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AUGUST 1974

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2 · 216V, 2 · 2 · 35V, 4 · 716 · 3V
4 · 7/35V, 10/16V, 22/6 · 3V
10/25V, 22/16V, 47/6 · 3V
10/25V, 22/6 · 3 ea. 14p ea. 14p ea. 18p ea. 20p

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Cone	vv all S	Uninis	1 10 9	10 10 93	700 Up	
			(see	note b	elow)	
C	1/3	4 · 7 - 470K	1 - 3	1:1	0.9 nett	
C	1/2	4 · 7-10M	1 3	1 1	0.9 nett	
C	3/4	4 · 7-10M	1 - 5	1 . 2	0.97 nett	
C	1	4 · 7-10M	3 . 2	2.5	1-92 nett	
MO	1/2	10-1M	4	3 - 3	2 3 nett	
ww	1	0 . 22 - 3 . 9	9	9	8	
WW	3	1-10K	7	7	6	
ww	7	1-10K	9	9	8	

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odes:
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0 47	_	_	10000	_	-	_	Hp	8p
1.0	_	_	No.		-	Hp		8p
2 2	-	_	-0.040	-	Hp	_	8p	9p
4 7	_	_	-	Hp	_	8p	9 p	8p
10	_		_	_	8p	9p	8p	8p
22	_	-	8р	_	9p	8p	8p	10p
47	8р	_	9p	8p	8p	8p	10p	13p
100	9p	8р	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	Hp	17p	28p
470	9p	10p	10p	Hp	13p	17p	240	45p
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2,200	15p	18p	23p	26p	37p	41p	-	_
4,700	26p	30p	39p	44p	58p	_	-	
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WIRELESS

VOL. 50 NO. 4 ISSUE 810 AUGUST 1974

BRITAIN'S PREMIER MAGAZINE FOR THE DO-IT-YOURSELF RADIO AND ELECTRONICS CONSTRUCTOR

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NEWS & COMMENT

304 SURPRISE!-Leader article and September preview

305 NEWS . . . NEWS . . . NEWS . . .

310 TELEVISION—Coming in the August issue

318 CQ1 CQ1 CQ1

326 HOTLINES on recent developments by Novus

327 NEXT MONTH IN PRACTICAL WIRELESS

348 SPECIAL PRODUCT REPORT—Cortina Major Multimeter

353 ON THE AIR

353 Broadcast Bands, Short Waves-Malcolm Connah

354

Medium Waves—Charles Molloy

007

VHF/FM—Simon David

354

357 Amateur Bands, Short Wave/VHF-Eric Dowdeswell, G4AR

358 BOOK REVIEW

CONSTRUCTIONAL

306 TWO-METRE CONVERTER-L. Case, G8BJQ

322 TAKE 20 No. 62, Variable Ratio Counter-David Andrews

323 EXPERIMENTAL WORKSHOP Loudspeaker Drivers— M. J. Hughes, M.A.

328 P.W. "DERBY" STEREO HEADPHONE AMPLIFIER-D. S. Glbbs

334 TELE-TENNIS, Part 2 Power Supply and Modulator— M. J. Hughes, M.A.

OTHER FEATURES

311 I.C. OF THE MONTH No. 46 LM381N Dual low noise amplifier— M. J. Darby

314 HIGH QUALITY SOUND LINKS-Vivian Capel

341 OSCILLOSCOPE TECHNIQUES Part 6-Alan C. Ainslie

349 GOING BACK--Equipment of yesteryear-Colin Riches

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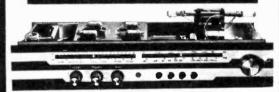
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Two models 15 amp \$1.98, 30 amp \$2.58. P. & P. 25p each

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But, if you install SAGA four smoke and gas alarm) your family will have the latest electronic protection against these killers. Saga uses a fantastic electronic sensor which "smells" smoke and gas and sounds the alarm immediately, smoke and gas and sounds the alarm immediately, smoke and gas and sounds the alarm immediately, it is as its own internal slarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. \$8.99 plus 30p post.



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TERMS:-

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Miniature mains driven blower centrifugal type blower
unit by Woods. Powerful but specially built for quiet
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fitting into a cooker hood, film drying cabinet or for
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bargain at 22.05.

Send postage where quoted—other items, post free if order for these items is £6.00, otherwise add 20p.





Sensational "once in a lifetime offer" because Mullard over-produced — definitely not repeatable once our stocks (now over half sold) are cleared. Hi-Fi 4 transistor amplifier complete in case ready to use. Batt., car or mains operated-req. range 50hr-15khz-distortion better than 2%. Comes complete with guarantee and data PREE to purchasers. Great handbook published by Mullard "tells all you need to know" to build your own stereo. Complete Uniter Stereo System £11'30, pair of speakers for same £3.80.



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PREE

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MINIATURE SEALED RELAY



RESEALED RELAY

American made. Our Ref. No.

REL Al. Measures only \$\frac{1}{2}\$ wide

\[\frac{1}{2}\$ \] it hick and \$\frac{1}{2}\$ wide

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i's a double cbange over, we
don't know the contact rating
but estinate this at \$35\$ amps.

The coil resistance is 600 ohms.

and 9-12 volt will close it. Ideal
for models and miniaturised
equipment. It's a plug in relay
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Price 33p including base.

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for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw KNUCKLED MODEL FOR F.M. 55p 42p.

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Tuning condenser as fitted to many Japanese and Hong Kong radios—probably 200pf each section with ½" spindle with terminal-less trimmers. Price 38p. With trimmers 50p.

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For digital instruments, counters, timers, clocks, etc. Hi-vac XN.3

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MAINS OPERATED SOLENOIDS



Model 2 — small but powerful lin. pull—approx size $1_{\frac{1}{4}} \times 1_{\frac{1}{4}} \times 1_{\frac{1}{4}}$ in. 68p. Model 4001/— ξ in. pull. Size $2_{\frac{1}{4}} \times 2 \times 14$ in. 88p. Model TT1— $1_{\frac{1}{4}}$ in. pull. Size $3_{\frac{1}{4}} \times 2 \times 14$ in. £10 £198 plus 20p post and insurance

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Easiest way to fault find—traces signal from aerial to speaker—when signal stops von've found the fault. Use it on Radio, TV amplifier, anything—complete kit comprises two special translators and all parts including probe tube and crystal earpiece £2.20, twin stethoset instead of earpiece 820 cxtra—post and lins. 20p.

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Complete with circuit 99p each + p & p 15p PAXOLINE BOARDS 71 × 9" approx 4 for 30p + p & p 20p.

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CH5. 1-5mH 25p
CH5. 1-5mH 25p

DRX1 Crystal set \$1p DRR2 Dual range 45p

COIL FORMERS & CORES NORMAN !" Cores & Formers 7p

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DI'/DT Toggle 25p SP/ST Toggle 18p

14" and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1-5A, 2A QUICK-BLOW 4p ca. ANTI-SURGE 5p ca.

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Crystal 2-5mm plug 33p Crystal 3-5mm plug 33p 8 ohms 2-5mm plug 22p 8 ohms 3-5mm plug 22p

DYNAMIC MICROPHONES B1223, 200 ohms plus on/off switch and 2.5mm and 3.5mm plugs £1.60

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CATALOGUE AND LISTS Send S.A.E. and 10p.

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Die		001	urou,			
No. 1	Length	W	idth	H	elght	Price
BV1	8"	×	5±"	×	2"	90p
BV2	11"	×	6"	×	3"	\$1.20
					-	

ALL	IMIN	IIUM	BO	KES		
BA1	51"	×	24"	×	14"	421
BA2	4"	×	4"	×	11"	41;
BA3	4"	×	21"	×	14"	41;
BA4	51"	×	4"	×	11	471
BA5	4"	×	2¼" 2"	×	2"	411
BA6	3"	×	2"	×	1"	841
BA7	7"	×	5"	×	21"	661
BA8	8"	×	6"	×	3"	841
BA9	6"	×	4"	×	2"	541
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BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen Model 42 £1 84

Ref. 32. Tape editing Kit £1-54

Model 9. Wire Stripper/Cutter 83p

Chrome Finish Model 60 £1:50



X25, 25 watt £1-93 CCN 240, 15 watt #2:15 Model G. 18 watt #2:15 SK2. Soldering Kit £2:86 STANDS: STI #1-21. ST2 77p SOLDER: 188WG Multicore 7oz 82n 228WG 7oz 82p. 188WG 22ft 28p 228WG Tube 22p

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EG 240 £1-16

Pack No. Qtv.

V.A.T. included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

Description

EX 25 £1:16

NEW COMPONENT PAK BARGAINS

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	Cl	250	Resistors mixed values apprount by weight	0.68
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	C3	50	Precision Resistors 1%, mixed values	2 % 0.55
	C4	75	hth W Resistors mixed preferr	ed 0.55
	C5	5	Pieces assorted Ferrite Rods	0.55
	C6	2	Tuning Gangs, MW/LW VHF	0.55
	C7		Pack Wire 50 metres associours	_
	C 8	10	Reed Switches	0.55
	C 9	3	Micro Switches	0.55
	C10	15	Assorted Pots & Pre-Sets	0.55
	Cll	5	Jack Sockets 3 × 3-5 in 2 × Standard Switch Type	0.55
	C12	40	Paper Condensers preferred types mixed values	0-65
1	C13	20	Electrolytics Trans. types	0.58
I	C14	1	Pack assorted Hardware— Nuts/Bolts, Grommets etc.	0.55
Į	C15	4	Mains Slide Switches	0.58
1	C16	20	Assorted Tag strips & Panels	0.55
1	C17	10	Assorted Control Knobs	0.55
ì	C18	4	Rotary Wave Change Switches	0.55
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1	PS 38 DIN	5 Pin 240°	0.10
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	PS 40	Jack 3.5mm Switched	0.10
1	PS 41	Jack 1" Switched	0.17
	PS 42	Jack Stereo Switched	0.26
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	PS 44	Phono Double	0.10
1	PS 45	Car Aerial	0.08
1	PS 46	Co-Axial Surface	0.01
,	PB 47	Co-Axial Flush	0.14
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INL	NE SOCKETS	
PS 21	D.I.N. 2 Pin (Speaker)	0.18
PS 22	D.I.N. 3 Pin	0.17
PS 23	D.I.N. 8 Pin 180°	0.17
PB 24	D.I.N. 5 Pin 240°	0.17
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PS 31	Phono Screened	0.14
PB 32	Car Aerial	0.15
PS 33	Co-Axial	0.17
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PILICS

Price

PB	1	D.I.N. 2 Pin (Speaker)	0.1
P8	2	D.I.N. 3 Pin	0.13
P8	3	D.I.N. 4 Pin	0.1
P8	4	D.I.N. 5 Pin 180°	0.14
P8	5	D.I.N. 5 Pin 240°	0-1
P8	6	D.I.N. 6 Pin	0.1
P8	7	8.I.N. 7 Pin	0-1
PS	8	Jack 2.5mm Screened	0.1
P8	9	Jack 3.5mm Plastle	0.0
P8	10	Jack 3.5mm Screened	0.1
P8	11	Jack 1" Plastic	0.1
P8	12	Jack 1" Screened	0-1
PS	13	Jack Stereo Screened	0.2
PS	14	Phono	0.0
P8	15	Car Aerial	0.1
PS	16	Co-Axial	0.1
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CP	1	LES Single Lapped Screen	0.06
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CP	3	Stereo Screened	0.08
CP	4	Four Core Common Screen	0.28
CP	5	Four Core Individually Screened	0.80
CP	6	Microphone Fully Braided Cable	0.10
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CP	8	Twin Oval Mains Cable	0.06
CP	9	Speaker Cable	0.04
CP	10	Low Loss Co-Axial	0.10

Log and Lin 4-7K, 10K, 22K, 47K, 100K, 220K, 470K 1M, 2M	
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VC 1 Single less Switch 0-1	4
VC 2 Single D.P. Switch 0.2	B
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2N3055. Bilicon Power Transistors NPN. Famous manufacturers out-of-spec devices free from open and short defects—every one able! 115w. T03. Metal Case.

OUR SPECIAL PRICE 8 for 41

LOW COST CAPACITORS 01UF 400v. 500UF 50v. Elect. 3p. each

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7" EP. 18%" x 7" x 8". (50 records) #2:10 12" LP. 13%" x 7%" x 12%". (50 records) #2:95

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Holds 12. 10" x 32" x 5". Lock & Handle.

8-TRACK CARTRIDGE

CASES

Holds 14. 13" x 5" x 6". Lock & Handle Holds 24. 13 " x 8" x 5 |". Lock & Hand COLOURS: Red, Black and Tan-Please state preference.

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240v. Primary. Secondary voltages available from selected tappings 4v, 7v, 8v, 10v, 14v, 15v, 17v, 19v, 21v, 25v, 31v, 33v, 40, 50 and 25v-0-25v.

Туре	Amps.	Price	P & P
MT50/1	1	£1.93	80p
MT50/1	i	£2·42	35p
MT60/2	2	#3 30	40p

CARTRINGES

CAKIKIDGES	
ACOS GP91-18C. 200mV at 1-2cms/se	c £1·16
ACOS GP93-1. 280mV at 1cm/scc	\$1.65
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TTC J-2005. Crystal/Hi Output	95p
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CARBON FILM RESISTORS The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:— R1 50 Mixed 100 ohms-820 ohms R2 50 Mixed 1K ohms-8-2K ohms 40p R3 50 Mixed 10K ohms-82K ohms 40p R4 50 Mixed 100K ohms-1 Meg. ohms 40p THESE ARE UNBEATABLE PRICES-LESS THAN 1p EACH INCL. V.A.T.

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C60, 32p C90, 41p C120, 52p

-the lowest prices

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AL10/AL20/AL30 **AUDIO AMPLIFIER MODULES**



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

3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tage recorders, stereo amplifiers and casette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f=1KHz	0.25%
LOAD IMPEDÂNCE		$8-16~\Omega$
INPUT IMPEDANCE	f-1KHz	100 k Ω
FREQUENCY RESPONSE ± 3dB	Po=2 WATTS	50 Hz - 25 K Hz
SENSITIVITY for RATED O/P	$V_8 = 25 V$. $Rl = 8 \Omega$ $f = 1 K Hz$	75mV. RM8
DIMENSIONS	_	3" × 24" × 1"

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

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30,
Power output for 2°_{0} T.H.D. (RL = 8 Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Mm.	10 watts RMS Min.

AUDIO AMPLIFIER

17 10 0		€2-19
AL 10. 3 watt	* 17.3155	
AL 20. 5 watt	RMS	£2·59
AL 30. 10 wat	ts RMS	£3·01
227		

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) SPM 80. (Use with also AL30 & AL50) £3 25 FRONT PANELS SP 12 with Knobs

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4-35 PA 100. (Use with AL30 & AL50) £13-15

TRANSFORMERS

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into Frequency response — 20Hz - 50KHz (-3dB) most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble.

Sensitivity 30 tripped are from left to the property of the specification table. Size 152mm × 84mm × 35mm

Bass control

Bass control—

± 12dB at 60Hz

Treble control—

± 14dB at 14KHz
*Input 1. Impedauce
1 Meg. ohm
Sensitivity 300mV

30 K ohms Sensitivity 4mV

Look for our

SEMICONDUCTOR ADVERTISEMENTS in Practical Wireless Eve Wireless World Everyday Electronics ss World Audio Electronics Today International Radio Constructor

ALL PRICES INCLUDE V.A.T.

The **STEREO 20**

The 'Stereo 20' amplifier is mounted, ready wired and testron a one-piece chassis measuring 20 cm \times 14 cm \times 5.5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble contransformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The Sterce 20° has been designed to fit into most turntable plintis without interfering with the mechanism or alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Oer.) 300mV into 1M. Freq. res. 25 Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12 dB at 50Hz typically 0.25% at 1 watt. Treble con. ± 14 dB at 14 kHz. volume control, balance, base and treble controls

NOW WE GIVE YOU 50w PEAK (25w R.M.S.) P. THERMAL PROTECTION! The NEW AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95

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

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



STABILISED POWER **MODULE SPM80**

AP80 is especially designed to power 2 of the AL50 Amplifers, up to 15 watt (r.m.s.) per channel simultaneously. This module embolies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1-5 amps at 35 volts. Size: 65mm × 105mm × 30mm. These units enable you to build Audio Bystems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address Intercom Units, etc. Handbook available 10p PRICE £3-25

TRANSFORMER BMT80 £2.15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

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



SPECIFICATION

Input overload Supply Dimensions

+ 26dB + 35 volts at 20mA

292mm × 82mm × 35mm ONLY £13·15

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



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31-221_(UG 1094/U)



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per 100 PCS.

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Smiths Time Switch with 24 hour dial which is simple to set to switch on/off twice per day at any times required. Also fitted with two lever switches which can be set to operate two circuits which can each be set to operate on Time Switch twice per day, all day, continouus, or off. Mounted in robust white plastic casing Drilled for fix-

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SA35 35W RMS 25-50V 7 transistors, 7 diodes

Carriage | ★ 25Hz-25kHz: free | ★ 0.2% distortion £4.45 ★ Noise-80dB ★ 500mV into 20K

SA50 £5.65 Carriage 50W RMS 25-65V 7 transistors, 7 diodes

SA100 £10.90

100W RMS 45-70V

 ★ 4-16 ohms
 ★ Simple wiring ★ Short and open circuit proof ★ Continuously rated ★ Top-grade components

120 watt module complete with builtin supply—extra heavy duty £19.75 Carr.



THE SAIM MODULE

POWER SUPPLIES

UNSTABIL	LISED		
PU45	Suits 2 SA35 or 1 SA50	£4-90	Carriage 30p
PU70	Suits 2 SA50 or 2 SA100	£7·75	Carriage 40p
STABILISE	D		
PS45	Suits 2 \$A35 or 2 \$A50	£3·50	Carriage free
MT45	Transformer for above	£3-50	Carriage 30p
PS70	Suits 2 SA100	£4·90	Carriage free
MT70	Transformer for	£4.90	Carriage 40p

N.B. PS70 is not suitable for the \$A50

Mk II STEREO DISCO MIXER £19.75

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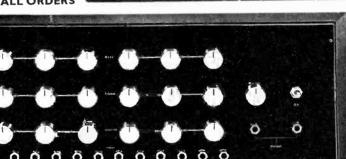
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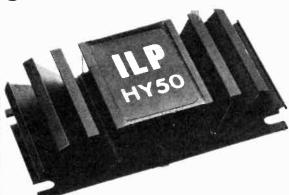
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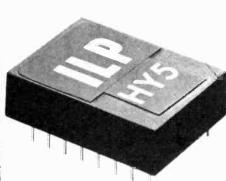
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FM5231 12v FM Tuner

£7-95. SD4912 Stereo Decoder

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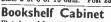
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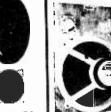
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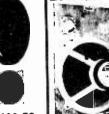






































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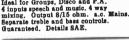
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4 ·0μF 40V 6∮p 100μF 6	3V 14p	2½ x 5"	(DI+:-	, 7p	.7p
4-7μF 63V 6 p 150μF 1	6V 6 p	2 × 3	(Flain), —	
6 8μF 63 V 6 ±p 150μF 6	3V 15p 1	5 x 31	(Fiai	n) —	12p
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10μF 16V 6±p 220μF 1	0V 6 p	Track C			
10µF 25V 6½p 220µF	6V 8p	Pins, Pk	utter		44p
10μF 63V 6½p 220μF 6	3V 21p	11113, 1 8	23	гор	rop
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15µF 63V 6 p 330µF 6	3∨ 25p	TRAN			
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22µF 25V 6 p 470µF 4	0 V 20p	AC128	22p	BC213L	12p
22μF 63V 61p 680μF 1	6V 15p	BC107	Пp	BC214L	17p
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28p 28p 26p 19p 32p 33p	Carbon Trac	IOMETERS k 5K Ω to 2M 10K, 100K, 50
32p 33p 28p 28p 7p 7p 14p 12p 	DIODES IN4001 6½p IN4002 7½p IN4003 9p IN4004 9½p IN4005 14p IN4006 14p IN914 7p	PLUGS DIN 2 Pin 3 Pin 5 Pin 180° 5td. Jack 1.2.5mm Jack Phono SOCKETS
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IN4001 6 p IN4002 7 p IN4003 9p IN4004 9 p IN4005 12p IN4006 14p IN914 7p IN916 7p I	DIN 2 Pin 1 3 Pin 180° 1 5 Pin 180° 1 5 Tin 180° 1 5 Tin 180° 1 5 Tin 180° 1 5 Pin 180° 1 5 Pin 180° 1 5 Std. Jack 14 2.5mm Jack 1 1 Phono 5
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N4001 6½p N4001 7½p N4002 7½p N4003 9p N4004 9½p N4006 14p N914 7p N914 7p N916 7p A100 10p A5 42p	PLUGS DIN 2 Pin 12p 3 Pin 13p 5 Pin 180° 15p 5 Fid Jack 14‡p 2.5mm Jack 1‡p Phono 5 \$\frac{1}{2}p\$ SOCKETS DIN 2 Pin 10p 3 Pin 180° 12p	22/63, 25/25, 25/50, 32/25, 50/25, 100/10, 100/25, 6t p. 50/50, 8p.

