1. Transistor Tr1 operates as a blocking oscillator, with feedback from the primary winding (1–2) to the secondary winding (3–4) of transformer T1 applied to its base. Resistor R1 sets the base current for Tr1, with C2 providing decoupling to ensure maximum feedback efficiency.

The pulses at Tr1 collector are also coupled to T1 tertiary winding (5–6–7–8) which is connected to the fluorescent tube LP1. At switch-on, all power will be directed to the tube heaters. When operating temperature is reached the high voltage present across the secondary of the transformer will cause rapid striking of the tube and the heaters will be extinguished. Operation in this manner prevents the tube "blackening" at the ends. When the tube has struck, this voltage drops to a much lower value due to the load then imposed on T1.



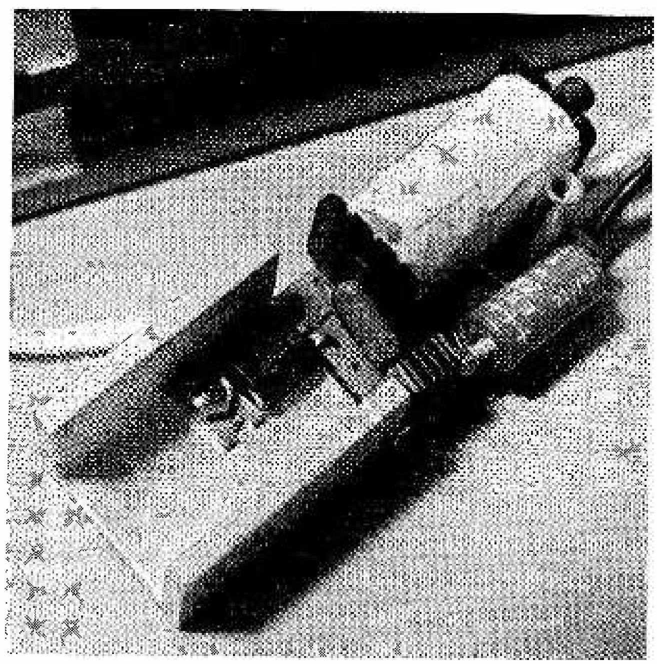




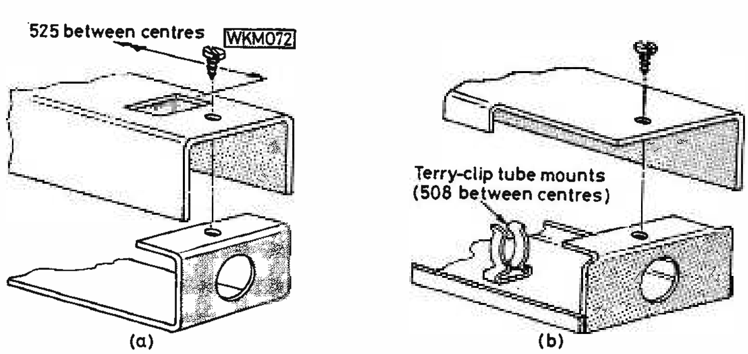


Interior view of the complete unit

Fig. 4: Board layout and transformer terminations



Assembly of board, transformer and heatsink



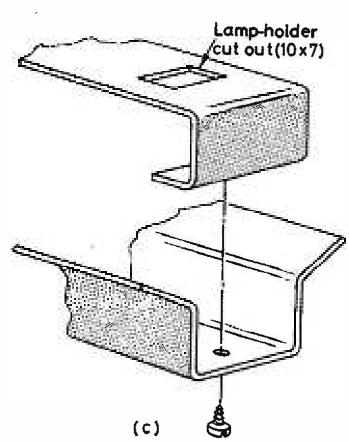


Fig. 5: Some suggested case forms: (a) standard open type (b) side-reflector type (c) large reflector type

Components

The type of transistor used in this circuit is not too critical and any h.f. *npn* power transistor can be used. Some types (for instance the 2N3055) will tend to self-destruct if run off-load. In this case, a cure is to connect an 82V Zener diode between the emitter and collector of Tr1 (cathode to collector). With transistor types other than that specified, it may be necessary to alter the values of R1 and C2 for optimum working.

The transformer is of a special design for use with this invertor circuit, and it is not practicable for the home constructor to wind a component to meet the required tolerances.

Dry Battery Operation

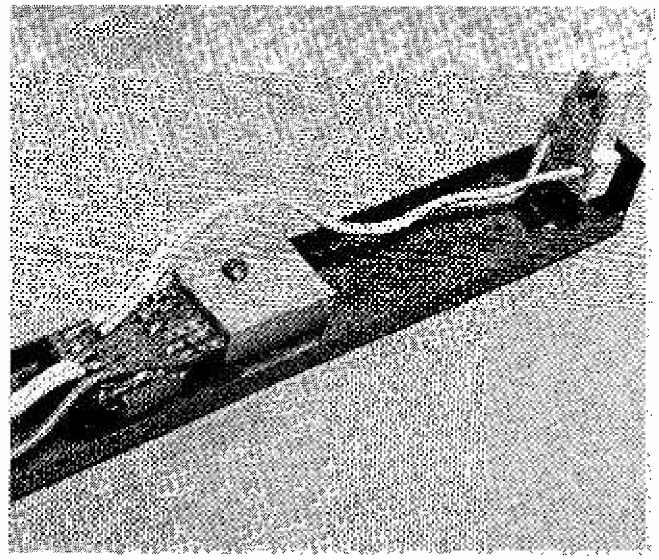
For operation from dry batteries, say two 6V hand-lamp batteries in series, the load of 1A is rather heavy, and in this application, the consumption can be reduced somewhat by increasing the value of R1. The light output will, of course, be reduced also, but a more serious draw-back is a possible reluctance of the tube to strike. The easiest way to overcome this is to fit a "Start/Run" switch, which will provide increased bias current to Tr1 to get the circuit going. A suggested arrangement is shown in Fig. 2, where R_A is of the value required to give the desired running current, and R_B is switched in parallel with it for starting, by closing switch S1. The value of R_B should be chosen so that in parallel with R_A it provides a resistance of about 270Ω.

From the point of view of the mechanical design of a portable lantern powered from dry batteries, it is probably more convenient to use a shorter fluorescent tube. This may be done without loss of light output by using two 8 watt tubes. These should be connected as shown in Fig. 3, with the centre pair of heaters powered from an additional winding of about 40 turns of 34 s.w.g. enamelled wire wound on the outside of T1.

Construction

The circuit is so simple that a printed circuit board is hardly justified. Instead, the components are mounted on a small piece of Verostrip or Veroboard. A suitable layout is shown in Fig. 4. The transformer and board may be held together by means of a double-sided sticky pad. Take care not to break the transformer leads, as these are fragile, particularly on the tertiary winding. The transistor heat-sink can be secured and insulated from the case with another double-sided sticky pad.

The exact form of the case metalwork will depend to a large extent on what metalworking facilities are available to the constructor. The only critical dimension is the spacing of the two lampholders. Some suggested designs are shown in Fig. 5.



★ components

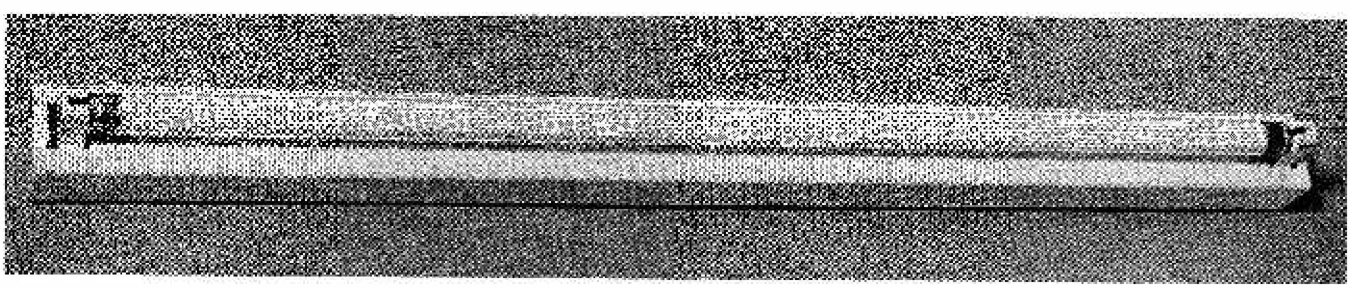
Resistors
R1 270Ω 1W (or 2 × 560Ω ½W in parallel)

Capacitors
C1 22μF 63V tubular electrolytic
C2 2·7μF 250V polyester

Transistors
Tr1 [illegible]

Miscellaneous
T1 12V 13W invertor transformer (G. F. Milward, 369 Alum Rock Road, Birmingham B8 3DR).
LP1 13W 21in fluorescent tube with 2 bi-pin holders.
Verostrip or Veroboard, 0·1in matrix, 16 × 26mm.
Materials for case and heat-sink.

To ensure reliable starting, one end of the tube must be connected to one side of the 12V supply and/or the lamp case. This is achieved in the layout of Fig. 4 by the circuit board mounting screw. If the lamp is to be used in a vehicle on which the positive supply line is connected to vehicle chassis, then care must be taken that no connection exists between the 12V negative supply line and the lamp case. In the two-tube version, this "earthing" connection should be made to one side of the centre pair of heaters, as shown in Fig. 3. ●



DIGITAL AUDIO AMPLIFICATION

Gordon J. KING

Almost all audio and hi-fi amplifiers employ a push-pull output stage biased either to class A or quasi-class B (which is rather like class AB), so that the analogue input signal swings over a fairly linear part of the transfer characteristic. To combat residual non-linearity and hence to reduce the distortion a liberal amount of negative feedback is commonly used, and with quasi-class B designs, which are currently the most common, the output transistors are biased for a small quiescent current to avoid transfer characteristic discontinuity at the centre, low-level point where the characteristics of the two output transistors join. Power amplifiers of this kind are well known and it is not here intended to dwell on their design.

A less well-known technique converts the analogue input signal to a digital format which is used merely to switch the push-pull output transistors on and off. The digital format is a pulse train derived from a stable squarewave generator, and the width of the pulses is caused to vary in direct sympathy with the audio information carried by the analogue signal, which is the usual output from a gramophone pickup, tape deck, radio tuner, etc.

The analogue signal is reconstituted for driving the loudspeaker by passing the encoded pulse chain through a low-pass filter which, while greatly attenuating the relatively high-frequency pulses, yields an output which is proportional to the average value of the pulse chain at any instant. Because the squarewave pulse chain is effectively modulated by the analogue signal, the system is generally referred to as pulse width modulation, or p.w.m. for short.

It is not new from the technical point of view, for amplifiers adopting the principle were referred to way back in 1947[1], well before the days of fast-switching transistors, and more recently in 1960 in terms of a practical design[2]. Since then one or two commercial amplifiers have appeared for a short time, later to be taken off the market as the result of various shortcomings, not the least of which being a high level of radiation of the harmonics of the squarewave switching signals. Audio amplifiers are designated class A, class B and class AB, and since class C refers to r.f. amplification, the next class in line was class D, so in the early days the first p.w.m. amplifiers were designated class D.

It is of interest to note that the Dynaharmony range of amplifiers by Japanese Hitachi have been designated class E in the US. This is because they employ an auxiliary output amplifier which automatically switches to a higher voltage supply on high amplitude signals as a means of combating bad distortion on the peaks, which other amplifiers of similar main-amplifier power may well clip; also, of course, because the letter "E" was the next in line! This range of amplifiers is also referred to as class "G" (mainly in the UK), but there is no connection with class D.

Principle of PWM

With the advent of fast-switching power transistors and more sophisticated circuit techniques there has been a revival of interest in p.w.m. amplifiers, and one or two excellent designs, including the recent Sony TA-N88[3], are on the market. The time is now ripe to explore the basic principle of class D operation, to see whether there are advantages (or, indeed, disadvantages) with respect to ordinary analogue power amplification, and to investigate some of the performance parameters of a commercial design.

An impression of the make-up of a p.w.m. amplifier is given by the elementary block diagram in Fig. 1. Here the switching devices are *p*- and *n*-channel V-type junction f.e.t.s (a complementary pair) which are switched on and off by the driver stage feeding the gates.

There are various ways in which the pulse chain can be modulated by the analogue signal, such as by a Miller integrator (an arrangement similar to this being found in the Sony TA-N88) or by a "comparator" stage, shown in the diagram by the block labelled Modulator.

The pulse chain starts life as a high-frequency sinewave, and is then changed to a square or triangle wave, depending on the nature of the modulation, after which it is buffered before being applied to the modulating system. A transformer feedback type of oscillator may be used, though, from the point of view of subsequent filtering, there can be merit in using a crystal-controlled oscillator. One design[4], in fact, employs a television subcarrier reference crystal which runs at 4·433618MHz, which is followed by a divide-by-ten TTL stage to yield a frequency of 443kHz. The Sony TA-N88 amplifier employs a transformer-coupled oscillator running at 500kHz.

Clearly, the switching rate must be much higher than the highest audio frequency. The higher the frequency the better, since this makes it easier to achieve high attenuation of residual ripple signal at the loudspeaker terminals. However, there are constraints related to the switching speed of the output devices and the losses involved if the switching rate is too high. With contemporary power transistors a fundamental switching rate of about 500kHz, corresponding to 2µs, seems appropriate. This also satisfies the requirement for an upper-frequency response extending to around 50kHz before the analogue output is unduly affected by the low-pass filter action. Moreover, if negative feedback is taken after the low-pass filter, as shown in the diagram, the phase shift of the filter at the frequency of unity gain must not be so large as to incite instability. The use of a high switching rate also helps in this respect. When the pulse chain is derived from a very stable oscillator, such as a crystal-controlled oscillator, very high-*Q* filtering can be employed for ripple rejection which, of course, is not possible if the oscillator is likely to drift slightly in frequency.

With the Miller integrator type of modulator, the tops of the pulses widen and the spaces between them shorten as the amplitude of the analogue signal increases and, conversely, as the amplitude of the signal falls so the tops of the pulses shorten and the spaces between them widen. Analogue signal is continuously changing in amplitude as the information carried by the signal changes, so this is encoded in terms of the pulse chain continuously changing in effective mark/space ratio. Information on the frequency components (rise-time, etc.) of the analogue signal is encoded in terms of rate-of-change of the mark/space ratio

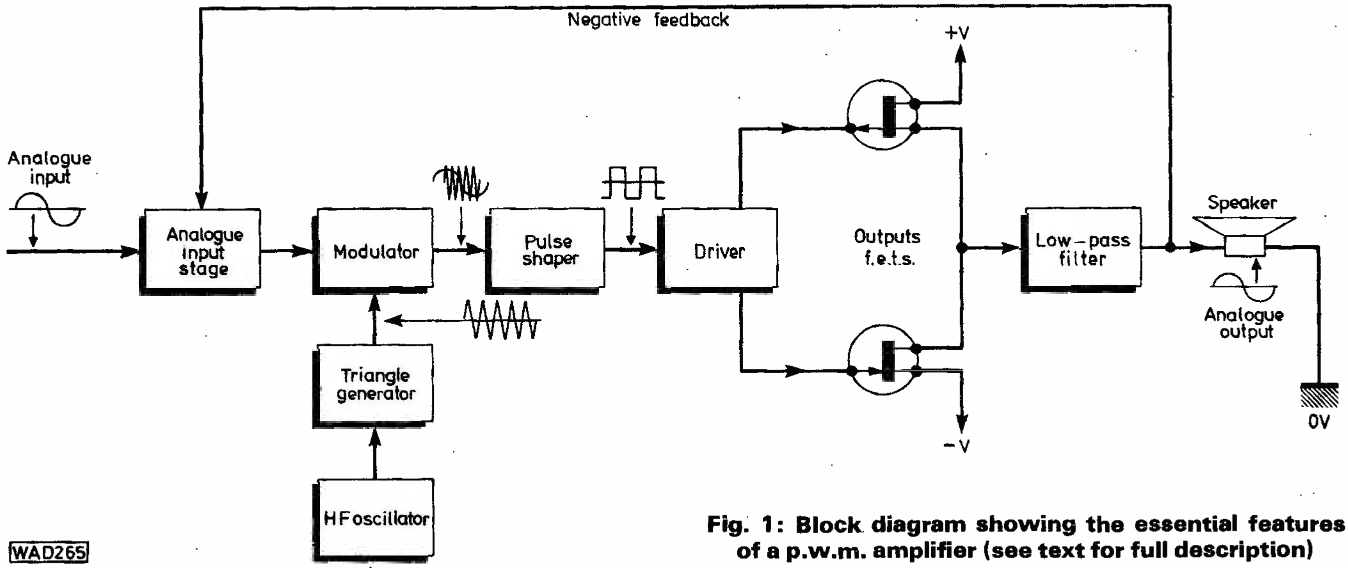


Fig. 1: Block diagram showing the essential features of a p.w.m. amplifier (see text for full description)

of the pulse chain. When there is no analogue input the pulse chain assumes a steady-state 50:50 mark/space ratio, which means that the tops of the pulses and the spaces between them are equal.

The Sony p.w.m. amplifier uses a dual-f.e.t. in differential configuration which, with current regulators and a bipolar stage, forms an integrator to which are applied the analogue and squarewave signals. It works by subtracting the inputs from the output, and has a bandwidth from d.c. to several megahertz. This is followed by a comparator composed of an i.c. containing three differential amplifiers, and its job is to produce the modulated pulse chain for switching the output devices via a driver amplifier. The configuration ensures that the rise-time of the pulse formation is less than 20ns.

Another method of modulation[4], which is that shown in Fig. 1, works in the manner shown in Fig. 2. As already noted, the analogue and pulse information, the latter first converted to a triangular wave format, are fed to the two input ports of the comparator or modulator. A simple sinewave analogue signal is shown in the diagram for the sake of rendering the description more apparent. In a practical situation, of course, the analogue signal would be continuously changing in amplitude and rate in accordance with the audio information. To ensure a faithful conversion to digital, and hence to minimise the amount of false information on the reconstituted analogue signal, a primary requirement is for the triangle wave to be very linear.

The diagram reveals that the output pulse chain encoding is a function of the amplitude of the analogue input

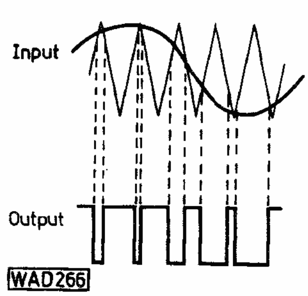


Fig. 2: Showing one method of encoding a pulse chain with information carried by an analogue signal

at any instant resulting from the corresponding changes in "slicing" level with respect to the constant-rate triangle wave input. The implication here is that the triangle wave rate is about four and a half times greater than the frequency of the analogue signal. Thus, if the triangle wave repetition rate were, say, 500kHz, then the analogue signal being encoded would have a frequency of around 111kHz. At lower analogue frequencies, of course, there would be many more triangle wave cycles per analogue cycle.

To avoid the former happening, the frequency of the analogue signal fed to the modulator for encoding is deliberately restricted by low-pass filtering. The audio spectrum is generally regarded as extending from 20Hz to 20kHz, and an amplifier with a small-signal response, at least, of less than this would certainly not be regarded as "hi-fi" by the devotees. However, having said that, it is of interest to note that even a high-quality stereo f.m. transmission carries little or no information below about 30Hz, while at the upper end of the spectrum the output is swiftly attenuated above about 15kHz or, perhaps, a trifle higher owing to the demands of pilot tone filtering.

Well-recorded gramophone records played with a top-flight pickup system fail to extend noticeably above the f.m. audio spectrum. Output below 50Hz is tamed by the specified low-frequency 3180µs time-constant of the RIAA equalisation, while the more recent IEC requirement calls for further filtering at 20Hz, corresponding to a time-constant of 7957µs. It is thus unlikely whether the equivalent **rise-time** of most of the best programme material fed into a hi-fi amplifier is quicker than about 15µs.

Nevertheless, to avoid this rise-time being further slowed down by rise-time limitations of the amplifier to which the programme material is fed, it is generally considered that the amplifier's small-signal frequency response at the −3dB points should extend to about 40kHz, corresponding to a rise-time of just under 9µs. Some amplifiers boast a small-signal rise-time of less than 2µs, corresponding to an upper-frequency response around 200kHz. It is my judgement that this is totally unnecessary and can detract from, rather than enhance, the reproduction.

It is not unreasonable, therefore, to filter the analogue signal before it is applied to the modulator so that the small-signal response is down to −3dB at 40kHz or, perhaps, a little higher (say, 50kHz). The p.w.m. amplifier design in Ref. 4 specifies a Bessel input filter for control-

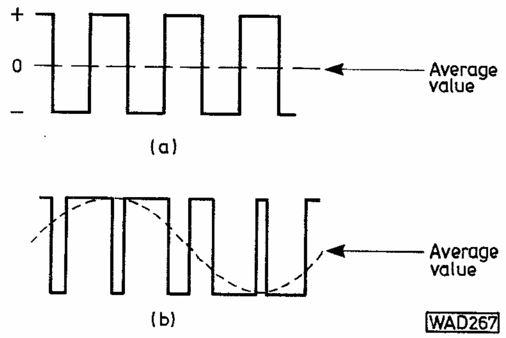


Fig. 3: The analogue of the pulse chain is represented by the average value of the pulse chain, which is shown at (a) with respect to 50:50 mark/space ratio (zero analogue) and at (b) when the pulse chain is encoded with sinewave signal, as produced by the process shown in Fig. 2

ling the input signal rise-time. As with any hi-fi amplifier, the design should aim for the widest open-loop bandwidth of the **power amplifier** section to prevent the effects of so-called transient intermodulation distortion (t.i.d.) which, to some extent, establishes the small-signal upper-frequency response of the analogue signal at the modulator input. To avoid phase distortion at infra-bass frequencies it is now common practice to employ direct coupling throughout the power amplifier system; this presents no problem.

Digital-to-Analogue Conversion

Referring to Fig. 1, the encoded pulse chain is fed to the output f.e.t.s merely to switch them on and off. In Fig. 3 a pulse chain of 50:50 mark/space ratio is shown at (a). Since this chain is perfectly symmetrical its average value is equal to half the peak-to-peak value which is zero. This is the condition when there is no analogue signal input.

Since this chain is fed to the loudspeaker through the low-pass output filter the current flowing through the loudspeaker is zero (the symmetrical switching of the complementary output f.e.t.s also ensures that this is the case). The filter, of course, greatly attenuates the switching component, and when the pulse chain is encoded the average value corresponds to the analogue input signal, as shown at (b) in Fig. 3, which is the pulse chain resulting from the sinewave modulation in Fig. 2. The result is that current corresponding to the analogue signal flows through the loudspeaker, along with a little switching residual, as shown in Fig. 4.

With a suitably high switching rate and well-designed filtering the switching residual is generally much lower than that implied by Fig. 4. The design aim is for a rejection ratio of 100dB which, referred to 100W output into 8 ohms, corresponds to a residual as small as 283μV; but not all commercial designs appear yet to be meeting this aim. The design in Ref. 4, aided by the crystal-controlled switching rate source, is one which has, at least, achieved the aim.

Although a higher level of ripple appears not to affect the reproduction (since it is well outside the response capability of the loudspeaker and up in the r.f. realm), it can cause medium-frequency radio interference owing to radiation from the amplifier direct and from the loudspeaker cables. This was one of the major problems with early p.w.m. amplifier designs. Some produced more than 1V of ripple signal, which is well above the requirements of international standards.

Advantages and Disadvantages of PWM

What are the advantages of p.w.m.? Probably the main advantage is high efficiency, which means that powerful amplifiers can be made in small size without undue overheating. With "linear" amplification the power transistors are not working very efficiently because a relatively high average power is dissipated by them. The maximum efficiency of push-pull class A working is only 50%. The efficiency is improved by class B, it working out to 78·5% excluding the driving and pre-amplifiers, of course[5].

Because the output transistors of p.w.m. remain either bottomed or cut-off for most of the time the efficiency is very high. Maximum theoretical efficiency is 100% (output power the same as the input power). In a practical design an efficiency of up to 90% is realisable. The loss stems mainly from the saturation voltage and the peak current in the "on" state. If it is assumed that these are respectively 1V and 6A, then the power dissipated by the transistors would be a mere 6W, while the peak power into an 8Ω load would be 288W. Other small losses result from transient switching dissipation.

The Sony TA-N88 p.w.m. power amplifier will deliver 2 × 160W average power into 8Ω loads yet its size is only about half that of a 2 × 100W quasi-class B amplifier. In comparison with a class A amplifier of similar power yield, the Sony has a power-to-weight ratio advantage of four or five times!

A quasi-class B amplifier is inherently a very non-linear animal in open-loop mode, which means that a high degree of negative feedback needs to be applied to bring its performance up to an acceptable hi-fi standard. Sadly, negative feedback is not a cure for all amplifier troubles and, contrary to some opinion, there are times when an increase in feedback can actually impair the performance.

On the other hand, a class A amplifier behaves much more linearly in open-loop mode, which means that it requires less feedback for a given fidelity. This is undoubtedly one of the reasons why class A power amplification has been favoured by devotees over the years. When a lot of power is required for driving very inefficient loudspeakers in large rooms, for example, then the major disadvantage of this type of amplifier is the abysmal power-to-weight ratio—very large and massive heat sinks being required by the output transistors along with large transformers to yield the high standing power.

A well-designed p.w.m. amplifier is endowed with virtually the same open-loop linearity as a class A amplifier yet it possesses a far more acceptable power-to-weight ratio. Hence, a p.w.m. amplifier calls for a relatively small amount of negative feedback merely to improve upon an already good intrinsic linearity rather than to correct for the shortcomings of some quasi-class B designs, which is the hallmark of favourable auditioning.

The greatest disadvantage is really related to the switching signal and the probability of this being radiated

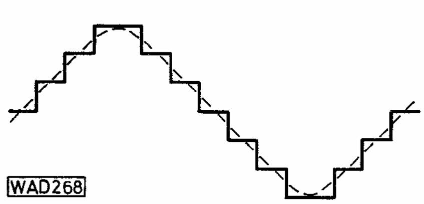


Fig. 4: Reconstituted analogue signal at the output carrying residual switching signal. In practice, the level of the residual is well below that implied by the waveform

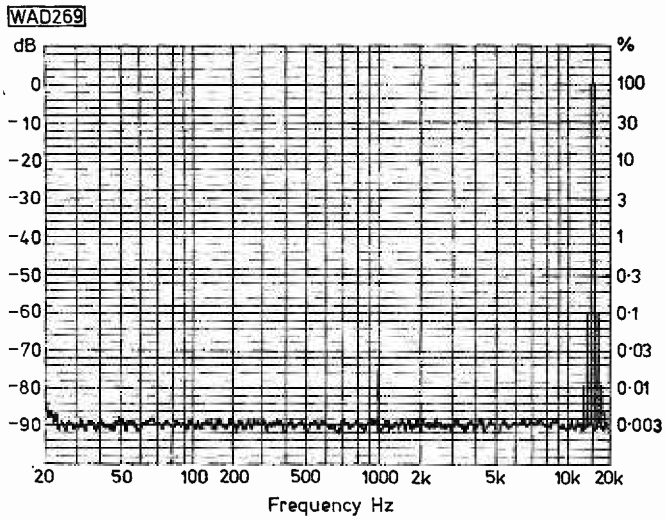


Fig. 5: CCIF intermodulation distortion produced by the Sony TA-N88 p.w.m. amplifier when delivering 38V peak composite signal across a load corresponding to a "difficult" loudspeaker of about 5 ohms modulus of impedance and 60 degrees phase-angle

if it is not suppressed properly. Most of the earlier problems have been resolved by the advent of new solid-state devices, including fast-switching i.c.s and power transistors.

Non-linearity arises when the pulse chain varies in amplitude or width from causes which are not directly related to the analogue modulation process. When this happens harmonic and intermodulation components and products appear across the output load, but by the use of suitably fast switching devices allied with competent design these aberrations are minimised. Normal feedback is possible from the analogue output to the analogue input, as shown in Fig. 1.

In some designs the feedback voltage is obtained prior to the output low-pass filter, as in the Sony, and with others the voltage is picked up after the filter, as in Fig. 1. The latter would appear to have merit, provided the filter does not cause phase shift likely to evoke instability, because it keeps the source impedance low and hence the damping factor high.

Limiting and Protection

Input overload can result in the loss of switching pulses at the extremes of modulation, accompanied by a severe rise in distortion and an increase in r.f. emission. To avoid this, most p.w.m. amplifiers are equipped with a "soft limiting" circuit in series with the analogue input signal. In the Sony, for example, this consists of a high-speed f.e.t. attenuator whose gate is connected to current sensors in the output stage. When the current threshold is exceeded the attenuator is activated so that the level of analogue signal reaching the modulator is reduced.

Thermal and short-circuit protection circuit are also included. These operate a relay whose contacts are in series with the loudspeaker, so that in the event of an output short-circuit under heavy drive or an abnormal rise in temperature the contacts open and disconnect the load. The relay is also connected to an energising delay circuit so that the contacts close after the power supply has fully stabilised. This avoids the switch-on "thump" from the loudspeaker when the power switch is turned on.

Auditioning

How do p.w.m. amplifiers compare in reproduction with more conventional class A and quasi-class B designs? Of the p.w.m. amplifiers that we have auditioned we have found the sound quality to be very close to that expected from a well-designed class A transistor or valve amplifier.

Lab Performance

As already noted, the Sony TA-N88 produced a full 160+160W into 8Ω loads to the threshold of heavy distortion rise (just prior to the peak clipping point) at any frequency, at least, within 20Hz to 20kHz. Second harmonic distortion at 1kHz and with both channels delivering 160W was −70dB, corresponding to about 0·03%. Odd-order and higher-order distortion was negligible, being equal to or below the residual of the switching signal at the output.

At 10kHz and the same two-channel power the distortion was, as would be expected, higher, corresponding to about 0·25% second harmonic, which predominated. The third harmonic was about 64dB down, corresponding to about 0·063%.

At lesser output power all distortion components shrank towards the level of the switching signal residual, which measured about 100mV r.m.s. across the output of one channel (less across the other). Although rather on the high side, the reproduction was not affected, but radio interference could just be detected on medium frequencies when a receiver with a ferrite rod aerial was placed a short distance away from the amplifier (a really tough test!).

The spectrogram in Fig. 5 shows the measured CCIF intermodulation distortion with 38V peak of composite two-tone signal across an impedance load corresponding to a "difficult" loudspeaker. There was a rise in amplitude of the IM products with increasing output voltage.

The amplifier required just under 1·5V r.m.s. for full drive; stereo separation was as high as 88dB, and residual mains ripple below 90dB. The damping factor was not too good, being 28 at 40Hz and 2·3 at 20kHz. This could possibly be improved by taking the feedback from the output side of the low-pass filter. Small-signal bandwidth was from d.c. to almost 90kHz (−3dB), after which the roll-off rate was 12dB/octave, corresponding to about 4µs, which we regarded as unnecessarily fast.

The amplifier is equipped with two pairs of complementary junction V-f.e.t.s in parallel. These devices or MOSFET power devices are ideally suitable for p.w.m. amplifiers, as also are fast-switching power bipolar transistors. However, with the inevitable price reduction of the V-f.e.t. species of power transistors, such as the Hitachi V-MOSFET, we are almost certain to experience a revival of the p.w.m. amplifier, especially when the pundits fully realise just how fine such an amplifier can audition. ●

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Follow-up to PW Wide range CAPACITANCE METER

Ian HICKMAN

Requests from readers for an even wider capacitance measurement range set the author thinking and here is the result—an add-on unit which enables the Wide Range Capacitance Meter (PW Sept '76 issue) to measure capacitors up to 30 millifarads, i.e. 30 000μF. Modifications to build the extra ranges into the original capacitance meter were hardly practical and this add-on unit involves only minimal changes, namely the addition of two 2mm sockets to the front panel.

To avoid possible confusion, component references for the extender follow on from those of the original capacitance meter.

Circuit Description

Fig. 2 shows the circuit diagram of the extender. It works on the same principle as described in the original article. The capacitance under test shunts a voltage waveform generator of known source impedance. The lowest impedance available in the original circuit was about 220Ω, limiting the measurement range to 10μF or 30μF with the function switch at x3. The extender unit takes the test waveform (at 220Ω source impedance) via an extra socket on the front panel of the meter and feeds it to a 220Ω attenuator chain; the extra loading of this chain attenuates the test waveform by 6dB. The chain is tapped at points where, looking in, one 'sees' a 22Ω source resistance (x10 socket) and a 2·2Ω source resistance (x100 socket). The latter point represents a further 40dB of attenuation of the test waveform and IC1 provides 46dB of gain, so producing the same voltage at its output as would have appeared at the red C_x terminal originally. The op. amp. output has a d.c. blocking capacitor whose reactance at the frequency of the test waveform is very low, and by setting the range switch to 10–100pF, the f.e.t. Tr5 is biassed via R22 but 'sees' a.c. signals only from the op. amp. Clearly, a 100μF capacitor connected to the x10 terminal, or 1000μF at the x100 terminal, will produce the same attenuation (in dB) of the test waveform as 10μF connected to the original meter (on the 1–10μF range).