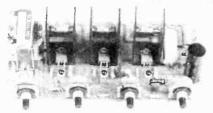
250V: 0 05 μ F, 0 1 μ F, 6p. 0 25. 6p. 0 5 μ F, 7½p. 1 μ F, 9p. 500V: 0 025. 0 05. 6p. 0 1. 6p. 0 25. 7½p. 0 5. 9p. 1000V: 0 01. 11p. 0 022, 13p. 0 047, 0 1. 15p. 0 22, 23p. 0 47, 28p. Soreened Wire, Metre
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ECL80	0 58	EZ80		PL81A	0.88	OF 23/ EEC	1.05	30PL14/	
ECL82	0.01	EZ81	0.40		0.50	30CI/PCF		PCL88	1.25
ECL83	0.68	G Y 501	0.90	PL82		3001/FCF	0.51	30PL15	1.05
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CY31	0.50	EF91	0 37	PCC84	0 40	UY41	0.48	7B7	0.70
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DCC90	1 85	EF98	0.75	PCC189	0.50	VR150-30	0.40	7H7	0.70
DF91	0.80	EF163	0 8 0	PCF80	0 40	QA2	0.40	7R7	0.75
DF96	0.50	EF184	0.85	PCF82	0.85	OB2	0.40	767	2.25
DK91	0.45	EL32	0.60	PCF86	0 60	1 R 5	0.45	7 Y 4	0.75
DK92	0.70	E1,38	1.75	PCF801	0.50	185	0.80	12AT6	0.40
DK96	0.60	EL34	0 60	PCF802	0.80	1T4	0.80	12AT7	0.40
DL92	0.40	EL36	0 50	PCF805	0.90	354	0.40	12AU6	0.45
DL94	0.48	EL37	2.50	PCF806	0.75	3 V 4	0.70	12AU7	0.88
DL96	0.55	EL41	0.90	PCF808	0.90	5R4GY	0.80	12AX7	0.88
DY86/7	0.36	EL42	0-90	PCL82	0.85	5U4G	0.40	12BA6	0.45
DY802	0.87	EL84	0.28	PCL83	0.66	8 V 4 G .	0.50	12BE6	0.50
EABC80	0-88	EL95	0.40	PCL84	0.45	5Y3GT	0.45	30C1	0-40
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EBC81	0.88	EM85	1.00	PD500	1.80	6AQ5	0.45	30FL1	0.80
EBF80	0.40	EY51	0.40	PEN45	0.75	6AB7G	0.85	30FL2	0.75
EBF83	0.40	EY86	0.40	PL36	0.63	6AT6	0.45	30FL14	0.80
EBF89	0.82	EZ40	0.75	PL81	0.50	6AU6	0.80	30L15	1.05
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ECH81	0.80	KT61	1.75	PX 25	8.50	6C4	0.32		
ECH83	0.45	KT66	2.50	PY33	0.68	6CD6G	1.80	35Z4GT	0.70
ECL80	0.55	KT81 (70		PY81	0.50	6CH6	1.40	50CD6G	1-20
ECL82	0.85		1.30	PY82	0.85	6CW4	1.00	807	0.50
ECL83	0.70	KT81	1.75	PY83	0.88	6F23	1.05	813 ITT	
ECL86	0-40	K T88	2.90	PY88	0.40	6F25	1.00	813 UBS	
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AAZ13	0.10	BF115	0.22	Quali	uty	dis	cou	1112	on
AAZ15	0.10	BF167	0.25		-4:	on. S	2	4 6	AE
AC107	0.85	BF173	0.28	appin	all	UII. 🤻	3 E I I	u 3	~ E
AC126	0.25	BF179	0.88	for fu	11 1	icte			
AC127	0-25	BF180	0.35	IOI IU		1212.			
AC128	0.20	BF181	0.35						
AC176	0.25	BF194	0.13	OC16	I-00 .	ZTX501	0.15	2N2904	0.20
AC187	0.20	BF195	0.18	OC20	2.00	ZTX503	0.16	2N 2904 A	0.25
AC188	0.20	BF197	0.15	OC23	1.25	ZTX531	0.25	2N2905	0.32
ACY21	0.22	BF200	0.32	OC25	0.40	ZTX550	0.18	2N2905A	
ACY39	0.65	BFS61	0.25	OC28	0.70	1N914	0.08	2N2906	0.20
AD140	0.50	BFB98	0.25	OC35	0.55	IN4001	0.6	2N2926	0.10
	0.50	BFX29	0.28	OC36	0.65	IN4002	0.7	2N3053	0.20
AD149		BFX88	0.22	OC42	0.40	IN4003	0.8	2N 3055	0.60
AD161	0.39		0.20	OC44	0.18	IN4004	0.8	2N 3525	0.80
AD162	0.39	BFY50	0.20	OC45	0.18	IN4005	0.10	2N3614	0.59
AF115	0.25	BFY51		OC71	0.15	IN4006	0.12	2N3615	0.65
AF116	0.25	BFY52	0.20	0C71	0.25	IN4007	0.12	2N 3702	0.11
AF117	0.20	BFW10	0.61		0.30				0 12
AF186	0-40	BY100	0.15	OC76		1N 4009	0.06	2N3703	
AF239	0.44	BY126	0.14	OC77	0.55	1N4148	0.06	2N3704	0.14
ABY27	0.80	BY127	0.15	OC81	0.28	18921	0.07	2N3708	0.12
ASY28	0.25	BZX61 se		OCSID	0.28	IB2033	0.50	2N3706	0.10
BA102	0.25		0.20	OC81Z	0.45	182051A	0.10	2N3707	0.18
BA115	0.10	BZY88 se		OC83	0.25	IB2100A	0.50	2N3708	0.07
BC107	0.12		0.10	OC140	0.65	183010	0.25	2N3709	0.10
BC108	0.12	CRBI-05	0.30	OC170	0.25	2N696	0.15	2N3710	0.11
BC109	0.12	CR81-40	0.45	OC171	0.80	2N697	0.15	2N3711	0 11
BC113	0.18	CR63-05	0.40	OC200	0 55	2N706	0.10	2N3819	0.35
BC117	0.21	CR83-40	0.55	OC201	0.80	2N706A	0.18	2N3820	0.80
BC143	0.30	MJE340	0.50	OC202	0.80	2N1131	0.25	2N3823	0.50
BC147	0.12	MJE370	0.68	OC203	0.55	2N1132	0.25	2N3903	0.15
BC148	0.10	MJE520	0.65	OCP71	1.00	2N1302	0.18	2N3904	0.20
BCI69C	0.14	MJE2955	1.10	ORP12	0.55	2N1303	0.18	2N3905	0.25
BC182	0.12	MJE3055	0.75	ORP60	0.45	2N1304	0.88	2N3906	0.18
BC182L	0.12	MPF102	0.40	T1005	0.80	2N 1305	0.55	2N4058	0.15
BC184L	0.13	MPF103	0.36	TIC44	0.29	2N1306	0.28	2N4059	0.10
BCY32	1.20	MPF104	0.35	TIC226D	1.50	2N1307	0.28	2N4060	0.18
BCY33	0.38	MPF105	0.46	TIL2C9	0.25	2N1308	0.88	2N4061	0.18
BCY34	0.45	NKT404	0.60	TI843	0.26	2N1309	0.30	2N4062	0.14
BCY70	0.15	OA5	0.60	ZTX 107	0.12	2N1613	0.20	2N4289	0.20
BCY71	0.20	OA10	0.40	ZTX108	0.10	2N1614	0.45	3N141	0.81
BCY72	0.15	OA79	0.10	ZTX300	0.14	2N2147	0.75	40350	0.40
BCZ11	0.65	OA81	0.10	ZTX301	0.14	2N2160	1.00	40361	0-45
BD121	1.00	OA91	0.7	ZTX302	0.20	2N2369A	0.18	40862	0.40
BD124	0.80	OA200	0.08	ZTX304	0.24	2N2646	0.50	40430	0 85
BD124	0.45	OA202	0.10		0.15			30 200	4.00
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TRANSFORMERS

		Ш	111		V.			U	
Bei	SAF	ETY M	AINS	SOLA	TIN	G TRA	NSFOR	1ERS	
Ref.	VA	Weigh	C. 120/.	Size ci	-entr	• Tapp	ed and S	creene	ď
				3126 (1	m.	E	L P		
07	20	1 8	7·0 ×	6-0 x	6.0	2.55	30		
149	60	3 12	9.9 x	7.7 x		3.79	36		
150	100	5 8	9.9 x		8.6	4-17	52		
151	200	B 0	12·1 ×		10.2	7.09		EASE NO	
152	250 350	13 12 15 0		11.8 ×		9.25	67 NE	W ADDE	RESS
154	500	19 8	14:0 X	10.8 x 13.4 x	11.8	12:32 17:87	82 A	S BELO	W
155	750	29 0	17.2 V	14-0 x	14.0	24:31	-		-
156	1000	38 0	17.2 x	16.6 x	14.0	29 87			
158	2000	60 0	21.6 x	15.3 x	18-1		_		
						RMER			
Ref.	VA	Weight	~ 0 . 0	Size c	Marc		to Taps		
No	(Watts)	Ib oz		3/26 (111.	~	to raps	E	& P
113	20	1 0	5.8 x	5-1 x	4.5	0-115-2	0-240	1 - 34	22
64	75	2 4	7.4 x		6.1	0-115-21	0-240	2.64	30
66	150	3 4	8.9 x		7.7	0-115-20	0-220-240	3 - 18	36
67	300 500	6 4	9-9 x	9.6 x	8.6	1.0		6-19	52
84	1000	19 8	14:0 ×	11-2 x 13-4 x	10.2	* *	4.2	9.20	67
93	1500	30 4	14-0 X	15.9 x	14.3		6.7	16:71	82
95	2000	32 0	17.2 £	16.6 x	14.0		* *	31.57	-
73	3000	40 0	21.6 x	13.4 x	18-1		**	39.17	
		CAS	ED AL	JTO T	RAN	SFORI	MERS		
1150	500W	enclose	d tran	sforme	r, wit	h mains	lead and	two I	15V
outie	t socke	ts. 49-4	19. P &	P 67p.	20 W	att vers	on £2 02	P % P3	7p
			TRA	NSF	ORN	1ERS			
PR	IMAR	240-25	O VO	TS 12	AND	OR 2	VOLT	RANG	E
Ref.	Ambs.	Weigh		Size cm			y Windin		
No. I	2V 24V	lb o	z				,	£	ı,
111 (0.5 0.2					0.12V a	t 0.25A x	2 1.34	22
213 1	2 0.5	1.4			4.8	0.12V a	t 0.5A x 2		22
íå	4 2	1 12			6-1	0.12V a	t IA x 2	2.09	22
70	6 3	3 8			7.7	0.124 2	t 2A x 2 t 3A x 2	2.95	30
108	8 4	5 8		8.9 x	8.6	0.127.3	t 4A x 2	3·52 3·96	42 52
72	10 5	6 4		9.6 x	8.6	0.127	t 5A x 2	4.67	52
116	12 6	6 12		10.2 x	8.6	0-12V a	t 5A x 2	5.61	52
	16 8	8 12		9.9 x	10.2	0-12V a	t 8A x 2	7.22	52
	20 10	11 8		9.6 x	8-11	0-12V a	t 10A x 2	9.20	67
	30 I5 60 30	15 8		12·1 ×	11.8	0-12V a	t 15A x 2	16.94	82
440	60 30	32 0	17-2 x	15-3 x			t 30A x 2	31.28	٠
Ref.	Amer	M/nint-			30 ₹	OLT	RANGE		
No.	Amps.	Weight Ib oz		Size cm.		Seconda	y Taps		& P
112	0.5	1 4	6-1 x	5-8 v	4.8 n.	12 15 2/	-24-30V	£ 1∙56	22
79	1.0	2 4	7.0 x	6.7 x	61	12-13-20	7-24-30 V	2.11	36
3	2.0	3 4	8.9 x	7·7 x	7.7	* * * * * * * * * * * * * * * * * * * *		3.18	36
20	3.0	4 8	9.9 x	8.3 x	8.6			3.96	42
21	4:0	6 4	9.9 x	9.6 x	8.6		11	4.67	52
				0.6 1					

3	2.0	3	4	8.9	×	7.7	7 ×	7.7			3.18	36
20	3.0	- 4	8	9.9	×	8.3		8.6			3.96	42
11	4.0	- 6	- 4	9.9					1.5	11		
			. 7							11	4.67	52
51	5.0	6	12	12-1	×	8.6	×	10.2	100	141	5.83	52
١7	6.0	8	0	12-1	~			10.2			6.94	52
88										4.9		
	B-0	12	0	12-1	×	11.8	З×	10.2			9.00	67
19	10.0	13	12	14-0		10.3		11.0				
-				170	^	10.2		11.0	1.0	1.1	11.36	67
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f.	Amps.		eigh	t	5	ize	cm		Secondo	iry Tabs	ρ.	& P
٥.		iЬ	οz								€.	. 6
)2	0.5		12	7.0		6-4			0.10.05	33 40 501		
		- 1						6-1		33-40-50V	2.09	30
)3	1.0	2	12	8.3	×	7.4		7.0			2.09	2.6

No.		iЬ	OZ						£	Þ
102	0.5	- 1	12	7·0 x	6.4 x	6-1	0-19-25-	33-40-50V	2.09	30
103	1.0	2	12	8-3 x	7.4 x	7.0	79		3.08	36
104	2.0	5	8	9.9 x		8.6		11	4.26	42
105	3.0	6	12	9.9 x	10·2 x	8.6	**		5.79	52
106	4.0	10	0		10.5 x		- 11		7.69	52
107	6.0	12	ŏ		10.2 x			**	11.38	67
118	8.0	18	0		12.7 x			20	12-40	97
119	0.01	25	ō		12.7 x				18.62	7,
							60 VÖLT	PANC		

									60 VOL	TRANC	iΕ	
Ref.	Amps.	· V	Veig:	ht .	Si	ze cn	n.		Secondo	ary Taps	Р	81 P
Vo.		IЬ	οż							,	6	~ p
24	0.5	2	4	7.0	×	6.7	×	6.1	0-24-30-	40-48-60	2.12	36
26	1.0	3	4	8.9	×	7.7	×				2.97	36
27	2.0	6	- 4	9.9	×					**	4.67	42
25	3.0	8	12	12-1	×	9.9	×	10.2	- 5	**	7.11	52
23	4.0	13	12					10.2			9.20	67
40	5.0	12	00	14.0							10 83	87
20	6.0	15	8	14.0					**		13-35	82
21	8.0	25		14.0							15.01	0.2
22	10.0	25	ő	17.2					1.4		22.10	
89	12.0		00	17.2					1.4	**		
٠,	120	4,7	00	17.7	~	140.		14.0	111	1.5	24.74	•

189	12:0 29 (00 17-2	2 x 14·0 x 14·0	0 0	24.74	•
	MINIATU	JRE TR	ANSFORME	RS WITH SCRE	ENSPL	P
Ref.	MA.	Weight	Size cm	VOLTS	-	P
238	200	2	2 8x2 6x2 0	3-0-3	1.44 1	ő
212	IA IA		6 1x5 8x4 8	0-6 0-6		ž
13	100	4	3 9x2 6x2 9	9-0-9		ō
235	330,330	- 4	4-8x2-9x3-5	0-9, 0-9		ō
207	500, 500	1 00	6 1x5 4x4 8	0-8-9, 0-8-9		2
208	IA, IA	1 12	7 · 0x6 · 4x6 · I	0-8-9.0-8-9		ō
236	200, 200	- 4	4 · 8×2 · 9×3 · 5	0-15, 0-15	1.67 /	ò
214	300, 300	1 4	6 · l x5 · 8x4 · 8	0-20, 0-20	1.76 2	2
221	700 (D.C.)		7-0x6-1x6-1	20-12-0-12-20	1.55 3	ō
206	IA, IA	2 12	8 · 3×7 · 7×7 · 0	0-15-20, 0-15-20	4.05 3	6
103	500, 500	2 4	8 · 3×7 · 0×7 · 0	0-15-27, 0-15-27	3-10 3	8
204	IA, IA	3 4	8 9x7 7x7 7	0-15-27, 0-15-27	3-15 3	Ä

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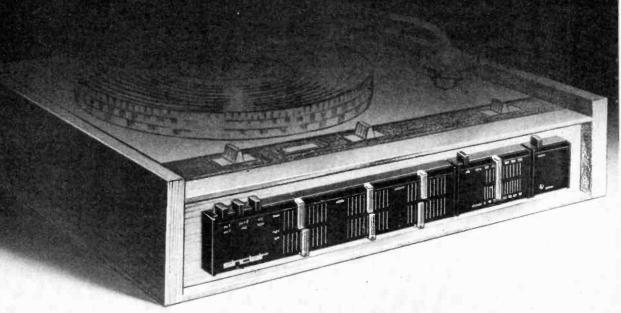
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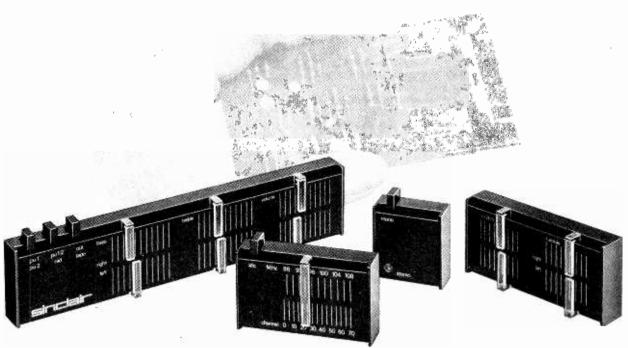
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Sinclair Radionics Ltd London Rd . St Ives Huntingdon PE174HJ Telephone St Ives (0480) 64646 Stereo 80 Control Unit Size = 260 · 50 · 20mm (10½ · 2 · ½ins) Finish - Black with white indicators and transparent sliders Inputs - Magnetic pick up 3mV RIAA corrected. Ceramic pick up 350mV Radio 100mV; Tape 30mV Signal/noise ratio - 60db Frequency range = 20Hz to 15KHz · 1dB, 10Hz to 25KHz · 3dB Power requirements - 20 to 35 volts Outputs - 100nV AB monitoring for tape Controls - Press button tape radio and P U Sliders on each channel for volume bass treble RRP £11.95

Project 80 FM Tuner size – 85 50 20mm (3 $\frac{1}{2} \cdot 2 \cdot \frac{1}{2}$ ins) Tuning range Dual varicap – 87 5 to 108MHz Detector – 1C balanced coincidence One I.C. equal to 26 transistors Distortion – 0.2% at 1 KHz for 30% modulation 4 pole ceramic filter in I.F. section Aerial impedance – 75 α or 240 300 α Sensitivity – 5 microvolts for 30dB S/N ratio Output – 300mV for 30% modulation Power requirements – 25 to 35 volts (R.R.P. add £1 19 V.A.T.) £11.95

Project 80 Stereo Decoder size = 47 · 50 · 20mm (1% · 2 · 3 ins) One 19 transistor I.C. Channel separation greater than 30dB Power requirements = 25V Output 150mV per channel (add 74p V A T.) $\begin{array}{c} \text{RRP} \\ \text{(add 74p V A T.)} \end{array}$

Active Filter Unit separate controls on each channel Size – 108 50 - 20mm (4½ 2 - ½ins) Voltage gain — minus 0 2dB Frequency response — 40Hz to 22KHz controls minimum Distortion — at 1KHz = 0 03% using 30V supply H F cut off (scratch) = 22 KHz to 5 5KHz, 12dB/oct slope LF. cut off (rumble) = 28dB at 20Hz 9dB/oct slope R R P (add 69p V A T)

Z.40 Power Amplifier size = 55 80 · 20mm (2 $\frac{1}{8}$ · 3 $\frac{1}{8}$] ins) 9 transistors Input sensitivity = 100mV Output 18 waits RMS continuous into 4 Ω (35V) Frequency response = 30Hz · 100KHz; 36B S/N ratio = 64dB Distortion = at 10 waits into 8 Ω less than 0.1% Power requirements = 12 to 35 volts, built in protection against overload RRP, £5.40

Z.60 Power Amplifier size – 55 98 × 15mm ($2\frac{1}{4} \cdot 3\frac{1}{4} \cdot 3\frac{1}{4} \cdot 31$) 12 transistors Input sensitivity – 100-250mV Output – 25 watts RMS continuous into 8 Ω (50V) Distortion – typically 0-03% Frequency response – 15Hz to more than 200KHz ± 3dB S/N ratio – better than 70dB Built-in protection against transient overload and short circuiting Load impedance – 4 Ω min safe on open circuit RRP (add 69p V.AT) £6.95

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SURPRISE!