Push button S3 reduces the source resistance at the x100 socket from 2·2Ω to 0·22Ω and raises the gain from the op. amp. to 66dB (x2000) to compensate. This provides a x1000 range, at reduced accuracy. This is because of the reduced bandwidth of the op. amp. when supplying the extra 20dB of gain. In particular, the x1000 range should only be used in conjunction with the x3 range of the function switch, as on x3 the test waveform frequency is reduced by a factor of 3. Even so, R46 has been set at 430kΩ instead of the theoretical 390kΩ. The latter value should be used if you use a high-speed op. amp. such as the LM318 instead of a 741. If using a 741, it should be a full spec. device from a reputable source—not a 'reject' or 'fall out'!

Note that no polarising voltage is applied to the capacitor under test, thus avoiding the inconvenience of a 6 seconds time constant for charging when measuring 30 000μF! The amplitude of the test wave form applied to the capacitor under test is so small that the absence of a polarising voltage is of no consequence.

Construction

The author used a diecast box and though only just deep enough internally, this fits neatly in front of the capacitance meter leaving the controls unobstructed. Any similar sized box would do, but metal is preferable to plastic. The box is connected to the black C_x terminal, i.e. the case of the capacitance meter. Two additional connectors are required on the capacitance meter, one to make the 12V supply available to the extender and one to supply the test waveform. These were added one either side of the existing C_x terminals.

This unit is an add-on extender for the Wide Range Capacitance Meter described in Practical Wireless September 1976. It is presented for the benefit of those readers who have already built the main instrument. We regret that the issue in which the meter originally appeared is no longer available.

The circuitry of the extender was made up on a piece of 0·1 inch pitch Veroboard as shown in the component layout drawing Fig. 1 and mounted on the three 4mm sockets and S3 along one edge of the board, the other edge being supported by a long 6BA bolt fastened to the back of the front panel with Araldite.

Resistors R41 and R42 may be wound using Eureka wire: 126mm of 36 s.w.g. gives 1·98Ω and 124mm of 24 s.w.g. gives 0·22Ω. This allows 2·5mm each end for soldering. Alternatives are to use 3·9Ω, 4·7Ω and 27Ω in parallel for R41 and a 0·22Ω $\frac{1}{2}$W metal film resistor for R42.

On completion of the extender, check that it will not short the stabilised supply of the Capacitance Meter, connect up and switch the Meter to x1 and 10–100μF. Check that the voltage at the junction of R45 and C13 is about 6V. The meter should read off-scale to the right. Connect a 20μF capacitor between the x10 terminal and common and check that the meter reads in the region of 20μF (i.e., 2 on the upper scale). Note that the tolerance on electrolytics is typically −20 + 50%, so precision cannot be expected!

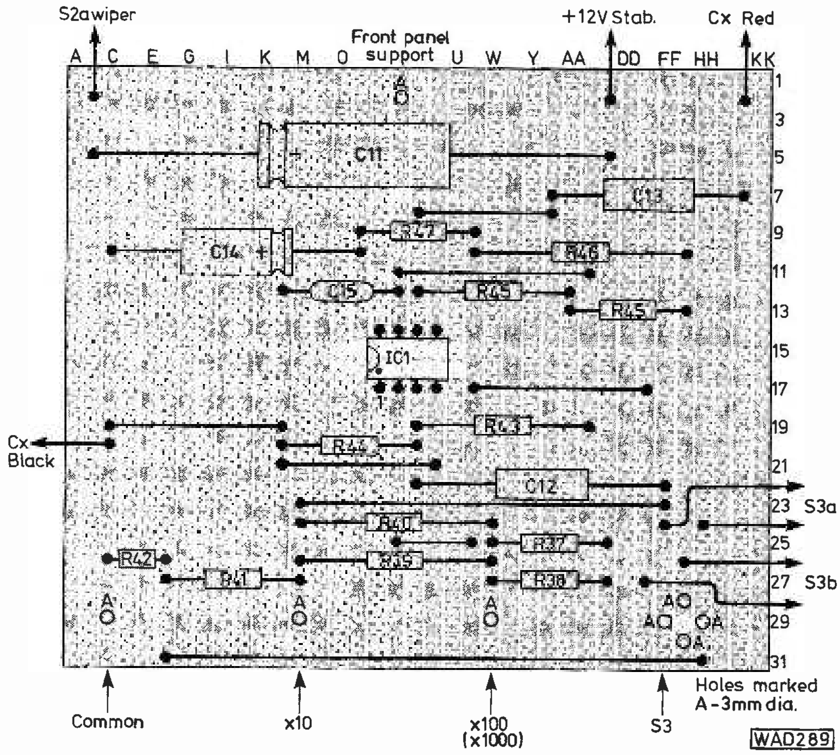


Fig. 1: The component layout of the add-on millifarad extender unit. 0·1 inch pitch Veroboard is used. The 741 op. amp. i.c. is shown as an 8 pin d.i.l. package but the alternative 14 pin d.i.l. package can also be used on the same board layout

★ components

Resistors

2% ½W metal oxide or thick film

22Ω	1	R39
220Ω	2	R37, 47
22kΩ	2	R45a, b
430kΩ	1	R46

5% ½W

470Ω	1	R40
1·8kΩ	1	R38
390kΩ	2	R43, 44

see text for R41 and R42

Capacitors

Disc ceramic

0·1μF	1	C15

Polyester			*Electrolytic*		
0·04μF	1	C13	47μF 10V	1	C14
0·47μF	1	C12	220μF 10V	1	C11

Semiconductors

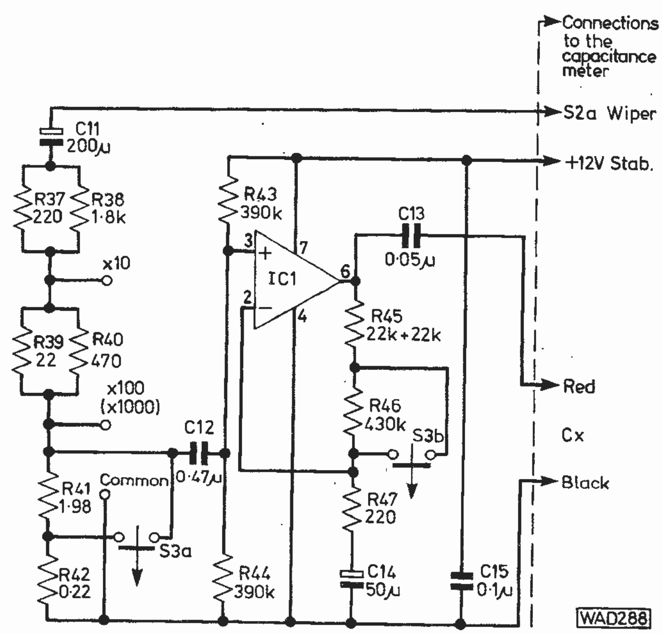
Integrated Circuits

741	1	IC1

Miscellaneous

2 pole min. push button switch (RS 337-942) (1).
Diecast box 114 × 89 × 55mm approx. (1).
Veroboard 0·1 inch pitch 36 tracks × 32 holes.
2mm sockets (5).

Fig. 2: The circuit diagram of the extender unit



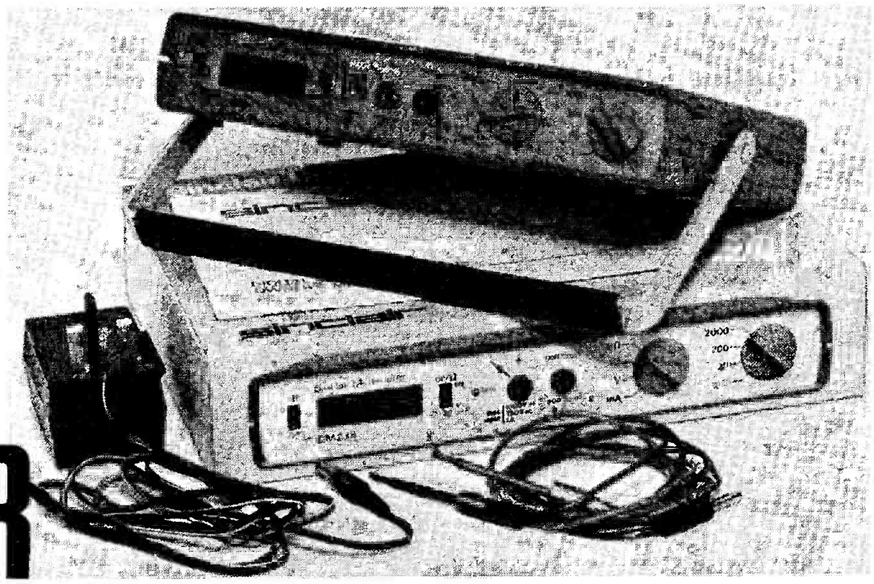
Use

Following the above checks, the unit is ready for use, as there is no calibration to carry out. Capacitors in the range 10–100μF can be measured by connecting between 'common' and 'x10', whilst capacitors between 100μF and 1000μF (3000μF with the function switch at x3) are connected between 'common' and 'x100'. These terminals are also used for measuring capacitors between 3000μF and 30 000μF, with press button S3 depressed and the function switch at x3. As the reactance of 30 000μF at the test frequency is only tens of milliohms, good quality plugs and crocodile clips with short stout leads should be used for connecting the capacitance under test to the extender. ●

SPECIAL PRODUCT REPORT

sinclair

DM235 DIGITAL MULTIMETER



Every person who claims to be actively interested in wireless or electronics needs some form of multi-test meter. If you are richer than most then this will probably be the ubiquitous Avo Model 8, for long regarded as the Rolls Royce of conventional multimeters. For the not quite so well off a lower priced oriental meter will suffice, some of them having a bewildering array of ranges—my own one even tests transistors.

The digital multimeter, or d.m.m. for short, is relatively new to the amateur scene mainly because of its very high initial cost for an instrument with a limited number of ranges.

Recently, however, several such instruments have been launched by manufacturers obviously aimed at the amateur segment of the market. The Sinclair DM235 is such an instrument and forms the subject of this test report.

A $3\frac{1}{2}$ digit, six function multimeter, the DM235 is both a bench-top and a fully portable unit. The carrying handle is arranged to act as a leg to tilt the case for easier reading of the display. With a set of dry batteries in the rear mounted compartment the instrument can be carried very easily with the front uppermost. The test leads fit neatly into a space behind the battery compartment panel when not in use. If you intend to carry the meter around a lot then an ever-ready carrying case is available as an extra. In use the DM235 proved to be simple to operate and the display was easily read with the unit on the bench top. Range selection is by two rotary switches, one of which acts as a function selector and other determines the full scale reading. A slide switch selects d.c./Ω or a.c. readings and a second slide switch controls the power to the unit.

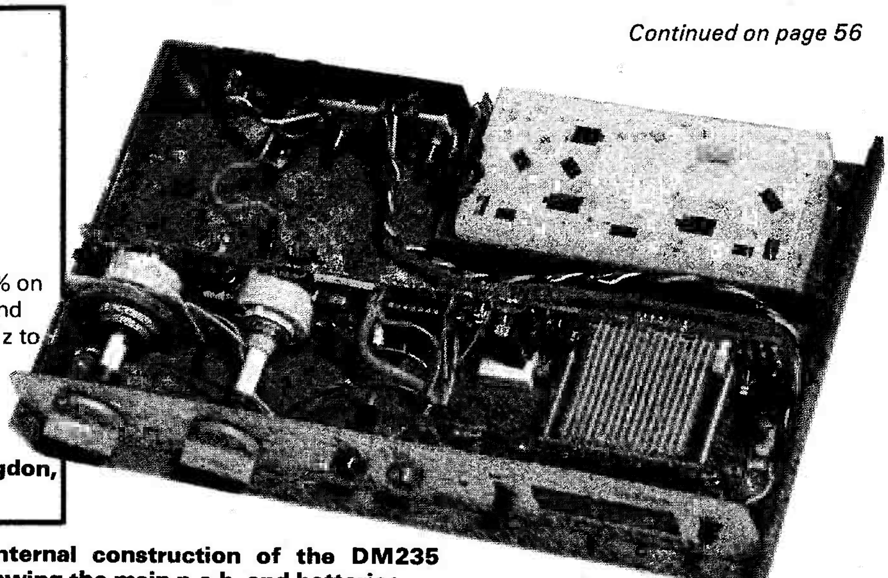
The test leads provided are the usual type with a banana plug at one end and a spring-loaded hook-grip at the other end. I found these to be more of a nuisance than useful. They never seemed to grip properly when I tried to hook them over a test point but when finally in position they seemed reluctant to let go. Also they proved difficult to use as a probe as the wire hook tends to get hidden inside the plastic end. The wander plugs fitted tightly into the two sockets provided on the front panel.

Continued on page 56

★ *specifications*

Voltage:	1mV to 1kV d.c. 1mV to 750V a.c.
Current:	1μA to 1A d.c. 1μA to 1A a.c.
Resistance:	1Ω to 20MΩ
Diode test:	0·1μA to 1mA
Input impedance:	10MΩ
Basic accuracy:	0·5% on 2V range; 1% on all other d.c. ranges and resistance; 1·5% 30Hz to 10kHz a.c. ranges
Size:	254 × 147 × 41mm
Weight:	682gm

Sinclair Radionics Ltd., St. Ives, Huntingdon, Cambs. PE17 4HJ.



The internal construction of the DM235 showing the main p.c.b. and batteries.

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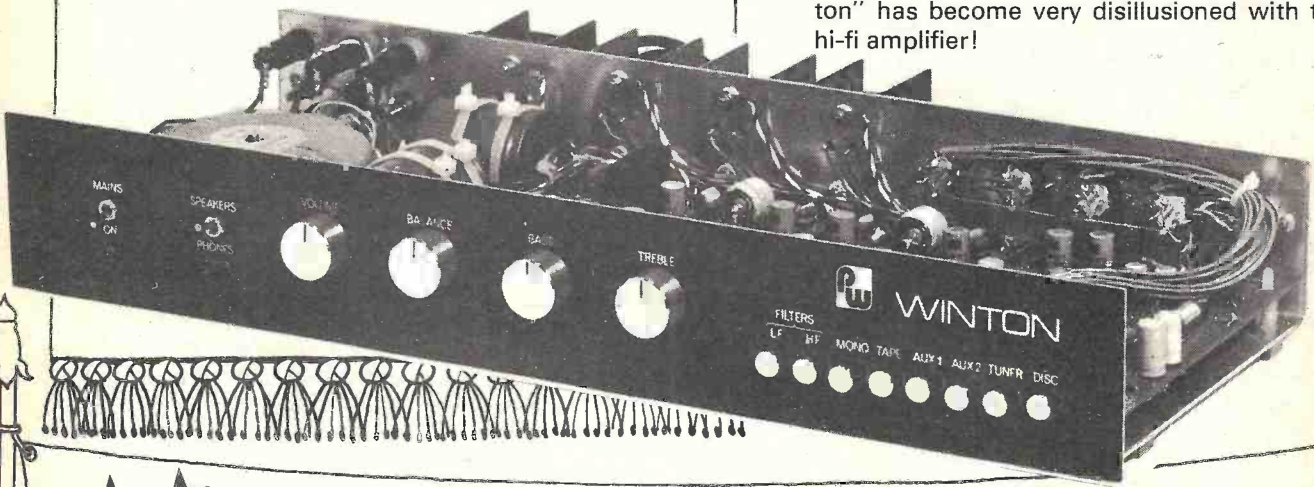

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F.M. RECEIVERS
DEVICES & CIRCUITS
PART 2

M. J. DARBY

In the first part of this feature we saw that the front-end unit of a receiver provides a 10·7MHz intermediate frequency output signal. The i.f. stages must amplify, filter and limit this signal before it is demodulated. Current trends are strongly towards the use of one or two integrated circuits in the i.f. stages rather than the use of discrete components, whilst ceramic filters are generally employed rather than inductance-capacitance tuned circuits, since they provide the required selectivity without the necessity for alignment.

In most designs a single quadrature-tuned circuit is employed in the demodulator circuit and this must be aligned so that it resonates at 10·7MHz. A few years ago Signetics produced an integrated circuit phase-locked loop, the NE563, which required no tuned circuits in the i.f. or demodulator stages, but this device is no longer available. Nevertheless, when using a commercially manufactured front-end unit, the alignment of the receiver is very simple—only the demodulator circuit need be adjusted. The position is very different to the alignment of the many tuned circuits in the older valve type of receiver where any slight mis-alignment of the band-pass tuned circuits or of the ratio detector circuit could result in considerably greater distortion.

Available Devices

There are quite a number of integrated circuits available which include all the devices required for the i.f. amplifier/limiter and demodulator stages of an f.m. receiver. The decoder required for stereo reception is always a separate circuit, normally a phase-locked loop i.c., but some amplifier/limiter/demodulator devices incorporate an audio amplifier. Many of the devices designed for use as amplifier/limiter/demodulators in the sound section of television receivers are suitable for use in f.m. radio receivers. A selection of typical amplifier/limiter/demodulator devices is shown in Table 1. These devices are suitable for the f.m. section only of receivers which cover both the f.m. and a.m. bands. However, some details will be given later of devices which can be used in both parts of an a.m./f.m. receiver.

Sensitivity

It is quite reasonable to feed the output from a high gain front-end unit through a single ceramic filter into a high gain i.f. device (such as the 3089) for local station reception, but in a situation using a relatively insensitive device, such as the μA2136 or the LM2111, it is almost essential to employ an interfacing amplifier in order to obtain adequate gain, reasonable a.m. rejection, etc. The amplifier used may employ one or two discrete transistors, but an integrated circuit amplifier is often much more convenient.

The sensitivity of the devices shown in Table 1 is expressed as a value which is known as "the input limiting voltage at the −3dB point" or sometimes as the "limiting sensitivity" or the "input limiting threshold", any of these terms being used in various data sheets. Let us consider what this definition means. If the input signal level to a device is relatively high, the amplitude of the output signal will be unaffected by any reasonable variations of the input signal, since the output amplitude is controlled only by the limiter circuit. As the input voltage falls, a point is eventually reached at which the input to the limiter is inadequate for it to operate correctly and the output amplitude must then fall. When this fall is equal to −3dB, the input signal level to the device is known as the "input limiting voltage at the −3dB point" or one of the other terms mentioned. The lower the value of the input limiting voltage, the more sensitive the device.

It can be seen from Table 1 that the input limiting voltage ranges from about 12μV up to about 450μV.

The main difference in the internal circuits of such devices is the use of a more sensitive amplifier-limiter with more amplifying stages in the more sensitive devices. Although it must be remembered that the more sensitive devices are likely to become unstable if the circuit layout is unsuitable, all of the devices should be stable if used in a reasonable circuit layout with the input well away from the output. The input to a sensitive device should not consist of a length of copper strip on a board, but rather a miniature coaxial lead or at least a short wire.

Facilities

Another important factor to be considered when choosing an amplifier/limiter/demodulator device is the range of facilities provided by each of the integrated circuits concerned. The 3089 device, the TDA1200 and the CA3189E offer a very wide range of facilities, including a.g.c. output, a.f.c. output, muting of noise when tuning between stations and generally a very high performance for high quality equipment. A few devices, such as the LM1808, are available with an incorporated audio amplifier and this can be useful when space is at a premium.

Gain Block

Before we consider typical amplifier/limiter/demodulator circuits, we will look at an integrated circuit gain block which will provide ample gain between the front-end unit of the receiver and any of the devices shown in Table 1.

The circuit of this 10·7MHz amplifier is shown in Fig. 7. A Fairchild μA753 integrated circuit (in a plastic 8 pin dual-in-line package) is very convenient for use in this type of circuit for a number of reasons. There is a choice of a

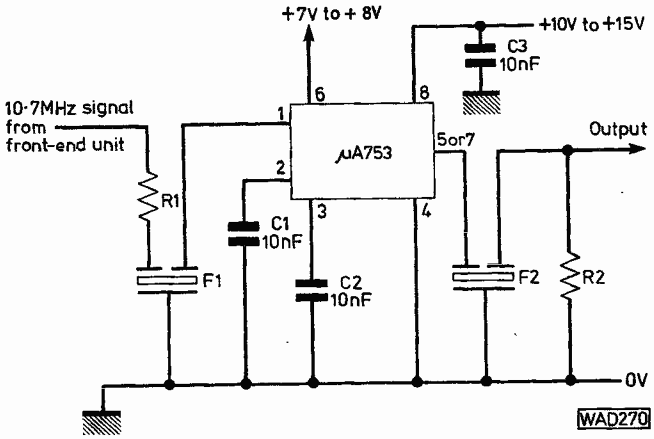


Fig. 7: A simple µA753 10·7MHz amplifier with ceramic filters

gain of about 34dB if the output is taken from pin 7 or a higher gain of about 50dB if the output is taken from pin 5. Another feature of the µA753 is that its input and output impedance have been chosen to match those of the ceramic filters normally used in the input and output circuits.

It is important that the filters (marked F1 and F2 in Fig. 7) should be reasonably closely matched with the circuit impedances. The 10·7MHz filters now available from Toko, Vernitron and Murata have been designed to operate with their inputs and outputs connected to circuits of 330Ω impedance; if the "in" and "out" impedance is far from this value, the band-pass characteristics of the filters will be impaired.

The input impedance of F1 can be matched by making the value of R1 equal to 330Ω minus the output impedance of the front-end. Similarly the value of R2 is selected so that this resistor, in parallel with any load which the circuit feeds, forms the required 330Ω value across the output of F2. The values of these resistors are not at all critical and R1 can often be 270Ω whilst R2 may be about 390Ω.

Ceramic filters are marked with a colour code to indicate the approximate resonant frequency. It is vitally important that the two filters used in the Fig. 7 circuit should both have the same colour coding or they will not match one another accurately enough in frequency; they must also come from the same manufacturer. Two such filters provide almost the ideal band-pass characteristic with a rejection of around 100dB at frequencies 0·2MHz or more from the resonant frequency. However, it is possible to omit F2 and to couple pin 5 or pin 7 through a small capacitor (perhaps 1nF) directly to the input of an amplifier/limiter/demodulator device. The rejection of unwanted frequencies will then be of the order of 55dB—which is adequate for many locations.

The µA753 provides a stabilised output of +7·8V from pin 6. This is ideal for use as a power supply to certain front-end units (such as the Mullard LP1186), but some of the Toko front-end units require a higher voltage supply which can be conveniently obtained using a Zener diode. The maximum current which can be taken from pin 6 of the µA753 is about 10mA.

The µA753 has been designed to operate over a wide temperature range, namely −40°C to +85°C, at almost constant gain. Naturally care must be taken to ensure that the leads to the decoupling capacitors C1, C2 and C3 in Fig. 7 are kept as short as possible.

There are few other similar gain blocks available. The Fairchild µA3076 (available from Arrow Electronics Ltd.) provides a relatively high gain (around 80dB) for use with a demodulator of moderate sensitivity.

Amplifier/Limiter/Demodulators

The output from the circuit of Fig. 7 may be fed into one of the amplifier/limiter/demodulator devices listed in Table 1. We will now consider some typical applications circuits using some of these devices. Although the principles of operation of each type of device are the same, the individual features of the devices (and therefore practical circuits) differ considerably. A common feature is that they all require a phase shifting "quadrature" tuned circuit.

The µA2136

The Fairchild µA2136 is a relatively simple device with moderate gain, three stage input amplifier/limiter, a quadrature demodulator circuit, an audio output amplifier, an internal voltage regulator and other circuitry. The connections of this device are shown in Fig. 8; it is available in a standard 14 pin dual-in-line case from Arrow Electronics Ltd., Coptfold Road, Brentwood, CM14 4BN at a price of about £2.

The basic circuit for a limiter/demodulator using a device such as the µA2136 is shown in block form in Fig. 9, whilst a full typical circuit is shown in Fig. 10. The input from the amplifier which follows the front-end may be coupled through C1 to L2 and hence into the limiter of the µA2136 device. Although inductor coupling is used in this circuit, other types of input coupling can be employed, such as in the examples used with other circuits in this article. It is important to note, however, that the maximum resistance between pins 4 and 6 is about 300Ω; in Fig. 10, this resistance is that of the winding L2 which is very low.

The output of the limiter is fed to the quadrature detector and appears at pin 10; after attenuation by a factor of about seven times, it also appears at pin 9. The quadrature tuned circuit is connected between pins 2 and 12, R1 damping the resonance of the circuit. The value chosen for R1 is a compromise between obtaining a relatively high audio output voltage and obtaining the lowest possible distortion at the output.

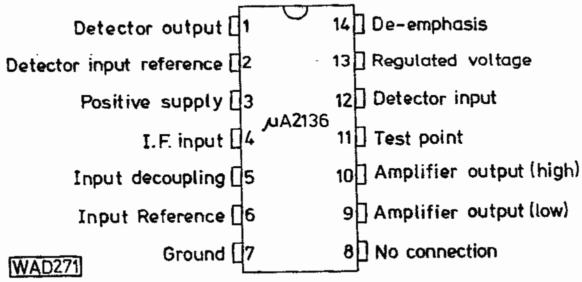


Fig. 8: The µA2136 connections

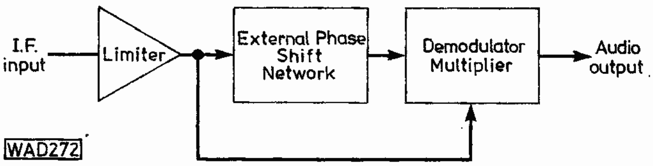
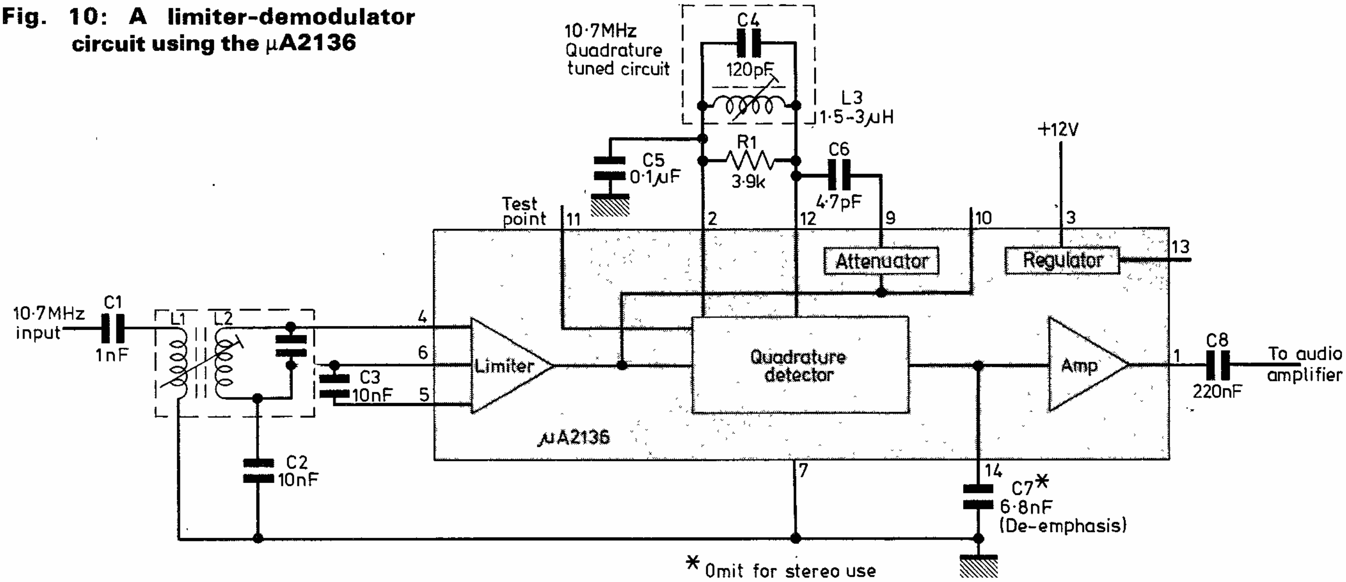


Fig. 9: Basic circuit in block form for a limiter and f.m. demodulator

Fig. 10: A limiter-demodulator circuit using the μA2136



The output from the quadrature circuit is amplified and fed to pin 1. A de-emphasis capacitor should be connected from pin 14 to ground, the internal resistance of the device at pin 14 providing the required resistive component of the de-emphasis network.

The regulated voltage appears at pin 13, but this voltage is also used to power the input limiter and the quadrature detector; the internal connections are not shown in Fig. 10 in order to keep the circuit as simple as possible. No external connection need be made to pin 13.

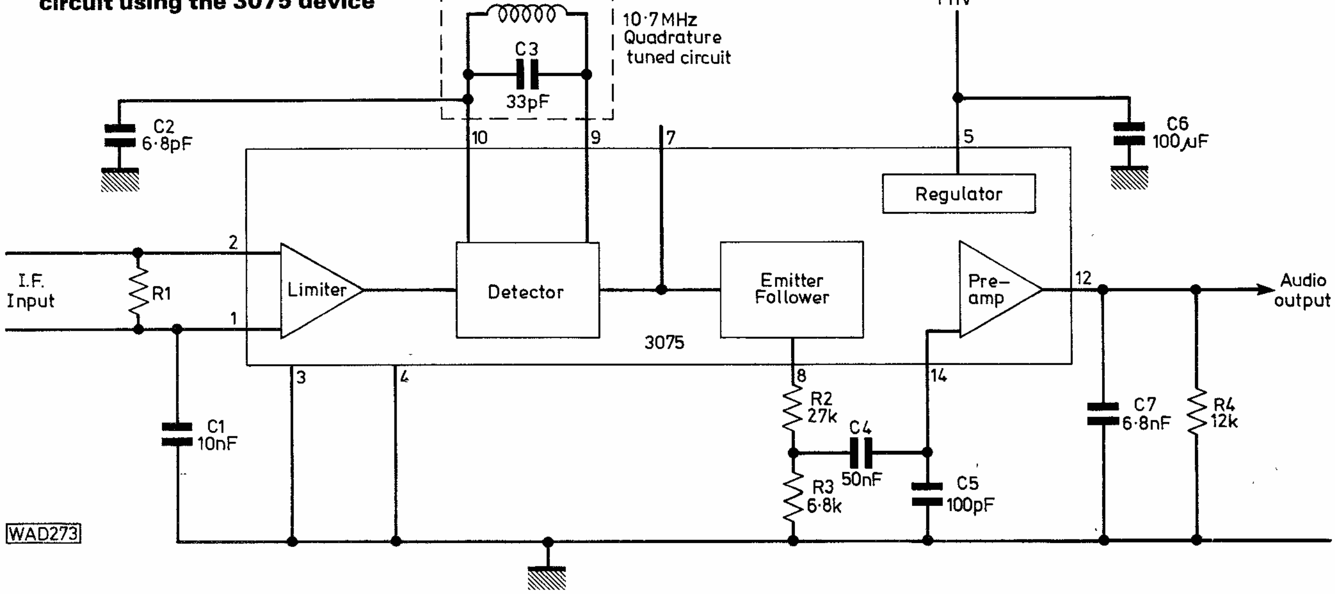
It may be noted that the μA2136 device is an improved version of the earlier ULN2111 14 pin dual-in-line device. The Sprague ULN2111 has no internal voltage regulator and the positive supply of about 12V must be connected directly to pin 13 instead of to pin 3. Otherwise, the connections are the same. Further similar devices are the ULN2111A (Sprague), the CA2111AE and its quad-in-line version the CA2111AQ (RCA) and the MC1357 (Motorola). The μA2136 is a direct equivalent of the Sprague ULN2136.

The 3075

The Fairchild μA3075 (available from Arrow Electronics Ltd.), the National Semiconductor LM3075 and the RCA CA3075 are somewhat similar devices to the μA2136, but an audio pre-amplifier is incorporated on the same chip as the i.f. circuitry. These are 14 pin dual-in-line plastic devices.

A typical 3075 circuit is shown in Fig 11. The i.f. input circuit may be similar to that of Fig. 10 or one of the other circuits, but the effective resistance between pins 1 and 2 must be fairly small so that pin 2 is correctly biased from pin 1. The 3-stage limiter has a gain of about 60dB and feeds a quadrature detector, the output from which feeds an emitter-follower before being coupled to the input of an audio pre-amplifier at pin 14. The output from the pre-amplifier stage is fed to pin 12. The capacitor C7 of Fig. 11 is for de-emphasis and should be omitted from a stereo circuit. The audio pre-amplifier provides a gain of about 21dB, but there is a loss in the coupling network between the emitter follower and the pre-amplifier.

Fig. 11: A limiter-demodulator circuit using the 3075 device



TBA 120 series

The TBA120 device was developed for television sound circuits and contains a six stage limiter, but the more sensitive TBA120S with an eight stage limiter is normally preferred for f.m. receiver applications (available from Chromasonic Electronics, 56 Fortis Green Road, N10 3HN). The TBA120T is similar to the TBA120S, but has an 820Ω input resistor to match it to the 5·5MHz ceramic filters used in television receivers; the TBA120U is another device in this series designed to be used with L/C tuned circuits. These devices are manufactured by Siemens, AEG-Telefunken, etc.