PROBABLY one of the most interesting features about our activities is that there is always a chance of the unexpected happening. It may be an unusual DX contact, or a circuit design that behaves in a different manner than expected. It could be that someone comes up with a new integrated circuit that can replace a mass of discrete circuitry. The element of surprise always helps to make a magazine interesting; readers are incredibly thirsty for such information because it is born out of curiosity (see last month's leader). Whilst curiosity is the expectation, you may describe surprise as "unexpectation"—if there was such a word.

At the same time, to preserve the value of surprise, one must exercise some degree of secrecy until it is reasonably sensible to release the full details. However, we often find ourselves caught between these two positions when we have to judge how much we can tell you in advance and how

much to leave until the last minute.

For this reason, little information was released about Tele-Tennis, much to the disappointment of our competitors and those who have a commercial interest, and little was released about the "PW Super Separates" that are being started in this issue. So far, we can tell you that the "PW Derby" is a high quality amplifier designed specially for us and described by the co-designer of the "Gemini" amplifier. What follows in future articles in this series must remain secret until the time is right to let readers know.

However, we can tell you that these designs are of a very high standard. For those readers who have a good domestic set-up already, we can probably help you to fill the gaps. If you are looking for a second set-up for the bedroom or

spare room, then stay tuned to P.W. every month.

The great advantage of the "P.W. Super Separates" is their flexibility; you don't have to spend a lot of money to build a complete integrated unit, that seems to go on endlessly for about a year. Take your choice and we shall try to publish all the required details of each project.

What better to start with than a stereo headphone amplifier, rapidly becoming the accepted way of personal listening, where the 20 or 30 watt amplifier is more expensive and often too much for personal listening. For information on future projects watch our advance notices each month.

Before packing my bags for a fortnight's holiday, there is just one more point. We understand that some readers are having difficulty in obtaining P.W. and that the Tele-Tennis game has created a rapid demand as soon as it appears. If there are none left on display in your newsagents shop, ask the assistant if they have any more. The chances are that there may be some in the stockroom. Better still, why not place a regular order or take out a subscription and be sure of it.

M. A. COLWELL—Editor.

The September issue brings you to the second in the "P.W. Super Separates"—the P.W. Epsom Short Wave Receiver, designed to provide wide coverage of both amateur and broadcast transmissions; a very useful practical article on the use of field transistors; an add-on "squelch" for suppressing noise in audio systems; and of course part 3 of "Tele-Tennis".

Further details on page 327

(All advanced details are subject to the current industrial situation)

NEWS...

BBC and quadraphony

THE BBC has been working for some time on the possible applications quadraphony to broadcasting. A number of four channel recordings have been made using different production techniques and several transmission systems have been examined. Unfortunately, no system has yet been devised which would enable quadraphonic material to be broadcast from a single v.h.f. transmitter while at the same time providing fully satisfactory reception to listeners using monophonic or stereophonic receivers.

The results obtained with some quadraphonic recordings are impressive, and there is considerable public interest in this development. To enable those who were interested to hear a number of recent BBC quadraphonic recordings, there was an experimental broadcast from 12.05 am to 1 am on the early morning of Saturday, 6 July. Two groups of stereo transmitters were used, Radio 2 carrying the left and right front signals, with Radio 3 carrying the left and right rear signals. To take full advantage of the quadraphonic transmission, listeners required two complete stereophonic receivers, one tuned to Radio 2, feeding the 'front' loudspeakers; a second stereo receiver tuned to Radio 3 connected to the 'rear' speakers.

The special programme included a variety of different musical items as well as some drama and outside broadcast material. The BBC would be grateful for reports from listeners who were able to hear this experimental broadcast.

It must be emphasised that there is no possibility of a regular quadraphonic service on the basis of two separate transmitter networks, but the BBC will continue its investigations into the possibility of a system to provide quadraphonic programmes from a single transmitter, without degrading the results obtained by those with mono or stereo receivers.

NEWS..

NEWS...

NEWS...

Interface 74

EXAS Instruments recently held a very interesting seminar called 'Interface 74'.

Several excellent lecturers spoke on new bipolar IC's and their applications and a very interesting talk on new opto-electronic products by Martin Abbott followed.

An ultrasonic remote-controlled-colour TV was demonstrated by Clive Hoggar, Product Marketing Manager (Consumer IC's) and this was followed by a talk on power transistors presented by John Thorogood and Bryan Norris, Texas Instruments' Applications Manager.

The "star of the day" was Pauline Hamill, Product Marketing Manager for Small Discrete Products. She gave a most interesting lecture (despite a dodgy radio mike!) on Timtor transistors to over 300 male delegates who sat in awed silence. At the end of her talk, Pauline received a great round of applause. (think what courage you would need fellas, to lecture to over 300 women!) Well done Pauline!

Millis Miller, in a lilting Texan accent told the delegates all about the various applications of optoelectronics and this was followed by a talk describing new MOS products.

The day's lectures finished with a question and answer session chaired by Richard Mann, the "mann" who very ably organised and produced the seminar. Richard is the Market Communications Manager of Texas Ltd.

All the delegates were presented with a very comprehensive Data Pack.

Texas hold these seminars every year and they're jolly good value for money, so if you want details of future presentations, contact T. I. Limited at Manton Lane Bedford (0234-67466).

Preston rally

N 18th August Preston Amateur Radio Society are holding their mobile rally at Deepdale Primary School, St. Stephen's Rd., Preston.

Marconi Exhibition at Science Museum

NCLUDED in the Science Museum, London, exhibition commemorating the centenary of Guglielmo Marconi is a case of personalia like this silver table lighter made in the form of a disc discharger used in the Marconi Company's early long range transmitters. A number of these lighters were made for presentation to delegates attending a conference arranged by the Company in 1912.



(Science Museum photo).

Lee Products

EE PRODUCTS (GB) are marketing a range of Aiko home entertainment and ICE products under an agreement with the Japanese manufacturer.

Aiko products are added to the existing Elizabethan, Elpico and Dulci brand names.

The 14 Aiko products range from portable cassette tape recorders to a stereo casette deck operating with the Dolby system and priced at £135 including VAT.

The announcement of the Aiko range coincides with Lee Products move to their new premises at Dallas House, Aintree Road, Perivale, Middlesex.

Sinclair price drop

UROPE's largest manufacturer of pocket calculators, Sinclair, has cut the retail price of its "Cambridge" model to £24 95 plus VAT.

Mr. R. Helmer, Sinclair's marketing manager stated recently that the firm's motive for making the price reduction is to open up a vast new market potential which recent research shows exists around the £20 mark.

The firm state that they are able to bear the price cut because of the scale already achieved on the production of the Cambridge. More than 200,000 units have been sold since its introduction last August.

Mr. Helmer said that 17,000 of the 25,000 units manufactured every month were required for export.

The Cambridge is still available in kit form at £14.95 plus VAT.

Our Front Cover

THE Zero 100 SB automatic single player featured on our cover this month was kindly loaned by Garrard Engineering. The Zero 100 was first introduced in 1971 and has established an excellent reputation, especially for its tangential tracking arm. This unique arm, with its pivoted head is claimed to economically reduce tracking error and harmonic distortion to virtually zero.

The Zero 100 SB retains the refinements included in the earlier decks but has the added advantage of belt drive and an automatic record counter to help monitor stylus wear.

Recommended retail price of the unit, fitted with a Shure M93E cartridge is £69·72. Further information may be obtained from Garrard Engineering Ltd., Newcastle Street, Swindon, Wiltshire.

SORRY WE ARE LATE!

We apologise for the late appearance of Practical Wireless. The delay has been caused by an industrial dispute within the printing industry.



COMMON procedure used to obtain reception of signals in the 2m Amateur band is to employ a crystal-controlled converter the output of which is coupled to the aerial input of a standard short wave communications receiver, which is utilised as a tunable IF strip.

Commercial converters are, in the main, quite expensive and in some cases can cost nearly as much as the listener's main receiver. The converter to be described can be built at less than half the cost of its commercial counterpart but, unfortunately, many constructors have a great deal of difficulty, if not in the actual constructional work involved, then in the alignment of the various stages of the converter.

Perhaps the biggest problem in attempting to construct a published design is the duplication of the low inductance coils and persuading them to resonate at the desired frequencies. The problem is made doubly difficult, if not impossible, by the lack of the appropriate test equipment.

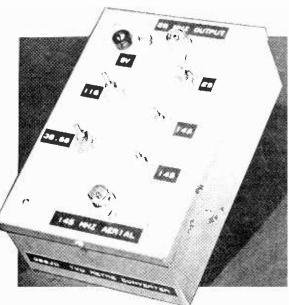
On first inspection of the various component catalogues and coil data available no coils are specifically manufactured for frequencies higher than approximately 80 MHz. The types available nearest to our requirements are the Denco Range 7 coils, intended initially for valve usage to cover a frequency range extending up to 78 MHz. Comparatively large parallel capacitance is used to achieve this coverage and simple calculations reveal that, using much smaller values of parallel capacitance, coverage to at least 150 MHz was possible. With this fact in mind the present design was evolved.

THE CIRCUIT

The circuit of the complete converter is shown in Fig. 1. The RF stage Trl employs an AF139 in the common-base mode with untuned input from the aerial and a double-tuned bandpass arrangement at the output to feed the mixer, top capacitance coupling being provided by means of C4. Extra gain could have been achieved by employing the same transistor in the common-emitter configuration, but this would have required some form of neutralisation so in the

interests of simplicity this was not thought to be desirable. The circuit used has been found, in practice, to provide ample gain and has at no time showed any signs of instability when using such diverse aerials as random lengths of wire and multi-element Yagi arrays.

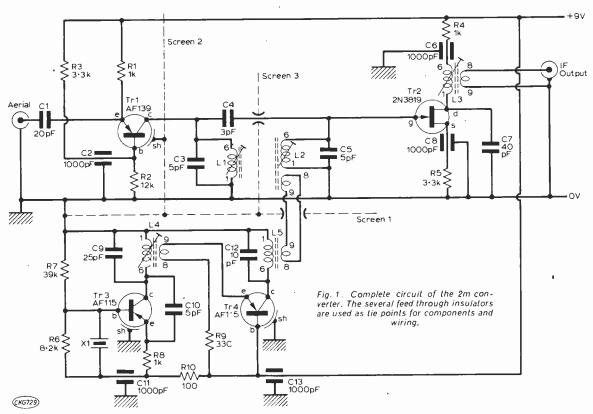
The crystal oscillator stage Tr3 employs an AF115 as does the common-base frequency multiplier Tr4. The frequency of oscillation is controlled by the quartz crystal X1, C10 providing the necessary feedback capacitance to maintain oscillation. The circuit will not oscillate unless the tuned circuit L4/C9 is resonant near to the frequency of the crystal, which in this case is 38-666 MHz, adjustment of the tuned circuit being achieved by means of the core in L4. The 38-666 MHz output is then link coupled to the tripler stage Tr4, the output of which is tuned to 116 MHz and link coupled via L5 to the gate circuit of the 2N3819 FET mixer Tr2.



The amplified RF signal at 145 ± 1 MHz is then mixed with the oscillator output frequency at 116 MHz. The difference frequency 29 ± 1 MHz is then extracted from the FET drain circuit and fed via L3, which is tuned to 29 MHz by C7, to the main receiver aerial socket. With the converter oscillator frequency operating below signal frequencies, the direction of tuning on the main receiver will be maintained. This means that when tuning from 28 MHz up to 30 MHz on the main receiver, the converter is tuning from 144 MHz to 146 MHz.

CONSTRUCTION

The converter is housed in a readily available aluminium box with lid measuring $6\times4\times2$ in allowing ample room for the coils and other components. Most of the wiring and small components are accommodated on a $5^1{}_2\times3^1{}_2$ in piece of single sided copper clad board Fig. 2 which has the advantage that components and screens can be soldered directly to it, enabling short earth returns to be made.



★ components list

_		ponenes				
	Resis	tors		•		
	R1	1kΩ	R6	8-2kΩ		
1	R2	12kΩ	R7	39kΩ		
l	R3	3 · 3kΩ	R8	1kΩ		
۱	R4	1kΩ	R9	330Ω		
l	R5	3·3kΩ	R10	100Ω		
l		All resistor	s ‡ or ⅓W 10			
	Capa	citors		j		
ļ	C1	20pF TC	C8	1000pF FT		
١	C2	1000pF FT	C9	25pF TC		
ı	C3	5pF TC	C10			
ı	C4	3pF TC	C11	1000pF FT		
	C5	5pF TC	C12	10pF TC		
ł	C6	5pF TC 1000pF FT	C13	1000pF FT		
l	C7	40pF TC				
	TC	Tubular Ceram	ic FT F	eedthrough		
	Semi	conductors				
l	-Tr1	AF139	Tr3/4	AF115		
		2N3819	4 30 1101			
	Indu	ctors				
l		2/5/ Range 7 Re	N Seguration and			
	L3/4		I O			
l	All D	enco miniature	dual-purpos	se (valve type) coils.		
l	Cores	must be specif	ically reques	sted for the Range 7		
	coils.	4				
	Misc	eilaneous				
	Alu	minium box 6 x	4 x 2in (Type	AB13). Copper-clad		
	board 5½ x 3½in. Coaxial sockets (2). Battery plugs/					
				z HC6U or HC18U		
1						

(Serator Crystals, 36 Valleyfield Rd., London,

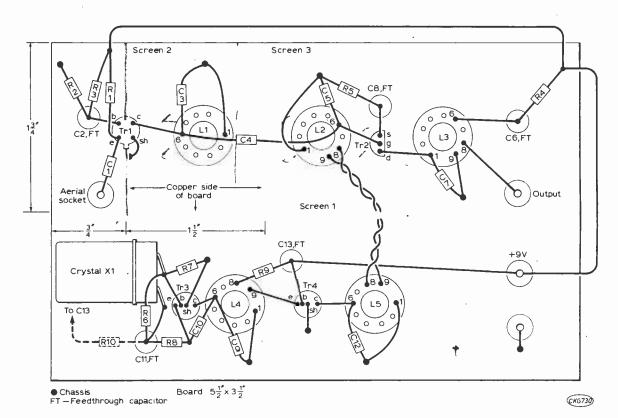
SW16 2HR).

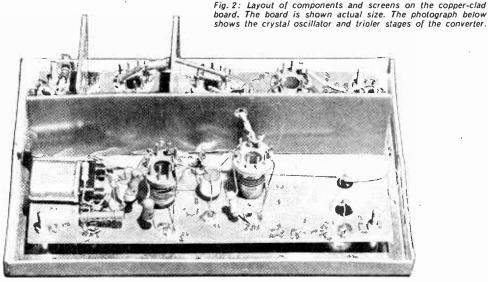
The copper clad board is mounted on \$\^3_8\$in spacers, one at each corner, and the five Denco coils are mounted on the aluminium box lid. This means that although \$^1_4\$in fixing holes are needed in the lid, \$^1_2\$in holes are required in the board so as to clear the main form of the coils. This method of construction, in effect, lowers the coil pins enabling shorter coil connections to be made, which is a distinct advantage at the frequencies involved. The two coaxial sockets and the battery sockets are also mounted on the box lid, holes being suitably provided in the copper board to take their connections.

The copper board should be cut and drilled Fig. 3, making sure that holes have been provided for all the coils, the feedthrough capacitors and the aerial, IF output and battery leads plus of course the holes for the 6BA fixing nuts and bolts. This board can then be used as a template for drilling the box lid. The feedthrough capacitors can now be soldered or bolted into position cutting off just enough of the pins on the non-copper side of the board so that they do not make contact with the underside of the box lid when it is in position.

At this point R10 must be soldered into position between the projecting pins of C11 and C13 on the non-copper side of the board. The aerial, IF output and battery sockets can now be fixed in position on the box lid and the copper board mounted on its spacers ready for wiring the remainder of the components.

Short direct wiring must be used and special care taken when soldering to the coil pins. The polystyrene formers used for the coils will melt if subjected to excessive heat and it is perhaps a good idea to use a heat sink on the coil pins, as well as on all the transistor leads, when soldering.





The crystal used in the original converter was of the HC6U type and the necessary crystal holder was glued in position on the copper board.

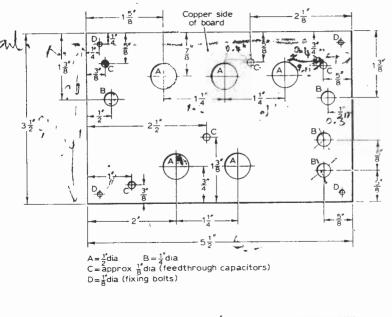
A wire ended crystal of the HC18U type could also be used, no holder then being required.

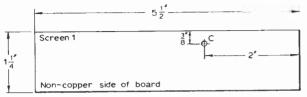
ALIGNMENT

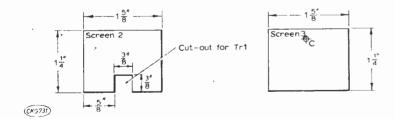
Before any 2m signals can be heard with the converter the crystal oscillator stage Tr3 must be operating. Adjustment of L4 core will make the oscillator work. This can be checked by connecting a meter in series with one of the battery leads and adjusting L4 for a peak in current, indicating that the

oscillator is functioning correctly The battery supply should be switched on and off several times to ensure that the oscillator works every time. If the oscillator fails to restart at any time, tune L4 very slightly to the high frequency side of the current peak, i.e. anticlockwise about half a turn. Adjustment of L5 core should now produce another similar but smaller increase in current when tuned to 116 MHz.

Operation of the oscillator on any frequency other than 38-666 MHz and thus the multiplier on 116 MHz, was found to be impossible with the values of parallel capacitance used. In order to align the emaining tuned circuits the converter should now be coupled to the main receiver by means of a short length of







coaxial cable and the receiver tuned to 29MHz. A suitable 2m aerial should be plugged into the converter aerial socket. The IF output coil L3 and the two 145 MHz tuned circuits L1 and L2 should be peaked by means of their respective cores for maximum noise from the loudspeaker or headphones. The coils should now be very close to their correct settings and any strong signals on the 2m band should be heard if the main receiver is tuned from 28 to 30MHz. The coils can then be finally adjusted on these incoming signals.