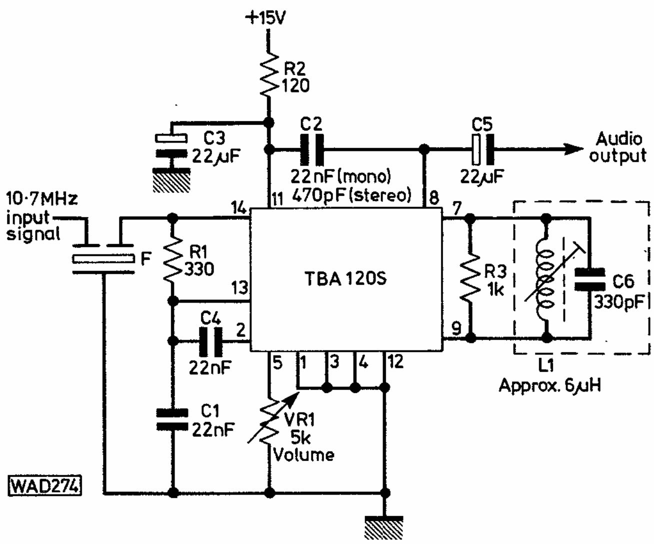


Fig. 12: A limiter-demodulator using the TBA120S device with an electronic volume control

A typical TBA120S amplifier/limiter/demodulator circuit is shown in Fig. 12. A particular feature of all the TBA120 series of devices is an electronic attenuator in the circuit shown. VR1 will provide a variation of about 70dB in volume and since only d.c. levels are involved the volume control leads need not be screened—this is another feature of the TBA120 and the LM1808 devices.

The filter F in Fig. 12 may well be the output filter F2 of the circuit of Fig. 7. L1 and C4 form the normal quadrature circuit of the demodulator.

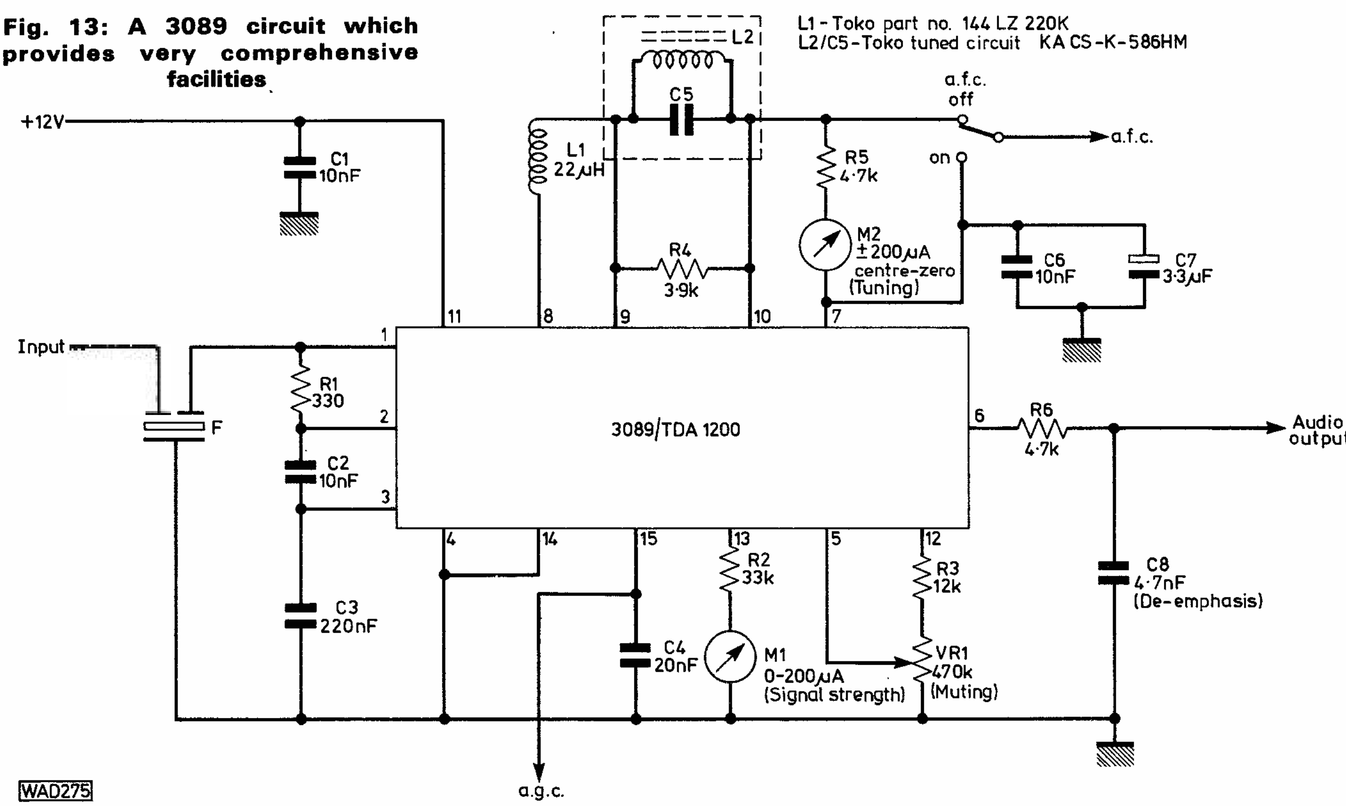
The 3089

The 3089 type of device (equivalent to the TDA1200) is probably the best known of all limiter/demodulator integrated circuits for 10·7MHz f.m. i.f. use; it is an "industry standard" type available from many manufacturers and provides a wide range of facilities for use in high quality equipment. It has been included in many circuit designs which have appeared in this magazine. It is a sensitive device with a 12μV limiting sensitivity.

A 3089 circuit is shown in Fig. 13. The input to pin 1 is obtained from the 10·7MHz ceramic filter F (which may be the output filter F2 of Fig. 7). Inside the device the signal passes through three cascaded amplifier/limiter circuits and hence to the quadrature detector circuit. This part of the circuit requires a 22μH choke (L1 in Fig. 13), but a miniature Toko component is available for this application. The Toko Company also produces a KACS-K-586HM 10·7MHz tuned circuit in a miniature can which has been especially designed for use as the quadrature detector tuned circuit with 3089 devices.

The output impedance of the 3089 device at pin 6 is about 5kΩ, so when the value of the series resistor R6 is added to this, the total of nearly 10kΩ produces the required 50μs de-emphasis time-constant with C8. The capacitor C8 should be omitted in stereo circuits.

Fig. 13: A 3089 circuit which provides very comprehensive facilities



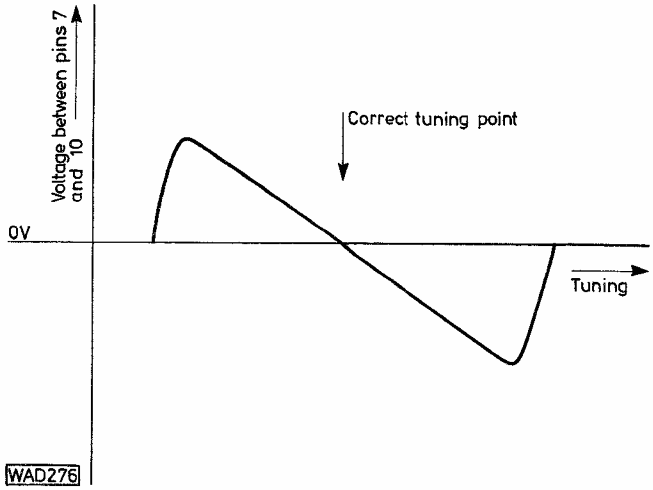


Fig. 14: Variation of the 3089 pin 7 potential with tuning

The meter M1 provides an indication of the signal strength of the i.f. signal at pin 1 of the device. The potential at pin 13 of the device increases approximately as the logarithm of the signal strength and the meter reading increases in proportion to this voltage. The logarithm scale has been chosen so that a very wide range of signal strengths can be accommodated and shown on the meter. In practice, the circuit can indicate any input signal level between about 5µV and 100mV by means of M1.

Each of the three cascaded amplifier/limiter circuits in the input of the device has a signal level detector associated with it. The combined outputs of these signal level detectors control the deflection of the signal strength meter. The first level detection circuit also provides the a.g.c. control signal from pin 15 which may be fed to the front-end unit.

The centre-reading meter M2 can be used as a tuning meter. When tuning towards the centre frequency of the signal, the meter needle is deflected to one side, but as tuning becomes closer to that of the signal, the meter needle returns through the centre position (when tuning should be exact) and is displaced to the other side. This variation of the potential at pin 7 with the tuning is shown in Fig. 14.

All the phase quadrature circuits discussed in this article must be aligned before use by adjusting the position of the core of the phase quadrature coil, whilst the extra input coil used in Fig. 10 must also be aligned. The alignment is greatly facilitated by the use of the meters shown in Fig. 13. When L2-C5 is correctly tuned, the meter M2 will show almost a symmetrical response when tuning through the signal (see Fig. 14) with optimum results when the receiver is tuned to the centre point of the curve.

The use of the meters in the Fig. 13 circuit is optional and some readers may wish to construct the circuit so that a meter is used only during the alignment of the receiver, since the incorporation of a meter permanently into a circuit does increase the cost of the receiver. The full scale reading of M1 and of M2 is not at all critical, as the values of the series resistors R2 and R5 can be adjusted to obtain suitable deflections with the meters available. However, the full scale deflection should not exceed a few mA or the device operation may be affected.

When tuning an f.m. receiver, a considerable amount of unpleasant random noise ("hiss") is formed when tuned to

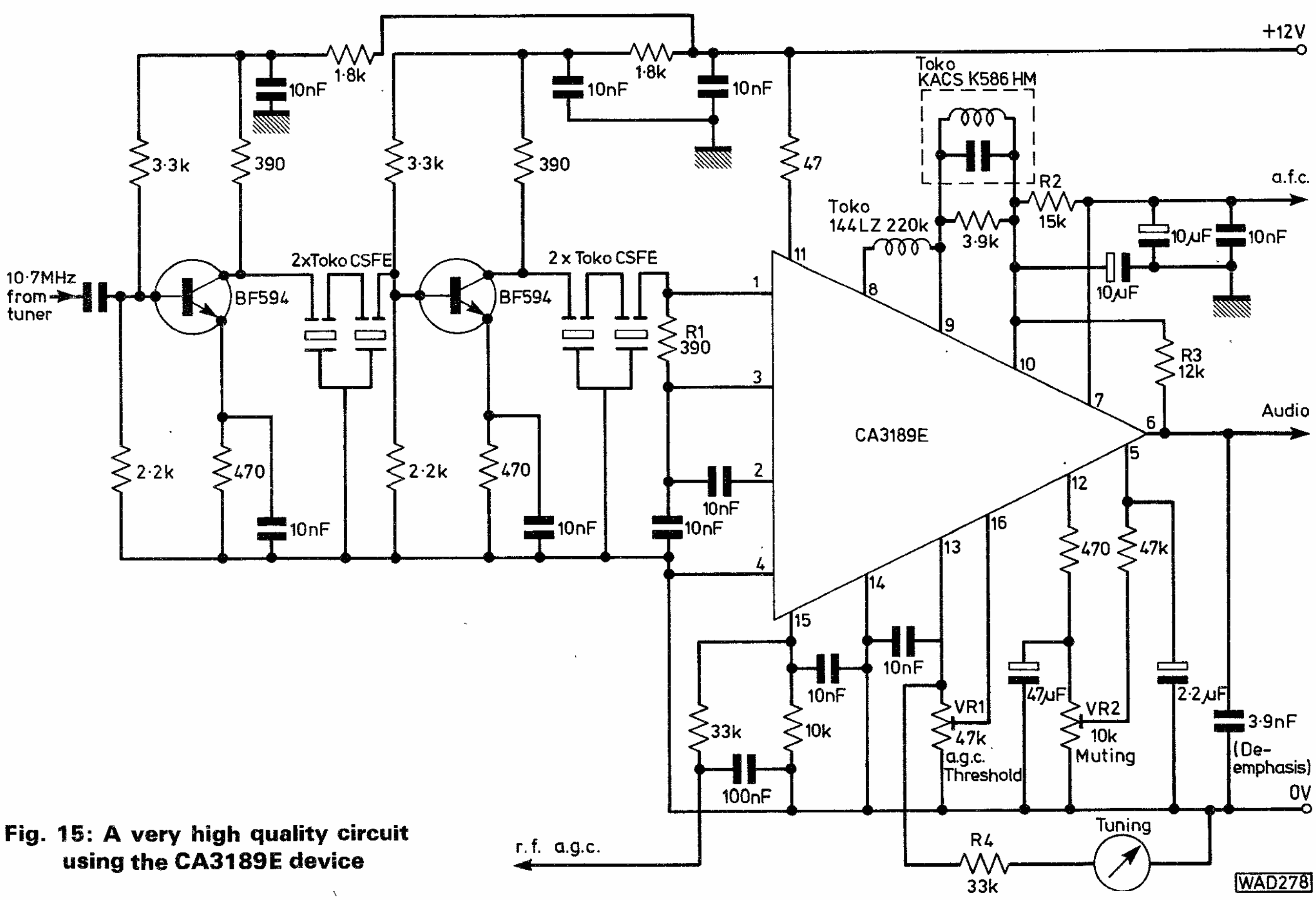


Fig. 15: A very high quality circuit using the CA3189E device

Device	Package	Sensitivity (Input voltage at −3dB point)	Supply Voltage	Supply Current (in mA at 12V)	AM Rejection (dB)	Total Harmonic Distortion	AFC Output	AGC Output	Muting	On-chip Audio Pre-amp	Electronic Volume Control range (dB)	Remarks
µA2136	14 pin d.i.l.	450µV (max. 800µV)	12V (20V max.)	17 (max. 22)	40	1% (max. 3%)	—	—	None	—	—	—
3075	14 pin d.i.l.	250µV (max. 600µV)	12V (max. 18V)	17 (max. 28)	50 (min. 40)	1% (max. 2%)	—	—	None	Yes	—	—
3089 or TDA1200	16 pin d.i.l.	12µV (max. 25µV)	12V (max. 16V)	23 (max. 30)	55 (min. 45)	0·5% (max. 1%)	yes	yes	Noise only	—	—	Industry standard type
CA3198E	16 pin d.i.l.	12µV (max. 25µV)	12V (max. 16V)	14 (max. 18)	55 (min. 45)	0·5% (max. 1%)	yes	yes	Noise and deviation	—	—	used in high quality receivers
TBA120	14 pin d.i.l.	80µV	12V (max. 14V)	14 (max. 20)	60 (min. 50)	—	—	—	none	—	60	designed for television sound
TBA120S	14 pin d.i.l.	50µV (max. 100µV)	12V (max. 18V)	14 (max. 20)	68	0·2%	—	—	none	single transistor available	85 (min. 70)	Internal transistor and Zener diode
LM1808	18 pin d.i.l.	200µV (max. 400µV)	18V (max. 26V)	11 (i.f. only)	min. 40	1·2% (max. 2%)	—	—	none	2W power amplifier	75	On-chip power amplifier with protection
2111A	14 pin d.i.l.	300µV	12V (max. 15V)	17 (max. 22)	40	0·3%	—	—	none	—	—	—

Parameters may vary from one manufacturer to another—consult data sheets

Devices suitable for use as 10·7MHz Limiter/Demodulators

frequencies between the incoming required signals. The 3089 device incorporates a circuit which is able to mute or silence the receiver when no signal is being received. A muting signal is obtained from a level detector connected to the quadrature circuit which feeds a steady output voltage to pin 12, this voltage varying according to whether an input signal or only noise is being received.

A fraction of the voltage from pin 12 is tapped off by VR1 and fed to pin 5, the muting input. The voltage fed into pin 5 can mute the audio pre-amplifier inside the 3089 so that no audio output is obtained whilst tuning between input signals.

The total harmonic distortion at the output of the 3089 device is about 0·3%, this being lower than that of most other similar devices. This distortion level is mainly a function of the phase linearity characteristic of the quadrature tuned circuit. A considerable reduction in the distortion level can be obtained by employing two tuned circuits instead of one between pins 9 and 10, but the alignment is then far more difficult and suitable test equipment is required to set up the double tuned circuit correctly. However, it is possible to reduce the total harmonic distortion at the output to a level of less than 0·1%.

The CA3189E

The RCA device type CA3189E is a recent development of the 3089 type of device. Like the 3089, it is encapsulated in a 16 pin dual-in-line package and the connections to the two devices are almost identical (except for pin 16), but the external circuits which must be used with the two devices are somewhat different. The CA3189E is the latest device for use in equipment of the highest quality.

The bandwidth of the CA3189E circuit has been restricted to about 15MHz (as opposed to the 25MHz of the 3089 type devices); this not only improves the noise level by reducing the amount of "in-band" noise generated by two signals outside the pass band, but also renders the circuit layout less critical and improves stability.

Unlike the 3089, the CA3189E includes an adjustable delay for the a.g.c. system; this means that the signal level at which the a.g.c. voltage commences to reduce the gain of the device is adjustable. Improvements in the design of the CA3189E internal circuit have resulted in the signal-to-noise ratio being increased to over 70dB. Another feature unique to the CA3189E is the inclusion of a "deviation" muting circuit in addition to the normal noise muting circuit used in the 3089 devices. This deviation muting circuit results in the muting of the "thump" noise when turning rapidly through a fairly powerful signal.

A typical CA3189E circuit is shown in Fig. 15. The limiting sensitivity of the CA3189E is about the same as that of the 3089 device and a similar input circuit can be employed. However, Fig. 15 shows a different type of input circuit using two BF594 npn transistors and a total of four Toko CSFE ceramic 10·7MHz filters which provide a band-pass characteristic which enables a signal-to-noise ratio of about 40dB to be obtained at an input signal level of onlu 3µV.

It is possible to omit one of the BF594 amplifier stages and two of the ceramic filters; the input signal is then fed directly (through a capacitor) to the base of the second BF594 transistor. In this simpler circuit the signal-to-noise ratio is appreciably lower, being rather over 20dB at the same input signal level of 3µV.

The similarity between the CA3189E and 3089 circuits can be seen from Figs. 15 and 13. An important difference between the two is the use of an external audio load resistor 12kΩ between pins 6 and 10 in the CA3189E circuit, whereas the load resistor is fabricated on the

continued on page 71

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS
In general, the author does not have any more information on products than appears in the article.

MPU bank cards

A popular cheque scheme on the Continent is one in which the owner's photograph is printed on each cheque. This gives a useful security "cheque"! The Continental bankers have again been looking at services to customers and on French electronics company has warmed to this theme by proposing to stick a microprocessor into everyone's bank credit card.

Cards in current use can store only a limited amount of information in magnetic stripes. The proposal is that, by using a microprocessor, every transaction could be recorded and the holders bank balance could be updated at each transaction.

While all this "with-it, latest, state-of-the-art" approach might be applauded by electronics pundits, I keep hearing about electronic accounting systems charging people idiotic amounts, like the £8 million gas bill etc. The Ginsberg abbacus rules—OK?

What is an 1154?

Say 1154 to most Lisle Street electronics buffs and they will draw you a picture of an enormous ex-RAF transmitter, complete with coloured knobs and a couple of PT15 directly heated valves in the p.a. stage.

Contrast this nostalgic collossus with the new i.c. that incorporates its own 4MHz oscillator. The chip uses silicon gate techniques (not to mention a touch of c.m.o.s.) and sips only a dainty 6µA at 1·55V. It is aimed at the watch market and deliveries are now rumoured to be rife.

Meter magic

So now I've heard it all, Magic Meters—well, they appear to be magic to me. A new range of analogue panel meters just out on the British market look all very smart in their black edged cases and large white dials with black lettering. The scale reads 0–150A (on the one I'm looking at). But if I want it to read 0–15kV, I can simply unplug one scale, and insert another. And the readings are guaranteed to be accurate to Class 1·5 accuracy. There's virtually dozens of scales; another reads 0–1 000kW.

The nice thing about these meters is that they are dustproof, the scales have a positive "click" insert mechanism, and you can change scales without taking the meter to pieces or, indeed meddling with anything else on the instrument.

The range of scales available is truly enormous, ranging from milliamps to Megavolts. These meters are intended for the professional who should look for the IMO J Series instruments.

Confucius—Il dit

Someone in History is always having his magic phrase "Damned clever these Chinese" repeated. Alas, to bring it up to date we must substitute French. An electronics company in Toulouse has been watching the growing market in home computing and business computing. Now, it is to launch its X1 system which is based on the Motorola 6800. The X1 offers 8K of memory, two minifloppy discs, keyboard, and 12in display monitor all for around £2 000 The display can handle 24 rows of 80 characters. Strong rumours persist that a basic version wil be made available for around £500.

The murky depths revealed

Television cameras on the seabed are all very well—until there's turbulence, or the water gets murky, then they're blind and virtually useless.

A British company has come up with a solution—use an ultrasonic TV camera. While the possibility has been argued about since the late 1930's, it is only now that a practical solution has been achieved. In use, an array of ultrasonic transducers fire forward to "illuminate" the screen at ultrasonic frequencies.

The reflections are focused onto a special converter tube. A half-wavelength piece of quartz is embedded in the faceplate of the converter tube and it is this that accepts the ultrasonic echoes and translates them into a voltage pattern. The new unit is said to operate at depths down to 30 metres, but can be used down to 300 metres with an added pressure window.

The TV scan details are $12\frac{1}{2}$ frames/second 201 lines/frame. Using a frequency of 2MHz it is claimed to see clearly through several metres of very murky water.

While underwater enthusiasts celebrate, doubtless Hams will wonder about further QRM at the high end of Topband!

Hothouse transducers

If you're interested in checking relative humidity, then you might be pleased to hear about a special relative humidity transducer that has recently appeared on the American market. It measures only 41 × 22 × 1·6mm and the humidity is sensed by an electrically conductive surface. It can monitor from 0% to 100% relative humidity over the temperature range −60°F to +200°F. Useful, perhaps, for electronics gardeners or budding sauna enthusiasts.

Optical disc store

In previous Ginsberg writings I mentioned that video discs were a reality and that many manufacturers were producing these. It now seems that these discs will have another application—for storage in computers. A European company has produced an optical disc memory system that looks very promising. One, single 12 inch double sided disc can store the equivalent of half a million pages of typewritten matter. This is considerably more than magnetic discs. The mean access time to any address anywhere on the disc is 250ms.

Self checking

When using computers and computer systems it is not unusual to find a thing called "self-diagnostic". This is where the computer (or system) fires signals around its own circuitry to check that all its circuits are functioning correctly. This usually happens in those fractions of a second that the system isn't being used.

The latest digital multimeter to arrive on the market does the same thing. It will self-check itself and, if it does find something it shouldn't, it will isolate the fault to one of the five basic boards. It will also function as a d.m.m. to an accuracy of better than ±2 p.p.m. of reading, and 1 p.p.m. of full scale ($6\frac{1}{2}$ digits). Input impedance of this truly magnificent beast is 1 000MΩ and the input is also fully protected against overloads to 1kV. And the price!

Ginsberg

HYTHE marine band receiver Part 1

M. TOOLEY & D. WHITFIELD

This modern receiver design offers very good performance at low cost, is easy to build and uses readily available components. The receiver provides for the reception of a.m., c.w. and s.s.b. signals. The construction of the receiver unit makes use of a single printed circuit board and the alignment procedure is simplified by the use of a pre-tuned ceramic i.f. filter. The resulting performance is more than adequate to satisfy the needs of the discerning short wave listener or medium wave DXer.

Although the basic receiver design is for a frequency coverage of 1·5 to 3·5 MHz, coil winding details are also given for alternative frequency bands in the range 1 to 12 MHz. Only two coils need to be wound by constructors and, to further simplify this task, they each make use of only a single tuned winding.

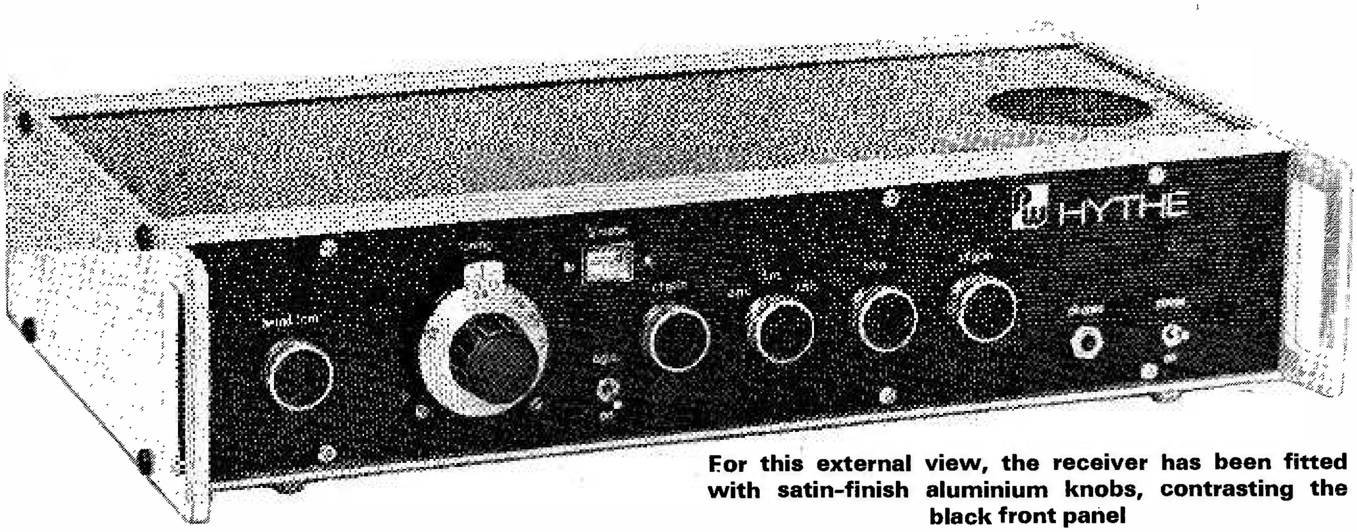
The multi-mode capability and the 2 MHz tuning range of the receiver also makes it ideally suited for use as a 'tuneable i.f.' in conjunction with a front-end convertor for the v.h.f. aircraft or amateur bands.

The receiver utilises the National Semiconductor LM373N i.f. amplifier. This versatile device, designed specifically for communications subsystems, provides all the necessary facilities for a complete multi-mode i.f. amplifier and detector. The LM373N is a 14-pin dual-in-line integrated circuit which comprises a gain-controlled i.f. preamplifier, main i.f. amplifier, f.m./c.w./s.s.b. product detector, a.m. peak detector and an a.g.c. system.

The product detector operates in an unbalanced mode for a.m. reception and functions as an amplifier followed by an envelope detector. For f.m. reception, the product detector is supplied with a signal which is in phase quadrature with the original i.f. signal (i.e. 90° out of phase). The product detector inputs for s.s.b. operation are the i.f. signal and the b.f.o. output. The audio output is then derived before the envelope detector. The envelope detector then acts as an audio frequency peak detector and the output of this stage is used for a.g.c. purposes.

Circuit Description

An overall block diagram of the receiver is shown in Fig. 1. It is a conventional single-conversion superhet which makes use of five transistor stages and two integrated circuits. The circuit diagram is shown in Fig. 2.



For this external view, the receiver has been fitted with satin-finish aluminium knobs, contrasting the black front panel

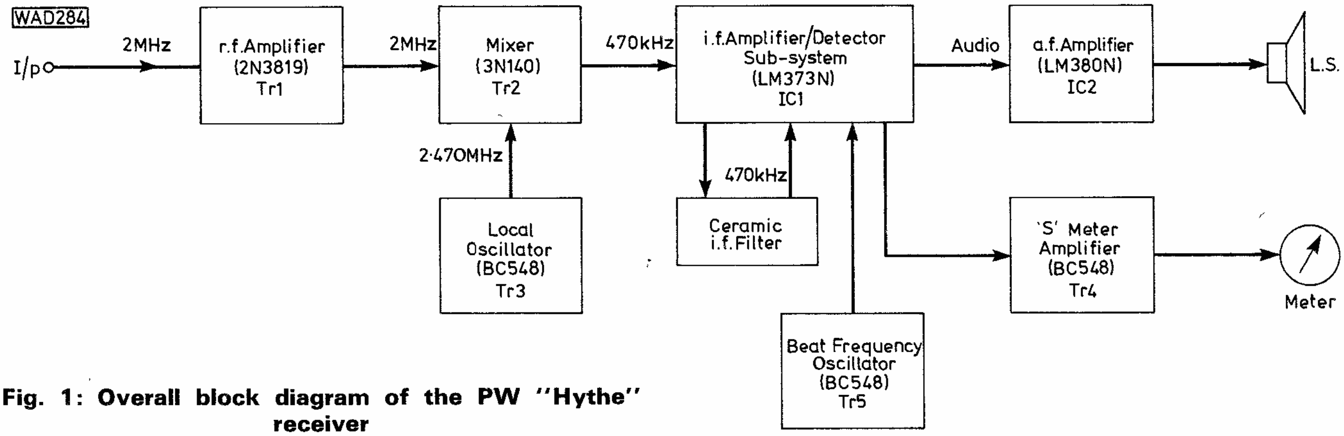


Fig. 1: Overall block diagram of the PW "Hythe" receiver

Amplification at r.f. is provided by a junction gate field effect transistor, Tr1, operating in common gate configuration. This stage exhibits a low input impedance, ideal for matching long wire aerials, and a high output impedance, which is necessary to reduce the loading on the r.f. tuned circuit, L1 and VC1.

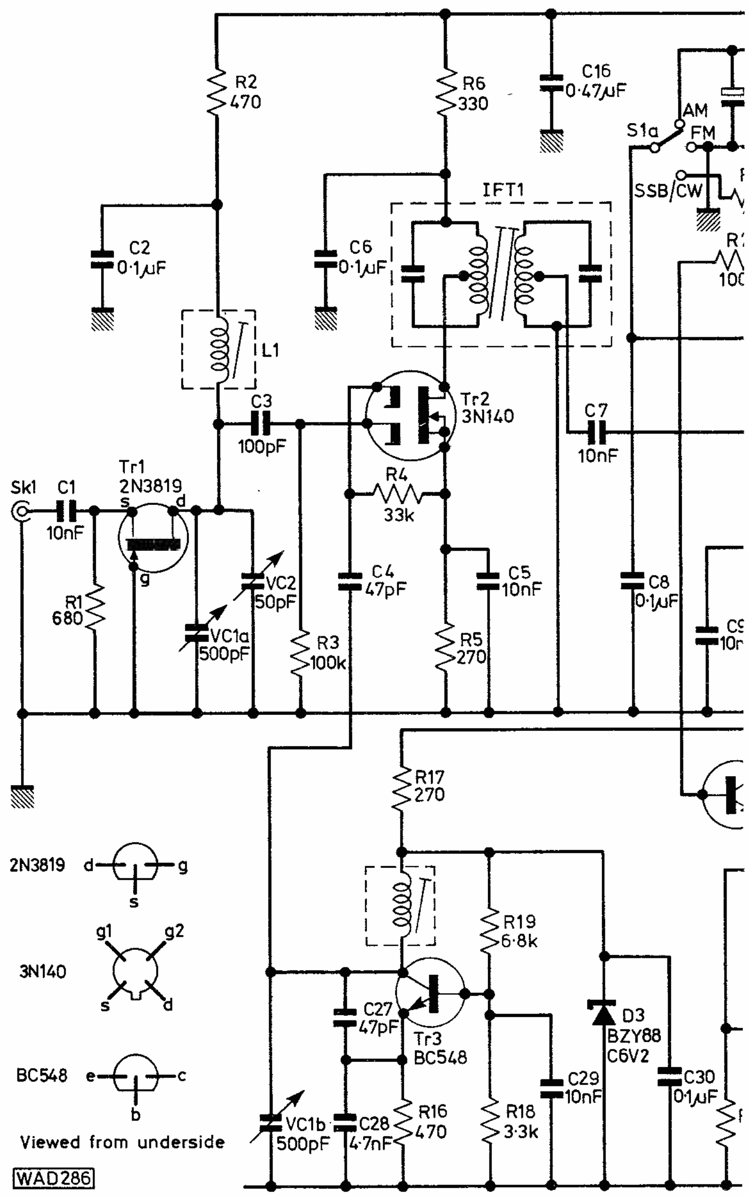
A dual gate field effect device, Tr2, is used in the mixer stage. The signal from Tr1 is applied to gate 1 and the

★ specification

Frequency Coverage: 1·5 to 3·5MHz
Modes of Operation: AM, FM, CW and SSB
Intermediate Frequency: 455kHz (nominal)
Sensitivity: 1·5µV RMS typical for 10dB S+N/N ratio measured at 2·5MHz (30% modulation at 400Hz)
Selectivity: 5·6kHz at −3dB points
11·9kHz at −20dB points
AF Power Output: 500mW maximum into 8Ω loudspeaker at 1kHz
AF Response: 130Hz to 7·5kHz at −6dB
Image Channel Rejection: Greater than 20dB at 2MHz. This figure is considerably improved with the aid of an aerial tuning unit or preselector)
IF Rejection: Greater than 55dB at 2·5MHz
AGC Range: AM; less than 3dB change in audio output for 40dB change in input. Measured at 2·5MHz, 30% modulation
BFO Tuning Range: 2kHz centred on 455kHz (nominal)
Input Impedance: 600Ω (nominal)
Output Impedance: 8Ω to 15Ω (nominal)

Table of component changes for alternative frequency coverage

Frequency coverage	L1 Turns	L1 SWG	L2 Turns	L2 SWG	C28
1·0–2·5MHz	140	34	105	34	4·7nF
2·5–6·0MHz	60	30	50	30	1nF
5·0–12·0MHz	40	30	38	30	470pF



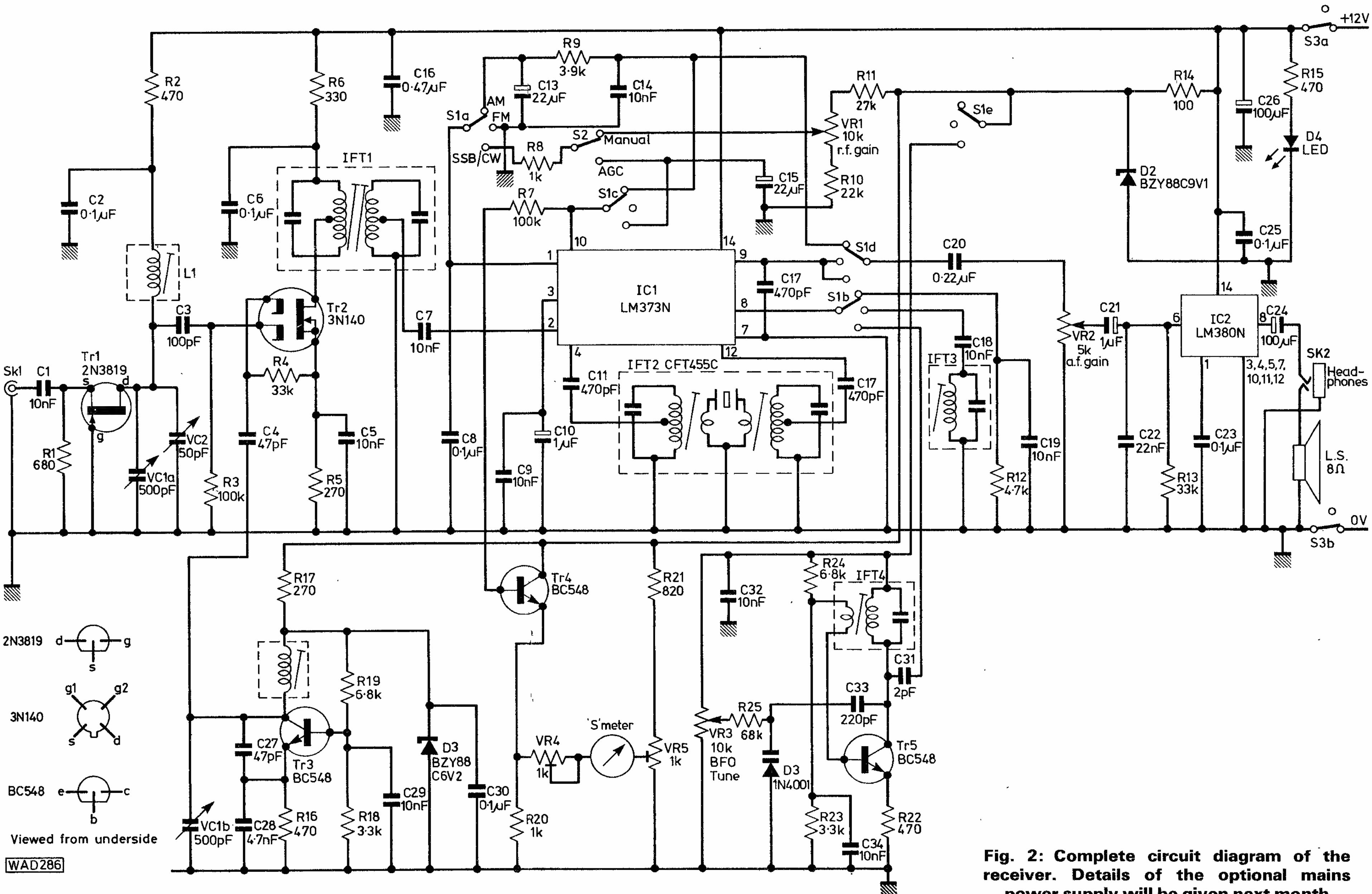


Fig. 2: Complete circuit diagram of the receiver. Details of the optional mains power supply will be given next month

local oscillator signal to gate 2. This type of mixer offers very good performance, providing considerable conversion gain and minimising the loading on the r.f. amplifier and local oscillator tuned circuits. The drain load of Tr2 is a double-tuned i.f. transformer, used to select the desired intermediate frequency signal.

The local oscillator stage is somewhat unconventional in design. A bipolar transistor, Tr3, is connected in common base configuration in a modified form of Colpitts oscillator. This arrangement provides an almost constant output level over a very wide tuning range, with the added advantage of requiring only a simple untapped inductor. The power supply to the oscillator is stabilised by a Zener diode, D1.

The i.f. amplifier and detector functions are provided by IC1. A ceramic filter is used to define the overall selectivity of the receiver. The LM373N is ideally suited for filters of this type having medium level input and output impedances.

External switching is used to select the different modes of operation. This switching is important, not only to select the appropriate signal paths, but also to ensure that the correct a.g.c. characteristics are provided.

As the LM373N uses only a relatively small a.g.c. voltage swing compared with a conventional i.f. amplifier, it is necessary to provide additional d.c. amplification in order to drive the signal strength meter. The current amplifier, Tr4, operates as an emitter follower which has a high input impedance in order to minimise the loading effect on the a.g.c. line. Pre-set potentiometers, VR4 and VR5, are respectively used to allow calibration and balancing of the 'S' meter.

The beat frequency oscillator (b.f.o.) stage uses a transistor, Tr5, operating as a conventional common emitter, tuned-collector oscillator. The emitter load, however, is left un-bypassed in order to improve the purity of the output waveform. The operating frequency of the b.f.o. is pre-adjusted by the core setting of IFT4. Fine frequency adjustment is achieved by means of a conventional silicon diode D3, connected as a "varicap"—i.e., to a variable reverse bias potential derived from a potentiometer across the supply. The b.f.o., a.g.c. amplifier and local oscillator

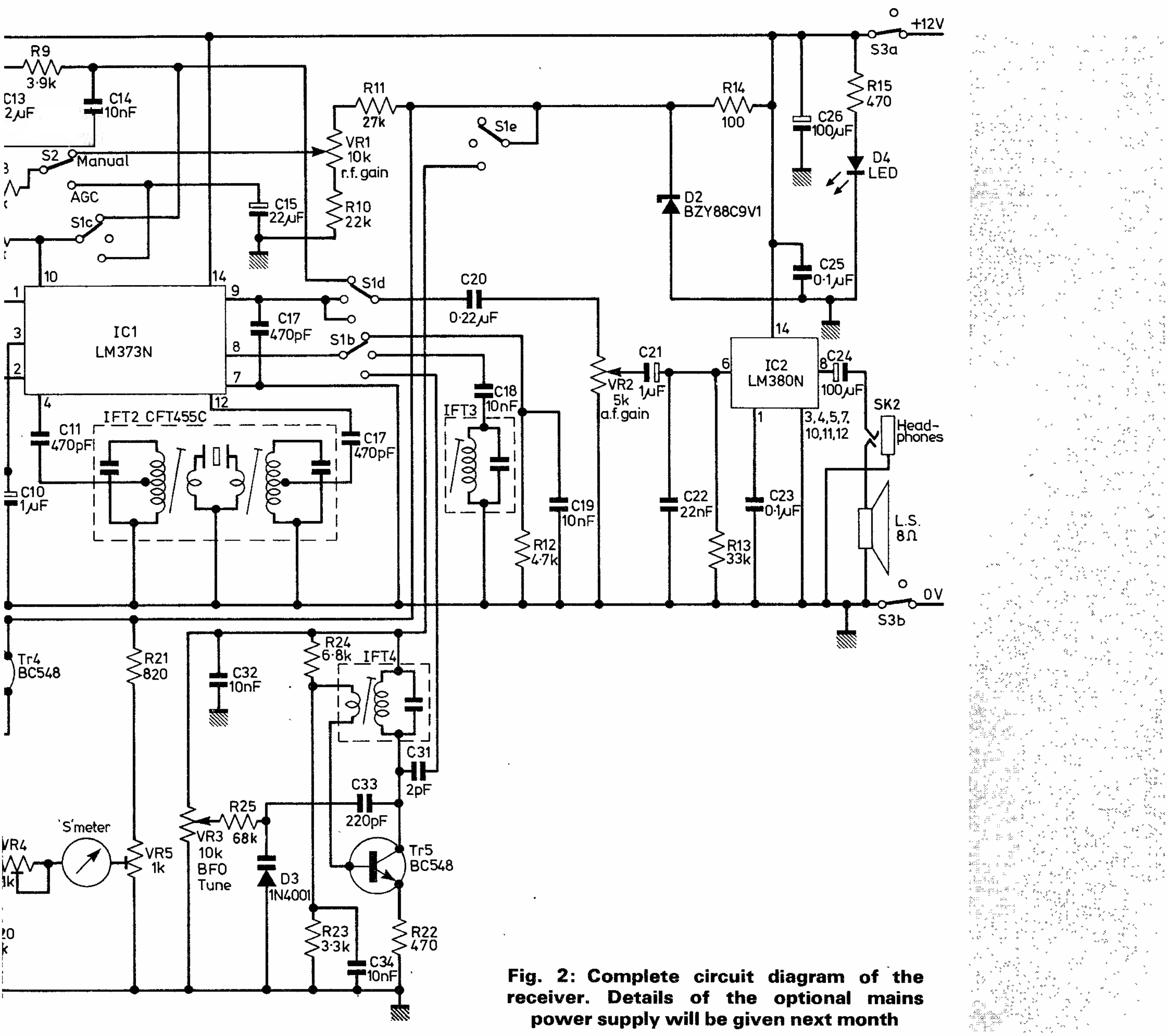


Fig. 2: Complete circuit diagram of the receiver. Details of the optional mains power supply will be given next month

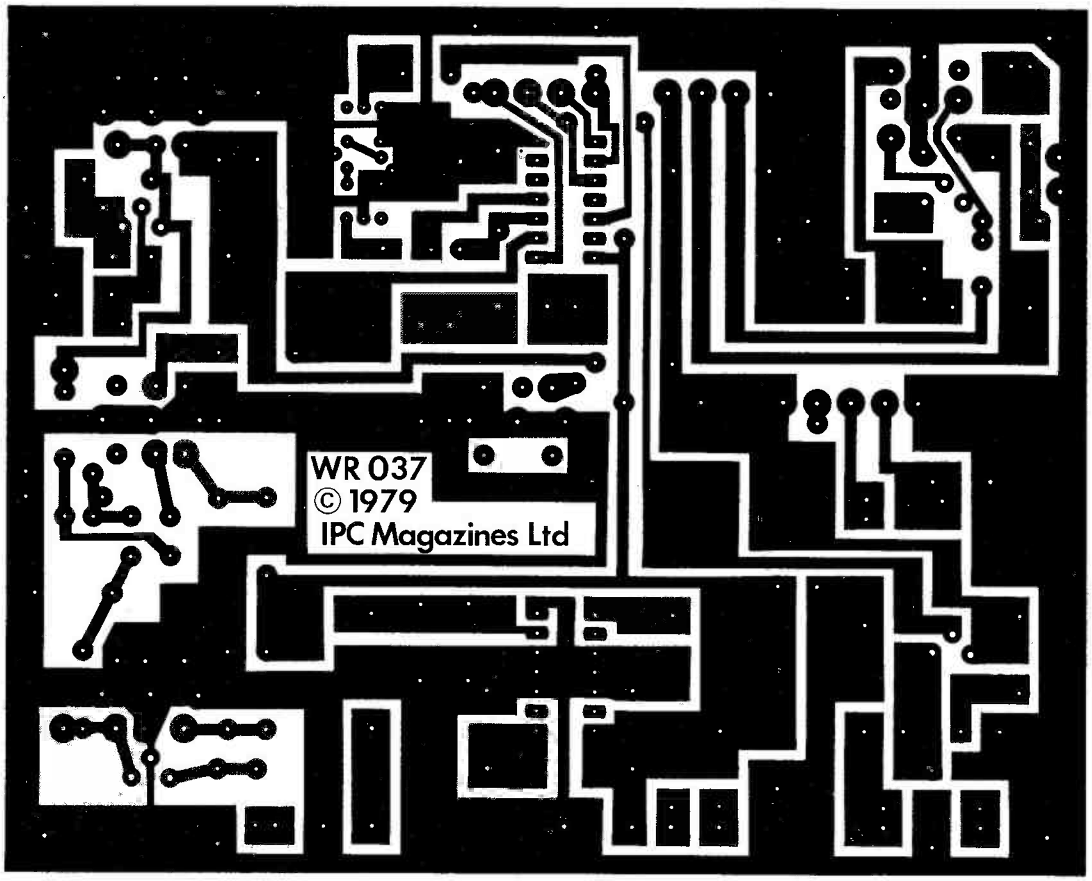
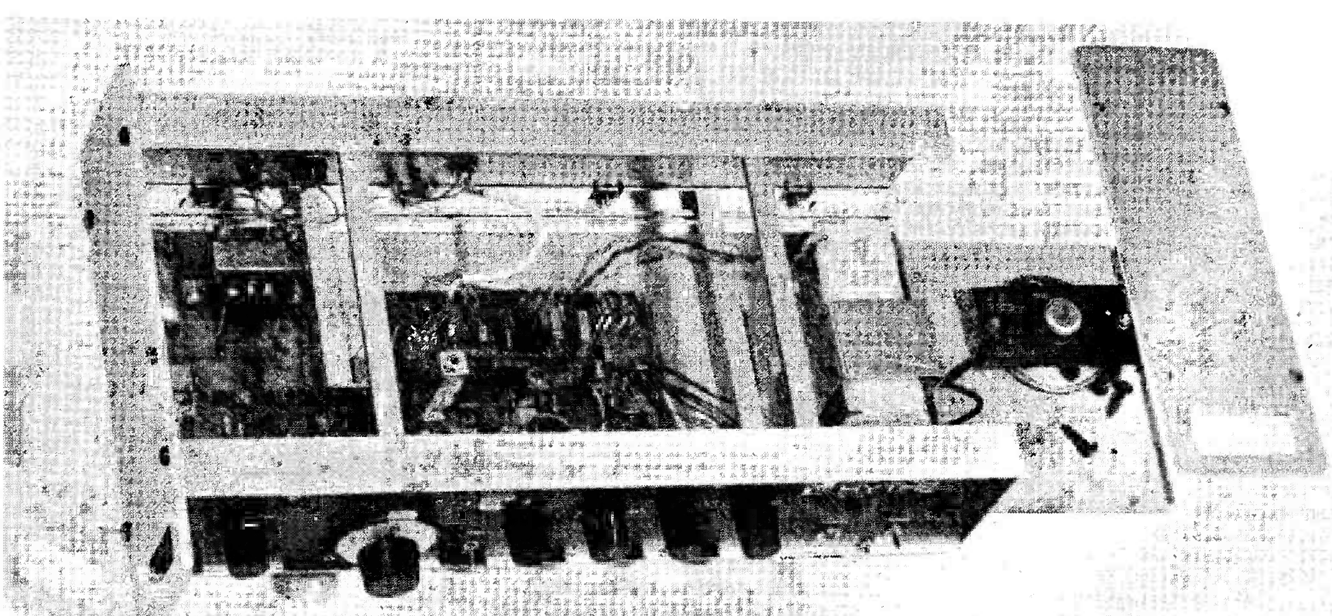


Fig. 3: Printed circuit board track pattern, shown full size



Internal view of the PW "Hythe". Access to the internal battery pack is by removing the right-hand end of the case. The case specified is also suitable for mounting in a standard 19 inch rack cabinet

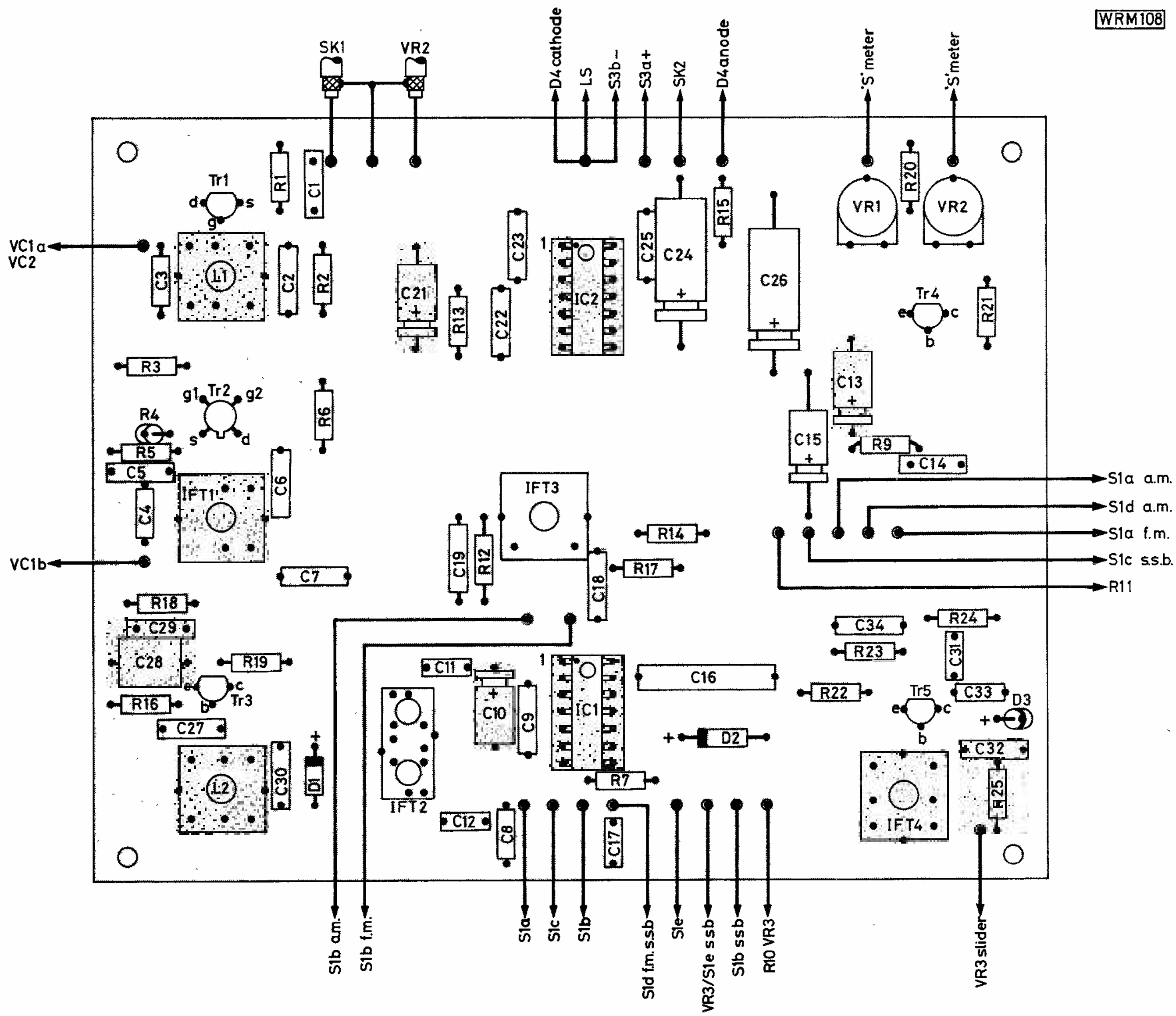


Fig. 4: Component location and external connections for the receiver printed circuit board

stages are all powered from a nominal 9V stabilised supply provided by D2.

Audio amplification of the detected signal is provided by IC2. This is a conventional arrangement using an LM380N. Little comment is needed, save to mention that this arrangement provides an adequate power output, with a fixed voltage gain of around 50, and uses an absolute minimum of external components.

Construction

The majority of components are located on the p.c.b. with controls and switches mounted on the front panel. After completing the assembly of the p.c.b. a careful visual check should be carried out in order to ensure that all components have been soldered correctly into place and that no dry joints or inadvertent short circuits exist. It is essential that the p.c.b. should be thoroughly checked at this stage since it is difficult to remove it for inspection once it has been wired to the front panel components. Push-fit terminal pins may be inserted into the p.c.b. to readily facilitate connections to the rest of the circuit. The p.c.b. is secured above the base of the chassis close to the front panel by means of four short stand-off pillars. The wiring from the main p.c.b. to the front panel, and par-

★ components

Resistors

all ¼W 10% carbon

100Ω	1	R14
270Ω	2	R5, 17
330Ω	1	R6
470Ω	4	R2, 15, 16, 22
680Ω	1	R1
820Ω	1	R21
1kΩ	2	R8, 20
3·3kΩ	2	R18, 23
3·9kΩ	1	R9
4·7kΩ	1	R12
6·8kΩ	2	R19, 24
22kΩ	1	R10
27kΩ	1	R11
33kΩ	2	R4, 13
68kΩ	1	R25
100kΩ	2	R3, 7

Miscellaneous

S1 miniature Maka-switch, two 4p 3w wafers and spacers, S2 s.p.d.t. miniature toggle switch, S3 d.p.d.t. miniature toggle switch. IFT1 Denco IFT18, IFT2, IFT3 Denco IFT13, VC1 dual gang 500pF (365pF if reduced frequency coverage acceptable). VC2 50pF variable. Ceramic filter CFT455C (6kHz bandwidth) Ambit International. Coil formers 4·8mm dia × 27mm in length 2 off, base plates, cans and dust cores to suit. 8Ω speaker (2½in dia), moving coil meter (see text), 50mm vernier drive, terminal pins, stand-off pillars, round BNC socket, countersunk 4BA screws, 15mm long (min.) 3 off, 4BA clearance spacers 12½mm long (min.) 3 off, standard jack, battery holders (optional), West Hyde "Brightcase" BC2121, front panel (D. J. Pattle).

Potentiometers

all carbon track

1kΩ lin	2	VR4, 5
5kΩ log	1	VR2
10kΩ lin	2	VR1, 3

Capacitors

Silvered mica

2pF	1	C31

Polystyrene

47pF	2	C4, 27
100pF	1	C3
220pF	1	C33
470pF	3	C11, 12, 17

Polyester min dipped

4·7nF	1	C28
10nF	10	C1, 5, 7, 9, 14, 18, 19, 29, 32, 34
22nF	1	C22
0·1µF	6	C2, 6, 8, 23, 25, 30
0·22µF	1	C20
0·47µF	1	C16

Electrolytics
63V tubular

1µF	2	C10, 21
22µF	2	C13, 15
100µF	2	C24, 26

Semiconductors

LM373N	1	IC1
LM380N	1	IC2
2N3819	1	Tr1
3N140	1	Tr2
BC548	3	Tr3, 4, 5
BZY88 C6V2	1	D1
BZY88 C9V1	1	D2
1N4001	1	D3
TIL 209	1	D4

ticularly that associated with the tuning capacitor VC1, should be as short and direct as possible, and wiring from the board to the volume control, and from the aerial socket to the board, should employ short lengths of screened cable. Some care is needed here in order to ensure that the control spindle of VC1 is correctly aligned to the shaft of the drive. If this alignment is not correct, undue wear may be placed on the vernier drive mechanism and also the tuning may be found to be somewhat erratic.

Inductors L1 and L2 consist respectively of 120 turns and 80 turns of 32 s.w.g. enamelled copper wire wound in two layers on a 4·8 mm diameter former fitted with a base, screening can, and dust core. In each case, care should be taken to ensure that the terminal pins of the base align correctly with the p.c.b. connections. After completing the winding of the coils, they should be liberally coated with a polystyrene impregnant in order to hold the windings in place. The screening can is then fitted and the entire assembly is located and soldered to the p.c.b. If an alternative frequency coverage is required, coil winding details are provided in the table shown. The moving coil meter used in the prototype was a miniature edgewise tuning indicator of approximately 200µA full-scale deflection. The receiver will, however, operate satisfactorily with moving coil meters having anything between 100µA and 1mA full-scale deflection and, if desired, constructors may choose to use a properly calibrated 'S' meter. In the authors' experience, however, the calibration of such meters in all but the most expensive of receivers has been found to be somewhat arbitrary and, for most purposes, a conventional linear meter scale will be found to be quite satisfactory.

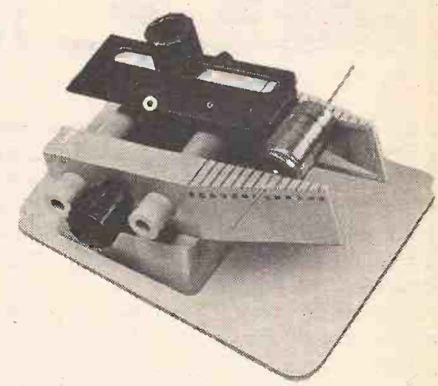
The second part of this article will deal with the two optional items involved—the power supply, and an aerial matching unit, the latter providing an improvement both in image rejection and impedance matching. Details will also be given for setting up and operation of the receiver generally.

PRODUCTION LINES

alan martin

If you please

Would readers kindly mention "Production Lines", when applying to manufacturers or suppliers featured on this page.



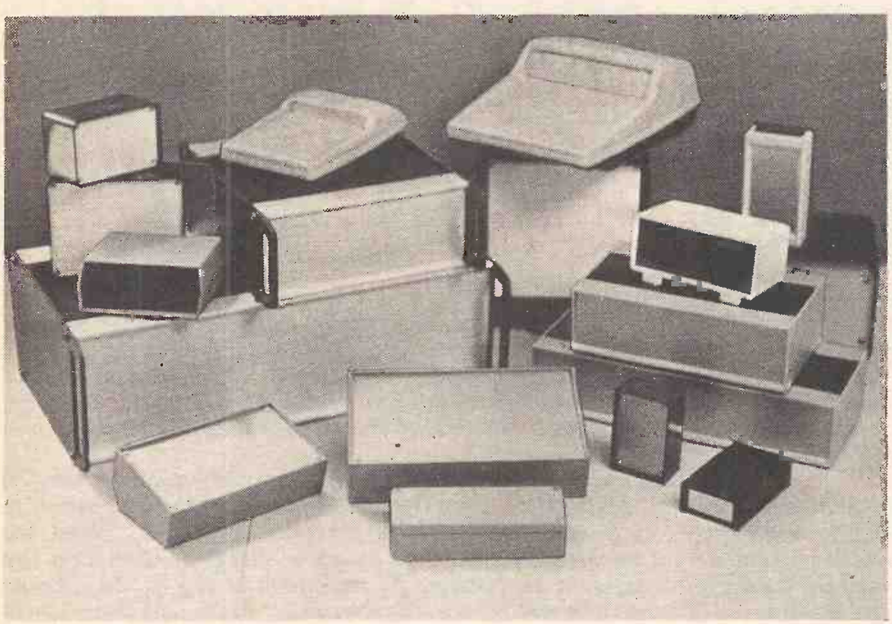
Cases Galore

West Hyde Developments, the Aylesbury based electronic hardware suppliers, inform me, that they can supply from stock a case to house virtually all projects likely to appear in journals such as *Practical Wireless.* The photograph shows a selection of the various families of cases available, however, the combination of sizes multiply this selection enormously.

West Hyde can also offer a full range of accessories such as knobs, handles, switches, indicators and tools.

With the aid of a computer, designed to complement West Hyde's accounting system, they are able to provide a speedy turnround of orders.

To obtain their latest, free catalogue and price list, applications should be sent to: *West Hyde Developments Ltd., Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET. Tel: (0296) 20341/4.*



Neat job

With the home constructor demanding a highly professional standard of finish to his projects, a useful tool has been introduced by Litesold.

The Opsec component lead bending tool is designed for simple and accurate preforming of component leads prior to insertion into the p.c.b.

The jaws may be adjusted, up to a maximum of 45mm, to accommodate most lengths of components likely to be used on circuit boards. An adjustable stop and numbered slots on the jaws ensure accurate positioning of the component prior to bending. The base is engraved in steps of 2.5mm to aid initial setting-up.

Manufactured in Deroton, a tough, high impact plastic and with the base fitted with non-slip feet, which may be drilled through and the unit screwed securely to the bench, the Opsec tool costs £4.99 plus 8% VAT and 15p P&P. *Light Soldering Developments Ltd., 97/99 Gloucester Road, Croydon, Surrey CRO 2DN. Tel: 01-689 0574.*

Drill stand

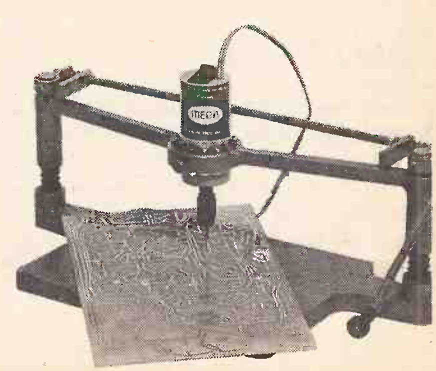
Recently introduced by Mega Electronics Ltd., a new low-cost p.c.b. drill stand designed for use with conventional hand-held p.c.b. drill units.

Designated the Photolab PLST-12A, the drill stand is constructed with a strong base of machined cast iron supporting precision steel guides by means of which the standard 12V drill is raised and lowered.

Important features are its combined simplicity and accuracy, and the fact that it will accept both the Mega and other proprietary drills of 34mm body diameter. Additionally, the same basic drill stand is available to special order from Mega, capable of accepting drills between 20mm and 41mm diameter, at marginal extra cost.

Printed circuit boards of up to 254 × 228mm (10 × 9in.) overall will be accepted by the drill stand.

The Photolab drill stand is priced at £16.50 which includes VAT, and is available from: *Mega Electronics Ltd., 9 Radwinter Road, Saffron Walden, Essex CB10 1EP. Tel: 0799 21918.*



OF THE MONTH 73

Brian DANCE M.Sc

NATIONAL LM391N-60 AUDIO DRIVER

The design of high quality audio power amplifiers is quite complex, and poorly constructed circuits may develop distortion or even burn out if used in a warm room. To avoid the problems associated with the construction of a complete amplifier using discrete semiconductor devices, a complete audio hybrid module or integrated circuit power amplifier can be used.

However, another approach involves the use of an audio power driver i.c. which contains most of the circuitry required for the early stages of the amplifier, but which is not itself designed to supply high power levels. This device will provide signals which can be used to drive external power transistors feeding the load.

Unfortunately very few audio power driver devices have been manufactured, but recently the new LM391N-60 has become available to the home constructor. This is a 16 pin dual-in-line device with the connections shown in Fig. 1 which can be used to construct audio power amplifiers producing only about 0·01% total harmonic distortion. It has the advantage that it is internally protected against output faults causing excessive current flow. In addition, it is protected against thermal overloading, and also protects the external power transistors.

A typical LM391N-60 amplifier which will deliver up to 20W into an 8Ω loudspeaker or up to 30W into a 4Ω loudspeaker when operated from suitable power supplies is shown in Fig. 2. Pin 8 of the LM391N-60 can deliver an output current of up to 5mA to the base of the BD345 driver transistor Tr1; this latter device amplifies the current before it is again amplified by the BD346 power transistor, Tr2. Pin 8 is a current source, but pin 5 accepts current and is therefore known as a current sink. The current is withdrawn from the base of the BD344 transistor Tr3 into pin 5; Tr3 drives the BD347 power transistor Tr4.

The positive half cycles of the waveform are handled by the BD346 power device, the current passing through R9, L1 and the loudspeaker to ground, but during negative half cycles current flows from ground through the speaker, L1, and R10, to the BD347 and hence to the negative supply line. This is a normal type of Class B operation in which each output transistor conducts alternately.

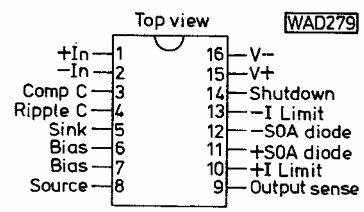
Circuit Details

The audio input signal is coupled by C1 to pin 1 of the device, R1 being the ground return resistor. The values of these components must not be too low or the bass response will be reduced. The amplifier input impedance is approximately equal to R1, but if this resistor has a very high value, board layout problems may occur when designing for stability. In addition, the use of a very high value for R1 may result in a high offset voltage at the output.

Negative feedback is taken from the output through R4 to pin 2. The gain at audio frequencies is equal to (1 + R4/R2) or about 20 (26dB) with the component values shown. However, the value of R2 can be altered (within reasonable limits) to obtain various values of gain. The input voltage required for full output power is about 630mV with the values shown. The value of R4 should be approximately equal to R1 for minimum offset voltage.

Capacitor C2 prevents the flow of a steady direct current in the feedback circuit so that there is 100% negative feedback at zero frequency; this reduces the gain of the circuit to unity at zero frequency with the result that any small input offset voltage is not amplified to produce a large output offset. Such an output offset would not only reduce the output voltage swing in one direction (and hence limit the maximum output power), but would also drive a steady current through the loudspeaker so that the loudspeaker coil would be displaced in its magnet gap or perhaps even burnt out. The value of C2 should be adequate to prevent the attenuation of bass frequencies.

Fig. 1



The 5pF capacitor C4 is for frequency compensation (as in an operational amplifier) and sets the high frequency gain-bandwidth product. This component is required for high frequency stability. Capacitor C3 connected to pin 4 improves the rejection of mid-band and high frequencies (see Fig. 3) and if used should have a value equal to that of C4.