As a guide when setting the coil cores the length of brass studding projecting from the top of coils L2, L4 and L5 when correctly aligned was 0.4in, L1 was 0.3in, and L3 was 0.2in. When final alignment has been completed the cores can be locked in position with 6BA nuts.

AERIALS

Although a simple dipole or halo type of aerial will provide satisfactory reception of signals from local or near local stations, the increase in range obtained by using a multi-element Yagi aerial far outweighs its cost and is a very worthwhile acquisition. Dimensions for a simple half-wave dipole suitable for initial tests are given in Fig. 4.

The choice of output frequency of the converter was purely a personal one and 28 to 30 MHz used because an Amateur-bands-only receiver was in

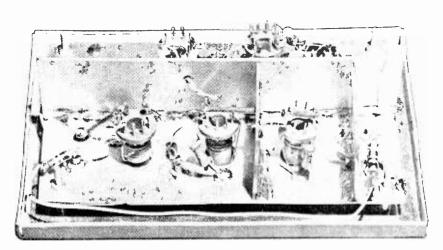


Fig. 3: Top left, gives all the drilling information required to prepare the board for wiring. The screens are soldered directly to the main board as are many of the component earth returns. The photograph emphasises the simplicity of the design. This view is of the RF tuned circuits and the IF output coil L3 at extreme left.

use. It is realised that not all general coverage receivers provide adequate performance at such high frequencies, often lacking in sensitivity, image frequency rejection and bandspreading facilities. In such cases a lower tunable IF is desirable, the most popular seeming to be 4 to 6 MHz. For this lower IF the crystal must be changed to 46·666 MHz, C9 to 18pF, C12 to 6·8pF. C7 to 35pF and L3 to a Range 3 Blue coil.

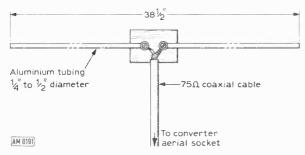


Fig. 4: This simple dipole will do for initial tests of the converter but a beam aerial will greatly improve results.

Although the converter is fully screened, if the lower IF is used trouble may be experienced with signals breaking through at the tunable IF frequencies, especially if the main receiver is not fully screened. The shortest practicable length of coupling coax should be used in these cases and if this is unsuccessful the metal case of the converter should be bonded to the main receiver case by a short metal strap.

NTEMERUSS No. 5 Solution



TELEUS III

IN THE AUGUST ISSUE

COMPONENT DISTRIBUTION SURVEY

Along with the rapid growth of the electronics industry in recent years there has arisen a very complex component distribution system. In fact there are so many manufacturers and suppliers operating with many different trading policles that it can be difficult and time consuming to find out what is the best course to adopt in seeking supplies, whether for one-off construction, servicing requirements or equipment manufacture. "Television's" survey next month examines this field with the aim of giving readers a clear picture of the current situation, and lists the trading policies and stock lines of a number of suppliers who are likely to be useful to readers.

SERVICING TELEVISION RECEIVERS

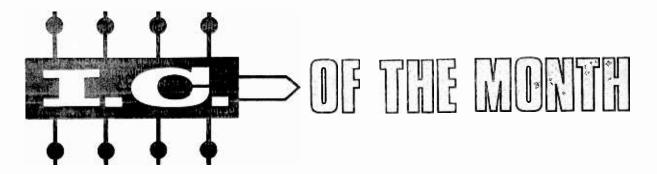
The next chassis to be covered by Les Lawry-Johns is the BRC/TCE 1590/1591 solid-state mainsbattery portable chassis.

LINE OUTPUT STAGE PROTECTION CIRCUIT

When the line generator falls to oscillate the line output pentode is left without bias and draws a very heavy current. This can damage not only the line output valve but the boost diode and line output transformer as well. It is tempting to speculate on how many line output valves and other components have been unnecessarily destroyed in this way over the years. Keith Cummins decided to see whether there was a simple solution to the problem and found that for a matter of pence an effective protection circuit could be built.

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Number 46

LM381N DUAL LOW NOISE AMPLIFIER

THE National Semiconductor LM381N device contains two similar low noise preamplifiers in a single integrated circuit. It has a wide range of uses in entertainment equipment, such as amplifying the signals from stereo tape recorder heads or cartridges. It is an ideal device for amplifying low level signals in low noise applications. The amplifiers are completely independent and each provides a gain, without feedback, of about 112dB; a voltage gain of 160,000.

The device provides a channel separation of 60dB whilst the internal power supply decoupling and regulator circuits provide 120dB rejection of signals on the power supply line, such as mains hum. Although many attempts have been made to use suitable operational amplifiers for low noise audio applications, the availability of the new LM381N designed specifically for these applications makes it possible to obtain lower noise levels, better rejection of signals on the power supply lines, wider bandwidth, with fewer external components.

A specially selected ultra-low noise version of the LM381N is available under the coding LM381AN. It is used in critical applications requiring the lowest possible noise levels, such as hydrophone amplifiers, studio sound equipment, scientific instrumentation etc. The LM381AN is naturally somewhat more expensive than the more commonly used LM381N.

The LM381N operates from a single power supply in the range 9V to 40V. The typical supply current is 10mA. The device contains internal circuits which protect it from damage if the output is accidentally shorted limiting the output current to about 12mA. The maximum output voltage swing which can be

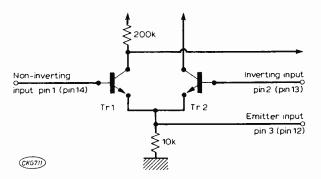


Fig. 1: The internal input circuit of the LM381N.

obtained from the LM381N is only 2V less than the power supply voltage used. The total harmonic distortion is typically 0.1%.

Input

The basic circuit of the input stage of one of the amplifiers in the device is shown in Fig. 1. In the circuits and text the pin numbers of the second amplifier will be shown in brackets. The optimum noise performance is obtained with 'single ended operation'. In this case Tr2 is biased OFF and feedback is taken to the common emitter of pin 3 (pin 12). Noise figures with single ended operation are typically 1dB with $50 \mathrm{k}\Omega$ input impedance, $1\cdot 3\mathrm{d}B$ with $10\mathrm{k}\Omega$ and $1\cdot 6\mathrm{d}B$ with $5\mathrm{k}\Omega$ input over the frequency bandwidth $10\mathrm{Hz}$ to $10\mathrm{kHz}$.

When the extra noise contributed by Tr2 can be tolerated, the feedback may be taken to the inverting input of pin 2 (pin 13). The impedance at the base of Tr2 is about one hundred times higher than that at the emitter; smaller capacitors and larger resistors can therefore be employed when the feedback in tone and equalization circuits is returned to the base. However, in this 'differential' configuration the noise is increased by a factor of $\sqrt{2}$. The input impedance is of the order of $100 \mathrm{k}\Omega$ whilst the output impedance is 150Ω .

Bandwidth

The amplifiers each contain an internal frequency compensating capacitor which results in a gain-bandwidth product of about 15MHz. This is the frequency at which the gain falls to unity. This compensation is adequate to preserve stability at a

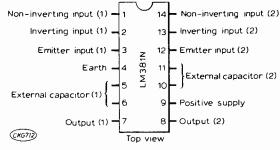


Fig. 2: The connections of the LM381N. The connections to the two internal amplifiers are distinguished by the numbers in brackets.

closed loop gain of 10. A suitable external capacitor may be placed in parallel with the internal capacitor connecting between pins 5 and 6 (pins 10 and 11), Fig. 2. This reduces the amplifier bandwidth and thus removes most of the high frequency noise.

Applications

Tape Playback Preamplifier using the LM381N is shown in Fig. 3. Tape playback amplifiers must contain frequency compensation circuits so that the overall record-replay operation shall produce a level frequency response. The capacitor C1 provides an amount of negative feedback which increases with rising frequency. The gain therefore decreases with rising frequency, the circuit being designed to have a response complying with the NAB standard for a tape speed of 334 i.p.s.

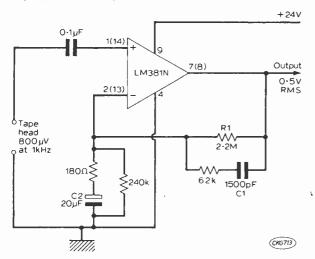


Fig. 3: A typical tape playback preamplifier.

The circuit will convert an output of 800μ V from a playback head into a 0.5V RMS signal at the preamplifier output at a frequency of 1kHz, a voltage gain of 56dB. This circuit requires about five seconds before it can be used after the power has been supplied since C2 takes time to charge through R1.

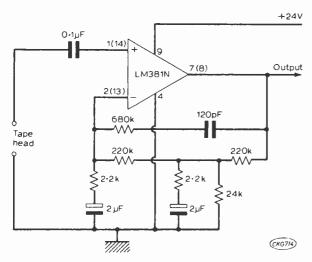


Fig. 4: A fast turn-on tape playback amplifier.

The circuit of Fig. 4, is slightly more complex than Fig. 3 but it has the advantage that it can be used immediately the power is applied. It has been designed to have a similar performance to that of the Fig: 3 circuit. The 120dB rejection of signals on the power supply line has been preserved in this circuit.

Tape Record Preamplifier used to feed tape recording heads must also be tailored to produce the correct response. Consider the case where a microphone producing a peak output signal of 10mV is required to drive a tape recording head which requires 30µA of audio drive current. This requirement can be met by the circuit of Fig. 5. A single ended input circuit is used for optimum noise performance.

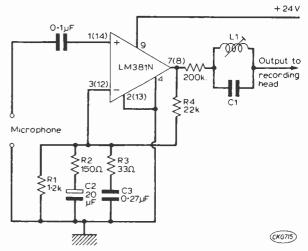


Fig. 5: A preamplifier for driving a tape recording head.

The values of the inductance L1 and of the capacitor C1 should be chosen to suit the particular recording head used. The feedback network R1 to R4, C2 and C3 provides the required frequency response.

Magnetic Pick-ups provide outputs which are typically in the range $3.5 \,\mathrm{mV}$ to $8 \,\mathrm{mV}$ at a velocity of $5 \,\mathrm{cm/second}$; high quality recordings use velocities of this order. The output is proportional to the velocity.

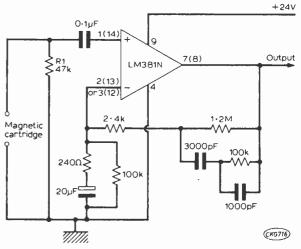


Fig. 6: A preamplifier for use with a magnetic cartridge in a record __ player.

A typical preamplifier for use with a magnetic pick-up is shown in Fig. 6. It provides the required response which falls with increasing frequency and has been designed for use with a cartridge of 0.5mV/ cm/sec sensitivity. The circuit will drive a power amplifier which reaches the overload level when a signal of 5V RMS is applied to its input. The resistor RI provides the load to a standard cartridge with the normal RIAA characteristics.

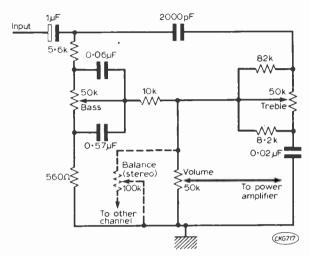


Fig. 7: A tone control circuit suitable for use between the output of the Fig. 6 circuit and the input of a power amplifier.

Tone controls. In many circuits two preamplifiers are employed, one before and one after the tone control circuits, in order to compensate for the insertion loss in the tone control network. However, when the LM381N is used as a preamplifier, only a single preamplifier stage is required owing to the high gain and high maximum output voltage provided by this device. A simple tone control circuit with bass and treble boost and cut facilities is shown in Fig. 7 which can, for example, be placed directly between the output of the record player amplifier of Fig. 6 and a power amplifier.

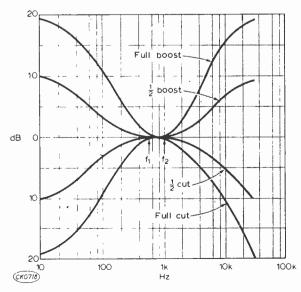


Fig. 8: The characteristics of the tone control circuit of Fig. 7.

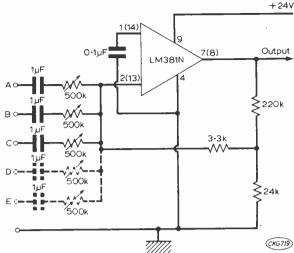


Fig. 9: An audio mixer circuit. Further inputs can be added, if required as indicated by the components shown in dotted lines.

The characteristics of the tone control circuits of Fig. 7 are shown in Fig. 8. It can be seen that a maximum boost or cut of about 20dB is available on both treble and bass.

Audio Mixer is the final example of the versatility of the LM381N, Fig. 9 designed for use with 600Ω dynamic microphone providing output level of 10mV. The circuit provides an output signal of 5V and can be used over a dynamic range of 80dB. A number of input signals (A to E) can be selected or combined with any other input signal.

The LM381N and AN are available from Athena Semiconductor Ltd., 140 High St., Egham, Surrey.

YOU CAN RUN YOUR OWN "WORLD-CUP" SOCCER OR "OPEN TENNIS" CHAMPIONSHIPS. BUILD THE

FOOTBAU GA

Suitable for colour or monochrome television

Simulate the green football pitch, red and blue players, pink touch-line. See the ball kicked bard or soft across the pitch. Move your players to any position on the screen. Simple to operate joystick control.

This project appears in TELEVISION only, starting in the July issue. Not to be confused with TELE-TENNIS, another TV game project appearing in PRACTICAL WIRELESS. Ideal for fund raising events.

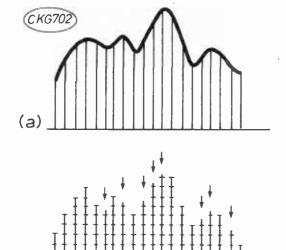
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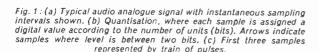
VIVIAN CAPEL

THE quality of the signals dispatched from the BBC studios for broadcast over the VHF frequency-modulation network is of a very high standard indeed. Development of domestic tuners and amplifiers over recent years has been such as to enable justice to be done to the high standard of received signals. Hi-fi radio enthusiasts will readily confirm the excellent results that can be obtained, yet sometimes with a note of reservation. It is often found that broadcasts originating in an area remote from the regional transmitter are of a lower standard than those coming from the local studio. So listeners in the South cannot expect as good results from a live broadcast at the Edinburgh Festival as from London's Festival Hall.

convey the signals from the studio or concert hall to the various transmitters. Owing to the limited range of VHF transmitters these must be sited within the locality they serve, hence the inescapable need for long studio links, often of several hundred miles. Many things can happen to a signal on a journey of that length, the higher frequencies can be lost, there can be phase differences due to varying transit times of different frequencies, any non-linearity will produce harmonic and intermodulation distortion, and of course noise can be picked up from numerous sources, thus imposing a restriction on the dynamic range which can be allowed. Furthermore reactive elements can give rise to 'ringing', the spurious oscillation produced by transients in the signal.

The reason for this is the links that are used to





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NEW LINKS

All this will be a thing of the past as the new pulse-code-modulation (PCM) links are installed between studios and transmitters all over the country. The South East is already so equipped and the links are being extended Westward and Northward, so that within two or three years the same standard of quality will be transmitted irrespective of the area of origin. By means of PCM, signals can be sent over great distances without any loss of information and with zero noise and distortion. This like the perpetual-motion machine may seem to be a sciencefiction dream, but it really does work. Like a lot of 'new' ideas, it is not new at all, having been invented in 1938, but the complex circuitry required, had to wait until IC's were developed before it could become a practical proposition.

In order to understand how it works we must first consider the nature of the normal audio signal such as the output of a microphone. It takes the form of a constantly varying voltage which in fact is comparable or analogous to the varying pressures of the sound-wave producing it. For this reason it is termed an **analogue** signal, and, because it consists of a wide range of frequencies and amplitude levels, it needs equipment capable of handling such ranges without modification of the signal in order to process it. Therein lie the difficulties.

(c) MM (c) 8 10

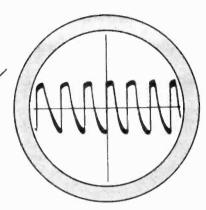
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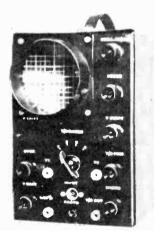
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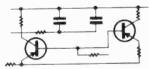
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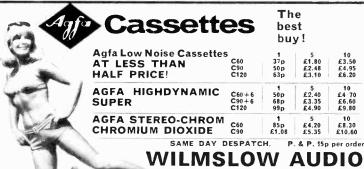
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QUANTISATION

If we take a typical audio signal, and sample the level at regular intervals we will get the result as shown in Fig. 1. Each sample represents the instantaneous level of the audio signal at the moment of sampling, and this level can be expressed by a certain number of electrical pulses. The individual samples are known as words, and the pulses making up each sample as bits. The conversion of the analogue signal into pulses is termed quantisation because it is quantitively expressed as a certain number of bits. As the signal is now a series of digits or numbers it is described as digital. This information can be later decoded and used to construct a wave identical to the original.

The quality of the result depends on two main factors. First, the number of samples or words that are taken in a given time. Any alteration of the wave-shape that occurred between two successive samples would be lost. Such an event would occur if the sampling rate was lower than the highest frequency contained in the signal. In practice it has been found that the sampling rate must be at least twice as high as the highest frequency to be sent. BBC FM broadcasts transmit frequencies up to 15kHz, and so the sampling rate is a little higher than twice this at 32kHz.

The other factor is the number of bits contained in each sample. If the amplitude of the original wave is to be accurately represented, the maximum number of levels definable must be large. Should the analogue wave amplitude fall between two specified levels, it will be assigned the value of the lower one and be reproduced at that level in the decoding process. Thus the wave shape will not be identical to that of the original and harmonic distortion will be added. This type of distortion arising during quantisation is the only type of distortion than can arise. Once the signal is encoded no further distortion can appear in the transmission. Thus it is always a known quantity and does not depend on outside variables.

BBC PCM

The BBC system uses a large number of sampling levels, actually 8191 different amplitudes, and so quantisation distortion is kept to a very low level. It is in fact 1 part in 8191, maximum, which is 0.0122%, far better than the domestic equipment used to reproduce it.

As described here though, the system has one major snag. With a sampling frequency of 32kHz, and each sample can contain up to 8000 bits, the resulting frequency will be 262MHz! This is completely unrealistic, and no link would have the bandwidth to accommodate anything like such a frequency, especially for a single audio channel.

Many readers who have followed thus far, will, by now, have cast their eyes down the following paragraphs with some apprehension and perhaps disgust. Practical men are often allergic to maths, and so the tendency may be to finish about here and turn over to the constructional features. However, don't be put off by what may appear to be a formidable array of figures. It's much easier than it looks, and actually it is very interesting to see the rather ingenious way by which the bandwidth problem has been solved. On the other hand, mathematical types, will probably have solved it already.

BINARY CODE

The solution lies in the use of the binary code by which large numbers can be represented by a small number of digits of only two factors, 0 and 1. To start with, most readers will know that when a number is multiplied by itself (squared), it is said to be raised to the second power and written n²; when so multiplied twice (n³) it is raised to the third power, and so on The table lists 13 values, the twelve powers of 2, and also 1. When all these are added the result is 8191 and it is a fact that any number between 1 and 8191 can be obtained by taking one or more of these numbers and adding them. None need be used more than once.

To illustrate the point consider a couple of examples. The number 3417 can be obtained by adding: $-2^{11}=2048$; $2^{10}=1024$; $2^*=256$; $2^6=64$; $2^4=16$; $2^3=8$ and 1. Agreed? Well, that wasn't too bad, so we will try another one, this time let's choose a nice round number, 5000. This is made up of: $2^{12}=4096$: $2^9=512$; $2^8=256$; $2^7=128$ and $2^3=8$.

In these examples we only listed the values actually used and ignored the others. However, to enable us to get the sequence right we must list all 13 even if it means assigning a zero value to the unused ones by multiplying by 0.