The potentiometer VR1 between pins 6 and 7 sets the bias for the external transistor output stages. Too little bias will result in excessive crossover distortion, whilst too much will result in an excessive power consumption and possible overheating. In the circuit of Fig. 2, VR1 should be adjusted for a quiescent current in the output devices of about 15mA, since this is just a little more than is required for minimum crossover distortion (as shown in Fig. 4). Crossover distortion is best detected at high frequencies and at low signal amplitude. The component C5 is a bias by-pass capacitor which reduces high frequency distortion and improves the transient response.

The components L1 and R14 connected in parallel may be made as a single item by wrapping about 25 turns of 19 s.w.g. wire around a 10Ω 2 watt resistor and soldering the ends of the wire to the resistor leads. It is possible to omit these two components completely with some loads, but the inductance L1 greatly improves the stability of the circuit with a capacitive load. Almost all the load current flows through the wire of the inductance (except at very high frequencies) rather than through the resistor R14. The value of this inductance is not at all critical, 2 to 12μH being suitable, but the wire used for L1 must be able to carry the

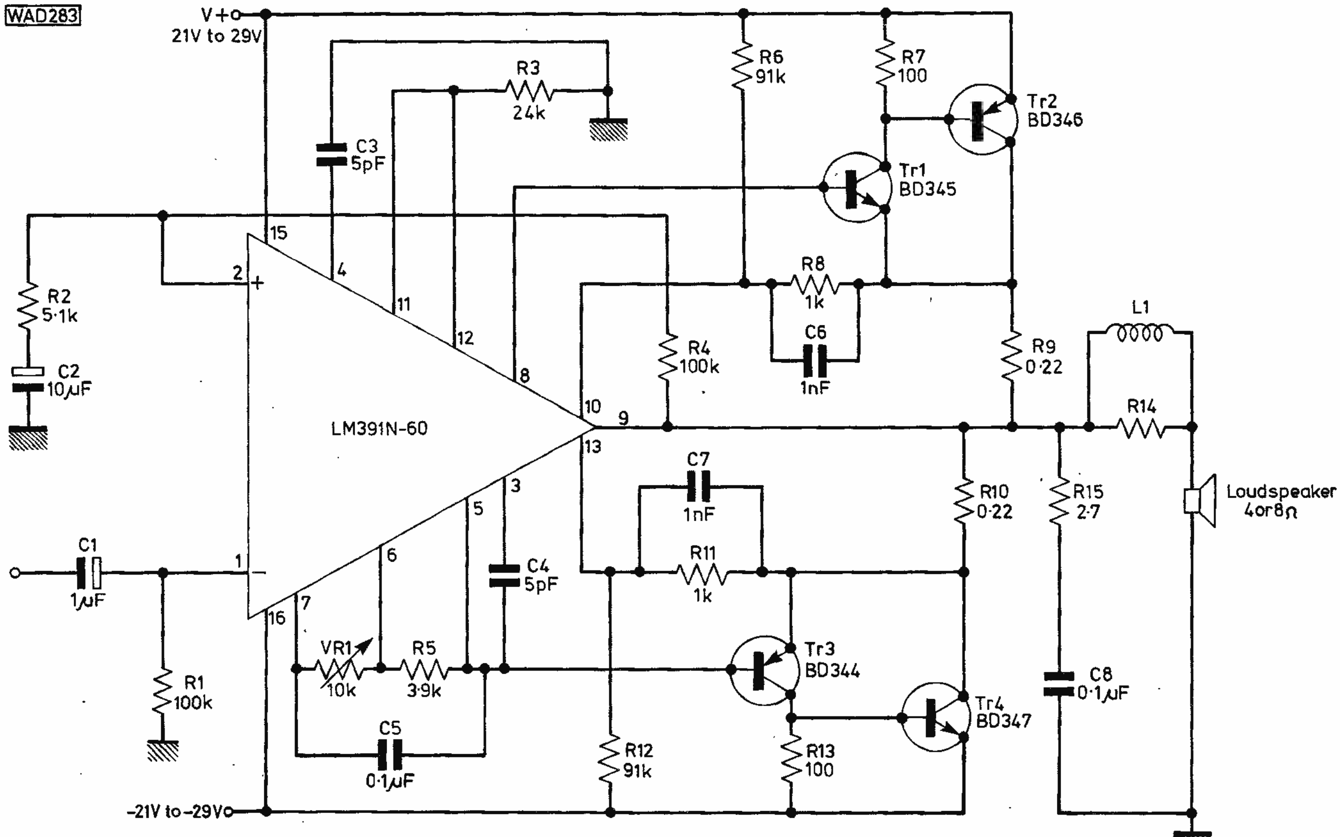


Fig. 2: Typical LM391N-60 amplifier circuit delivering 30W into 4Ω

peak current required by the loudspeaker.

The components R15 and C8 form the normal Zobel network which improves the stability at very high frequencies with certain types of load. Although the circuit may possibly operate satisfactorily without these two components, it is wise to include them rather than risk having trouble with the finished amplifier.

The resistors R9 and R10 are the emitter stabilising resistors for the power output transistors Tr2 and Tr4 respectively. They can easily be wound from a short length of resistance wire (possibly around a resistor of higher value), but the resistance wire used must be able to carry the peak current passed by the transistors. R9 and R10 stabilise the ouput stage quiescent current against variations of temperature.

The resistors R7 and R13 are bleed resistors which remove the charge stored in the base of the output transistors and thereby speed up the operation of these components.

Protection Circuit

If an excessive current passes through R9, the voltage drop across this resistor will be passed to pin 10 of the LM391N-60. The internal circuit of the device will then cause the current drive to pin 8 to be reduced so that the current passing through R9 is limited to a safe value. Similarly, a high current through R10 results in an increased voltage being applied to pin 13; this results in a reduction of the pin 5 current so that the current in Tr4 is limited to a safe value.

The limiting action of this protective circuit commences when the voltage between pins 10 and 9 or between pins 9 and 13 exceeds about 0·65V. When the component values shown are used, this means the output current in each transistor is limited to a few amps.

The safe operating area (s.o.a.) protective diodes connected in the pin 11 and pin 12 circuits are not used in the relatively simple circuit of Fig. 2 and neither is the device shutdown facility of pin 14. However, a thermal switch may be fitted to one of the ouput device heat sinks so that this switch closes when the temperature rises above a certain level and connects pin 14 directly to ground. A current of less than 0·5mA in the pin 14 circuit is adequate to shut the device down.

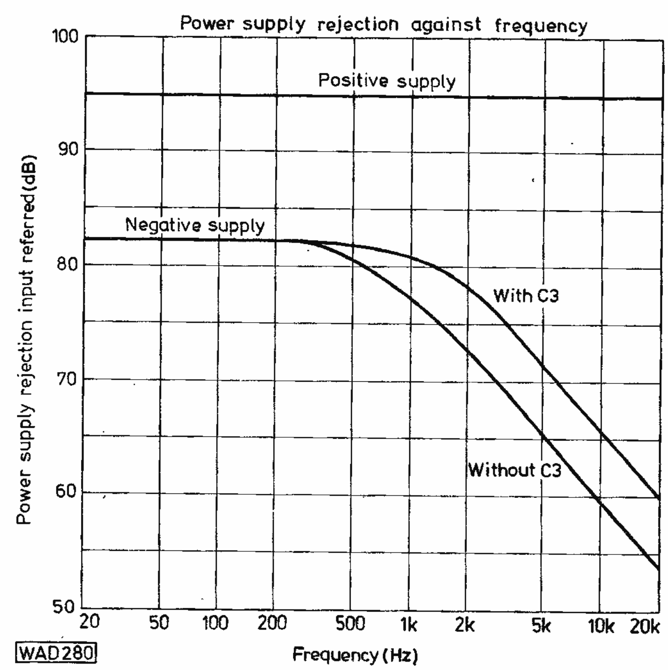


Fig. 3

Power Supply

The maximum power supply voltage which can be safely applied to the LM391N-60 is ±30V. However, it is wise to keep the applied voltage appreciably below this value so as to provide a margin of safety to allow for any normal increases in the mains supply voltage producing a higher supply line voltage. An upper limit of 27V is suggested unless stabilised supplies are employed. If the power supply voltage is low, the maximum output power may be reduced. The LM391N-60 draws a quiescent current of about 3mA (maximum 10mA for any device of this type).

The output voltage of a typical LM391N-60 can swing to within 5V of the potential of either of the supply lines. When using a supply of ±21V, the maximum output voltage swing will therefore be about ±16V. The current in a 4Ω load will be 16 ÷ 4 = 4A peak, whilst the peak power

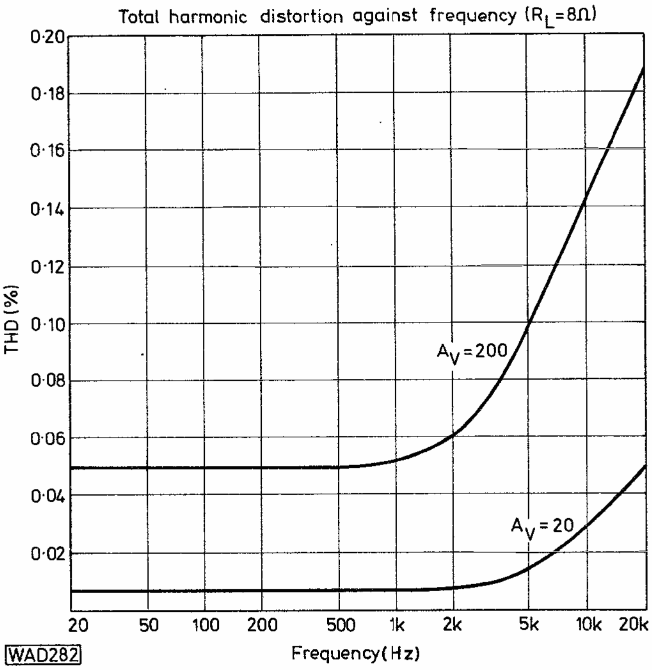
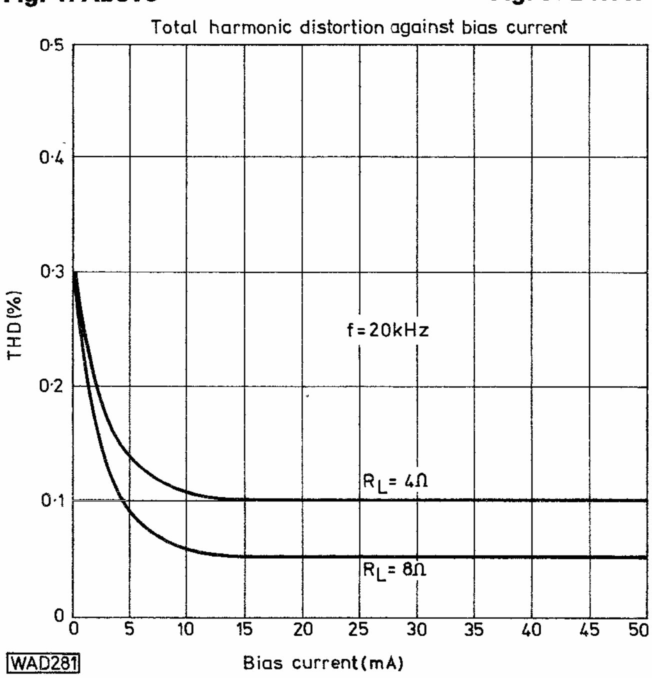


Fig. 4: Above **Fig. 5: Below**



will be 16 × 4 = 64W. In Europe amplifiers are rated according to the maximum mean power they can deliver; the mean power is one half of the peak power in the case of a sine wave, so the peak power could be about 32W provided the current limiting circuit does not limit at a current under 4A.

When employing an 8Ω loudspeaker with ±21V power supplies, the peak current is 16 ÷ 8 = 2A and the peak power 16 × 2 = 32W. Thus the maximum mean power is about 16W. A little more power can be obtained with an 8Ω load if the power supply voltage is increased to about ±23V.

The LM391N-60 provides excellent rejection of noise and hum present on the power supply lines. The amplitude of any such noise and hum signals at the output of the device is typically 31 600 times (or 90dB) less than their amplitude on the power supply lines; the typical variation of the rejection with frequency is shown in Fig. 3. The minimum rejection figure for any LM391N-60 is 70dB or 3160 times.

The noise generated by the LM391N-60 is only 3μV referred to the input.

Performance

The total harmonic distortion in a LM391N-60 circuit is about 0·01% at 1kHz when the circuit gain is 20, but it increases with frequency as shown in Fig. 4. The distortion is also higher in circuits employing higher gain, since the amount of negative feedback is smaller. Typical values of the total harmonic distortion at two values of gain are shown in Fig. 5. The intermodulation distortion has been measured as 0·01% for signals of 60Hz and 7kHz simultaneously present.

External transistors

Various types of complementary output transistor (Tr2 and Tr4 in Fig. 2) may be used with various types of driver device (Tr1 and Tr3). The transistors used must have a V_{CEO} breakdown voltage rating which is not less than the total voltage applied across the circuit (namely the sum of the positive and negative supply voltages). The maximum current at the LM391N-60 outputs is 5mA. The gain of the driver transistor multiplied by the gain of the output stage must be adequate to bring up this 5mA current to a value which is great enough to drive the loudspeaker at the required power level.

The complementary driver transistors in the circuit shown have a gain of 40 at 200mA collector current. Thus they can bring the 5mA output up to the 200mA level. The output transistors have a minimum gain of 30 at a current of 4A, so this is adequate for the purpose. The driver transistors should have a much higher transition frequency (f_T) than the output transistors to prevent instability.

It is recommended by the device manufacturers that the output transistors of the Fig. 2 circuit should each be mounted on a heatsink of thermal resistance not more than 4·8°C/W or alternatively both could be mounted on the same heat sink which should not have a higher thermal resistance than 2·4°C/W. No heat sinks are required for the driver transistors. These heat sinks are not designed to cope with long duration short circuiting of the output to ground.

The LM391N-60 can be used together with external transistors in high fidelity amplifiers which are reasonably simple to construct. The device is available from Arrow Electronics Ltd., Coptfold Road, Brentwood, Essex, CM14 4BN. ●

Introduction to LOGIC ~ 7

S. A. MONEY

Having examined the various types of logic element and some typical applications it may now be interesting to look at some of the more recent developments in digital integrated circuits and see how they might affect amateur projects in the future.

Probably one of the more significant advances in the technology of integrated circuits in recent years has been the development of Large Scale Integrated (LSI) circuits in which there might be a thousand or more gates, or flip-flops, on a single silicon chip. This has been made possible by using larger chips, maybe 4mm square, and better photographic and etching techniques allowing more components to be packed into the chip. These complex chips make it possible to build a complete logic system into a single i.c. package. Even more complex devices, having tens of thousands of gates on a chip, known as Very Large Scale Integrated (VLSI) circuits are now being developed which promise to reduce complete computer systems to little more than a handful of i.c. chips.

MOS Logic

Most of the LSI logic devices currently being built use MOSFETs to form the logic elements. Unlike CMOS logic, which uses both *p*- and *n*-channel devices, the MOS logic in LSI chips uses either all *p*-channel or all *n*-channel type transistors.

The earliest LSI chips used *p*-channel transistors and this type of logic is generally referred to as PMOS logic. Power supplies for PMOS devices are negative and often there are two or three different voltages required to produce the correct bias conditions. Typical devices might use supply lines of −5V and −12V although some circuits may need as much as −20V for the supply rail. Because the logic signals are of different amplitude and opposite polarity there can be problems in interfacing PMOS logic with normal TTL and CMOS circuits. Discrete transistor circuits are normally used to match the PMOS outputs to TTL inputs and vice-versa.

Production of LSI circuits using *n*-channel transistors was initially more difficult than that of PMOS devices, but, once the fabrication problems has been overcome, these new NMOS devices, as they came to be called, were found to be better than their PMOS counterparts.

Initially NMOS devices, like the PMOS types, used two or three positive power supply rails but in many of the new NMOS circuits the bias supplies are derived inside the chip so that only a single supply voltage is required. One big advantage of NMOS circuits is that they can easily match up with TTL or CMOS logic and in many cases direct connection between the two types of logic is possible. Most NMOS logic circuits are faster in operation than PMOS equivalents.

A typical NAND gate in NMOS logic would have a circuit arranged as shown in Fig. 77(a) whilst a NOR gate would be as shown in Fig. 77(b). As with CMOS the input impedance of PMOS or NMOS circuits is very high so static electricity can be a problem. Most modern LSI chips will have protection diodes built in to minimise the possibility of damage due to static. Nevertheless it is wise to handle all MOS LSI type devices with the same care as CMOS, and they should be stored with all device pins shorted together by aluminium foil or conductive plastic foam.

Semiconductor Memories

Among the earliest applications of LSI techniques was the production of semiconductor memory systems for use

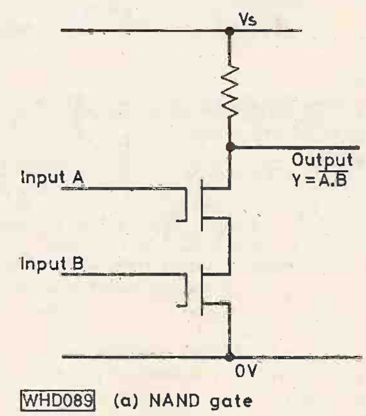


Fig. 77 (a): Typical MOS LSI NAND gate

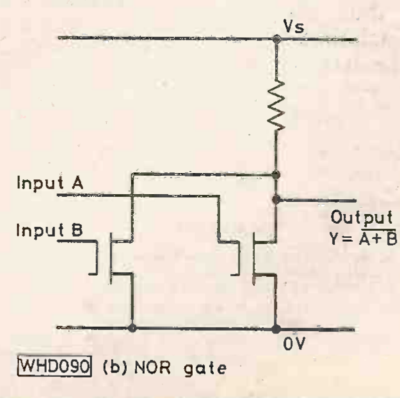


Fig. 77 (b): Typical MOS LSI NOR gate

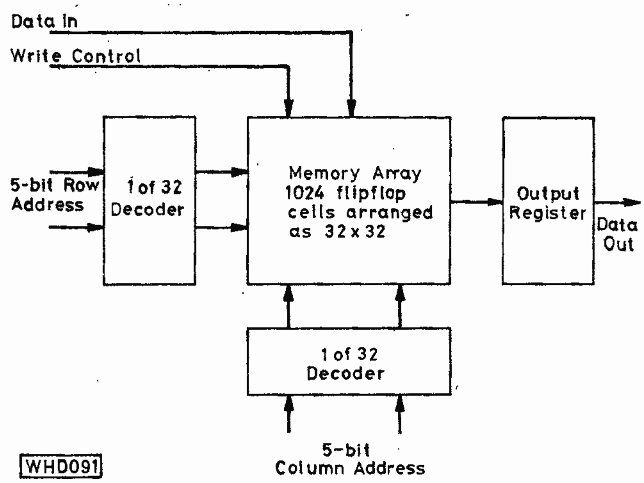


Fig. 78: Organistion of a typical 1024-bit (1K) memory

with small computers. Prior to the mid-1970s virtually all of the digital computer systems used ferrite cores as memory cells. These small ferrite ring cores were magnetised one way to represent a logic *1* state and the magnetisation polarity was reversed to represent a *0* state. A vast array of these tiny magnetic cores would be used to store the states of perhaps thousands of bits of data. Complex addressing logic had to be used to select a particular core in the array, to read its state or to write in new data. Because the windings often consisted of only one turn quite large current pulses were needed to magnetise the cores, so power supplies tended to be rather large.

A semiconductor memory can readily be produced by using a flip-flop for each memory cell. Using LSI techniques it is possible to build 1 000 or more such cells on a single chip and with MOS logic the power requirements will be relatively small.

To simplify the addressing logic the array of flip-flop cells in an MOS memory would be arranged as, say, 32 rows and 32 columns, and the general arrangement of the chip would be as shown in Fig. 78. To select a particular memory cell a 32-way decoder is used to select one row of flip-flops. Next a second decoder is used to select one of the 32 columns and hence will select one flip-flop in the chosen row. The input and output circuits of this selected flip-flop will now be routed to the input and output pins of the chip. When a clock pulse (called the Write input) is applied, the selected flip-flop will take up the state of the data input line thus allowing data to be written into the memory. Each time a flip-flop is selected, its output will be routed to the data output line of the memory chip allowing the data to be read out.

In a typical memory device, such as the 2102, there might be 1024 cells arranged as a 32 × 32 array. Such a chip would be called a 1K memory. Note the convention by which the "binary thousand" (1024) is denoted by a capital K. Thus a 4K memory would hold 4 × 1024 = 4096 bits, a 16K memory would hold 16 384 bits and so on. The address decoders would each be 32-way devices and would be controlled by a pair of 5-bit binary codes, giving a total of 10 pins allocated to address signals for the memory. Apart from the address and power supply there will also be data input and output and a Read/Write control signal to be accommodated. Some chips also have a Chip Enable (CE) line and provide a tri-state output signal. The connections for a 2102 memory are shown in Fig. 79.

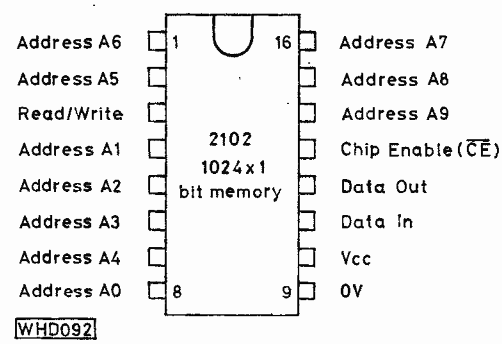
Larger memory devices use capacitors as the storage device and the *0* or *1* state is determined by whether the capacitor is discharged or charged. A typical memory cell of this type is shown in Fig. 80.

One problem with capacitor-type memories is that, due to leakage paths on the chip, the charge on the capacitor is slowly leaked away and memory would be lost unless the cell could be topped up. In fact this process of "refreshing" the state of the memory cell is achieved by regularly reading the state of the cell and rewriting this state back into it. This refresh process needs to be carried out at about 2ms intervals and for this reason such memories are called dynamic memories, whereas the normal flip-flop types are referred to as static memories.

In a dynamic memory the capacitors used for storage of data are very small and in a typical chip there may be as many as 16 384 cells together with the addressing logic. Newer types with 65 536 cells are already starting to appear. Static memories, with their more complex cell structure, tend to be less dense and may have perhaps 4096 cells, although here too larger devices are being developed.

Digital Calculators

Until a few years ago most engineers used slide rules or mathematical tables to carry out their calculations. Today they almost invariably use an electronic calculator and even the housewife shopping at the local supermarket may be found using a pocket electronic calculator to check prices.



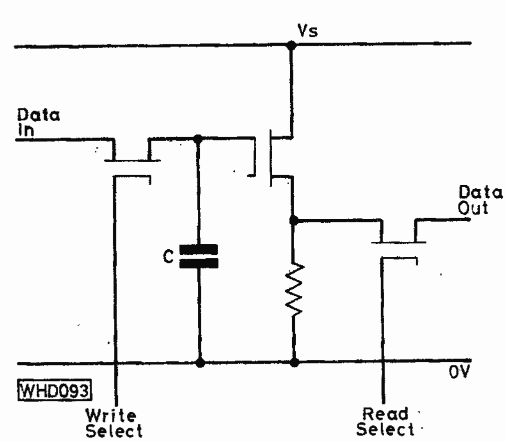


Fig. 80: A typical dynamic memory cell

Prior to 1971 calculators were desk-top machines which were either mechanical or used a vast array of SSI devices. The complex logic of these machines was however an ideal application for the new LSI techniques. In 1971 MOSTEK were to produce the first calculator chip which could add, subtract, multiply and divide numbers. The LSI revolution had begun.

Early calculator chips used PMOS logic and needed a number of extra circuits around them to drive the displays and communicate with the keyboard but despite this it was possible to build a complete four-function calculator unit into a case that would fit into a coat pocket and run from a set of batteries.

The basic logic scheme inside a typical calculator is shown in Fig. 81. At the heart of the device is the ALU (arithmetic and logic unit). This is a complex logic array which can add or subtract two numbers and perform one or two simple tests on the result. For convenience the numbers are represented in the BCD format and the ALU deals with them four bits (one BCD digit) at a time. For multiplication and division a sequence of successive additions or subtractions is carried out in much the same way as if the sum were being worked out on paper.

Apart from the ALU there are flip-flop registers which will hold the two numbers to be operated upon and the result of the operation. An 8- or 10-digit l.e.d. or l.c.d. seven-segment display is provided to present the numbers in visible form. To minimise the number of pins needed on the calculator, chip display is multiplexed with the digits flashing up in sequence at a sufficiently high rate to produce a flicker-free display. A further complex section of logic controls the activities of the ALU, registers, keyboard and display to produce the desired results.

Suppose we are going to add two numbers. At the start the control logic connects the keyboard and display to the "A" register, and as numbers are keyed in their 4-bit data patterns are shifted into this register one digit at a time. The display will show the contents as the number is fed in. When the "+" function key is pressed, a flip-flop is set to select the addition process whilst the keyboard and display are switched to the "B" register where the second number will be stored. When the second number has been entered and the "=" key is pressed, the numbers from the "A" and "B" registers are routed to the inputs of the ALU which adds them together, and the result from the ALU is fed to the display. Digits are switched in sequence by the control logic and any carry bits from one decade are added in as the next decade is dealt with.

In the case of multiplication and division, a sequence of add or subtract operations is carried out in the ALU as the control logic works its way through a preset sequence of commands. These commands switch the operation of the ALU and control the transfer of numbers between it and the other registers. A similar complex sequence of operations is used in some modern calculators to work out trigonometric and other mathematic functions. Sometimes additional registers will be included to allow intermediate results of a complex calculation to be stored temporarily.

LSI in Television

Another application of LSI devices which has come into prominence in the past year or two has been the TV game. In the early 1970s TV based games, such as Pong (or TV tennis), began to make their appearance in the amusement arcades. In these early games conventional logic devices were used, but soon GI introduced an LSI chip which could provide a choice of several different games such as tennis, hockey and squash. Recently much more sophisticated games such as tank battle, which would have needed hundreds of TTL devices, have been introduced.

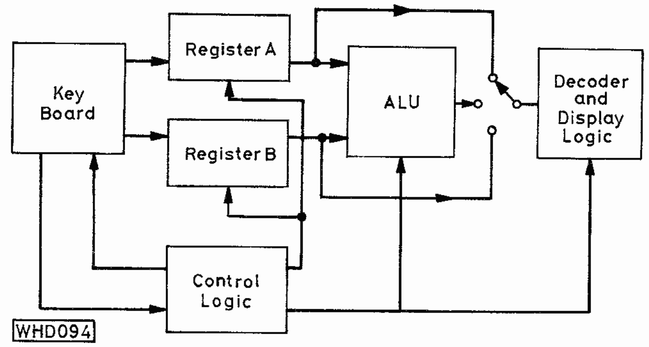


Fig. 81: Block diagram of a digital calculator

The games chip itself has to generate a complete video signal for the game display including sync pulses and in some cases colour signals. Sound effects, such as the ball striking the bat, are generated as bursts of pulses by the games chip. Apart from producing the display the chip must control the motion of bats, balls, etc., and also detect scoring moves and keep the score for both players. Further logic is needed to display the score on the screen and to control the selection of the various games.

External controls for bats, tanks, etc., are normally potentiometers which alter the timing of delay circuits in the chip and hence alter the position of objects on the TV screen. Sometimes the speed of movement may be controlled in a similar way as in the stunt rider and racing car games.

Another recent application of LSI devices in television has been in building decoder systems for the Ceefax and Oracle teletext transmissions now being broadcast by the BBC and ITV.

In teletext decoders the logic must select out the data signals from the television picture signal and decode them. A particular page of text, selected by the viewer, must then be detected and removed from the incoming data stream. The selected page of text is stored as a set of binary data words in a memory and data from this memory is regularly read out and converted into video signals to produce a text display on the screen in place of the programme picture. Using conventional logic such a decoder system might require about a hundred TTL devices whereas by using LSI it is possible to reduce this to perhaps six to ten chips which will fit conveniently on to a small card mounted in the back of the television receiver.

Universal Logic Chips

One of the problems facing the manufacturer of LSI chips is to decide what to put into them. As the logic gets more complex the number of options also increases as each user will want his own favourite features. Unfortunately it costs a lot of money to design an LSI chip and unless it can be made in thousands or even millions it will not be economic to produce it.

One solution to this problem adopted by the chip makers was to build a standard chip which contained a large array of identical gates and to tailor the devices to the user's requirements by interconnecting the gates as required during the final stages of making the device. Thus only the final interconnection pattern needed to be designed for each new application and the overall cost of a new device could be kept down.

Another approach was to make the circuit on the chip more versatile so that it might satisfy a number of varied applications. The limit here is in the number of pins that can be used on the chip package and typically a 40-pin d.i.l. is about the biggest practical container for normal use.

Intel faced this basic problem when they were making calculator chips for various designs of calculator unit. It occurred to their engineers, however, that basically all of the systems were the same but the control sequence used in each calculator was different. Since most logic systems can be broken down into a sequence of separate logic operations, a universal logic chip might now be produced where the set of commands to the ALU and control logic was fed in from an external memory. Now the basic calculator or logic operation chip could be standard and mass produced, whilst its action could be tailored to suit the user's needs by supplying the appropriate sequence of instructions from some external memory device. The basic idea of the microprocessor has been born and Intel's 4004 device became the world's first microprocessor chip which could handle 4-bit data words and process them in any way the user desired.

Microprocessors

Recently, microprocessors have been very much in the news and in some circles have taken on the aura of being a kind of magical device which can solve all of our problems. In practice, as we shall see, the microprocessor is nothing more than a very versatile logic element that will respond to a set of external commands to perform a wide variety of logic functions. In essence the device works in virtually the same way as the central processing unit of any digital computer system.

Internally a microprocessor will be arranged more or less as shown in Fig. 82. It consists basically of some control logic, an ALU and a set of registers which connect to two external data bus systems. At any time the signal interconnections between the internal circuits are set up by the control logic in response to the external commands, and the internal circuits can communicate with one another via an internal data bus system. Outside the chip an 8-bit-wide data bus is used to carry data to and from the processor chip. A second bus, usually 16 bits wide, carries address signals from the processor which define the particular external circuit that is to talk to the 8-bit data bus. Usually most of the external circuits are memory arrays and the address bus will select the particular memory location where the desired data is to be found or sent to.

The ALU is perhaps the heart of the processor since it can add or subtract numbers, carry out AND, OR, INVERT and EXCLUSIVE OR logic operations or act as a counter or shift register. This is the versatile logic element. The control logic decodes the command instructions fed in from the external memory and sets up the appropriate operation in the ALU and the interconnections between the registers.

The Accumulator register is used to take data from the external data bus and process it via the ALU, after which the result is held in the Accumulator. A second register, called the Program Counter, keeps track of the memory address where the next instruction is to be found. The Program Counter also controls the transfer of instructions from the data bus into the instruction register, from whence they pass to the control logic for decoding and execution.

An Address register is used to hold the current memory address for any data or instructions that are to be passed from the data bus into or out of the processor. Two other registers may also affect this address signal. One is the Index register which allows the processor to modify the memory address during program execution whilst the Stack Pointer register is used to hold the address of a special area of memory used as a scratchpad by the processor as it executes the program. Finally there is usually a Status register which provides information on the state of play within the processor device. This register can for instance indicate if the result of the last arithmetic operation was zero or negative.

Microcomputers

A microprocessor chip by itself is totally useless, apart from its value as an objet d'art or collectors item. To produce a working system it needs the addition of some memory to hold program and data information and also there must be input-output circuits to allow the device to talk to the outside world. A typical microcomputer system might be as shown in Fig. 83.

To make the system work, a set of program instructions must be written into the memory system and the program counter register is then loaded with the address of the first instruction of the sequence. Each instruction may consist of from one to three 8-bit data words. The first word is always an Operation code which will tell the processor what to do. The second and third words convey the address in the memory where any data needed is to be found or stored. As each of the instructions is executed the Program counter register is updated automatically so that

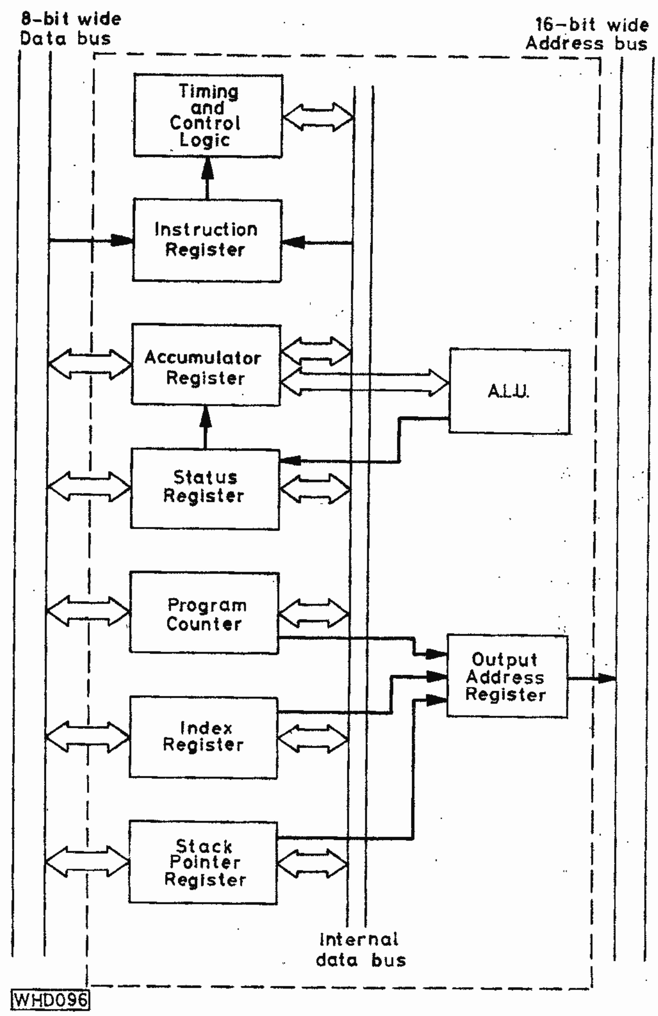


Fig. 82: Block diagram of a simple microprocessor chip

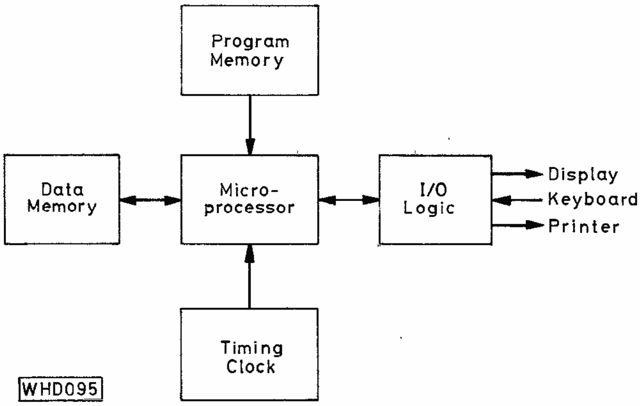


Fig. 83: Block diagram of a typical microcomputer system

it now contains the address in memory where the next instruction to be executed is to be found.

Programming

Perhaps the most important part in designing a system using microprocessors is the process or writing the program of instructions, or software as it is called in computing circles.

Actual instruction codes stored in the memory are just 8-bit binary numbers which represent instruction codes and addresses. Programming in this machine code is difficult and definitely not recommended. To overcome this problem a new language called Assembler code is normally used for writing the programs for a microprocessor. Here each operation code is given a mnemonic name such as ADD, SUB or LDA (Load the Accumulator) and the memory addresses can be given names, such as TEMP, SPEED or SUM.

Suppose we want to add two numbers together. The set of instructions might be;

```
LDA N01    (Load N01 into accumulator)
ADD N02    (ADD N02 to accumulator)
STA SUM    (Store the result in SUM)
```

When the complete program has been written in this mnemonic language it must next be translated into the 8-bit binary words of the machine code before it can be loaded into the microcomputer's memory system for execution. The translation is carried out by a complex program called an Assembler. This translation process may be carried out on a similar microcomputer system or on a full-size digital computer system. Once the machine code data has been generated it may be put on to a cassette tape or written into a Read Only Memory. In the small microcomputer system the program is either loaded from cassette tape into a normal read/write memory or read directly from the programmed ROM in order to make the microprocessor carry out its required operations.

Where the microprocessor is being used as a calculator or computer it is convenient to use a higher level language than the Assembly code. Typical of these are the FORTRAN and BASIC languages used on larger digital computers. In this case our simple addition program is reduced to the statement:

$$C = A + B$$

where A and B are the two numbers and C is the answer. These high level languages also need to be translated. In the case of BASIC this is done by using an interpreter-type program to translate each instruction as it is executed, but FORTRAN is translated to machine code in much the same way as the Assembly code.

Where do we go from Here?

In this series the basic principles of logic have been discussed and some of the applications of these devices to amateur electronic projects have been touched upon. It is to be hoped that the reader will now be in a position to understand how a logic system works and perhaps to follow the descriptions of logic operation in books and articles, though it must be admitted that some books on logic tend to be a bit obscure.

How will microprocessors and LSI affect our projects? It is certain that microprocessors are here to stay and that they will feature in the more advanced amateur projects such as RTTY systems, Morse decoders, control systems and various types of electronic games.

LSI devices are already making themselves felt in the field of amateur electronics. It is now possible to buy a single LSI chip which, with a suitable display, makes a very nice digital voltmeter. The counter and control logic for a digital frequency meter can now be reduced to a handful of LSI chips whilst text displays can readily be produced on the domestic TV screen using a few LSI devices.

Small logic circuits and discrete transistors will not disappear however, and still have their uses in the simpler applications. It's foolish to use a microprocessor when a few simple gates will do the job, unless of course the microprocessor is already in the system somewhere. It's always a good idea to look at the simple approach first before a microprocessor or LSI chip is considered. The problems are all out there waiting to be solved so why not see if you can put those logic chips in the junk box to some good use? ●

SPECIAL PRODUCT REPORT—DM235

continued from page 32

The readout is a full $3\frac{1}{2}$ digit l.e.d. display with 8mm high red digits reading up to ±1999. The digits are bright and well formed giving a good angle of view.

The instrument is well built with most of the components on one main printed circuit board. The two halves of the plastics case are held together by several screws. The display board is mounted onto the main board.

For use in the lab it would make sense to use the a.c. mains adaptor which is built into a 13A plug. This small unit was a shade tight fitting into a standard mains socket but otherwise was satisfactory, and should repay its cost by saving on dry batteries. Rechargeable batteries are also available and can be recharged from the mains adaptor while the instrument is being used.

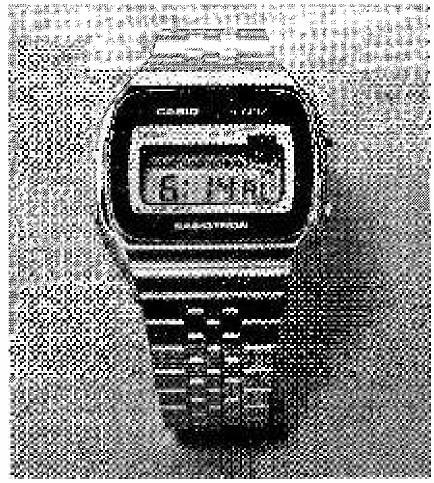
The advantages of a d.m.m. over the conventional analogue type is the unambiguous readings given by the digitial display. Even with a mirror scale such as provided by the Avo 8 type of instrument it is difficult to obtain an accurate reading and almost impossible if you cannot stand right over the scale. The d.m.m. eliminates any parallax error as well as any misreading of ranges or scales. Against this, however, is the comparatively slow scanning rate of the DM235. It can be a little disconcerting for the newcomer to digital meters to have to wait for three or four changes of the display before the true reading is shown. With an analogue meter the reading is instantaneous. Also, if you are used to using your conventional meter to indicate maximum or minimum voltages, such as when tuning a circuit, then the digital readout will be no real substitute, as it is difficult to interpret trends.

However, taken all round the DM235 represents good value for the enthusiast and should prove to be a useful addition to his workshop test equipment.

Dick Ganderton

PRODUCTION LINES

alan martin



High power batteries

A new heavy-duty battery has been added to the range of transistor and high-power types from the Vidor division of Crompton Parkinson Ltd., a Hawker Siddeley company.

The new Vidor battery, which is known as the VT3C, is identical in size to the "small" transistor type currently available. It has been designed for use in portable electronic and electrical equipment and is particularly suitable for heavy-duty applications where sustained high power is required.

Typical applications for the VT3C include calculators, TV games, toys, remote TV programme selectors and small battery-powered domestic appliances.

The new VT3C complements the recently introduced HP7C calculator battery. *Crompton Parkinson Ltd., 50/52 Marefair, Northampton NN1 1NY. Tel: (0604) 30201.*

Alarm watch

If you feel like treating yourself to a really nice present, the Casio Alarm watch (25CS–14B) should fit the bill.

Presented with a superb stainless steel case and strap, the watch displays in the normal time mode—hours, minutes, seconds, a.m./p.m. and day, with a claimed accuracy of ±10 seconds per month.

The calender mode displays day, date, month, year and is pre-programmed until the year 2009.

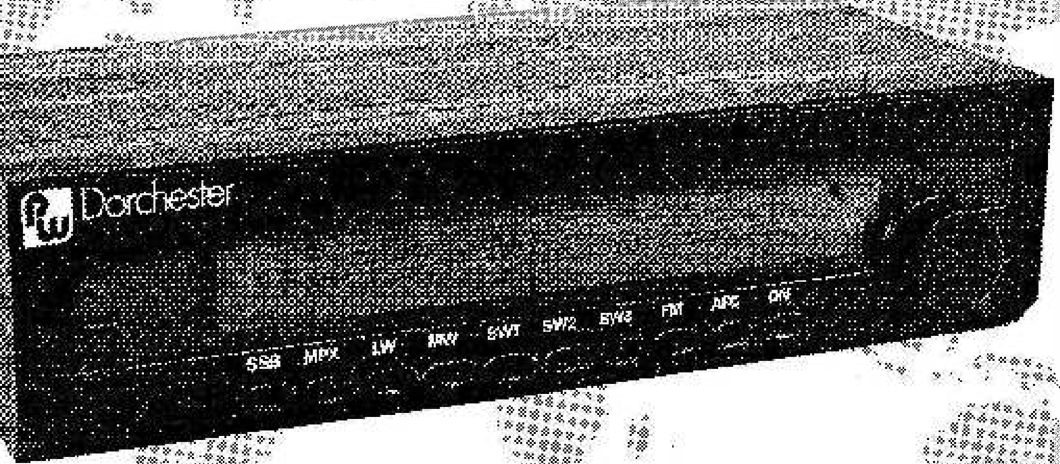
Also the watch features an alarm facility with a rather piercing voice.

Powered by one silver oxide battery (type UCC393) with an operating life of approx. 15 months, calculated on the basis of 5 pushes of the light button per day for 1 second duration each, and the alarm running for 60 seconds.

The recommended retail price is £74.95, but Tempus offer the watch at a discounted price of £59.95 which includes VAT. *Tempus, Dept. PW, 19/21 Fitzroy Street, Cambridge CB1 1EH. Tel: 0223 312866.*

Dorchester

PART 3



ALL-BAND TUNER

W. S. POEL

This part deals with the extensions and accessories that you may wish to consider in connection with the "Dorchester" tunerboard, some of which are likely to be methods of housing, powering and tuning the receiver, in a manner which will not disgrace your sitting room.

The case housing the Author's unit was modified from parts used for a commercial design which is no longer produced. In this way, a professional standard of presentation, with a neatly sculptured front panel and proven mechanics were available instead of the usual combination of folded aluminium and Dymo tape.

The basic mechanical layout of the prototype is given in Fig. 11: subsequent versions had the chassis deepened slightly to accommodate the tuner with a little more ease. An extension shaft is required which is fitted to the tuning capacitor spindle and held rigid by means of a bush mounted on a bracket.

The tested tuner board—remember not to expect a completely un-tried unit to work first time, no matter how carefully you may have constructed it—is fitted to the base plate by means of pillars mounted in the bottom of the chassis. The Author prefers spacers which are designed for use with self-tapping screws so that the pillars are fixed down independently of the tuner board. The approach whereby the bolt is simultaneously passed through a pillar and fixed through the p.c.b. is usually frustrating and tedious to perform.

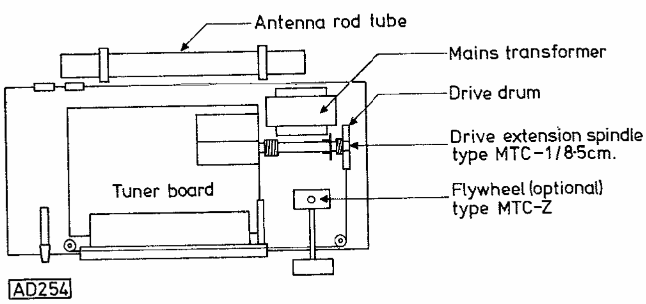


Fig. 11: Mechanical layout of the tuner

Tuner Power Supply

This unit (Fig. 12) is simply a mains transformer, followed by a rectifier and three-terminal voltage regulator from the 7812 series, or the SGS TDA1412. Radio frequency interference from this type of regulator needs to be suppressed with additional filtering circuitry, so note the extra decoupling.

The current-handling capacity of the power supply needs to be about 150mA—but in the prototype, a degree of headroom has been left, so that the illumination of the meter and tuning scale may be included. Before you consider attaching any sort of audio power amplification to the tuner supply, make absolutely certain that there is sufficient reserve to prevent the voltage from falling below the minimum at which regulation takes place.

Where a steel chassis is used, it is desirable to mount the ferrite rod antenna on the back panel (outside) or the efficiency will be greatly impaired. There are various methods employed in commercial designs, the most elegant of which is to mount the rod in a non-ferrous tube on some form of infinitely-adjustable pivot so that the angle may be adjusted to the user's requirements. A long wire antenna coupled to the rod tends to reduce directional effects and can be the conveyor of problems arising from one of the many thousands of sources of r.f.i. This design makes a simple approach, using proprietary parts and tubing—since it seems the more intricate mechanical arrangements are exclusively customised to individual manufacturers' specifications.

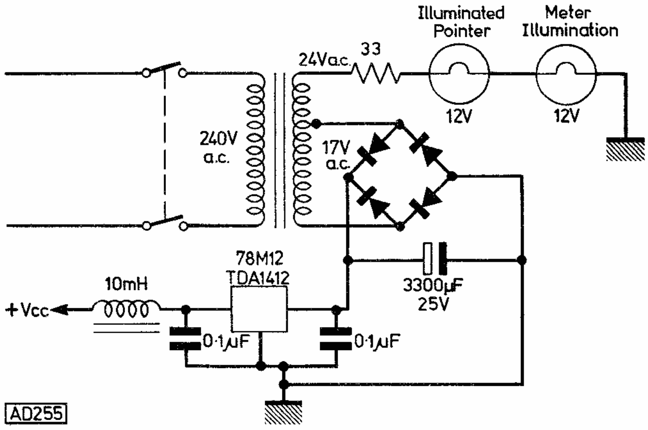
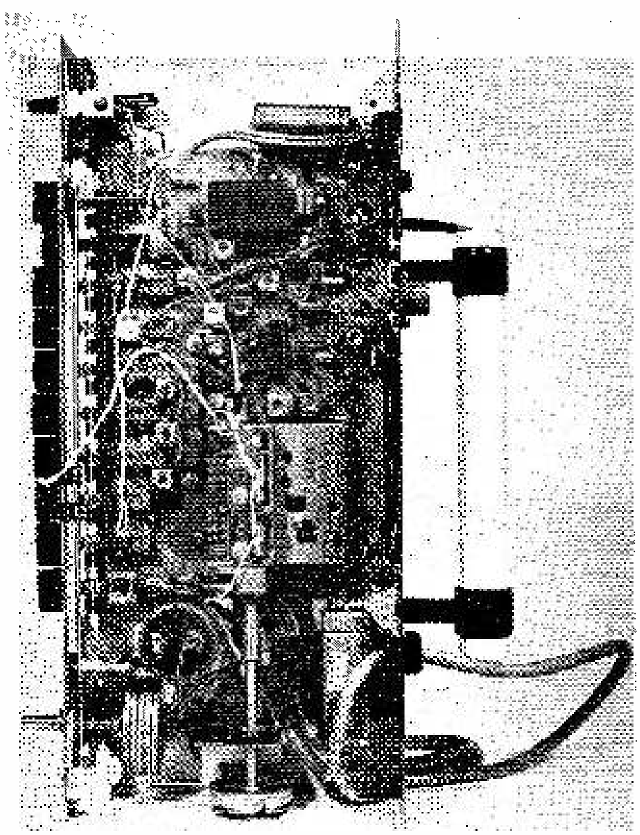


Fig. 12: Power supply arrangements

In stretching the wiring feeding the ferrite rod, the possibility of extraneous pickup on the coupling leads has been greatly increased, so this wiring must be tightly wound and kept to an absolute minimum. It is not feasible to use fully screened connections of this length, since their additional capacitance would restrict the necessary bandwidth.

Remember to secure the coils on the rod when you have adjusted them. This should be carried out whilst the rod is in place at the rear of the chassis, since the presence of adjacent metal will tend to modify the aerial tuning characteristics somewhat.



A view of the completed unit prior to the outer case being fitted

Coverage and Sensitivity

In the Author's prototype, SW3 was restricted to a maximum of approximately 22MHz. In this way, the main broadcast bands are given a bit more spread on the dial. No modification of the circuit is necessary, since the adjustment is simply carried out using the trimming adjustments of capacitors and tuning slugs.

A preselector is frequently suggested for use in conjunction with receivers that are to be fed with nondescript antenna arrangements and have broad coverage—and before considering a suitable design here, it is very important to bear in mind that gain and h.f. receivers are not necessarily the best of companions. Certainly everyone likes to think their set can resolve s.s.b. below 1μV, but then, there isn't much point if the set overloads when another station a few kilohertz away flattens the whole thing with a 1mV input!

The basic tuner has excellent sensitivity for a unit of this type—a broadcast transmission receiver, first and foremost. An antenna of some twenty feet in length proved to be more than adequate, so before getting carried away with antennae it must be borne in mind that some selectivity in the tuner is called for, to limit cross-modulation of the mixer by strong adjacent channels.

The average casual listener usually has a length of wire for an antenna, and as far as receiving is concerned, this can be turned into a beautifully affective and versatile arrangement with a simple pi-network tuner. Various designs have been featured over the years (Fig. 13 shows two examples) and so we will not go into too much detail here. By switching coil taps at various positions along an inductor, almost any piece of wire can be tuned to resonance at h.f. Wires that are much shorter than a wavelength tend to exhibit a high impedance—and the pi-network is one of the best ways of matching.

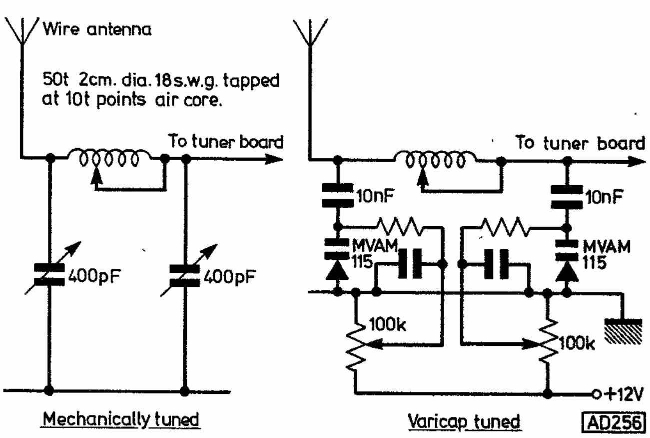


Fig. 13: Typical pi-network aerial tuning arrangements with (left) ganged variable capacitor and (right) varicap diodes

If you still want more gain with your tuner, then the circuit of Fig. 14 is suitable, but remember that the gain control is not merely an adornment, but a necessity—since the preselector may be used as a tuned attenuator when things get out of hand simply by backing-off the gain control.

If you are a keen s.w.l. then a digital frequency-readout is a virtual must these days. The recently-published PW design will readily suit this receiver. Take the oscillator from pin 20 of the i.c.—or by f.e.t. buffering from the oscillator section of the tuning capacitor.

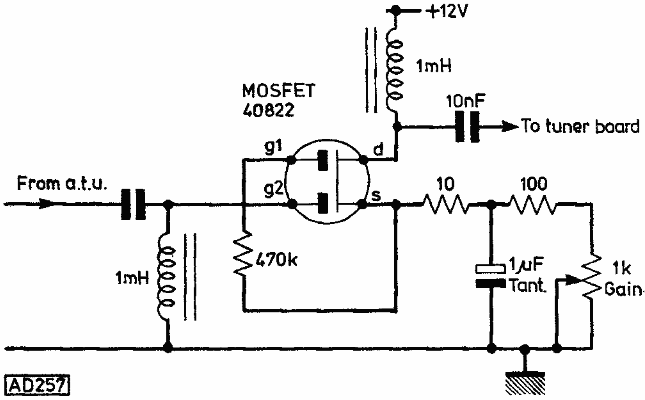


Fig. 14: R.F. pre-amplifier

Audio

Some readers may wish to include audio amplification within the tuner—and the many i.c.s that exist to fulfil this requirement scarcely need additional comment here. However, there is one point to watch, and that is the almost universal tendency of such amplifiers to exhibit h.f. oscillation at their output. Remember to decouple the power supply carefully—and feed the loudspeaker/headphones using screened audio cable, taking care to follow manufacturers' recommendations concerning Zobel networks, ferrite bead suppressors, etc. The high gain of the tuner makes it susceptible even to quite low levels of spurious radiation that most applications could quite easily ignore.

The question of using the tuner in a portable configuration was briefly discussed in the first part of this article. The main i.c. consumes a fair amount of current for this application—especially in the a.m., mode; but in f.m. the consumption reaches around 23mA, with another 12mA for the tunerhead. This is not necessarily unreasonable by modern standards, and indeed, many of the larger portables have a much higher consumption.

Thus the unit makes the basis of a very fine portable. The really superfluous part of the circuit would then be the stereo decoder, for however desirable the idea of a stereo portable may seem, it is usually a wasteful extravagance. In units incorporating mains/external 12V options, the decoder arrangement should be locked out when the internal batteries are used. All scale lighting functions should be wired so that they only illuminate on the operation of biased switch or pushbutton.

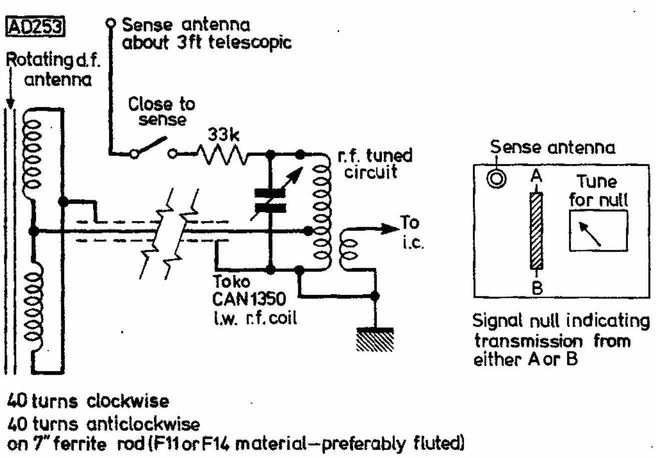
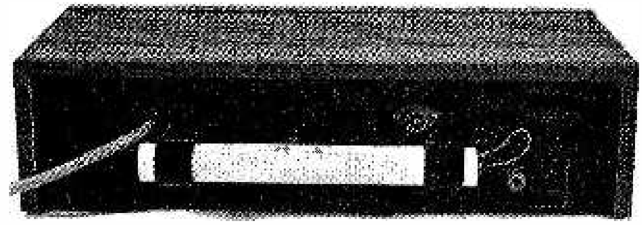


Fig. 15: Typical arrangements when direction-finding facilities are to be incorporated

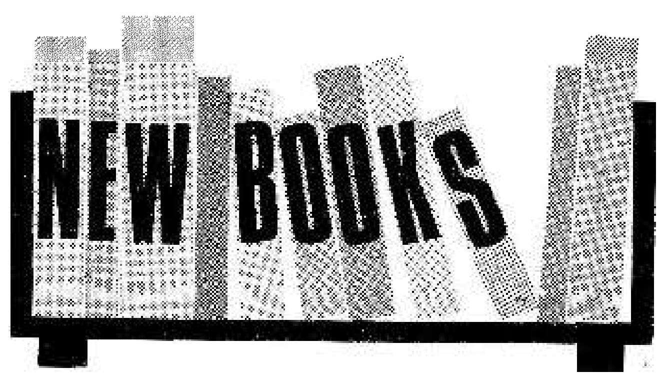


A rear view of the Dorchester showing the ferrite rod aerial and other connections

The question of direction-finding has recently been raised, and since the nautical and aero transmissions are located in the only section omitted from the standard broadcast range of 175kHz to 30MHz (250–400kHz approx.) one of the s.w. bands has to be sacrificed if the facility is to be accommodated. This will probably be SW3 and oscillator coil is changed for a 632µH DF band type. The antenna coil is also changed, and a second ferrite rod antenna for the DF band fitted—or, as an alternative, the "loopstick" arrangement used to permit sensing of the rod position relative to the transmission (Fig. 15).

The tuned circuit for DF is then the l.w. r.f. coil, with the DF rod coupled to the tap.

Work on DF applications is far from finalised as yet, but if sufficient reader-interest is apparent, then further developments will be published at a later date. ●



ELECTRONICS—an elementary introduction for beginners
by L. W. Owers
Published by Talbot House Press
Freeland, Oxford OX7 2AP
119 pages. 209 × 149mm. Price £2.95

This book sets out to give a broad introduction to the subject of electronics, providing a background for more advanced study. This is achieved well, starting with the discovery of electric charge and ending with semiconductors.

Moving away from electrostatics into the realm of moving charges and conduction we meet resistors, capacitors and inductors, progressing through valves and the cathode ray tube into semiconductors and the doping of semiconductor materials to form transistors and integrated circuits.

The whole book is well illustrated with some excellent diagrams which are available as 35mm slides for teaching purposes.

KA

ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

The business of listening on the amateur bands ought to be more than just a matter of entering long lists of stations in the log. After some months it will become apparent that there is a definite pattern to the times at which stations in different parts of the world appear on the various bands.

I have mentioned this before as a means of understanding the mechanics of the propagation of radio signals in connection with the 11-year sunspot cycle. However there is another aspect which should not be overlooked. Since none of us have unlimited time to spare listening or working on the air, it is essential that the time we do have available is well-spent.

The newly-licensed amateur whether a G4 or a G8 is going to waste an awful lot of time if the optimum band or mode is not chosen as a result of experience gained as a listener. The tyro may call CQ for hours without a reply on a dead band or use the wrong mode for a particular part of a band.

On the h.f. bands a note should be kept of prefixes and when they are heard, at what time and which band, to build up a picture over a year or so. If a band is found to be dead then note it and check all bands if possible, whenever sitting down to listen.

For the listener who is able to copy c.w., check the c.w. end of each band as it is strange how often there is activity there when the s.s.b. part is comparatively dead. In contest work the listener and the transmitting amateur can perform much more efficiently by choosing the right band to work on at any given time. In days gone by I would always watch the bands for a couple of weeks before a big international contest just to get the feel of them, noting when the more elusive countries and prefixes were coming in well, band by band.

Then an operating schedule was compiled of bands against time for 24 hours thus giving two "windows" for working a particular DX station in a 48 hour contest, all aimed at reducing unnecessary operating to a minimum. This resulted on one occasion in being able to work 99 countries on c.w. in a weekend contest using all bands from 3·5 to 28MHz.

It will be noted that occasionally signals from the west coast of the US and from VK are audible in the early morning and late afternoon due to short and long path propagation, thus doubling the possible openings for working or copying stations in these areas.

On the Bands

In spite of our most welcome Indian summer the change to winter conditions has gone on apace on the h.f. bands, exemplified by reports from readers such as **Ian Marquis** A9140 of Leigh-on-Sea, Essex, who copied CT2, EA6, EA8, JA, VP2 and 9K2 on 80m s.s.b. Ian's FRG-7 and long wire also found the extremely rare Willis Island in the form of VK9ZM on 20m, in the DX Net on 14 265kHz. 15m revealed another new country in KV4KV/D on Deception Island, plus W0DX/D on c.w. on 10m, part of the same set-up there.

Richard Smith in Porthcawl, S. Wales, has forsaken his old and trusty t.r.f. set for a KW77 and is particularly glad to find it incorporates a crystal calibrator. He plans to put a 2m converter in front to get the feel of the v.h.f. world before he takes his RAE in the not too distant future. Richard found a 5Y3 and 7X2 on 80m so let's hope this is a sign of more good stuff to come from that direction. African activity has always been low on the l.f. bands due to the high level of static experienced there. It's something that has to be experienced to be believed!

SSTV has captured the imagination of **Simon Robinson** in Stocksfield, Northumberland, and now G8POO. Using an MK Electronics monitor he has seen DL, OZ, I, EA and OK stations, using a 10in diagonal c.r.t. The only call of interest on 10m s.s.b. was JW7FD on Bear Island.

Rod Hunt (Darlington) sticks with his t.r.f. rig and to date has logged over 80 countries on it, mainly on 21 and 28MHz. The latter band has come up with DX such as JW7, ZP5, with 21 producing EA0, HP0, ZB2DV (G4EMR on holiday!), ZL1, 3D6 and 9J2. Rod has started his own RAE course and is not neglecting to get some practice in on the key, while a G3 "on the other side of the hill" is giving advice and assistance.

Loft aerials for **Bob Bell** in Blyth, Northumberland, means sloping tubular ones with coils to load to a particular band but due to the awkwardness of the set-up it's all likely to finish up in the garden very soon! Bob found PY0EG on 20m s.s.b. and an early morning session provided VK7, not heard too often, ZL4 and VK5.

Not a very exciting month for **Bill Rendell** of Truro but KG4KG in Guantanamo Bay is a rare bird on 20m s.s.b., with KC6GF a good find. Bill also intends dumping his attic aerials and getting something up outside. **Allan Stevens** is still plugging on with his *PW* direct conversion set plus PR40 preselector and has notched up 81 countries so far including excellent find VR6TC on Pitcairn, a real rarity.

In Oswestry, Salop, 14-year-old **David Wyatt** has moved to the amateur bands with his home-brew 4-transistor superhet plus audio amp and b.f.o. Prefixes like HH and HP and another KG4 aren't bad on 20m but an AR88 is in the pipeline. **John and Steven Goodier** have been struggling over the rig trying to decide on BC or amateur bands and I'm glad to report that the latter has won the day! Reports to follow regularly now, I gather. They've been looking for LU3ZY on South Sandwich but no-one seems to have heard them yet. J and S have an FRG-7 and 30ft wire so it can't be the rig.

With the Clubs

Barking Radio & Electronics Society is on a recruitment drive and meets, wait for it, FOUR nights a week, Monday to Thursday. Morse classes Tuesdays and main club night Thursdays, all at 1930. Stations G3XBF and G8GPK are active on h.f. and v.h.f. but club activity tends to favour v.h.f. at the moment, hopefully to be redressed very soon! So pop along to the Westbury Recreation Centre, Westbury School, Ripple Road, Barking, Essex some time or contact Sec Nick Dowsett G8PUY, 44 St Ann's, Barking, Essex.

Every Tuesday sees the **Bury RS** hard at work at Mosses Centre, Cecil Street at 1930 onwards with RAE classes at nearby College of FE. 9 Jan has G2BTO on TVI and the Amateur, with G4CLF holding forth on the SL600 series of i.c.s on 13 Feb. The subject on 13 March is v.h.f. linear amps with G8NOF covering Orbiting Satellites on 10 April so there's plenty to look forward to at Bury RS. Write to Eric Thirkell G4FQE, 59 Oulder Hill Drive, Rochdale.

It's all go, down with the Wessex AR Group with a proposal to revert to the old title of the Bournemouth ARS, similar to the society that was first formed there in 1922. As an outsider I heartily approve! Don't like changes that cause a group to lose its identity! Meetings are held at the Dolphin Hotel, Holdenhurst Road, Bournemouth at 1930 hours. Friday 19 Jan sees G2YH talking and demonstrating miniature v.h.f. transmitting devices while 2 February is devoted to "Planning and Preparation for HF and VHF Contests". Note new QTH of Sec/Editor Geoff Cole G4EMN 3A Cavendish Road, Bournemouth or ring 20027.

Log Extracts

R. Bell:—20m PY0EG **20m** VK7AZ **15m** JR3IIR

S. & J. Goodier:—20m CE0AE HK0QA (San Andres) KG6SW KJ6BZ VK2AGT (L. Howe Is) VK9ZM (Willis Is) VK9ZR (Mellish Reef) VP2EEK VP2GVI VP5BD VR6TC ZK1CV

D. Wyatt:—80m VO1FG **20m** CT2CB HH2SD HP1XDN KG4EP

A. Stevens:—20m JW7FD (Svalbard) VE8RCS VK7AZ VR6TC WA4YUG/VQ9 (Diego Garcia)

W. Rendell:—20m CT2BQ HR1JAG KC6GF KG4KG VK7AE VP2AW **15m** C5ABK HV3SJ KZ5BA ZB2DV **10m** CT2SH HK4DF

I. Marquis:—80m CT2QN EA8CR JA6BSM VP2SD 9K2IX **20m** PJ8CO VK9ZM VP2VER **15m** EA9EO JW7FD KV4KV/D (Deception Is) TA1DF **10m** EP2SL FG0EID/FS VS6FE W0DX/D (Deception Is) YJ8KM

R. Smith:—80m 5Y3GT 7X2DG **40m** EA8CR **20m** CT3AC S79MC VP8PF **15m** AP2KS **10m** EL2AG

S. Robinson:—SSTV 20m DL6HP OZ2ARD I2II EA2JO OL7VI **10m** JW7FD

R. Hunt:—15m EA0NS HP0ED ZB2DV 3D6BP **10m** JW7FD ZP5AO 9K2DR

All s.s.b. unless indicated otherwise.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

This is the time of year to listen to North America on the medium waves. Although reception is possible at any time of year it is in the winter when the nights are long that one can pick up a few local broadcasts from across the Atlantic before going to bed. Listen between 2300 and midnight, as European interference begins to subside for CKVO in Clarenville, Newfoundland on 710kHz, CJYQ in St John's, Newfoundland on 930, WINS in New York City on 1010 and WNEW also in New York on 1130. These are but a few of the many North Americans that can be picked up in the UK when conditions are favourable but be careful. All transatlantic signals are subject to slow fading and it is very easy to pass over quite a strong signal that is temporarily in the minimum of a fading cycle. So tune carefully and slowly. The path is not always open and fadeouts do occur at times so if you are unsuccessful at first then try again a few nights later.