Going back to our first example then, the sequence is: $2^{12} \times 0$; $2^{11} \times 1$; $2^{10} \times 1$; $2^{9} \times 0$; $2^{8} \times 1$; $2^{7} \times 0$; $2^{6} \times 1$: $2^{5} \times 0$; $2^{4} \times 1$; $2^{3} \times 1$; $2^{2} \times 0$; $2^{1} \times 0$; 1×1 .

The second example gives us: $2^{12} \times 1$; $2^{11} \times 0$; $2^{10} \times 0$; $2^{9} \times 1$; $2^{9} \times 1$; $2^{7} \times 1$; $2^{6} \times 0$; $2^{5} \times 0$; $2^{4} \times 0$; $2^{3} \times 1$; $2^{2} \times 0$: $2^{1} \times 0$; 1×0 .

Then, if both sending and receiving equipment 'understand' that they refer to a consecutive series of powers of 2, each sample of up to 8191 amplitude levels can be accurately represented by thirteen digits of either 0 or 1. In our examples the series would be 3417=011010110101 and 5000=1001110001000. In the transmission, 1 is represented by a pulse and the 0 by a space.

BINARY TABLE

1	1
21	2
22	4
23	8,
24	16
25	32
26	64
27	128
28	256
29	512
210	1024
211	2048
212	4096
	2 ¹ 2 ² 2 ³ 2 ⁴ 2 ⁵ 2 ⁶ 2 ⁷ 2 ⁸ 2 ⁹ 2 ¹⁰ 2 ¹¹

This table shows the 13 binary bits, 1 and the 12 powers of 2. Any number between 1 and 8191 can be obtained by adding specified bits. Use or omission of a bit is indicated by 1 or 0 expressed electrically by pulse or space.

Thus there is a dramatic saving in bandwidth: now the frequency will be 13 binary bits × 32000 (the sampling frequency) or just over 400kHz. It may be thought that this is still rather high for an audio link that handles just the same programme as a 15kHz analogue link. This, of course, is true, but if we consider the advantages the extra bandwidth is well worth it.

Take noise, for example. Radio amateurs know from experience that when conditions are poor and noise levels high, that the morse code is far more



Fig. 2: Quantisation distortion. Wave-form of Fig. 1 distorted because number of bits (12) is insufficient to accurately represent amplitude levels as indicated by arrows in Fig. 1.

intelligible than speech. Morse is, of course, a digital signal being composed of a series of pulses and spaces similar to our PCM. A feature of both is that the pulses are all of the same amplitude, irrespective of whether the modulated audio signal in the case of PCM, is of high or low level. Low audio signals cannot then get lost in a high noise-level, so this in turn enables a higher dynamic range (ratio of high to lowlevel signals) to be sent. As the receiving equipment responds only to the pulses, noise originating in the link has no effect at all, so it is, in fact, noiseless. Only if the noise approached the level of the pulses would it have an effect but this would be extremely unlikely.

PULSE SHAPE

Pulse-shape is of minor importance as long as the receiver recognises it as a pulse and counts it; harmonic distortion therefore will likewise not affect the signal and there can be no loss of information contained within the modulation, so the audio frequency response cannot be modified. Hence there is zero distortion over the link. It can be seen then that high bandwidth requirement is more than compensated for by the virtually ideal transmission characteristics.

The BBC links combine 13 PCM channels into one having an overall bandwidth of 5.5MHz, the same as for a single television channel, which enables the links and associated equipment to be standardised with that of the television service. The 13 channels can be used for separate mono programmes or six stereo with one spare.

NOISE

Although the signal becomes unaffected by noise once it is encoded, noise in the analogue or encoder circuits will be encoded along with the audio signal. The noise is stated to be -69dB weighted, which is of a very low order, much less than could be picked up on a long analogue studio link. The possibility of error in the signal has been provided for. Each sample, as we have seen, consists of thirteen pulses or spaces. If, due to an error in the encoder or elsewhere, there is a discrepancy, the decoder will recognise the error and hold the value at the last errorfree sample until the next such one arrives.

RESULTS

For high-quality results the sampling rate and bit quantity used by the BBC is necessary, but good results are possible with more modest parameters. Some private telephone systems which carry speech only use an 8kHz sampling rate to give a 4kHz upper frequency response and 7 binary bits. An interesting feature of some of these systems is the polarity reversal of alternate pulses. Thus two pulses form a complete cycle and thus halve the bandwidth requirement.

A demonstration at the Sonex 1973 exhibition gave a direct comparison, with recorded piano music, of results obtained with different bit quantities. When using 12 bits, results were indistinguishable from the 13. At 11, results were still very good but there was a barely perceptible trace of distortion, while at 10 it was more easily detected. From 9 down it became progressively worse. The quantisation distortion has a rather unusual sound which can best be described as a 'crumbling' effect. It should be noted that each binary digit reduction corresponds to a halving of the actual sampling levels, and a doubling of the distortion.

It should be emphasised too, that PCM applies only between studios and transmitters, the broadcast signal being in the normal analogue form irrespective of the type of link used. Digital broadcasting is possible but existing receivers would be rendered obsolete unless both forms existed together, since compatibility is always a major consideration when contemplating any change in a broadcasting system. Furthermore, with the present congestion of the radio bands, the extra bandwidth, although technically easy to achieve, would be impractical.

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5V40	. 54	6EW6	.75	7¥4	. 65		. 90	AZI	-60	ECC88	. 28
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523	.70	6F1	. 70	9D7	.85	SOFS	- 80	AZ41	.68	ECC85	. 86
6Z40	-85	6FGG	.40	10C2	. 65	30 FL1	. 75	BL63	2.00	ECC86	- 85
5Z4GT	. 46	6F13	. 55	10DR7	. 65	80FL2	.75	CL33	1.50	ECC88	. 44
6/801.2	.80	6F14	. 75	10F1	. 50				1.00	ECC169	. 66
	1 . 26	6F18	. 55	10F9	. 65	30FL13	.65	OY31	. 45	ECC804	. 80
6AC7	.49	6F23	.80	10F18	. 55	30FL14	.70	DAF91		ECC807	
6AH5	. 27	6F24	.85	10LD11	.70	30L16	. 75	DAF96		ECF80	. 84
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6AJ5	. 75	6F28			2.00	30P4MF		DF96	.44		.76
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75	EF184 .88	KT66 2.40	-67	UY85 .88	AC176	61 BF158	-82 OC45	18
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.48	EL83 .55	PC86 .60	PY88 .38	U301 -68		40 BFY51	-21 OC78	-17
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.00		PC95 .75	PY500A .85	U404 .49		.50 BY100	20 OC81	-19
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.70		PC900 .45	PY801 .35	U4020 .55	AF106	55 BY114	20 OC82	-19
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. 65	BY61 .40	PCF801 .48	UAF42 .60	2N1756 55		16 OA10	47 OC204	-88
. 80	EY83 .54	PCF802 .50	UBC41 .53	2N2147 94			11 OC205	-47
1.00	EY84 .70	POF806 .55	UBC81 .45	2N2297 ·26	BAII6	20 0 A 47	; 0	•
. 84	EY87/6 .88	POH200 .70	UBF80 .88	2N2369 -15	ļ			
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.76	EY91 -58	PCL83 .54	UBL21 .77	2N3053 -36	LPIS (AC	113. AC154. A	C157. AA120) ·58p
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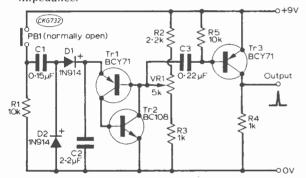
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Repeated pressing of PB1 will build up the potential on C2 until it exceeds the level set at the base of Tr1 which is preset by VR1. When this happens Tr1 and Tr2 go rapidly into conduction, aided by regenerative feedback, and C2 is discharged giving rise to a negative going signal at the collector of Tr2. This is fed to the PNP transistor (Tr3) and generates a 9V spike with a reasonably low source impedance.

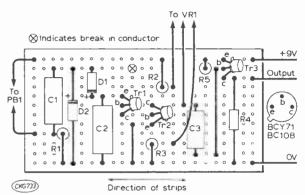


Circuit of the variable ratio electronic counter.

With the values shown the circuit should divide satisfactory up to frequencies of about 1kHz. To interface the input with an electronic drive source PB1 and R1 should be discharged and C1 should be taken straight to a point that can give DC voltage swings from 0V to +9V at low impedance, e.g. the emitter of an emitter follower that is normally held at 0V. The output of the circuit can easily be used to drive a pulse stretching circuit which could trip a low speed counter or a relay.

* components list

R1 $10k\Omega \pm W$ R4 $1k\Omega \pm W$ R2 $2 \cdot 2k\Omega \pm W$ R5 $10k\Omega \pm W$ R7 $1k\Omega \pm W$ R7 $1k\Omega \pm W$ R8 $1k\Omega \pm W$ R9 $1k\Omega \pm W$



Circuit arranged on Veroboard, VR1 and pushbutton being mounted externally.

The divide ratio is given by the number of times PB1 has to be pressed before C2 is discharged by the transistors and with the values given in this circuit is adjustable, by means of VR1, between about 3 and 20. If the repetition rate of button pressing is low there is bound to be some charge lost from C2 due to its own and transistor leakage. However, the prototype worked quite reliably at a rate of approximately one press per second. It is, however, anticipated that this circuit would interface with an electronic source of signal operating at a low audio frequency and this problem is then not likely to arise.

P.W. ELECTRONIC COMPONENTS BUYERS' GUIDE

Special supplement in the October issue giving details of components commonly available, followed by additional sections in succeeding issues. More details on page 116 of the June issue.

WIRELESS TELEGRAPHY ACT

Readers and advertisers are reminded of the requirements laid down by the Wireless Telegraphy Act. It is an offence in the U.K. to install or operate wireless telegraphy apparatus except under the provisions of the Act and, except in the case of broadcast sound-only receivers, a licence must be obtained. Included within the provisions of the Act are any apparatus transmitting deliberate signals for any purpose such as "walkie-talkies", radio-controlled models or servos and some types of metal detectors. Apparatus radiating interference signals are subject to controls which also come under the administration of the same Ministry. If you require full information, please write to Waterloo, Bridge House, Waterloo Rd., SE1 8UA.

P.W. TOOL KIT OFFER

Demand for the above tool kit far exceeded expectations and we have had to look for alternative supplies. We apologise to all those readers who have been kept waiting. By the time this issue appears we expect to have cleared the arrears of orders.

EKPERSITESTAL LICHES M.A. HUGHES M.A.

LEARNING BY PRACTICAL PROJECT STEPS

PART 10—LOUDSPEAKER DRIVERS

In ANY audio system there comes a time when it is necessary to use electronic signals to drive a loudspeaker. This part of the series will describe several alternative ways this can be done but we shall limit ourselves to considering only low powers in the experimental projects mentioned. The reason for this is solely to keep construction simple and to ensure that only low cost components need be used. Having said that let us hasten to add that the principles to be described are also applicable to the highest of power amplifiers, however, there are usually special protection circuits in these cases which tend to complicate the issue—and in many instances the protection circuitry can be more complex than the amplifier itself.

In one or two previous projects we have driven loudspeakers without saying too much about the method we have adopted; now is the time to fill the omission.

In an amplifier we have to provide several logical stages of amplification some of which we have already covered; basically these can be summarised as, (a) an input pre-amplifier which helps compensate for the impedance of the signal source, (b) a stage which will tailor the frequency response or provide a degree of tone control and (c) a stage that increases the level of signal voltage; this latter stage often brings the signal level up to the maximum needed for the application but usually the output impedance of such a stage is fairly high and certainly cannot be used to pass sufficient current through the low impedance of a loudspeaker speech coil-which can be anything in the range of from 3 to 70 ohms. The prime objective of a power stage is to take the output from the voltage amplifier and match this to the low impedance of the loudspeaker's coil; at the same time a degree of voltage amplification might also be applied.

The loudness of a loudspeaker is proportional to the amount of electrical power one can dissipate within the speech coil of the loudspeaker. If one knows the impedance of the loudspeaker the power can be quite simply calculated in terms of either the voltages developed across the speech coil or the current flowing through it. These, of course, are a.c. quantities because we are dealing with signals as opposed to bias currents—in some instances (as

we shall see) we have to take account of the latter. If we assume that all the current flowing through the coil is a.c. and comprises signal current the power dissipation can be stated as

$$I^2 \times Z$$
 or $\frac{V^2}{Z}$

where I is the current through the coil and V is the voltage developed across it (these can be peak or r.m.s. values depending on whether we are dealing with r.m.s. or peak power). Z is the loudspeaker's impedance. It is simpler to take the second equation for most purposes and we can see from it that for a given signal voltage we get most power dissipation for the smallest loudspeaker impedance; however we must ensure that the voltage source is not "current limiting" i.e. it must come from a very low source impedance.

For maximum power coupling the source impedance should equal the loudspeaker's impedance. Assuming ideal impedance matching ;if we have a signal amplified to 1V r.m.s and apply this to a 35Ω loudspeaker the output power will be

$$\frac{1\times1}{35}$$

which is just under 30mW; reducing the speaker impedance to 3 Ω would, theoretically, give about 300mW of power but the current requirement would be up by a factor of about ten.

It would be better to double the voltage of the signal to get higher power, because there is a square law relationship between the two, and one does not have to provide a very low source impedance—this is always difficult and provides other problems with power supplies etc. For highest powers it is obviously desirable to have as high a signal voltage as possible together with a low impedance output. To obtain 50W into a 15Ω loudspeaker would require signal voltages in the order of 27·5V r.m.s. To obtain this high signal level it is necessary to have power rail voltages in excess of 50V. It is thus impossible to get really high powers unless one is prepared to operate with reasonably high voltages as well as low loudspeaker impedances.

Throughout this series we have operated, in the main, with a 9V supply rail and a 35Ω loudspeaker. Assuming we made preamplifiers with ideal mid rail

biasing the peak signal voltages we could obtain would be 4.5V which corresponds to about 3.2V r.m.s. Given these parameters the maximum powers we could produce would not exceed 300mW r.m.s.

Summing up, we need to get as high a current with as high a voltage as possible across the speech coil and the experiments that follow show various attempts at getting to this end by different methods—each method has its pros and cons which we shall discuss.

Fig. 71 shows an obvious way of driving a loud-speaker and is an extension of the grounded emitter amplifier—covered in previous parts. Strictly speaking we should consider the loudspeaker as having an impedance a.c. signal but in practice this is very close to its d.c. resistance; inductance is low and hence inductive reactance at low frequencies is fairly small. If one considers LS1 of Fig. 71 as being a 35Ω resistor we can select a value for R1 which will give us a mid rail bias at the collector of Tr1.

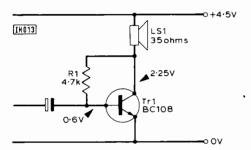


Fig. 71 : For the collector potential to be mid rail Ic Ω 65mA and hence R1 must be about 5k Ω . Quiescent power dissipation in Tr1 is about 150mW. Input impedance is low.

Before doing this we have to consider the maximum current rating of the transistor with reference to the maximum current that might flow through LS1 when the transistor is fully conducting. Imagine that the supply voltage was our usual 9V and that Tr1 was fully conducting; the potential at the collector would be a fraction of a volt (the saturation voltage) and the current flowing would be nearly

$$\frac{9}{35} = \text{approx } 250 \text{mA}.$$

This is more than twice the current rating for the transistor hence if a.c. input signals were of sufficient amplitude we might drive the transistor into saturation and burn it out at the same time. By reducing the supply rail to 4.5V we would only just be exceeding lc(max) for the BC108 even if we applied this maximum input signal. Due to saturation voltages and forward drops in the preceding circuits it would be unlikely that the collector current would exceed the maximum rating of 100mA. We have thus deduced that with this particular transistor the maximum supply voltage in this application is 4.5V for safety. R1 is calculated in the same way as in a previous part to give a mid rail collector voltage so that signals can give peak positive and negative going excursions of 2.25V.

Wire up the circuit of Fig. 71 and measure the quiescent voltages but also take special note of the quiescent current being drawn in the absence of input signal. It is comparatively high and causes power to be dissipated in the transistor and the

speech coil of the loudspeaker to no useful effect. This is a feature of this type of amplifier which comes into the general class of Type A circuits. The maximum r.m.s. power output for a 2·25V peak signal would be approximately 70mW and this compares with nearly 150mW of static dissipation caused by the quiescent current. Not very efficient!

In theory the maximum efficiency of a Class A amplifier is 50 per cent and this is its main drawback; it means that transistors get unduly hot, a lot of current is drawn from the supply under quiescent conditions and, in the case of portable equipment, one would suffer from rapid battery exhaustion. Some Hi-Fi purists will claim-probably correctlythat the class A circuit will provide the best fidelity of signal reproduction because the transistor is operating as a "more or less" linear amplifier, i.e. the current through the loudspeaker is directly proportional to the signal current and there is no way that distortion can creep in. This, of course, is not strictly true—particularly in a simple circuit such as this one because, for a start, h_{FE} for a transistor varies with collector current and thus the true linearity (assumed) is not realisable in practice without considerably more complexity. Nevertheless this is a very simple way of providing an audio low power output in simple applications-in particular those that will be subjected to intermittent use.

An example is shown in Fig. 72 where the output from a simple oscillator is used to drive a loud-speaker as a morse practice oscillator. When constructing this unit observe that LS1 must be 35Ω and the supply should not exceed 4.5V.

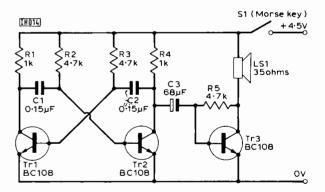


Fig. 72: Using the simple class A power stage in a morse practice oscillator circuit. As the signal voltage is high C3 could be omitted and R5 is then connected directly between Tr2's collector and Tr3's hase.

Because we have signals as high as 4.5V at the collector of Tr2 it is not necessary to have C3 in circuit because the signal will be driving Tr3 from one extreme of conduction to the other and the sophistication of mid rail biasing is not necessary hence the circuit can be simplified by taking R5 from the collector of Tr2 direct to the base of Tr3.

To obtain a higher output power we need to increase the supply voltage and reduce the loud-speaker's impedance. If this is done we have to use a transistor with a higher current and power dissipation rating; at the same time we illustrate, in Fig. 74, how we can use the simple expedient of making the power stage from an emitter follower (the input signal is so high that we do not need any form of voltage amplification). To provide sufficient

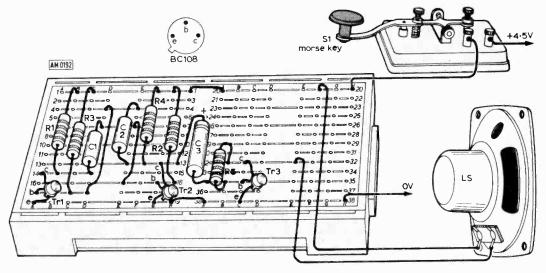


Fig. 73: Layout for Fig. 72

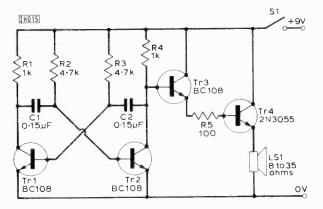


Fig. 74: Using a power transistor and an emitter follower driver enables us to use a lower resistance load (giving more power) and at the same time we can increase the supply voltage for more power.

signal base current into Tr4 without loading the output of the multivibrator we have inserted Tr3 making, in effect, a super alpha pair. This type of output is ideal if we are not worried about mid rail biasing in the output stage.

The base of Tr3 could have been connected directly to the collector of a conventional grounded emitter amplifier and the mid rail voltage would automatically have been reflected in the quiescent potential at Tr4's emitter—if one allows for base/emitter forward drops. The only problem with that would be that there is a high standing quiescent current flowing through the speech coil of the loudspeaker giving rise to heating and also the cone would be displaced preferentially in one direction.

To be continued

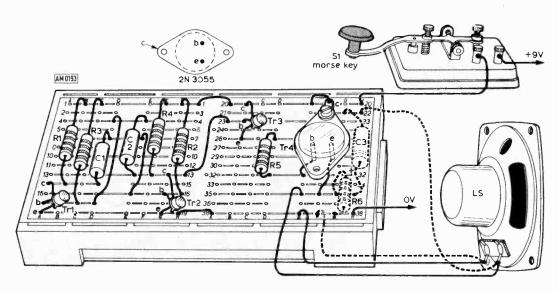


Fig. 75: Layout for Fig 74

ON RECENT DEVELOPMENTS

NO TICK GIVEN HERE

CMOS circuits intended to form a two-chip digital watch system have recently gone into quantity production at Intel. A total average power consumption of only $15\mu W$ means that the watch will operate for more than a year from one mercury cell.

The oscillator/divider chip isintended for use with a 32kHz crystal and is capable of an accuracy of better than 1 minute per year. The other chip contains the decoder/ driver circuitry and is offered in two versions. One of these provides the facility of being able to switch the display to show minutes and seconds. The hours display is then blanked. To help you time intervals of a few seconds, both versions of the output chip cause the colon separating the hours and minutes to flash at 1Hz.

GROWING

Developments in liquid crystal displays continue apace. A French company has recently exhibited a 5000-point matrix display giving a text of 96 characters and, even more intriguing, a simple animated picture display twelve inches square.

At the IEA exhibition in London, an Austrian firm was showing a seven-segment display some 6 inches high.

MORE SCOPE OR LESS?

Whilst television CRTs have got a lot shorter over the years, those used in oscilloscopes have stayed much the same length, mainly as a result of the good deflection linearity required. Now Philips have developed a new type of CRT which has a diverging lens in the form of a domed mesh between the deflection plates and the screen. The tube length for a given size of display is considerably reduced as a result.

ELECTRIFYING

News from the USSR that scientists at the Latvian Academy of Sciences have discovered a method of rotating non-metallic objects by passing them through an intense electric field. This effect, similar to that of a magnetic field upon ferromagnetic materials, has been demonstrated using wood, mica and plastics components. Suggested practical applications include alignment of parts on a conveyor belt or in other assembly systems.

SOMETHING'S MOVING

Small enough to be held in the palm of the hand, Mullard's new X-band (3cm.) Doppler transmitter-receiver modules may well find application in future vehicle collision alarms.

Greatly enhanced signal-to-noise ratio has been achieved by using separate cavities for the transmitter oscillator and receiver detector, both coupled to a single integral antenna.

When used in an intruder detection system, the module can pick out a man moving at a range of 50 feet. Just the thing to protect your priceless art treasures!

SUNPOWER

In the United States, a Senate investigation has been set up to consider Federal support for a programme of solar energy development. Giving evidence to the investigating committee, RCA Research director Paul H. Rappaport forecast that economical solar energy systems could be in widespread use in the U.S. within five years.

A planned extension to the RCA Building in New York will use solar energy to help run its heating and air-conditioning system.

FACE TO FACE

A spin-off resulting from the recently introduced local government changes is a new video-telephone system developed by Rediffusion Industrial Services.

The idea was that members of the public wanting to make an enquiry or complaint should not have to travel long distances to one of the new regional government offices in order to see an officer specialising in a particular field. Instead they would go to their local office where an automatically operated console would give them "acrossthe-desk" contact with the regional office via video-phone. Also included is a document scanner large enough to show household goods or package foods which may be the subject of complaint.

Already, one large company has expressed interest in the system as a means of providing conference facilities for its senior managers.

It would appear that the system has great potential for saving time and fuel by reducing the need for travel.

MULTIPLEX

More news from British Rail on improved communications, this time aboard Inter-City expresses.

Equipment being fitted will provide three channels—guard to passenger, guard to driver and an audio message playback system which is controlled by distance travelled along the track. All this information is distributed through the train on only two wires, which are also used to control the train lighting.

Rather special measures have been taken to protect the audio equipment from spikes on the train wiring. These spikes can reach 7kV!



Listen clearly:

NNEXT VOITES PRACTICAL WIRELESS



GENERAL COVERAGE SHORT WAVE RECEIVER

Do you get annoyed at interference apparent on some short wave stations? Do you find the same station twice, once where it should be on the dial and again where it shouldn't? These problems are frequently generated in the receiver itself. Listen to the bands as they really are, on the 'Epsom' receiver. Alignment is simplicity itself—no expensive test gear needed. One range calibration method sets up whole spectrum 2.5 to 23MHz. Copies AM, CW and SSB signals with automatic sideband switching. Its special features can be built into your own receiver.

add-on AUDIO SQUELGH

Field-effect transistors are quite common

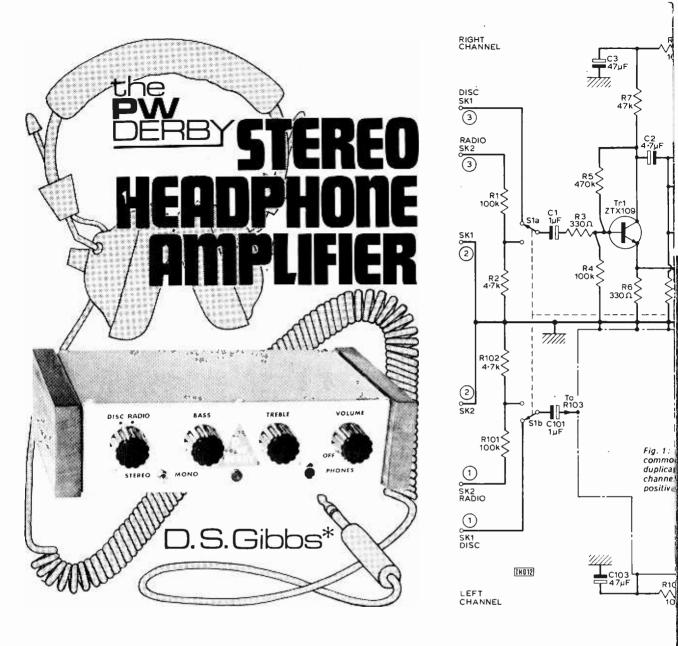
Field-effect transistors are quite common nowadays in D-I-Y electronic projects but what do you realfy know about them? We eliminate the mystery and show how they work and describe their advantages. Many practical circuit applications complete a useful guide to FET's.

UNIT

MANY OTHER CONSTRUCTIONAL ARTICLES, SPECIAL FEATURES AND REGULAR COLUMNS ON, SALE IN AUGUST

Audio squelch circuits are frequently found in radiotelephones, cutting out objectionable noise in the absence of a signal. This simple one-IC unit can be fitted to a public address, intercom or other audio system where a high background noise level presents a problem.

The above details are subject to the national industrial situation at the time of going to press.



ANY hi-fi enthusiasts tend to dismiss headphones out of hand, probably through memories of the strangulated reproduction of the Services surplus 'cans'. In contrast, modern stereo headphones are capable of giving a startlingly clear and well defined stereo image, with a quality of reproduction exceeding that of the best loudspeakers. By isolating the listener from his environment they give a sense of detachment, enabling one to devote one's entire attention to the music. For the same reason they are excellent for studying languages or for those whose musical tastes differ from those of their family.

Headphones are ideal for those just starting to acquire a hi-fi system as they minimize the expenditure required. Later, when it is desired to expand the system, it is only necessary to add a pair of amplifier modules, a power supply and a pair of

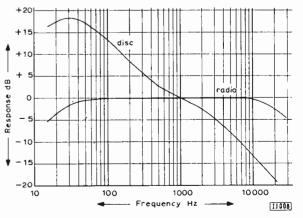
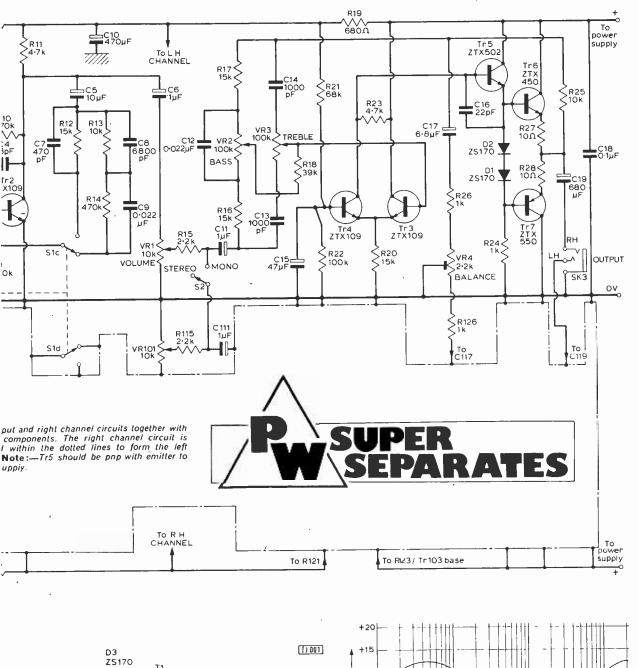


Fig. 3: Response curves of the amplifier for record or radio.

^{*} Ferranti Ltd.



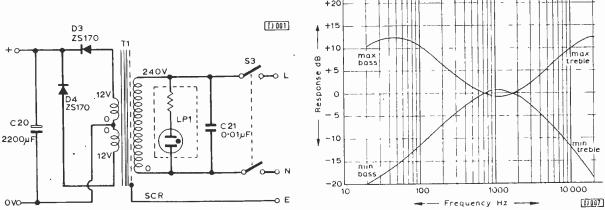


Fig. 2: Circuit of the power supply section of the 'Derby'.

Fig. 4: The effects of the tone controls are shown in these curves.

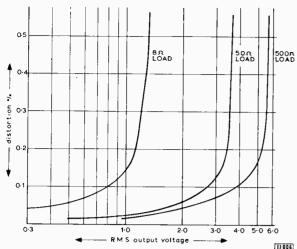


Fig. 5: Curves relating distortion with output voltage and load impedance.

loudspeakers as the headphones amplifier serve as a preamplifier. The circuit described here gives a standard of perfomance equal to a good hi-fi amplifier and it can be used with any make of headphones provided the impedance is greater than 8 ohms. The circuit is designed to give an output level of at least 1 volt into any impedance and this will be sufficient to generate a sound pressure level of 90dB or more with most types of stereo headphones.

CIRCUIT

The circuit diagram of the amplifier is shown in Figs. 1 & 2. The input stage comprising Tr1 and Tr2 is conventional and provides a 5mV input with RIAA equalisation for magnetic cartridges and a 100mV input with a flat frequency response for radio etc. Other inputs can be added by the constructor if desired. The response curves of the radio and disc inputs are shown in Fig. 3.

The output stage, comprising Tr3-Tr7, follows the same general lines as a normal hi-fi power amplifier but has been designed for a very much lower power level. The tone control is of the Baxendall type and is incorporated into the feedback loop of the amplifier. The response curves of the tone control are shown in Fig. 4. The output stage thus serves as both a power amplifier and a tone control stage.

The balance control operates by varying the feedback and hence the gain of the output stage and for this reason it cannot reduce the signal level to zero. It does however provide a variation of $\pm 9dB$ between channels. This is entirely adequate for use with headphones as the headphones themselves are usually well matched. The variation of distortion with output level is shown in Fig. 5.

CONSTRUCTION

The prototype was constructed in a $7^{1}_{4} \times 4^{1}_{2} \times 2in$. diecast box which was decorated with a coat of silver paint and a pair of wooden ends, to give a domestically acceptable appearance. However, any suitable case can be used, provided that the same layout is adhered to. A duplicate of the prototype has been constructed in a record player plinth on a small aluminium chassis. Drilling details for the diecast

* components list

R9 R109 220kΩ

R10 R110 470kΩ

Resistors R1 R101 100kΩ R11 R111 4 · 7kΩ R21 R121 68kΩ R102 4-7kΩ R12 R112 15kΩ R22 R122 100kΩ R3 R103 330Ω R13 R113 10kΩ R23 R123 4 · 7kΩ: R4 R104 100kΩ R14 R114 470kΩ R24 R124 1kΩ R5 R105 470kΩ R15 R115 2 · 2kΩ R25 R125 10kΩ R6 R106 330Ω R16 R116 15kΩ R26 R126 1kΩ R7 R107 47kΩ R17 R117 15kΩ R27 R127 10Ω RR R108 10kΩ R18 R118 39kΩ

R28 R128 10Ω

R29 R129 Fig. R30 R130 10

All 1W or 1W 5% carbon film LH channel numbers have 100 prefix

R19

VR1 VR101 10kΩ log dual gang with DPST switch-VR2 VR102 100kΩ linear dual gang VR3 VR103 100kΩ linear dual gang VR4 2·2kΩ skeleton preset pot

R20 R120 15kΩ

680Ω

If a fully variable balance control is desired VR4 should be made a 2·2 or 2·5kΩ pot (linear law) and mounted on the front panel

Capacitors

C1 C101 1µF 35V TB C12 C112 0.022 uF 160V P C2 C102 4 7µF 35V TB C13 C113 1000pF 125V Poly C3 C103 47µF 25V Elec C14 C114 1000pF 125V Poly C4 C104 33pF 125V Poly C15 C115 47µF 10V Elec C5 C105 10µF 25V Elec C16 C116 22pF 125V Poly C6 C106 1µF 35V TB C17 C117 6.8µF 40V Elec C7 C107 470pF125V Poly C18 C118 0 1 µF 250V P C8 C108 6800pF 160V P C19 C119 680µF 16V Elec C9 C109 0 · 022 µF 160 V P C20 2200µF 25V Elec 470μF 25V Elec C21 C10 0.01 µF 750V D C11/111 11µF 35V TB

TB-Tantalum bead Elec-Electrolytic Poly—Polystyrene P—Polyester D—Disc ceramic

Semiconductors

Re	commen	ded Alternatives
Tr1 Tr101	ZTX109	ZTX108B/C, ZTX382, ZTX383, ZTX384
Tr2 Tr102	ZTX109	as above
Tr3 Tr103	ZTX109	as above
Tr4, Tr104	ZTX109	as above
Tr5 Tr105	ZTX502	ZTX550, BFS97, ZTX537/538, ZTX212
Tr6 Tr106	ZTX450	ZTX337/338, BFS60
Tr7 Tr107	ZTX550	ZTX537/538, BFS97
D1 D101	ZS170	ZS270 or any ZS170/270 series
D2 D102	ZS170	as above
D3	ZS170	as above
D4	ZS170	as above

Miscellaneous

S1, 4 pole 3 way rotary switch. S2, Single pole toggle switch. LP1, Miniature neon indicator lamp. SK1/2, 5 pin DIN sockets (2). SK3, Stereo jack socket. T1, Mains transformer 12V+12V 6VA (RS Components Ref. Min. Tr. 12V). Knobs (4). Diecast box Eddystone 6827P.

Davian Electronics, PO Box 38, Oldham, Lancs, OL2 6XJ can supply PCB at £1.85, kit of semiconductors at £3.10 or both for £4.75, all inclusive of VAT and P/P.

This is sufficient to generate a sound OUTPUT 1.3V into 8 ohms pressure level of over 90dB with most 4V into 50 ohms 6V into 500 ohms headphones DISTORTION 0.02% with 50, 500 ohm load 1V output at 1kHz 0.14% with 8 ohm load TONE CONTROLS Bass ± 12dB at 50Hz Treble ± 12dB at 15kHz **DYNAMIC RANGE** (Input) 25dB referred to 1V output Disc 67dB unweighted 20Hz to 20kHz SIGNAL/NOISE RATIO referred to 80dB weighted, 30 phon curve 1V output Radio 69dB unweighted 72dB weighted **BALANCE CONTROL** +9dB variation between channels Disc within 1dB of RIAA curve 20Hz to 20kHz FREQUENCY RESPONSE Radio -3dB at 20Hz and 22kHz

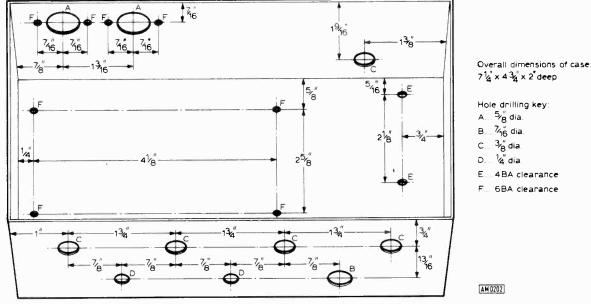
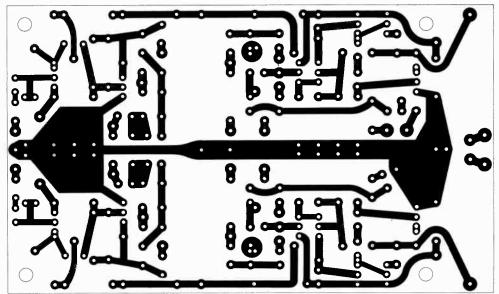


Fig. 6 above, gives drilling information for the diecast box while in Fig. 7: below, the printed circuit board is shown actual size.



AM 0203

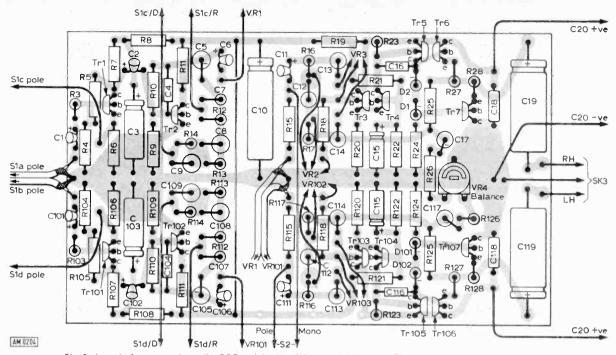
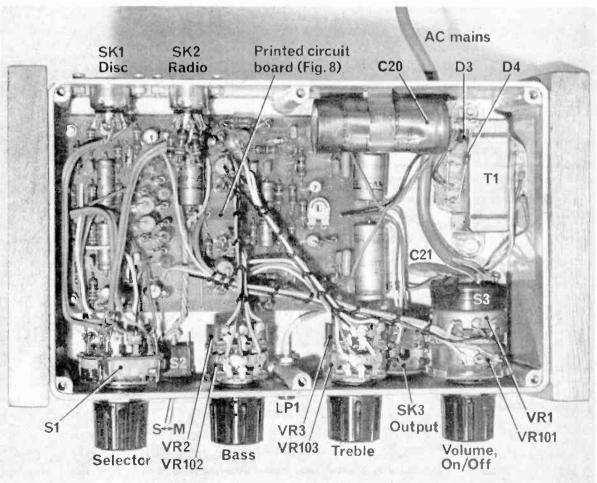


Fig. 8: Layout of components on the PCB and details of the associated wiring. The photograph shows the location of the components mounted on the box.



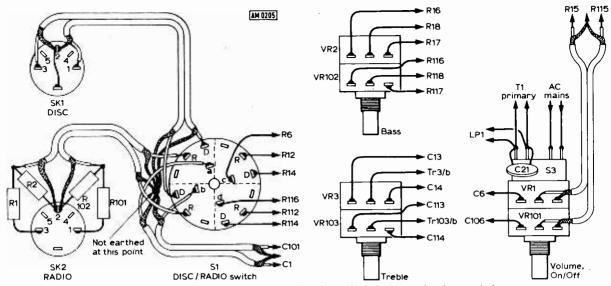


Fig. 9: Detailed information on the connections to the input sockets and various controls.

box are given in Fig. 6, and after drilling the box should be painted as desired. If wooden ends are required the ends of the box should be left unpainted.

Most of the small components are mounted on a single fibreglass printed circuit board, Fig. 7, measuring 5×3 in. There is not a great deal of room to spare and miniature components should be used throughout. The first step is to assemble all the components on the board as shown in Fig. 8, and then to solder all wires for the external connections. Twin screened wire should be used at the input and between the volume control and R15/R115, but ordinary thin connecting wire is satisfactory elsewhere. All leads should be as short and direct as possible.