North American Medium Wave Stations

There should be no problem identifying North American DX, for nearly all broadcasts are in English and all, without exception, are issued with callsigns which the stations are obliged to use when they identify themselves. In the United States the callsigns are either of four or three letters which begin with a W or a K. For example, WINS is the call of the station on 1010kHz located in New York while KDKA on 1020 is in Pittsburg. Similarly in Canada where the prefix is C, or V in the case of a few outlets in Newfoundland.

The station separation in North America is 10kHz instead of the 9kHz we have in Europe and each channel is also a multiple of 10kHz which means that the band is divided up into 107 "channels" starting at 540kHz and ending at 1600kHz. It is a lot easier to use kHz instead of metres when dealing with North Americans and receivers in that part of the world are often marked from 54 to 160, i.e., with channels 54 to 160.

North Americans are usually good verifiers, that is of course if you send them an accurate reception report. The time to gather material for the report is just before the hour and the half hour when commercials (jingles),

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

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

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

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

weather reports, news items and station identification takes place. The reports themselves should be sent to the chief engineer of the station and the address should include the call letters of the station and the town or city mentioned in the announcement. For example, The Chief Engineer, WNEW Radio, New York City, NY, USA will certainly find the station on 1130kHz.

Loops and Aerials

Although the standard 40in box loop has a single turn for the coupling winding it is worth experimenting a bit to find out what suits your particular receiver best. This point is highlighted by **Harold Emblem** (Mirfield) who tried the effect of using two turns instead of one with a Layfayette HA63 receiver a few years ago. The two turns gave much better results with this receiver. Harold thinks it is worthwhile trying a second turn to see if there is any significant improvement and also the adjustment of the position of the two turns is worthwhile.

Shortwave DXer **J. F. Porter** of Belfast would like to listen to some medium wave DX and he wonders if a ferrite rod aerial could be used as a substitute for a loop. The pick-up of a ferrite rod aerial is really too small for serious DXing. I have played about with ferrite rods (see July 1978 *PW*) and they can be useful for semi-DX but this is really the field for someone who likes experimenting rather than hearing DX. There is nothing wrong with an FRG-7 plus Joystick or 100ft long wire for m.w. DXing and if you want a substitute for a full size loop then try Bob Bell's half size loop (Nov. 1978 *PW*).

Beacons

Although the medium waves are supposed to be used exclusively for broadcasting there are a small number of navigation beacons that operate inside the band at the low frequency end. In answer to **E. C. Adams,** this is probably what you are hearing around 460 metres. Navigation beacons have callsigns which are repeated in Morse and the majority of them operate on the long waves on frequencies between the long and medium wave broadcasting bands. The third harmonics of some of these beacons occasionally appear on the medium waves to cause QRM with broadcasting stations and to mystify the DXer. Sometimes these harmonics can travel a considerable distance, much farther than the fundamental. For a number of years, using several different receivers, I have picked up the call SW (··· ·——) on approx 930kHz while listening to CJON (now CJYQ). There is an SW on 310kHz situated at the Cabo de Santa Marta Grande lighthouse on the north-west coast of Brazil which transmits with a power of 0·5kW (fundamental) and it is interesting to speculate whether it really is the tiny third harmonic of this beacon that we hear as QRM on CJYQ.

Readers' Letters

A number of interesting loggings of stations in the USSR come from **Bob Bell** in Blyth who uses an FRG-7 receiver and a mini (half-sized) loop. These are Kharkov on 836 (837), Stavropol 881, Arkhangelsk 908, Tallin 1034 (1035), Yoshkar Ola 1061 (1062), Baku on 1295 and an unidentified station on 1525. The frequencies are pre-Geneva Plan and those in brackets are the new ones where known. The station on 1525kHz may in fact be in China even though the language was Russian and there is often jamming to be heard on this unauthorised channel. Bob is willing to supply information and to advise anyone who is genuinelv interested in his half-size loop. Letters should go direct to Bob at 5 Byron Avenue, Blyth, Northumberland NE24 5RN with, I would hope, a stamped addressed envelope for a reply.

News of Manx Radio comes from **Douglas Gibb** (Selkirk) who heard their test transmission on 1368kHz last September. This local station is now full-time on the new frequency and the 219 Times gives details of their broadcasts. It is available from Manx Radio, Broadcasting House, Douglas, IOM which is also the address for reception reports. Manx Radio will QSL by return.

Some countries are easier to hear on the medium or long waves than on the short waves and this has been noted by **David Wyatt** of Oswestry who logged Radio Andorra on 710kHz. He received a QSL in three weeks in answer to a report made out in French. On the long waves he picked up Radio Algeria in English on 251kHz at 2025, another country he had not been able to hear. The receiver in use is a 1947 Kolster Brande BR20 and a 90ft long wire. These older domestic sets often perform very well on the medium waves especially when used with a loop. Why not try this before looking for another receiver; it is possible to use low impedance phones in place of the loudspeaker. Be careful though to keep away from the chassis which may be live.

Sweden Calling DXers is now on a second frequency on the medium waves as the transmitter at Gothenburg on 991kHz has been allocated to the foreign service during the evening according to a station announcement. A final item from **Ian Rennison** (Horsham) who has logged Radio Paradise, St Kitts on 1265kHz at 0014, details of receiver, etc., not given.

SHORT-WAVE BROADCASTS

by Charles Molloy G8BUS

The majority of short-wave receivers tune from 6MHz to 18MHz, a range which includes six international broadcast bands. These are the 49 metre band (6MHz), 41m (7MHz), 31m (9MHz), 25m (11MHz), 19m (15MHz) and 16m (18MHz). There are also the 13 metre band (21MHz), the 11m band (26MHz) and the 75m band (4MHz) which are within the range of some receivers. It is traditional to quote a band by its wavelength in metres and the individual station within the band by its frequency in kilohertz (kHz) but there is a trend these days to refer to a band by the frequency in megahertz (MHz) and this is the figure shown in brackets. The 49m band for example can also be referred to as the 6MHz band. The relationship between MHz and kHz is quite simple. 1MHz is the same as 1000kHz. Radio Nederland is on 6020kHz in the 49m band but it may appear on 6·02MHz on some receivers.

Short-wave reception is entirely by means of the sky wave, which is reflected by the ionosphere many miles above the surface of the earth. The sky wave is influenced by the amount of daylight between transmitter and receiver. The more daylight the higher the frequency that may be used. DX is possible on the highest frequencies during the day and on lower frequencies after dark. Short range reception is on lower frequencies by day and either 75m or the medium waves by night. In general, the frequency in use over any particular path will be higher during the day than after dark. In order to help beginners to find their way about the different bands it might be useful to have a look at each one in turn to see what sort of DX can be found there, starting this month with 25m.

25 Metre band

The 25m band has official limits of 11 700kHz to 11 975kHz, though in practice stations are to be found between 11 600kHz and 12 100kHz. There is something to be heard on 25m at any time of the day or night or during any season of the year and for that reason it is a good place for the newcomer. Last autumn the Radio Japan relay in Sines Portugal could be heard on 11 825kHz from 2200 to 2230, but after sign-off the much weaker Voice of Free China in Taiwan could be heard in English in its place, so always investigate weak signals.

During the day, look for distant broadcasts from Radio Pakistan on 11 640kHz, Radio Australia 11 760 and 11 900, Madagascar 11 730, Bonaire 11 790, Kuwait 12 085. Medium range stations that can be heard are Vatican Radio 11 740, Finland 11 755, Spain 11 815, Austria 11 855, Norway 11 865, Budapest 11 910, Greece 11 925 and Bucharest on 11 940. Latin America appears on 25m during the evening. Look for Radio Guaiba on 11 785, Radio Globo 11 805, Pernambuco on 11 865, all of them being in Brazil, and Radio Habana Cuba on 11 760. Other DX that may be heard at this time are WFYR Family Radio USA on 11 805, ELWA Liberia 11 835, Canary Islands 11 880, Radio Bamako in Mali on 11 960 and Radio Abidjan Ivory Coast on 11 920. Broadcasters on the short waves often move around and some of the frequencies mentioned may change but the list is typical of what a DXer may hope to hear without too much difficulty on the 25m band.

Readers' Letters

Sean Stray of Market Harborough (details of receiver and aerial not mentioned) reports some useful DX heard during his recent half term holiday. Radio Japan is a regular on 21 535kHz in the 13m band between 0800 and 0830. The signal is weak but clear of interference but a curious echo effect was observed, probably the result of propagation along different paths through the ionosphere. Radio Nacional Argentina was logged on 11 715 in the 25m band at 2320 and the address for reception reports is RAE Ayacucho 1556, 1000 Buenos Aires, Argentina. Riyadh in Saudi Arabia was picked up at fair strength at 1930 the address to write to being Ministry of P and T, Riyadh, Saudi Arabia. An unidentified with the call Radio Tinian (not Tirana) was heard on the 25m band at 2145. Has anyone any ideas on this?

A signal like a short burst of machine-gun fire is reported by **T. M. Headley** of Seaford in Sussex who has started listening on the short waves again after an absence of many years. This is over-the-horizon radar which can be heard all over the short waves and was the subject of international complaints to the USSR a year or two ago. A Sanyo RP8700 portable communications receiver which was a present from USA is in use by 13-year-old **Paul Cox** of Twickenham. When used with a 70ft long wire this rig pulled in Delhi on 11 740 at 2125 SIO 544, Radio Kuwait 12 085 at 1940 SIO 544 and Radio Japan on 17 820 at 0715 SIO 344. From Walsall comes another report of reception of R. Japan on 17 820 from **Craig Kelly** who used a t.r.f. receiver and 75ft long wire. Craig asks for identification of a station playing guitar music but he forgot to mention the frequency or band concerned. Requests for identification should contain as much detail as possible including the frequency, date, time and station announcement and the language used.

Tropical Bands

From Blyth in Northumberland comes an interesting log compiled by **Bob Bell** using his FRG-7 and home-made vertical antenna. On the 60m band he heard USSR (unid) on 4775kHz at 0255, Radio Lara Venezuela on 4800 at 0300, Radio Luz y Vida in Ecuador on 4800 at 0405, plus Radio Nacional Canaries on 11 880 in the 25m band at 1400. A Vega 206 plus 20ft outdoor aerial are in use by **Bill Stevenson** who heard Radio Yaounde Cameroon in French on 4850 at 0430 SIO 333, Radio N'Djamena Chad also in French on 4905 at 0430 sign-on SIO 333 and Radio Nigeria in English on 4990 at 0430 SIO 333, all on 60m. Bill has built an r.f. pre-amp for use with his receiver but it does not give good results. The symptoms are of overloading. Bill would be interested to hear from other Vega 206 users. Replies direct to him at 10 Crompton St, Swinton, Lancs.

Reception Reports

A DX Press Release from Radio Finland makes disturbing reading for the DXer. This station has stopped using QSL cards. In their place there will be audience cards with a different card for each month of the year. The new cards will not confirm the date, time or frequency and will therefore only be an acknowledgment of the listener's letter.

The reasons for the change are interesting. Radio Finland gets about 300 reception reports a week and to quote the press release "you could say we were keener to receive programme comments". Of course, if they stop issuing QSLs then they may not get any reports at all and a better policy surely would be to restrict QSLs to reports that are of real value to the station. None-the-less the point of view expressed by Radio Finland is a valid one. A short-wave station transmits a programme for its audience to listen to rather than a signal for DXers to pick up and DXers should bear this in mind when writing to a station. Perhaps if DXers were to include comment on the programme heard and how it compares with other stations, which apparently is what Radio Finland wants, in addition of course to the reception reports, then everyone would be satisfied. The "powers that be" at Radio Sweden, according to a recent broadcast from that station, feel they have few listeners but many DXers for an audience and this might be a prelude to another attempt to cut back the popular Sweden Calling DXers. Radio RSA has reduced its English transmission and cancelled its DX Corner, so abruptly that the editor Gerry Wood did not even have the chance to say goodbye. The future for DXers does not look too good at the moment. On a lighter note, A DXer who recently sent a report to a Middle East country received the reply "Don't you have radio in your country, why you listen to ours?".

by Ron Ham BRS15744

What more could we v.h.f. addicts ask for than a new amateur satellite to play with, the 10m band alive with signals from all parts of the world, a tropospheric opening which sent the amateur and broadcast bands haywire, and all between mid-October and 18 November?

The 10 Metre Band

How often the new recruits to amateur radio must have heard the old hands reminiscing about the great 10m openings of the past. Well, hopefully, those good times are here again, but now, thanks to the RSGB, we have the International Beacon Project going well and it is almost a daily occurrence to hear strong signals from the beacons in Bahrain A9XC, Bermuda VP9BA, Cyprus 5B4CY, Florida N4RD and Germany DL0IGI indicating the best DX path to use.

Like many other clubs and individuals throughout the world, the Mid-Sussex Amateur Radio Society entered the CQ World Wide contest on 28/29 October from their club shack in Burgess Hill. During the event the operators, G3JMB, WPO, WYN, ZYE, G4GNX and HHB, worked almost 500 stations and more than half of these were on 10m. Afterwards, G4GNX said that conditions were so good that around 1800 on the 28th they worked 60 Ws in 45 minutes, and at 0730 on the 29th they had 16 contacts with JAs in about 20 minutes. Throughout the contest good signal reports were exchanged with stations all around the world, and **N. Clarke** BRS 34306, Knottingley, Yorks, logged all W call areas within one hour.

While **John Branegan** GM8OXQ, Saline, Fife, N. Clarke and myself kept a daily watch on the IBP signals and found that A9XC was the most consistent, closely followed by 5B4CY, DL0IGI, N4RD and VP9BA. **Graham Lay,** West Chiltington, **Alan Baker** G4GNX, Newhaven and **Ian Rennison,** Horsham, all in Sussex, listened to the world-wide DX on 28MHz. Ian also mentioned the very strong American CB signals he heard in the 27MHz band, especially on 21 October.

Solar Activity

Although the sun has been "quiet" at 136MHz compared with the same period in 1977, a few small bursts of solar radio noise were recorded on 6, 7, 8, 11 and 13 November by John Branegan, **Cmdr Henry Hatfield,** Sevenoaks, **John Smith,** Rudgwick, Sussex and myself and, on 6 and 13 Nov., Henry saw several filaments on the sun's disc with his spectrohelioscope.

Satellites

John Branegan has completed a 6-month survey of 70cm propagation from space, based on the signals from OSCAR-8J and says "Not only is OSCAR-8J affected by propagation disturbances both in, *and way above,* the normal E and F regions, all 70cm satellites are affected. Attenuations of up to 20dB (not due to polarisation rotation) seem to occur regularly in two regions of the world. The most noticeable are the Denmark Strait between Iceland and Greenland (i.e. between us and the magnetic pole) and over the equator in the South Atlantic". So far he cannot correlate these effects with solar disturbances but there is, writes John, "A positive correlation with time of day, the equatorial disturbance being most marked in the evenings".

For about 20 minutes at 1258, on 27 October, John heard the Russian amateur radio satellite, RS-1, come up over North America, heading east, and pass between his QTH and the pole. The satellite appeared again at 1502 and John accessed it on 145·890MHz (Down link 29·370MHz), called CQ and immediately a c.w. station answered, so excited that he sent John's call sign six times and forgot his own! The next pass was at 1708 when John had a good five-minute QSO with G3IOR. On the 28th he had his first transatlantic QSO via the new bird with W2BXA in New Jersey, followed by contacts with DC9II and DC9ZP. During the same orbit 5 GMs were in QSO with European stations and, that afternoon, a delighted GM8PSM made his first contact outside the UK via RS-1.

Microwaves

The two Erns, G8BDJ and G8GKV assisted **Mitch Tribe** G8PMT, Worthing, a newcomer to 10GHz activity, to contact four QRA locator squares on Sunday morning, 12 November. While Mitch set up his equipment, with a 60cm dish aerial, on Chanctonbury Ring, a high spot on the South Downs, G8GKV, accompanied by **Matthew Walton** a keen SWL and student of microwave activity, took his gear to other high spots in squares AK, AL and ZL. G8BDJ made the QSO with Mitch in ZK. Conditions were good and all contacts were 59. During the morning both G8BDJ and G8PMT heard the Isle of Wight beacon, GB3IOW on 3cm, and were later joined by G3JHM to make arrangements for future tests on the band.

Tropospheric

On 18 October, the atmospheric pressure rose rapidly from 30·0in to 30·4in, and with a few fluctuations it remained high until 12 November when it dropped back to 30·1in. This high pressure, coupled with mild and fine weather, frequently upset the v.h.f.s between 27 October and 12 November and as usual, our readers were both active and observant. At 2237 on 27 October, Alan Baker worked G8FRB/P near Derby on 2m s.s.b. and during the evening of the 28th, Belgian stations were working through the Dover repeater GB3KR, R4. While continental broadcast stations were audible in Band II on 28, 29 and 30 October, I frequently received strong pictures from the IBA transmitter at Lichfield, 189MHz, with a dipole aerial. Between 1900 and 2000 on 5 November, **Dermot Cronin** G4GRO, Royal Sovereign Light, heard 2m s.s.b. signals from DM, HG, OE and OK and at 2057 **Ken Smith,** Horsham reported patterns on u.h.f. TV. On the 9th both Ken and Ian Rennison heard continental stations in Band II and Alan Baker heard DL3HB and worked F6EVL on 2m c.w. At 0044 on the 10th, Alan, behind 400ft of chalk had a QSO with G8FUE in Somerset on 2m s.s.b.

Although conditions were generally very good for v.h.f. and u.h.f. DX throughout the 10th, 11th and part of the 12th, some strange things also happened. For instance, during the morning of the 10th, **Brian Houghton** G4BCO, Hastings, worked a station in Luton on f.m. running 1 watt from a hand-held set and **Brian Fenwick** G8BTC, Brighton, was listening to G8BDJ in nearby Southwick on 2m f.m., when suddenly his strong signals were obliterated by a station in Birmingham.

At 0843 on the 10th, I received strong pictures plus co-channel interference from Lichfield, and with patterning on some u.h.f. TV channels I was not surprised when I heard signals from the 70cm beacons at Emley Moor GB3EM and Sutton Coldfield GB3SUT, using only a dipole aerial. Around 1800 **John Keegan,** Steyning, Sussex saw German TV signals, complete with adverts in Band V. Later the same evening, **Peter Beer,** near Saffron Walden, Essex, using a loft aerial, received pictures from French u.h.f. television.

Mitch Tribe was delighted with his achievements on the 10th because, using his Multi-800D rig from his stationary car, he worked several PD0 (Dutch Novices' call sign) on 2m f.m. and at 1300 G4GNX/M, situated on Beachy Head, worked PA0 and DJ via the Brugge repeater ON0VW, R2. Between 2145 and 2230 Ian Rennison received Belgian, Dutch and French stations in Band II, using a dipole aerial into his AIWA 5080 stereo system. At 0054 on the 11th, **John Cooper** G8NGO, Cowfold, heard an OZ on 2m s.s.b., and periodically between 0900 and 1400 both Ian Rennison and myself received pictures from a Dutch station on Channel E4.

Amateur Co-operation

While in contact with PA0OOM at 0036 on the 11th, G4GNX learnt that the Dutch station had been trying for two years to work a station in QRA square ZK, so he called G8NGO who lives in ZK who was very soon in touch. Later, PA0OOM told G4GNX that he was going QRT, a very happy man.

During the opening, several amateurs and u.h.f. televiewers complained about total loss of signals and a good example was a local QSO in Hastings between G3JSF and G8PUW on 2m, only about three miles apart, who suddenly completely lost contact with each other. More fading was reported by **Guy Stanbury,** Chelmsford, who became aware of the disturbance when he saw patterning on Band V pictures on the 10th, and from about 1900 received f.m. signals, some in full stereo, from stations in West Germany and the Low Countries. Throughout the evening he noticed that signals would appear for a while and then fade away, and very soon the space would be taken by another. Guy also remarked about the extensive fluctuations in signal strengths and writes "I am sure you will agree that this type of opening is as fascinating when it deteriorates as when it starts".

New VHF Repeater

The first QSO through the Brighton repeater GB3SR, which commenced operation on R3 at 1900 on 15 October, was between G8ETL/M, Brighton, and G3WPO, Worthing, who was using a home-brew, hand-held transceiver. The Sussex Repeater Group, who are responsible for the station, are delighted with its initial performance despite the fact that they are using temporary filters.

From our Overseas readers

Congratulations to **Anthony Mann,** Applecross, Western Australia, who sent us the exciting report that he had received Ch.B1 BBC TV sound, 41·5MHz, down-under, on 13, 14, 16 and 19 October, the vision, 45 MHz, on the 13th and Ch.F2 French sound, 41·25MHz, on the 16th. Anthony also received strong f.m. signals from the Korean Broadcasting Service, 44·3 and 44·9MHz, on each of these days and Russian signals on 41, 42 and 43MHz on the 19th. Also on the 19th he heard signals from Japanese amateurs on 52MHz, and Chinese and Malaysian TV signals on Channels R1 and E3 respectively.

"You might realise that any v.h.f. from the north is DX long before it arrives" writes **Ian Roberts,** Pretoria, South Africa, who also says that 19 October was remarkable because he was receiving Ch. R1 vision at 0900 and the Cyprus beacon, 50·5MHz, just above the noise. Also on the 19th, Ian heard the second harmonic of the French (Issoudum, 500kW) programme at 43·16MHz S5, while the fundamental at 21·58MHz was S9.

Oddleiv Tungland, Trondheim, Norway, is now licensed as LA3GW and is operating from LA1K, the club station of the students in Trondheim. Oddleiv is also interested in DX TV, and in recent years has received signals from about 10 European countries using a dipole aerial in Band I.

15—240 Watts!

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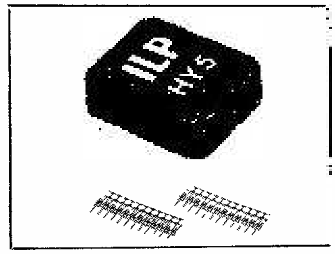
Preamplifier



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FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise —Low distortion—High overload—Two simply combined for stereo.
APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address
SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
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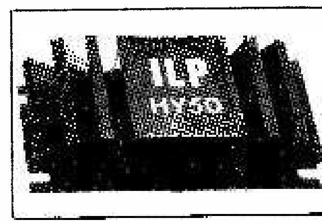
FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.
APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.
SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.
Price £6·27 + 78p VAT P&P free.



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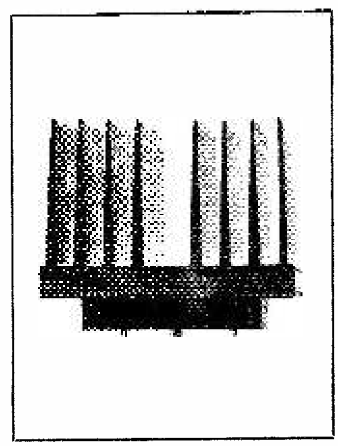
APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier
SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm
Price £8 18 + £1·02 VAT P&P free

HY120
60 Watts into 8Ω



The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.
FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components
APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ
SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz - 3dB SUPPLY VOLTAGE ±35V
SIZE 114 50 85mm
Price £19·01 + £1·52 VAT P&P free.

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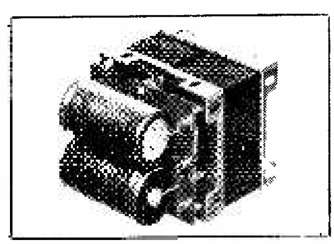
APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address
SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz - 3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm
Price £27·99 + £2 24 VAT P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
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APPLICATIONS: Public address—Disco—Power slave—Industrial
SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz - 3dB SUPPLY VOLTAGE ±45V
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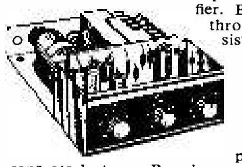


A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3″ high × 6″ wide × 7½″ deep. AC 200/250V. PRICE **£16·00**, P. & P. £1·20.

HARVERSONIC MODEL P.A. TWO ZERO

An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp). Input 1, 15mv into 47k. Input 2, 15mv into 47k. (suitable for use with mic. or guitar etc.). Input 3 200mv into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240v. Size approx. 12½″ w. × 5″ h. × 7½″ d. Special introductory Price **£28·00** + £2·50 carr. & pkg.

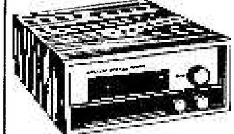
"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER

Size 11¾″ × 14$\frac{11}{16}$″ × 1$\frac{7}{16}$″ deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only **£8·40** each + p. & p. (one 90p, two £1·10). Now available in either 8″ round version or 4½″ × 8½″ rectangular, 10 watts RMS 60Hz-20KHZ **£5·25** + P. & P. (one 65p, two 75p).

STEREO MAGNETIC PRE-AMP. Sens. 3mV in for 100mV out. 15 to 35V neg. earth. Equ. ± 1dB from 20Hz to 20KHz. Input impedance 47K. Size 1⅝″ × 2⅛″ × 5⅝″H. **£2·60** + 20p P. & P.

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

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State FM AM Stereo Tuner. Covering M.W. A.M. 540-1605 KHz VHF/FM 88-108 MHz. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp Indicator. Built in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600m/v RMS into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8¼″w × 4″h × 9¼″d approx.

LIMITED NUMBER ONLY at **£28·00** + £1·50 P. & P.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p + SAE (Free with parts). All parts sold separately. ONLY **£15·50**, P. & P. £1·40. Also available ready built and tested **£20·00**, P. & P. £1·40.

STEREO DECODER

SIZE 2″ × 3″ × ½″ ready built. Pre-aligned and tested for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6·00 plus 20p. P. & P. Stereo beacon light if required 40p extra.

SPECIAL OFFER

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MODEL FL4

Few only similar to above, but battery operation only and fitted with twin speakers. Four wave bands, MW, FM and two VHF bands for reception of aircraft and some public services. ONLY **£9·50** + £1·30 p. & p.

MODEL MULTI 5

Specification as Model FL4 but with additional SW band. Fitted wih twin speakers. ONLY **£11·00** + £1·30 p. & p.

HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT

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

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT .. .. **£14·50** P. & P. 80p
(Magnetic input components 33p extra)
POWER PACK KIT .. **£6·00** P. & P. 95p
CABINET .. .. .. **£6·00** P. & P. 95p

SPECIAL OFFER—only £25·00 if all 3 items ordered at one time plus £1·25 p. & p.

Full after sales service

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A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets & 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½″ × 2¾″ × 1″ max. depth. Supplied brand new & tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically) at only **£10·00** plus 50p P. & P. Mains transformer with an output of 17v a/c at 500m/a can be supplied at **£2·00** + 40p P & P if required. Full connection details supplied.

All prices and specifications correct at time of press and subject to alteration without notice.

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. SEND SAE WITH ALL ENQUIRIES.

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7404	17p	74107	34p	74278	290p	74LS221	100p	74C163	155p
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7408	19p	74116	200p	74285	400p	74LS243	175p	74C175	210p
7409	19p	74118	130p	74290	150p	74LS245	175p	74C192	150p
7410	15p	74119	210p	74293	150p	74LS251	200p	74C193	150p
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7412	20p	74121	28p	74298	200p	74LS259	175p	74C195	110p
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7416	27p	74125	55p	74367	150p	74LS374	195p	4000	15p
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7421	40p	74132	75p	74393	200p	81LS97	120p	4006	95p
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7423	34p	74141	70p	**74 LS SERIES**		8T28	230p	4008	80p
7425	30p	74142	200p	74LS00	18p	9301	160p	4009	40p
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7427	34p	74147	190p	74LS04	20p	9308	316p	4011	17p
7428	36p	74148	150p	74LS08	22p	9310	275p	4012	18p
7430	17p	74150	100p	74LS10	20p	9311	275p	4013	50p
7432	30p	74151A	70p	74LS13	38p	9312	160p	4014	84p
7433	40p	74153	70p	74LS14	100p	9314	165p	4015	84p
7437	35p	74154	100p	74LS20	22p	9316	225p	4016	45p
7438	35p	74155	90p	74LS22	28p	9322	150p	4017	80p
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7441	70p	74157	70p	74LS30	22p	9370	200p	4019	45p
7442A	60p	74159	190p	74LS47	90p	9374	200p	4020	100p
7443	112p	74160	100p	74LS55	30p	9601	100p	4021	110p
7444	112p	74161	100p	74LS73	50p	9602	175p	4022	100p
7445	100p	74162	100p	74LS74	40p	9603	60p	4023	22p
7446A	93p	74163	100p	74LS75	50p	**INTERFACE I.C.s**		4024	50p
7447A	70p	74164	120p	74LS83	110p	MC1488	100p	4025	20p
7448	80p	74165	130p	74LS85	100p	MC1489	100p	4026	130p
7450	17p	74166	140p	74LS86	40p	75107	160p	4027	50p
7451	17p	74167	200p	74LS90	60p	75182	230p	4028	84p
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7454	17p	74172	720p	74LS107	45p	75451/2	72p	4030	55p
7460	17p	74173	120p	74LS112	100p	75491/2	96p	4031	200p
7470	36p	74174	93p	74LS123	75p	**C-MOS I.C.s**		4033	180p
7472	30p	74175	85p	74LS132	900p	74C00	25p	4034	200p
7473	34p	74176	90p	74LS133	60p	74C02	25p	4035	110p
7474	30p	74177	90p	74LS138	60p	74C04	27p	4040	100p
7475	36p	74178	160p	74LS139	60p	74C08	27p	4041	80p
7476	35p	74180	93p	74LS151	100p	74C10	27p	4042	80p
7480	50p	74181	200p	74LS153	60p	74C14	90p	4043	90p
7481	100p	74182	90p	74LS157	60p	74C20	27p	4044	90p
7482	84p	74184A	150p	74LS158	120p	74C30	27p	4046	110p
7483A	90p	74185	150p	74LS160	100p	74C32	36p	4047	100p
7484	100p	74186	700p	74LS161	100p	74C42	110p	4048	55p
7485	110p	74190	100p	74LS162	140p	74C48	250p	4049	32p
7486	34p	74191	100p	74LS163	100p	74C73	75p	4050	49p
7489	210p	84192	100p	74LS164	120p	74C74	70p	4051	80p
7490A	33p	74193	100p	74LS165	80p	74C85	200p	4052	80p
7491	80p	74194	100p	74LS173	110p	74C86	65p	4053	80p
7492A	46p	74195	95p	74LS174	110p	74C90	95p	4055	125p
7493A	33p	74196	95p	74LS175	110p	74C95	130p	4056	135p
7494	84p	74197	80p	74LS181	320p	74C107	125p	4059	600p
7495A	70p	74198	150p	74LS190	100p	74C150	250p	4060	115p
7496	65p	74199	150p	74LS191	100p	74C151	260p	4063	120p
								4066	55p

LINEAR I.C.s

*AY1-0212	600p	*MC1496	100p
*AY1-1313	668p	*MC3340	120p
*AY1-5050	212p	*MC3360	120p
*AY5-1315	600p	*MFC4000B	120p
*AY5-1317	636p	MK50398	750p
*AY5-1320	320p	NE531	130p
*CA5019	80p	*NE540	200p
*CA5046	70p	NE543K	225p
*CA3048	225p	NE555	25p
CA3080E	72p	NE556	70p
*CA3089E	225p	NE561B	425p
*CA3090AQ	375p	NE562B	425p
CA3130S	100p	NE565	130p
CA3140E	70p	NE566	155p
CA3160E	75p	NE567	175p
FX209	750p	RC4151	400p
ICL7106	925p	*SN76003N	175p
ICL8038	340p	*SN76013N	140p
LM301A	36p	*SN76013ND	120p
LM311	190p	*SN76023N	140p
LM318	200p	*SN76023ND	120p
LM324	70p	*SN76033N	175p
LM339	90p	*SP8515	750p
LM348	95p	*TBA641B11	225p
*LM377	175p	*TBA800	90p
*LM380	75p	*TBA810	100p
*LM381AN	150p	*TBA820	90p
*LM389N	140p	*TCA940	175p
LM709	36p	*TDA1022	600p
LM710	50p	XR2206	400p
LM733	100p	XR2207	400p
LM741	29p	*XR2216	675p
LM747	70p	XR2240	400p
LM748	35p	*ZN414	90p
LM3800	70p	ZN424E	135p
LM3911	130p	ZN425E	400p
LM4136	120p	ZN1034E	200p
*MC1310P	150p	95H90	800p
MC1458	55p		
MC1495	400p		