Mount the stereo/mono switch S2, the pilot lamp and the output jack socket SK3 on the front panel of the case and then mount the mains transformer inside. The assembled printed circuit board can now be fixed in place on ¹4in. spacers and wired up to S2 and SK3. Then mount the three potentiometers and the selector switch and wire up as shown in Fig. 9. Finally mount the two DIN input sockets and C20 and complete the wiring. The two rectifier diodes D3 and D4 are wired directly between the transformer and the positive tag of C20. It may be necessary to cut short the negative tag of C20, or bend it down, to avoid shorting against the transformer. After assembly the wooden ends can be fixed in place with contact adhesive.

The specified selector switch has three 'ways', so an extra input can be added if desired. All that is necessary is to provide an extra DIN input socket and wire it as for the Radio input. If a sensitivity differing from 100mV is required R1 and R2 can be altered appropriately.

HEADPHONES

Headphones specifications tend to be rather confusing, as they are often specified as "suitable for 4/16 ohm amplifiers" when the impedance of the phones themselves is usually much higher than 4 ohms. Most commercial hi-fi amplifiers feed the phones output through a high value series resistor,

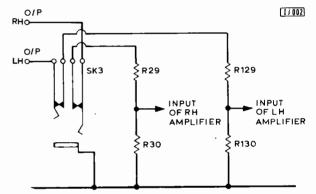


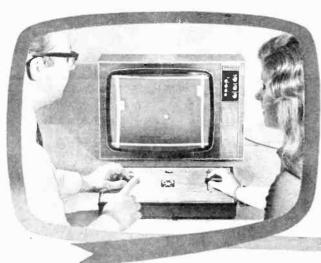
Fig. 10: Attenuator circuit for use when 'Derby' is employed to drive power amplifiers. Take values of resistors from table below.

AMPLIFIER SENSITIVITY	R29 R129	R30 R130
50mV	1kΩ	47Ω
100mV	1kΩ	100Ω
200mV	1kΩ	220Ω
500mV	1kΩ	1kΩ
1V	0	1kΩ

to reduce the signal level to an acceptable level. This unit feeds the headphones direct and has a very low output impedance, giving good electrical damping. If the reader is in any doubt about the correct impedance of his headphones the best course it to measure the DC resistance with an ohmmeter. The impedance is not likely to be less than this figure.

USE AS A PREAMPLIFIER

As stated earlier, this circuit will make a very satisfactory preamplifier. The output of IV is rather too high for most power amplifier modules, so it will be necessary to interpose an attenuator between the unit and the power amplifier. Suitable values for various amplifier sensitivities are given in Fig. 10. If the attenuator resistors are connected via a switched jack socket then the amplifiers will be automatically muted when the headphones are plugged in



THE POPULAR NEW ELECTRONIC GAME

TELE~ TENNIS

PLAYED ON THE TELEVISION SCREEN

PART 2

Physical Features

Apart from the modulator itself, layout of the game is not critical; nevertheless constructors are strongly advised to use printed circuit boards due to the large number of integrated circuits. Mechanical construction of the prototype was kept as simple as possible. In many respects the single plane layout adopted proved to be ideal, allowing easy access to all the preset controls. Another advantage of the planar construction is that you can build the unit in stages without having to keep it inside its case—this is useful for carrying out tests and checking each board as you go along.

Six circuit boards are used, each secured to a sub-frame made of lengths of aluminium bar or extrusion; when completed this subframe is lowered inside a case. The only extra connections then required are to the front panel controls and the output points. The case was made from bent aluminium sheet carefully glued at the corners with an epoxy resin. The sloping front panel is hinged.

M.J. HUGHES MA

The six boards are designated A to F and these are laid out on the sub frame as shown in Fig. 7. The mains transformer is bolted on to an aluminium plate shaped to screw under the longer struts of the subframe. When making the subframe ensure that you allow sufficient clearance between the aluminium struts so that there can be no chance of short circuits between them and the pcb tracks. (About $^{3}_{8}$ in. clearance is allowed between the longer edges of each board and the copper to prevent such short circuits.)

Apart from Board F each printed circuit has overall dimensions of 3^3 4in. x 5^1 2in. Board F has a length of 3in. but it has the mains transformer alongside it. The overall length of your subframe should take into account the dimensions of the transformer used if different to that in the prototype. By making this subframe first you can get the system partly functioning at each stage. Make sure that there is at least one inch clearance between the underside of the circuit boards and the lowest points on the subframe. This is to prevent the modulator screening box,

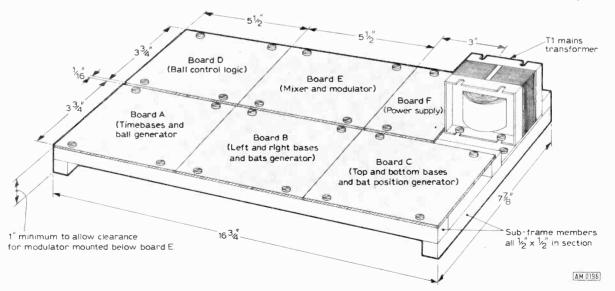


Fig. 7: Layout of printed circuit boards and mains transformer on the subframe. In the prototype this was made from aluminium bar but any material of similar size may be used.

which is live, touching the bottom of the Tele Tennis final enclosure.

This month we shall describe the operation and construction of boards E and F. If these are built first it is then possible to monitor the signals from other boards on your own television set—this obviates the need for an oscilloscope (although if you have one it would be most useful for setting up purposes!).

Power Supplies

Three power rails are needed; a stabilised +5V for the logic circuits, +12V (nominal) for the Ball control ramp generators and +12V (nominal) for the modulator. We have separated the latter two 12V supplies with heavy decoupling to prevent hum on the RF carrier and to prevent the ball control ramps altering the supply level to the modulator. Apart from this heavy smoothing and decoupling it is not necessary to stabilise the 12V rails.

The circuit for the power supply board is shown in Fig. 8. The stable 5V rail is provided by a TO-3 encapsulated voltage regulator 7805. Other similar devices could be used but some are prone to high frequency oscillation which could present problems. A $1000\mu F$ capacitor on board A provides LF decoupling, while 0·1's at various points on other boards reduce the chances of noise spiking from the TTL. The smoothing capacitors for the two 12V rails are located on boards D and E respectively.

Layout is pretty straightforward but it is essential to heat-sink the voltage regulator with a piece of shaped aluminium sandwiched between the IC and the board. This heatsink can be live and there is thus no

* PCB functions

Board	Function
A	Time bases, Sync mixer, Ball generator, Ball vertical change control
В	Left and Right Base generators, Bat width generators, Bat output
С	Top and Bottom Base generators, Bat height and position generators
D	Ball control ramp generators, Ball control logic, Service and Ball Boy control, Ball blanking
E	Video mixer, Video blanking, Sync/Video mixer, UHF Modulator
F	Power supply

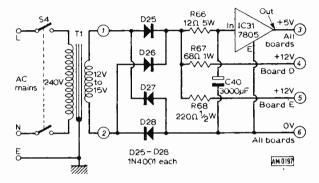


Fig. 8: Power supply circuit diagram. Smoothing capacitors for the +15V rails are mounted on Boards D and E.

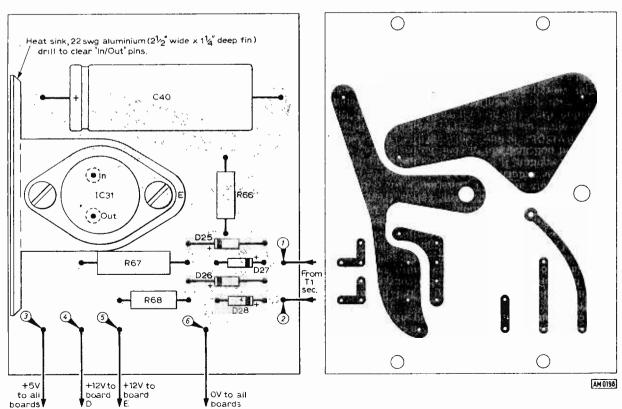


Fig. 9: Actual size layout of Board F and location of components.

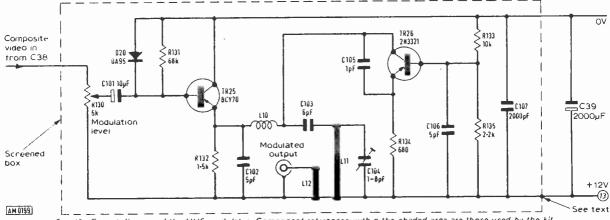


Fig. 10: Circuit diagram of the UHF modulator. Component references within the shaded area are those used by the kit suppliers and should not be confused with references in the rest of the project.

need for insulating mountings. Mount board F and the transformer on to the subframe and check that the correct voltages are present. Do not worry if the 12V rails are reading high (probably around 15V) because they are off load.

Modulator

The next step is to assemble the modulator. The circuit is shown in Fig. 10 and we are indebted to Crofton Electronics for permission to publish it here. Provided the kit's instructions are carefully followed in every detail there are no major problems to be expected. Remember, though, to take care with the ceramic feedthrough capacitors and ensure that the strip inductors L11 and L12 are precisely cut and positioned. Mark and drill or cut holes in the uniform copper area of the Mixer/Modulator board so that the modulator will rest flush against the square copper land. Bolt the modulator case firmly into position under the board by means of the potentiometer bush, so that the control spindle and input and output connections all protrude through the plain side of the board.

Using a large soldering iron you should, eventually, run a fillet of solder between the tinned modulator case and the copper land to give extra mounting support. Before doing this, however, it is as well to test the modulator. Connect temporary leads between the +12V and 0V pins of the modulator

board and the corresponding points on board F and fit the 2000 µF smoothing capacitor (C39) on board E. Set the tuning trimmer of the modulator and the modulation potentiometer to mid positions and connect the output socket of the modulator to the aerial socket of a 625 line standard television set via a short length of coaxial cable. Switch on the power and there should immediately be some indication on the television screen that something has happened—maybe the screen will brighten up or blacken off.

Check that the supply voltage is now about +12V and try adjusting the tuning of the television set. In the absence of any modulating signal there will be no picture as such, but it should be quite obvious that there is a carrier present as you tune through the range. By turning up the modulation control (turning anticlockwise) and touching the input pin with a finger you might be able to display a faint hum bar. At this stage it is sufficient to know that there is a carrier. You can now progress with the rest of board E.

Video mixer

The circuit for the mixer stages is shown in Fig. 11. Diodes D17 and D23 in conjunction with R61 form a diode OR gate which assembles all the waveforms that define portions of the final picture. We call this stage the Video Mixer. The combined output of this stage is fed to the blanking circuit where the mixed

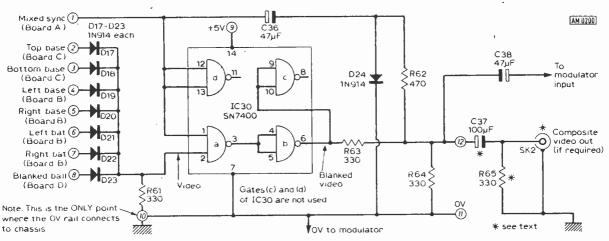
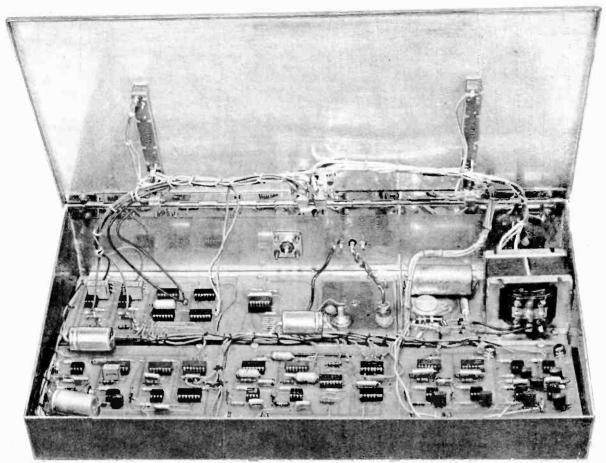


Fig. 11: Circuit diagram of Board E, including Video Mixer, Blanking and Sync/Video Mixer.



Interior view of the prototype Tele-Tennis unit. The composite video output socket is not connected up.

sync (from board A) is ANDED with it by IC30a. This has the function of ensuring that no video signal is present during periods when we shall be adding the field and line sync pulses.

The next stage is to combine synchronisation pulses with blanked video. R62, R63 and R64 form an additive mixer for the two signal sources, whilst D24 clamps the tops of the sync pulses to ground. Therefore, whenever a sync pulse occurs this is added to the video in a negative going direction. The ratios of the resistors in this stage are important to ensure the correct proportions of video and sync.

Two outputs are provided from this point. The composite video signal can be taken straight to a monitor if required, however we expect that most constructors would not possess such an instrument, and in that case C37 and R65 can be omitted. The alternative is to feed the composite signal to the modulator input via C38. Make sure that you connect this capacitor with the correct polarity because the case of the modulator is connected to the positive rail.

Throughout this project we recommend that you use dual-in-line sockets for all the integrated circuits. Apart from allowing you to replace suspect devices you will protect the guarantee given by most reputable suppliers. Do NOT connect any of the power lines to the subframe as chassis grounds. There is only one connection to chassis and this is made on final assembly into the case.

★ components list

BOARD 'E'

Resistors—all ; or ; W

R61 330Ω R62 470Ω R64 330Ω R65 330Ω

Capacitors—all 25V electrolytics
C36 47µF C37 100µF C38 47µF

C39 2000µF

Semiconductors

D17-D24 1N914 1C30 S@7400

Miscellaneous

PCB; DIL14 IC socket; 14 wiring pins; Modulator kit from Crofton Electronics, 15/17 Cambridge Road, Kingston-upon-Thames, Surrey KT1 3NG, price £7-30 including p.p. and VAT.

BOARD 'F'

Resistors

R66 12Ω 5W R68 220Ω ½W F67 68Ω 1W

R63 33012

Capacitor

C40 3000 µF 25V electrolytic

Semiconductors

D25-D28 1N4001 IC31 7305 regulator

Miscellaneous

T1 Priz 240V, Sec: 12-15V [A] PCB; 6 wiring pins; material for heat-sink, transformer mount and sub-frame.

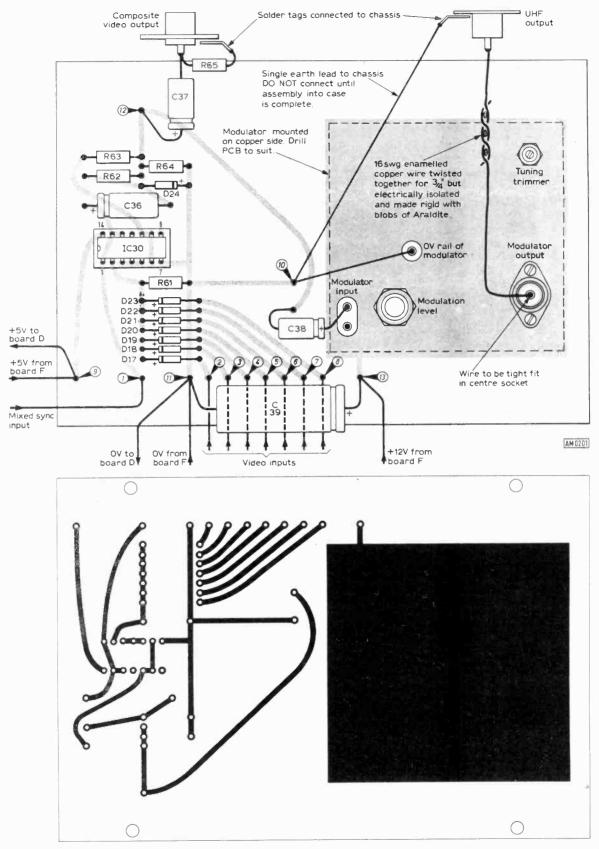
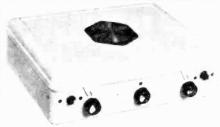


Fig. 12: Actual size layout of Board E and location of components.

-continued on page 346



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Oscilloscope

PART 6

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POWER SUPPLIES

It is not intended in this section to go into all aspects of power supply theory as it is very involved and all manner of supplies are used in oscilloscopes. However we can take a general look at power supplies and some of the problems encountered.

VALVE HEATERS

Valve heaters are usually wired in parallel, in groups of perhaps 5 or 6A maximum. Because of considerations of heater-cathode voltages some of the heater lines may be at certain potentials, e.g. 0V, +100V or -150V etc. Perhaps the most obvious case of this is in the case of the CRT heater which must be at -1 or -2kV. The bright up bistable is usually at EHT potential as would be the EHT series regulator if fitted. All these heaters would be run from one transformer winding and strapped to the negative EHT supply.

We shall shortly look at RF EHT generators which provide an output that is usually doubled or tripled to provide the 10 or 12kV needed on a high voltage tube. If the tripler uses valves then the heaters are usually run from a winding on the EHT transformer. A failure of the EHT generator will therefore cause these valves not to light.

In order to prevent hum and drift the input valves to the Y amplifier are sometimes fed from a stabilised HT line in series. One open circuit heater will therefore cause the whole lot to go out. One further difficulty is that heater cathode shorts can put a few valves out without affecting the others, giving rise to very misleading faults. However this practice of series valves is limited to only a few valves in very complex oscilloscopes and is not usually found in fairly simple ones.

Also supplied from a heater line is the graticule illumination, if fitted. This usually consists of a pair of small 6.3V, 0.1A bulbs in parallel, fed from a 6.3V line by a 1000hm pot. This enables the illumination to be changed to suit the display intensity.

HT SUPPLIES

The HT requirements of a small AC coupled scope may be quite modest and if no accurate calibration is intended the power supply can follow normal radio practice, i.e. a full wave rectifier and simple smoothing. Both metal and valve rectifiers are used but care should be taken when replacing a valve with a couple of BY127's, as is often done for economy in the event

of a failure having occurred. In general it is very bad practice as the HT comes on straight away and decoupling capacitors can short circuit through overvoltage and electrolytics can blow up making a mess when they do so and that can be dangerous so always replace a valve with a valve, or provide a thermal switch to put the HT on after 30 seconds or so.

This is the method incorporated in several large oscilloscopes where valve rectifiers would waste too much power. A small thermal switch puts 6·3V on to a relay after 30 seconds or so. The relay flips over and connects the HT windings to their rectifiers as well as providing a "holding" current for the relay and taking the supply off the terminal switch which cools down. If there is a small power break the relay loses its holding current and the HT cannot be reconnected until the thermal switch has heated up again. This protection can be extended to switch off the HT in the event of a plug-in unit being removed and another inserted, HT taking another 30 seconds to come on.

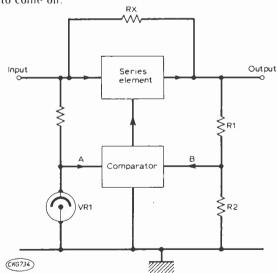


Fig. 1. Circuit requirements for a series stabilised HT line.

If some valve heaters are run from the HT line then there is also a delay while these warm up. In general this type of scope takes about 5 minutes to switch on and sort itself out, but the advantage of circuit protection is well worth the operating delay.

In most oscilloscopes some or all of the HT lines are stabilised. Because the HT load is predictable (except under fault conditions) the series stabiliser can be arranged to stabilise with little loss of power.

Fig. 1 shows the general arrangement of this type of stabiliser. R_x can be made such that the power dissipation in the stabiliser valve is kept to a reasonble level, whilst maintaining adequate stabilisation. The comparator, usually a long-tailed pair, senses the difference in potential between the points A and B and drives the series element so as to correct the difference. The ratio R1/R2 sets the output voltage and R1 is usually made preset so that the HT rail can be accurately set to its prescribed value.

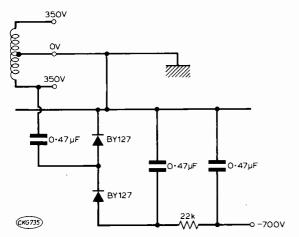


Fig. 2. Method of obtaining EHT for a small CRT using a standard mains transformer.