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		1A	—ve	
5V	7805	90p	5V	7905	100p
12V	7812	90p	12V	7912	100p
15V	7815	90p	15V	7915	100p
18V	7818	90p	18V	7918	100p
24V	7824	90p	24V	7924	100p
100mA	**TO-92**		**100mA**	**TO-92**	
5V	78L05	35p	5V	79L05	80p
12V	78L12	35p	12V	79L12	80p
15V	78L15	35p	15V	79L15	80p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
LM317T	200p	TL430	65p
LM323K	625p	78HO5KC	675p
LM723	37p	78MGT2C	135p

OPTO-ELECTRONICS

2N5777	45p	ORP12	90p	ORP61	90p
OCP71	130p	ORP60	90p	TIL78	70p

TRANSISTORS

AC127/8	20p	BFY51/2	22p	TIP41C	78p	2N3866	90p
AD149	70p	BFY56	33p	TIP42A	70p	*2N3903/4	18p
AD161/2	45p	BFY90	90p	TIP42C	82p	*2N3905/6	20p
BC107/8	11p	BLY83	700p	TIP2955	78p	*2N4036	65p
BC109	11p	BRY39	45p	TIP3055	70p	*2N4058/9	12p
*BC147/8	9p	BSX19/20	20p	*TIS43	34p	*2N4060	12p
*BC149	10p	*BU105	190p	*TIS93	30p	*2N4061/2	18p
*BC157/8	10p	*BU108	250p	*ZTX108	12p	*2N4123/4	22p
*BC159	11p	*BU205	220p	*ZTX300	13p	*2N4125/6	22p
*BC169C	12p	*BU208	240p	*ZTX500	15p	*2N4289	20p
*BC172	12p	*BU406	145p	*ZTX502	18p	*2N4401/3	27p
BC177/8	17p	MJ481	175p	*ZTX504	30p	2N4427	90p
BC179	18p	MJ491	200p	2N457A	250p	*2N4871	60p
*BC182/3	10p	MJ2501	225p	2N696	35p	*2N5087	27p
*BC184	11p	MJ2955	100p	2N697	25p	*2N5089	27p
BC187	30p	MJ3001	225p	2N697	45p	*2N5172	27p
*BC212/3	11p	*MJE340	65p	2N706A	20p	2N5179	27p
*BC214	12p	MJE2955	100p	2N708A	20p	2N5191	83p
BC461	36p	MJE3055	70p	2N918	45p	2N5194	90p
BC477/8	30p	*MPF102	45p	2N930	18p	*2N5245	40p
*BC516/7	50p	*MPF103/4	40p	2N1131/2	20p	*2N5296	55p
*BC547B	16p	*MPF105/6	40p	2N1613	25p	*2N5401	50p
*BC549C	18p	*MPSA06	30p	2N1711	25p	*2N5457/8	40p
*BC557B	16p	*MPSA12	50p	2N2102	60p	*2N5459	40p
*BC559C	18p	*MPSA56	32p	2N2160	120p	*2N5460	40p
BCY70	18p	*MPSU06	63p	2N2219A	20p	*2N5485	44p
BCY71/2	22p	*MPSU56	78p	2N2222A	20p	*2N6027	48p
BD131/2	50p	OC28	130p	2N2369A	16p	2N6247	190p
BDY56	200p	OC35	130p	2N2484	30p	2N6254	130p
BF200	32p	*R2008B	200p	2N2646	50p	2N6290	65p
*BF244B	35p	*R2010B	200p	2N2904/5	25p	2N6292	65p
*BF256B	70p	*TIP29A	40p	2N2906A	24p	2N128	120p
BF257/8	32p	*TIP29C	55p	2N2907A	30p	3N140	100p
BF259	36p	*TIP30A	48p	*2N2926	9p	3N201	110p
*BFR39	30p	*TIP30C	60p	2N3053	20p	3N204	100p
*BFR40	30p	TIP31A	58p	2N3054	65p	40290	250p
*BFR41	30p	TIP31C	62p	2N3055	48p	40360	40p
*BFR79	30p	TIP32A	68p	2N3442	140p	40361/2	45p
*BFR80	30p	TIP32C	82p	2N3553	240p	40364	120p
*BFR81	30p	TIP33A	90p	*2N3565	30p	40408	70p
BFX29	30p	TIP33C	114p	*2N3643/4	48p	40409	65p
BFX30	34p	TIP34A	115p	*2N3702/3	12p	40410	65p
BFX84/5	30p	TIP34C	160p	*2N3704/5	12p	40411	300p
BFX86/7	30p	TIP35A	225p	*2N3706/7	12p	40594	97p
BFX88	30p	TIP35C	290p	*2N3708/9	12p	40595	105p
BFW10	90p	TIP36A	270p	2N3773	300p	40603	58p
BFY50	22p	TIP36C	340p	*2N3819	25p	40673	90p
		TIP41A	65p	*2N3820	50p	40841	90p
				2N3823	70p	40871/2	90p

DIODES

*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p

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1 W 15p

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*2A 50V	30p
*2A 100V	35p
*2A 400V	45p
*3A 200V	60p
*3A 600V	72p
*4A 100V	95p
*4A 400V	100p
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6A 400V	120p
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25A 400V	400p

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silicon chip of the 3089 device. The use of an external load resistor in the CA3189E enables any noise at pin 10 to be decoupled by a 10μF capacitor to ground; in addition, the value of the load resistor can be selected as desired so as to vary the audio output level, which increases with the value of the load resistor. The value of the de-emphasis capacitor from the output to ground must be chosen according to the value of the load resistor used so that the produce of the values of these two components is about 50μs.

There is no connection to pin 16 of the 3089 devices, but in the CA3189E this pin is used to feed the controlling voltage for the a.g.c. threshold into the device. This controlling voltage may be obtained using the voltage at pin 13 as shown in Fig. 15, in which case the onset of a.g.c. action will vary from about 200μV up to 200mV at pin 1 according to the setting of VR1. When the a.g.c. voltage is plotted against the input voltage a curve with an extremely sharp "knee" is obtained, so the onset of a.g.c. action is very rapid. When the a.g.c. voltage from the CA3189E is fed to one of the gate electrodes of a MOSFET in a front-end unit, a range of 40dB in the gain is easily obtained.

FM/AM Devices

The f.m. i.f. devices we have discussed process only an f.m. signal, but many new devices are now coming onto the market which will not only handle the f.m. i.f. signal, but which will also process an a.m. signal. When an f.m. front-end unit is coupled to such a device together with an audio amplifier, all the devices (except possibly one or two diodes or transistors) which are required in a receiver to cover both a.m. and f.m. bands are then available. Devices in this class include the Fairchild μA721, the A.E.G.-Telefunken TDA1083, the Mullard TBA570 and their new TDA5700 and the SGS-Ates TDA1220 device.

One of the problems of using these devices in a home constructed receiver is the complexity of the circuitry around a single integrated circuit. Many constructors therefore prefer to keep the a.m. and f.m. sections of their receivers quite separate. However, in car radio receivers and in small portable receivers where space can be at a premium, these new combined a.m./f.m. devices are very attractive, especially to the receiver manufacturers.

The μA721

The Fairchild μA721 device is encapsulated in a standard 16 pin dual-in-line plastic package (available from Arrow Electronics Ltd.). It contains the semiconductor devices required for the a.m. r.f. stage, oscillator, mixer and i.f. stage together with an f.m. limiter and quadrature demodulator circuit. Although all of this circuitry has been compressed onto a single chip, the total quiescent current required is only some 20mA. The device operates from a supply of about 9V.

The f.m. section input has a limiting sensitivity of about 500μV and provides an audio output signal of about 520mV r.m.s. at a typical total harmonic distortion of some 0·9% (maximum for any μA721 device is 2%). The signal-to-noise ratio is typically 75dB with a minimum value of 60dB. The rejection of a.m. signals is some 46dB (as opposed to about 60dB in the case of the CA3189E).

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Only £11.05 inc. p & p and VAT

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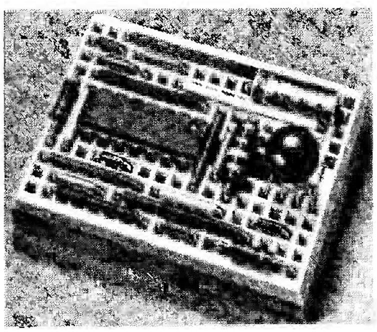

Best Buy 2-8

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From £3.25 inc p & p and VAT

The modular, solderless system! Breadboards that link together for any size, any configuration. With pitch of 0.1" to accept all IC's. Just take each component, choose its hole and push it in.

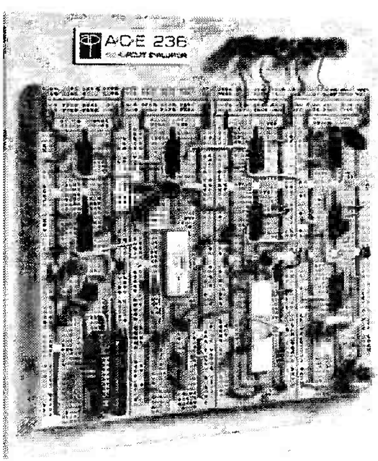
BREADBOARDS

Model	*Contacts*	*Price, each*
264L	640	£8.32
248L	480	£6.65
234L	340	£5.75
217L	170	£3.25

(All prices include p & p and VAT)

BUS STRIPS

Model	*Price*
212R	£1.78
209R	£1.62
206R	£1.45



Best Buy 9-15

Lektrokit All-Circuit Evaluators

Seven ACE models from £12.53
—all prices inc p & p and VAT

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PW4

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ELECTROVALUE Buying Guide

Section 5

IMPORTANT ANNOUNCEMENT

With completion of our series of itemised advertisements we announce release of our newest catalogue, CATALOGUE No. 9—completely revised, enlarged and best yet.
SEND FOR YOUR FREE COPY NOW TO DEPT. PW29

Catalogue No. 9 NOW READY

HARDWARE/SOLDER TOOLS

SOLDER TOOLS

ORYX50
Temp controlled ...... £9·75N
Spare element ...... £3·90N
Bits (11 types) ...... ea. £1·00N

ORYX Super 30 ...... £4·45N
Spare element ...... £3·00N
Bits as for ORYX50

ISO-TIP Quick Charge cordless iron ...... £20·50N
Bits micro 7566 ...... £2·30N
fine 7545 ...... £2·30N
h.d. 7546 ...... £2·30N
Std 7535 ...... £2·30N
PC drill attachment 6500 ...... £10·60N
Spare bulb 35pN

ERSA Sprint
Solder gun ...... £8·62N
Spare element ...... £5·00N
Bit No 862VN 40pN

ERSA solder station
Temp controlled iron with stand ...... £59·00N

GREENWOOD PYROMETER ...... £25·00N

DESOLDER TOOL
SR3A ...... £6·50N
Spare nozzle. PTFE SR3AN 70pN

ANTEX C–240V 15W £3·60N
Spare element ...... £1·60N
Nickel plated bits 46pN
No 2 ·094"; No 4 ·187";
No 6 ·047"
Iron coated bits 46pN
No. 102, 104, 106

ANTEX CCN–240V .. £3·80N
(low capacitance) 15W
Spare element ...... £1·90N
Iron coated bits 46pN
1100 ·094"; 1101 ·225";
1102 ·187"

ANTEX CX 240V .... £3·60N
Spare element ...... £1·60N
Bits for CCN above

ANTEX X25-240V 25W £3·60N
Spare element ...... £1·60N
Iron coated bits 50pN
50 ·094"; 51 ·125"; 52 ·187"

ANTEX STAND ST3.. £1·50N
No 666 Sponge 6pN

SOLDERSTAT RANGE
HMS 240V 16W ...... £4·75N
HMS 240V 24W ...... £4·75N
HMS 110V 16W ...... £4·75N
HMS 110V 24W ...... £4·75N
Spare elements ...... £2·35N
Nickel plated bits
2037 3·2mm 80pN
2038 2·4mm 80pN
2003 2mm stub 80pN
Iron plated
2032 4·5mm ...... £1·90N
2033 6·5mm ...... £1·90N
IC desolder head for HMS Irons
14-way ...... £5·70N
16-way ...... £5·70N
HMS 240V Solder Kit in presentation box ...... £8·90N
HMS 12V Solder Kit in wallet ...... £7·60N

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FERRITES
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3·75" × 2·5" 46p
5" × 2·5" 55p
5" × 3·75" 55p
5" × 3·75" 62p
8·45" × 1·5" 57p
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VQ Dip-Board ...... £1·11
24-way plug-in ...... £2·20
32-way ...... £2·40
EURO Dip-Board ...... £3·57
0·1" matrix unclad
3·75" × 2·5" **31p** 5" × 3 75" **56p**
EURO Board 89p
0·15" matrix, copper clad
3·75" × 2·5" **44p** 5" × 2·5" **53p**
3·75" × 3·75" **53p** 5" × 3·75" **74p** 8·45" × 1·5" **57p**
0·2" matrix, copper clad
5" × 3·4" ...... TO CLEAR **30p**

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No PIT1 for 0·040" pins (0·1" matrix) ...... £1·27
No PIT5 for 0·052" pins (0·15" matrix) ...... £1·27

SPOT FACE CUTTER
Suitable for any matrix 89p

TERMINAL PINS
(Not made by Vero)
0·040" dia for 0·1" matrix per 100 **35p** per 500 **£1·15**
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VEROBOX STANDARD BOXES
High Impact polystyrene light grey top, dark grey bottom section.

Type	L	W	H	
2514F	100	50	25	£1·64
2516G	100	50	40	£1·86
2518H	120	65	40	£2·07
2520J	150	80	50	£2·45
2522K	188	110	60	£3·13

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Constructed from ABS material light grey top & dark grey bottom section. Anodised ali. front and rear panels. Internal guides for PC boards.

Type	L	H	D	
1237J	154	40	85	£2·56
1238D	154	60	85	£2·82
1239K	154	80	85	£3·38
1410J	205	40	140	£3·53
1411D	205	75	140	£3·96
1412K	205	110	140	£5·12

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The 1798K has white top and grey bottom section, the 2523E has light grey top and dark grey bottom section.
Both have anodised aluminium panels.

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1798K	171	38	75	121	£4·19
2523E	220	52	100	156	£6·36

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accepts plug-in modules and standard Euro-pean size circuit boards.
Light blue with natural anodised aluminium end plates.
Can be rack mounted.

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3843A	8" Module	£4·00N
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2846H	1" Front panel	97pN
3979K	Board for module	£1·39
1034E	Veroboard, clad	£1·42
1041J	DIP-board	£3·59
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0258C	31-way socket	£1·06N

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2874C 64-way socket £4·48N

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GP602 50V 2A tapped 24, 30, 40, 48V .. £6·70
50TS2 50V 2A tapped 25, 45V
Pri/sec shield ...... £6·55
50TS2A 50V 2A (110/120V pri) tapped 25, 45V
Pri/sec shield ...... £6·55
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28T1 12V, 12V, 2–0–2V 1A £4·90
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CT2 17V 2A charger duty tapped at 9V £3·25
CT4 17V 4A charger duty £3·85
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909/1 9–0–9V 75mA .... £1·00
GP909 9–0–9V 0·5A .... £2·10
12012/1 12–0–12V 50mA £1·00
1200 12–0–12V 100mA £1·20
MT150 12V, 12V, 150mA £1·70
151A 15–0–15V 1A .... £3·20
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301A 30–0–30V 1A .... £3·80
Miniature L.S. transformer
LT700 Pri. 1K2 C.T.
Sec 3·2 Ω

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300 × 150mm
Single Sided
SRBP **85p;** Fibreglass .... £1·65
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Lab grade 100gm pack 47p
500gm jar ...... £2·30

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(V.A.T.—12½%)

DIN	Plug	Socket
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4 way	13p	15p
5 way 180°	14p	10p
5 way 180° PC	—	12p
5 way 240°	15p	15p
6 way	16p	12p
7 way	18p	18p

Full range available from 2 way.

REED RELAYS open construction
5V 106Ω CSA5 single n/o 90p
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12 double n/o ...... £1·19

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Gold flash contacts
0·1" 24 way **£1·06;** 32 way **£1·29;** 36 way **£1·55.**

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Quad socket **13p**
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1 pole 12W **37p;** 2 pole 6W **37p;**
3 pole 4W **37p;** 4 pole 3W **37p.**

ROTARY SWITCH KIT
Type RA 6 wafers 60p
RA Wafers MBB
1P 1W or 2P 5W 66p
RA Wafers BBM
1P 12W, 2P 6W, 3P 4W, 4P 3W, 6P 2W 66p
RA Shorting wafer, MBB
Rotating open-circuit 66p

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Standard Size
SSP10, 250V 3A a.c. push on, push off panel hole 0·5" 67p
SSP11, as SSP10 push to make 56p
Sub-Miniature 250V 0·5A a.c.
8531 push to make 62p
8533 push to break 62p
(Panel hole 0·25"). Buttons in choice of black or red.

CASTELCO RANGE 250V 1A a.c.
0·375" hole with long white fixing ring unless otherwise ordered
No. 2644 SP make 18p
No. 3244 DP make 34p
No. 2648 SP break 18p
No. 3248 DP break 34p
No. 2634 SP on/off 17p
No. 3234 DP on/off 30p
No. 4434 as 3234 but switch sections reversed 30p
No. 4444 as 3244 but switch sections reversed 34p
Spare rings in black, red, yellow, green, blue, white or pink **each 2p**

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Chrome finish
1011C SPST 56p
1016C SPDT 61p
1019C SPDT centre-off 64p
409 DPDT 77p
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S7201 DPDT 84p
S7203 DPDT centre-off 84p
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IMERSET for wired-in situations. 2 on & 2 off actions per day ...... £13·75N

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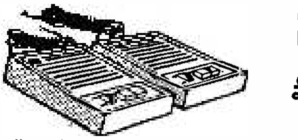
MAINS INTERCOM



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Solve your communication problems with this 4-Station Transistor Intercom system (1 master and 3 Subs), in robust plastic cabinets for desk or wall mounting. Call/talk/listen from Master to Subs and Subs to Master. Ideally suitable for Business, Surgery, Schools, Hospitals and Office. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. A Battery and other accessories. P. & P. 99p.

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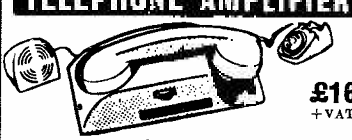

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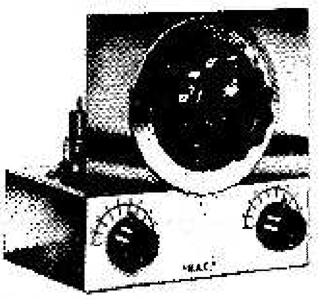

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£10·50 INCLUSIVE—the ever popular and easy to construct DX receiver Mark III; containing all genuine short wave components, drilled chassis, valve, accessories and full instructions.

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P.O. Box No. 16, 10 Windmill Lane
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Sonic

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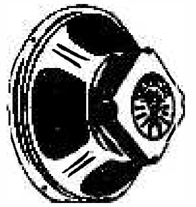

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FANE LIFETIME
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ALL PRICES INC. VAT

Prices correct at 11.12.78

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20" × 11½" × 9½" Suitable for Mode 1 or FR1 Kits and Models 80, 83 or 808T Spkrs.
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12" CELESTION G12H 30w	£22·00	£14·95
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12" GOODMANS 12 PD	Sp. Price	£21·95
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12" FANE 'SPECIALIST' P.A. 80	£29·95	£18·95
12" „ „ DISCO 80	£29·95	£19·95
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12" „ „ GUITAR 80L	£28·95	£18·95
12" „ „ GUITAR 100L	£31·95	£19·95
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15" TITAN T15/100 100w	£41·00	£29·95
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15" „ „ BASS 100	£44·50	£31·50
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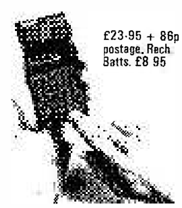

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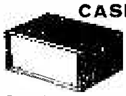

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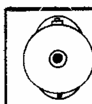

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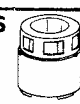

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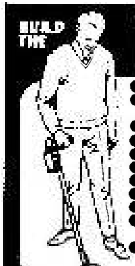

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12 OR 24 VOLT OR 12-0-12V
PRIMARY 220-240 VOLTS

Ref	Amps 12V	Amps 24V	£	P & P
111	0·5	0·25	2·20	0·45
213	1·0	0·5	2·64	0·78
71	2	1	3·51	0·78
18	4	2	4·03	0·96
70	6	3	5·35	0·96
108	8	4	7·42	1·14
72	10	5	8·12	1·14
116	[illegible]	6	8·99	1·32
17	[illegible]	8	10·72	1·32
115	20	10	13·98	2·08
187	30	15	17·05	2·08
226	60	30	36·74	OA

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 & 25V-0-25V.

Ref	Amps	£	P & P
102	0·5	3·41	0·78
103	1·0	4·57	0·96
104	2·0	7·16	1·14
105	3·0	8·56	1·32
106	4·0	11·41	1·50
107	6·0	15·06	1·64
118	8·0	20·26	2·08
119	10·0	24·98	OA

MAINS ISOLATING (SCREENED)
Pri 120/240V SEC 120/240V CT

Ref	VA (Watts)	£	P & P
*07	20	4·40	0·79
149	60	6·70	0·96
150	100	7·61	1·14
151	200	11·16	1·50
152	250	13·28	1·84
153	350	16·43	1·84
154	500	20·47	2·15
155	750	29·06	OA
156	1000	37·20	OA
157	1500	51·38	OA
158	2000	81·81	OA
159	3000	86·66	OA

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

HIGH VOLTAGE ISOLATOR
Pri 200/220V or 400/440V
Sec 110/120V CT or 200/240CT

Va	Ref	£	P & P
60	243	6·70	1·32
350	247	16·43	1·84
1000	250	37·10	OA
2000	252	61·81	OA

SEND 15p FOR CATALOGUE

30VOLT 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 & 15V-0-15V.

Ref	Amps	£	P & P
112	0·5	2·64	0·78
79	1·0	3·57	0·96
3	2·0	5·77	0·96
20	3·0	6·20	1·14
21	4·0	7·99	1·14
51	5·0	9·87	1·32
117	6·0	11·17	1·45
88	8·0	14·95	1·64
89	10·0	17·25	1·84

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	£	P & P
124	0·5	3·88	0·96
126	1·0	5·91	0·96
127	2·0	7·60	1·14
125	3·0	11·00	1·32
123	4·0	12·52	1·84
40	5·0	15·84	1·64
120	6·0	18·06	1·84
121	8·0	25·56	OA
122	10·0	29·55	OA
189	12·0	34·06	OA

AUTO TRANSFORMERS

Ref	VA (Watts)		£	P & P
113	15	0-115-210-240	2·48	0·71
64	75	0-115-210-240	4·01	0·96
4	150	0-115-200-220-240	5·35	0·96
67	500	0-115-200-220-240	10·99	1·64
84	1000	0-115-200-220-240	18·76	2·08
93	1500	0-115-200-220-240	23·36	OA
95	2000	0-115-200-220-240	34·82	OA
73	3000	0-115-200-220-240	59·21	OA
80s	4000	0-10-115-200-220-240	76·86	OA
57s	5000	0-10-115-200-220-240	89·50	OA

CASED AUTO TRANSFORMERS
240V cable in 115V USA flat pin outlet

VA	£	P & P	Ref
15	4·96	0·96	113W
75	7·73	1·14	64W
150	10·01	1·14	4W
200	9·92	1·45	65W
250	10·49	1·45	69W
500	19·17	1·64	67W
750	23·41	1·76	83W
1000	27·88	OA	84W
1500	26·02	OA	93W
2000	49·97	OA	95W

Prices correct 21-11-78. Please add VAT after P & P.

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	2·57	0·55
212	1A, 1A	0-6, 0-6	2·85	0·78
13	100	9-0-9	2·14	0·38
235	330, 330	0-9, 0-9	1·99	0·38
207	500, 500	0-8-9-, 0-8-9	2·77	0·71
208	1A, 1A	0-8-9, 0-8-9	3·53	0·78
236	200, 200	0-15, 0-15	1·99	0·38
214	300, 300	0-20, 0-20	2·80	0·78
221	700 (DC)	20-12-0-12-20	3·41	0·78
206	1A, 1A	0-15-20-0-15-20	4·63	0·96
203	500, 500	0-15-27-0-15-27	3·99	0·96
204	1A, 1A	0-15-27-0-15-27	6·04	0·96
239	50	12-0-12	2·57	0·38

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65 High Quality Metal Oxide 5% ½ + ¼ W resistors.
150 Mixed Value Capacitors.
10 Reed Switches.
50 Wire Wound Resistors
10 3000μF 30V Caps.
25 Assorted presets.
50 3 tag terminal strips.
Hardware pack nuts, bolts, washers, insulators
200 Mixed Resistors
70p ea. P&P 40p. VAT 12½%

BRIDGE RECITIFIERS

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

VAT 12½% 15p P & P *VAT 8%

AMPLIFIER MODULES

10W	(AL30)	£3·75
25W	(AL60)	£4·57
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125W	(AL250)	£17·25
Power Supply PS12		£1·30
Power Supply SPM80		£4·25

VAT 12½% P & P 35p.

MINI-MULTIMETER
DC-1000V AC-1000V DC-100mA Res-150kΩ 1000Ω/V Bargain **£6·45.** VAT 8% P & P 62p.

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.** VAT 8%. P & P **£1·05.**

TEST METERS

AVO 8 MK5	£81·70
AVO 71	£33·50
AVO 73	£44·20
AVO MM5	£28·66
Wee Megger	£66·90
EM272	£53·70
DA116 digital	£102·00

Meggar BM7 battery **£45·15**
U4315 Budget meter 20KΩ/VDC2K/VAC 1000V AC/DC 2·5A AC/500K res, in robust steel case and leads **£15·85**
AVO TT169 in circuit Transistor Tester **£34·75**

NEW RANGE TRANSFORMER
Pri 120V or 220/240V. Sec 0-36-48 twice to give 36-0-36V 48-0-48V 72V or 92V.

Ref	Price	P & P
3A	14·70	1·48
4A	18·77	1·84
5A	26·64	2·15

PANEL METERS

41 × 41mm		82 × 82mm	
0–50μA	£5·50	0–50μA	£6·70
0–500μA	£5·50	0–500μA	£6·70
0–1mA	£5·50	0–1mA	£8·40
0–30V	£5·50	0–30V	£8·40

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VU Ind. Edge 54 × 14mm 250μa FSD **£2·60**
65p Carriage 8% VAT.

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TMK 500
30K/V Mirror scale meter, AC 0-2-5-10-25-100-250-500-1000V,DC 0·25-1-2-5-10-25-100-250-1000V. Resistance 0-6K-60K-6M-60M, auto o/load protection **£23·30.** P & P £1·05. VAT 8%

250VA ISOLATOR
0-200-220-240V
0-240V centre tap.
250VA **£5·20** P & P 96p Ref. 62.

Aluminium Boxes—with ½″ lip lid & screws.

	l	w	h	
B1	5¼	2¼	1½	62p
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P & P 29p. VAT 8%

S-DECS
Solderless bread boarding

S Dec 70 contacts	£3·10
T Dec 208 contacts	£4·35
U Dec "A" for I.C.s etc	£4·50
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VAT 8% P & P 40p

ANTEX SOLDERING IRONS
15W **£3·75**
25W **£3·95** Stand **£1·52**+
VAT 8% P & P 46p VAT 12½%

Electronic Construction Kit
Home electronic teacher. Start simply and progress to a TRF radio or electronic organ. No soldering, all parts included in presentation box. **£8·29** + 96p p & p VAT 8%.

ABS PLASTIC BOXES inset brass nuts, slots to take P.C. cards flush fitting lid.

PB1 180mm × 62 × 40	65p
PB2 100mm × 75 × 40	73p
PB3 120mm × 100 × 45	87p
PB4 215mm × 130 × 85	£2·54

P & P 66p VAT 8%

Miniature Transformers 0-CT-15V

Ref		Price	PP
171	500 ma	2·09	·45
172	1A	2·96	·78
173	2A	3·59	·78
174	3A	3·75	·86
175	4A	5·73	·96

P.W. Purbeck oscilloscope transformer in stk 250-0-250 6·3V, 12·9V **£6·20** p & p 90p
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BE6 Pn 0·220V sec 4500V 10ma **£4·50** p & p £1·00
BE7 0-110-120-220V Pn 240V sec 20V 1 amp **£1·50** p & p 30p
BE8 0·240 15-0-15V 2A **£1·50** p & p 70p
Ref 30 240-240 Isolator 200Va **£4·20** p & p 96p

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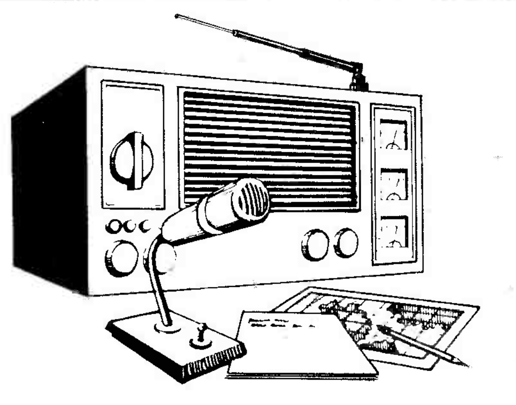

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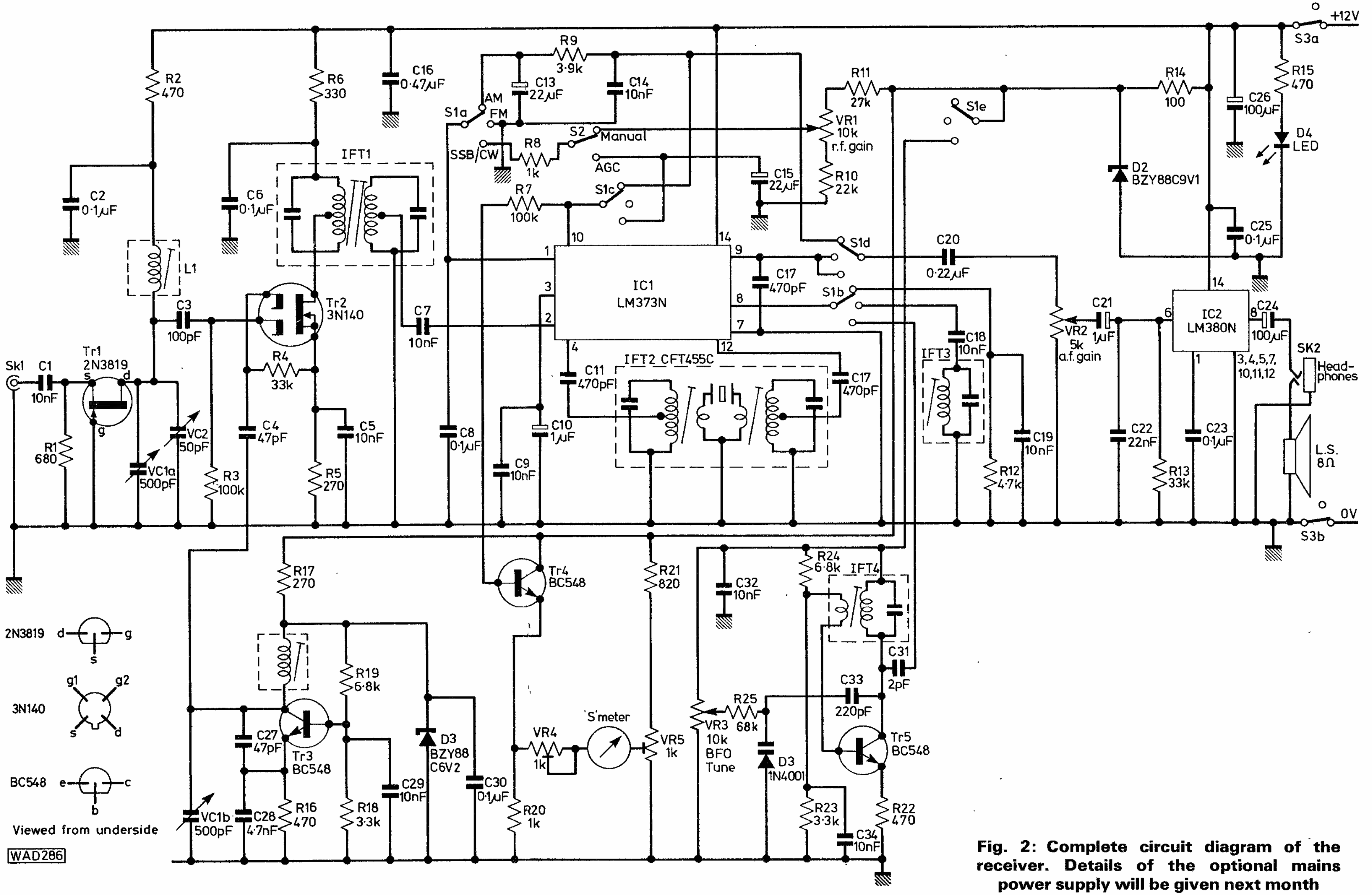

Fig. 2: Complete circuit diagram of the receiver. Details of the optional mains power supply will be given next month

Practical Wireless, February 1979

PULL-OUT

practical
WIRELESS

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MAY TO DECEMBER 1978

Note: This volume consists of eight issues only to permit Volume 55 to begin with the January 1979 issue.

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EXTRA

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(for details see page 33)