The circuit also has a hum reducing action in that no hum exists at point A (set by VR1) and so the comparator "makes sure" that no hum exists at point B. Hum can be injected into the comparator as well to give virtually perfect DC (ripple less than 25mV) with a ripple input of several volts. The series element is usually a power pentode or triode. If the current demand is large several valves may be placed in parallel to meet the current requirements.

If more than one HT line is required to be stabilised it is usual to make a very good job of stabilising one of the lightly loaded lines and to use this to stabilise all higher voltage lines. A typical oscilloscope would usually have HT rails at -150, +150, +400V to cover the requirements of the Y amplifier and timebase.

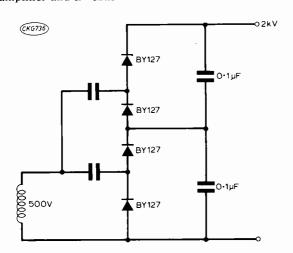


Fig. 3. Development of the voltage multiplier to produce 2kV.

EHT can be derived from one winding of the mains transformer at full voltage (say $1\cdot 5kV$) and rectified and smoothed. If the oscilloscope is calibrated then the EHT must be regulated and a small series pentode is generally used for this purpose. The provision of a $1\cdot 5kV$ winding on a mains transformer is difficult and expensive (also lethal if you happen to get hold of it!) and so many scopes use voltage multiplication from a low voltage winding, followed by a series regulator if necessary.

Fig. 2 shows how 700V can be obtained from the 350-0-350 mains transformer of a small oscilloscope and Fig. 3 shows how the idea is extended to give 2kV from 500V. The Solartron D1400 used this principle to produce nearly 1.5kV from a 140V transformer winding.

These methods of deriving HT from a mains transformer are satisfactory up to a few kV but when 8 or 10kV is needed RF supplies are usually employed. These have the advantage that the supply can be self stabilising, can supply all the EHT supplies, operates at a high frequency and so does not need bulky smoothing capacitors and is fairly harmless in the event of accidents. Fig. 4 shows a block diagram of a typical form of this type of generator. The oscillator is self-oscillating by virtue of positive feedback from the transformer (a small winding feeding the output valve grid). The comparator provides an error signal to maintain the potential at point A as it should be, obviating any changes in the cathode supply. The PDA supply tends also to be stabilised but not so well, but is in any case not so important.

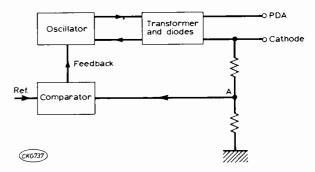


Fig. 4. Block diagram of RF generator producing 8 to 10kV.

The oscillator is tuned by a capacitor across the anode transformer winding and normally runs at 25 to 30kHz. The transformer is usually a ferrite toroid for high efficiency with the windings on polythene bobbins. As we have already mentioned, there are also windings for the voltage multiplier valve heaters if fitted. The whole EHT unit is usually isolated in a small compartment and the supply leads decoupled to prevent RF appearing everywhere. It is advisable to keep dust and damp out of this compartment and vulnerable points are usually given a coat of shellac during manufacture. Any damp might cause tracking which can cause a surprising amount of damage. In damp environments it is perhaps useful to place a small bag of silica gel in the compartment to keep the area as dry as possible.

When setting the EHT voltage with the "SET EHT PRESET" it is as well not to go over the voltage prescribed as this overruns the output valves, overruns the multiplier heaters and puts a strain on the insulation and the CRT. Any repairs in the EHT unit must

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10	63	6p	150	6.	3 6p	680	6.3	10p
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15	40	бр	150	25	6p	680	25	18p
15	63	вр	150	40	10p	680	40	22p
22	10	8p	150	63	12p	1000	4	10p
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be done with neat, round soldered joints to prevent corona discharge which produces ozone which destroys the insulators. It is also important to replace all screening and earth braidings. Spark gaps are often provided, especially in equipment with transistors, to break down when excess voltages occur, preventing damage to other parts of the circuit and they should be kept free of dirt otherwise they will flash over for no apparent reason.

The EHT generator is usually supplied from the highest available voltage rail in the oscilloscope and the supply line is very well decoupled. The current taken is usually only about 50 or 60mA and so represents a light load on the line.

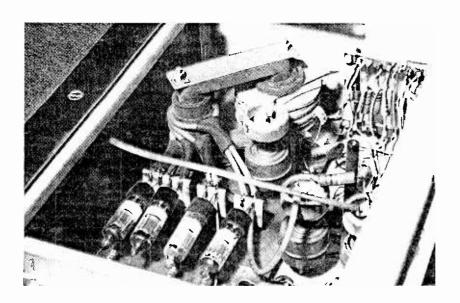
Taking into account the overall power requirements of a complete oscilloscope the mains transformer is physically rather large (weight perhaps 10 or 15lb) and tends to produce a large magnetic field. In order to guard against this field and external magnetic fields the CRT is enclosed in a Mumetal shield which acts as a magnetic screen. The excellent screening properties of Mumetal make it possible to mount the transformer fairly near to the tube without ill effects. When removing a CRT it is important not to bend the Mumetal as it loses its properties if bent and replacement shields are expensive. The Mumetal is also earthed to prevent external electric fields penetrating the tube and causing deflection.

The internal layout of the oscilloscope is to a great extent governed by thermal considerations. For example the X and Y output stages and the power supply regulator valves are situated so that they can lose their heat easily. Small signal stages can be tucked away in any odd corners without coming to much harm. Power valves are always operated vertically for maximum reliability as the grids may sag when used horizontally. This should be borne in mind if the scope is run on its side for long periods during calibration etc.

Signal leads also play a part in dictating the layout in that signal-carrying leads are kept as short as possible to reduce capacitance and stray pick-up. When undertaking any modifications on oscilloscopes it is important to bear the above facts in mind as regards positioning of any extra stages or wiring.

GENERAL MAINTENANCE

Apart from recalibration, say every 6 months, or if obviously needed, an oscilloscope needs additional care and attention. The heat generated causes dirt and dust to stick and if a fan is fitted this makes matters worse. When used in a dusty environment it is as well to keep the oscilloscope covered with a plastic sheet to keep out unnecessary dust. However, when the scope is in use there is little that can be done because to obstruct the dust is to obstruct the



The EHT section of an oscilloscope, the rectifier valves heaters being fed from individual windings on the transformer.

COOLING

Large oscilloscopes usually have a fan at the back to keep the scope cool and the field from the fan motor is such that a piece of Mumetal is often needed around the motor. This should always be replaced when servicing of the motor is completed. The danger of an excessive rise in internal temperature is so great in some scopes that a thermal cut-out is incorporated to switch off the HT, but leave the fan running if the temperature should become too high. Clogged air filters can cause this to happen and it should not be ignored because all manner of awkward faults can be brought on by excessive temperatures.

airflow necessary to maintain a safe working temperature.

The author used to think that a scope could not be cleaned and pampered too much but is now a bit wiser! When cleaning out dust with a small brush connections become dislodged and dust gets into switches and controls. So it is best to keep the number of "spring cleans" to as few as are really necessary and to allow a bit of time for fault finding afterwards, But do not be put off—the result of a clean scope is a more reliable scope that is much easier to work on when it does break down.

For general chassis cleaning a brush round with a 1" paint brush is usually adequate unless the dirt is greasy when the chassis may be rubbed down with a

rag soaked in acetone or carbon tetrachloride. It is important not to disturb any preset pots or trimmers, especially in the distributed amplifier and attenuator and in the timebase. The EHT generator whether RF or from the mains should be kept clean as the dust builds up quickly in this area and also can do the most damage. Oil from leaking EHT capacitors also aggravates the situation but a cloth soaked in acetone will probably clear up the mess.

CONTROLS

Controls quite naturally come in for a lot of hard wear and pots and switches tend to become erratic. A gentle squirt of "SERVISOL" aerosol will sort out most problems. It is important not to spray too much as it can make rather a mess. Beware of the cheaper brands, they dissolve plastic switch parts in a flash, leaving a gooey mess in place of the switch! When potentiometers become noisy or erratic in operation a gentle squirt of "SERVISOL" on the track will probably effect a lasting cure. Some spurious effects can be traced to the spindle bearing and a gentle squirt here may well help, but it is important not to get the fluid on to the front panel as it can make rather a mess and dissolve some types of lettering.

Input sockets (especially the UHF83) sometimes need tightening to ensure reliable contact but it is necessary to be careful not to cause too great a deformation especially with the BNC sockets which are quite fragile. Oscilloscopes equipped with plug-in units often need a little lubrication on their runners and it is advisable to keep the rear connector clean otherwise erratic operation will result. One point often overlooked is that power valves (regulator, X and Y outputs and EHT generator) when they are greasy suffer a much higher running temperature due to lack of cooling. It is a good idea to keep all valves clean and polished and to give the base a tiny squirt of "SERVISOL" before replacing the valve. Several oscilloscopes place the EHT generator valves in screening cans (to prevent radiation) and if these fill up with dust, as often happens, the valve tends to run scorching hot with the possibility of early failure.

SERVICING

With regard to the electronics there is little that can be done in the way of maintenance on a regular basis, it being necessary to wait for faults to occur before they can be rectified. Fortunately the majority of oscilloscopes are constructed to be as reliable as possible for the price and consequently the fault rate is low. Most faults can be found with a multimeter and a signal source applied to the scope. When found the faults usually turn out to be due to faulty valves, faulty rectifiers, open circuit or "high" resistors or short circuited capacitors. When making replacements it is important to keep to a high standard of workmanship and to use good quality components of adequate rating.

COMPONENT REPLACEMENT

A word is perhaps of use here concerning the AC qualities of resistors. The reactances of resistors becomes important at high frequencies in critical cir-

cuits, such as the Y amplifier and timebase. The standard carbon rod type of resistor, usually 10% tolerance at best, is perhaps one of the best types with regard to its AC performance. Its inductance is zero and the capacitance is usually less than 1pF. Metal film resistors are also as good in this respect and are available in a wide range of ratings and with tolerances as close as 0.5% if necessary. Other types of carbon resistor although of high reliability may have quite significant inductance and also fairly high self-capacitance. Wirewound resistors are absolutely useless in such applications and should only be used where they are well decoupled and their reactance of no consequence.

In general it is best to replace any components by identical types, which can be ordered from the scope manufacturer if necessary. Replacement component tolerances should be better or the same as the item they replace. Servicing of oscilloscopes, particularly by their owner, rarely creates any problems as the circuits are well defined in their operation and the layout in the majority of cases is intended to aid servicing.

To be continued

TELE-TENNIS

-continued from page 338

The reason for making an issue over grounding is that the Crofton modulator has inverted supply rails, i.e. its case is at +12V, whereas we shall ultimately be making our system ground OV. **Do not under any circumstances** let the case of the modulator come into contact with other metal work or you will put a dead short across the power supply. It is best to cover all exposed metal work of the modulator's case with a couple of layers of PVC tape.

When Board E is complete it can be screwed to the subframe alongside the power supply board and the supply leads wired in. Apply power and check that a carrier is present by watching the television screen. If you have a signal generator (you can make a simple one from a standard multivibrator circuit) giving outputs of up to 5V you can inject a 15.625kHz signal into the mixed sync input. Turn up the brightness of the television set and you should if the set is in tune-see a dark band running down the left hand side of the screen. Adjust the tuning for maximum signal—it is easier to adjust the set rather than the modulator—and then see the effect of varying the modulation level. Alternatively injecting a 50Hz square wave into the same point should produce a dark horizontal band running across the screen. The signal generator will need fine adjustment to obtain precise field or line lock. A square wave having a frequency between 50Hz and a few hundred kilohertz connected to the inputs of diodes D17 to D23 should cause a random array of white dots to appear on the face of the television set. Further tests must wait until we have produced a correctly generated set of field and line sync pulses. This we shall do next month when we describe the circuitry and construction of boards A and B.

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Garrard	8 or 15 ohm (K2006)	£2 · 50		£26:00 £14:20	Bush CR128 LW/MW	£13 · 60
SP25 MkIV P & C G/800 £19 95	Cone Tweeter 3 watt		*Headphone adaptor	214 20	Bush CR232 MW/VHF	€24-95
AP76 Module £30 00	8 ohm (K2003)	£1 · 55	(Junction box)	€2-50	Murphy MV5600	
Goldring GL78 P & C/ G800E 459 · 95	Horn Tweeter 8 ohm		extension lead 2ft curly		MW/VHF	£22-95
	(K2007)	£6·50				
Connoisseur BDI Kit £12-25	Dome Tweeter 8 ohm	£5-50	CASSETTES C40 C60 C90	0 C120	CASSETTE RECORDS	
BD2 Chassis/SAU2 £29-95	(K2011) 2-way Crossovers (CN23.	E3 30		55p	Murphy BA206	£16-95 £25-75
5AU2 £13.00	CN28, CN216)	£1 · 20	Philips — 50p 69p	105p	Bush TP66 M/Batt Murphy BA200 M/Batt	£22 · 75
SCUI <u>£4-95</u>	3-way Crossover (CN38)	£2 · 75	Memorex 55p 65p 85p	120p	Bush BT8504 (miniature)	
Plinth & Cover for Garrard			Ampex (360) 45 p 55 p 70;	p 99p	Wien 500 M/Batt	£14-95
SP25 MkIV Mk. III	CARTRIDGES		Ampex	. 125		
2025TC £3:50	Acos	£1-10		p 135p	RADIO CASSETTES	
TAPE DECKS	GP1/25C or 3SC GP93/1	£1:35	Ampex Chromium		(Mains/Batt.)	(3F OF
Akai	GP94/1	£1 75	Dioxide — 99p 140p	ь —	Micado 8155 AM/FM Sharp RD4225 MW/3SW	£25 · 95 £46 · 50
4000DS £93-95	GP96/1	£1 - 75	Casette Head Cleaner	45p	Hanimex HRC3070	E40 30
1721L £87·95	GPIOI	€0.90	Ampex Head Cleaner		AM/FM	€29 - 95
GXC36D £82:00	GPI04	£1 · 75	Demagnetiser	£1 · 65	Murphy BA209 MW/VHF	
GXC38D £103.95	BSR		Cassette Racks (hold 6)	€0 - 45		
CS33D £79-95	5C6M	£2:75	Cassette Rotating Racks (hold 20)	£3-50	STEREO RECORD PI	LAYER
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player £73-95	X5M	£1 50	(BIB) (hold 12)	£1-60	Bush SPR58 Bush SPR59	£31-50
SPEAKERS	X5H	£1-50	8-Track Cartridge Blan		Bush A1005	£56 · 50
Wharfedale	Sonotone		C40 C64	C80	Hanimex H101	£39 95
Denton 2 (pair) £33 00	9TAHC (Diamond)	£1 80	Ampex 80p 95p		Hanimex HRC5060 8-trac	k
Linton 2 (pair) £42.95	9TAHC/G (Diamond)	£1 ·80	8-track H/Cleaner		AM/FM/MPX + Speaker	
Linton 2 Kits (pair) £19:95	Double Diamond Stylii	41.35	Demagnetiser	£1·90	CAR ALIDIO	
Glendale 3 Kit (pair) £36 95 Dovedale 3 Kit (pair) £59 95	for above Goldring	£1 · 25	8-track Carrying Cases	(1) (5	Bush Car Cassette BT8501	£34.75
	G850 Cartridge	€2-95	(BIB)	£1 · 65	Hitachi Car Radio	230 73
Chassis Speakers EMI (Plain) 13in x 8in,	G800	£3 · 95	TAPES		WM702R LW/MW	€16-50
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with Single Tweeter £2:45	Audio Tecnica AT55	£1 · 95	5" 55n 69n	90p	Hitachi Car Cassette	
with Twin Tweeter £3:95	Empire 999 REX	£3.95	51" 69p 88p 1	·25p	C5114	£45 ⋅ 00
Type 350 Kit 15 watt 8 ohm £8 · 25				60p	with Radio CSW17	CET. 00
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15 watt 8 ohm £4-95	G850/G800/G800H	€1.95		55p	ALL ITEMS SUBJECT TO	
8in x 5in 5 watt 3, 8 or	CC90/7	£1:00 £3:60	7" 1:90p 2	95p	MANUFACTURERS INCREA	SE
15 ohm £1⋅50 8in x 5in 10 watt	G800E CS91/E	£2 · 25	CALCULATORS		AND AVAILABILITY	
Dualcone 8 ohm £2:50	AT66	£3 60	Sinclair Cambridge Build	£19-95	PERSONAL CAL	EBC
6}" 10 watt 8 ohm £2.65	N44-5	£2 · 25	Sinclair Cambridge Kit	£17·95		113
8in 10 watt 8 ohm £3-90	N44-7	€2 50	Scientific	£45 · 95	WELCOME	
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SPECIAL REPORT

I F you are a conscientious constructor, you would not be able to get very far without getting frustrated by the need for a multi-range meter. It is almost as essential as a speedometer to a motorist. Without one, how can you locate fault conditions, or check component values.

Practical Wireless recently published an article on this subject, illustrating examples of well known types. When looking around to buy a multimeter what should you look for? Well this will depend to some extent on the usage expected of it. There are meters renowned for robustness and the ability to withstand fairly rough handling. There are those that have a high sensitivity, or an extended voltage range, or built-in capacitance meter. Good ones are not cheap to buy, but this does not mean that cheap ones are not worth having.

There has been a recent introduction of some Italian instruments into the U.K. which are certainly worth looking

MANUFACTURER'S SPECIFICATION

Sensitivity A.C. & D.C., $40 k\Omega/V$ D.C. \pm 2.5% Ohms \pm 2% Accuracy Bandwidth 20Hz to 10kHz 156 x 100 x 40mm Dimensions Weight 650 grammes Internal, 2 x 1.5V HP7 or Power requirements

similar) 1 x 22.5 (B 122 or similar) for resistance. External, 220-240V 50Hz for capacitance and frequency

RANGES

0-1,200V

V	DITS	Current		
D.C.	A.C.	D.C.	A.C.	
0-420mV	0-3V	0-30μA	0-3·0m A	
0-1·2V	0-12V	0-300μΑ	0-30m A	
0-3·0V	0-30V	0-3mA	0-0-3A	
0-12V	0-120V	0-30mA	0-3·0A	
0-30V	0-300V	0-0·3A		
0-120V	0-1,200V	0-3·0A		
0-300V				

Resistance Ω	Power dB
0-2kΩ	10 to + 11
0-20kΩ	+ 2 to + 23
0-200kΩ	+ 10 to + 31
$0-2M\Omega$	+22 to +43
$0-20M\Omega$	+30 to +51
0-200M Ω	+42 to +63

Frequency Hz Capacitance µF 0-50Hz 0-0.05µF 0-0-5/iF 0-500Hz 0-5kHz

Ballistic Capacitance

Extends ranges up to one Farad.

Universal Signal Injector

500kHz modulated at 1kHz Frequencies Usable up to 500MHz Harmonic content 20V peak-to-peak Output Probe will withstand 500V d.c. Isolation

at circuit under test 25mA from internal battery Power requirements

into for several reasons. These are made by Chinaglia Dino and are being distributed in this country by Chinaglia (UK) Ltd*. There are several types, each having its own performance/cost parameters; we have selected as being a very useful all-rounder, the "Cortina Major" which costs £22.27 or, if you want the Universal Signal injector with it, will cost £27, plus VAT in each case. There are lower priced meters in the range that are also worth looking into, but with more modest performance.

PERFORMANCE

The quoted performance figures are tabulated here and straight away, readers will notice the sensitivity of 40k\O/ volt. This is adequate for transistor and i.c. circuitry and brings the meter into possible applications even with high impedance work without serious shunting errors in the readings indicated. When used as a voltmeter across any a.c. or d.c. load, the internal resistance of the instrument will often have some effect on the reading accuracy. The higher the sensitivity in terms of kilohms per volt, the less will be that error.

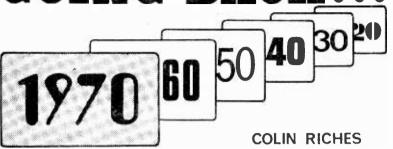
The Major will handle a.c. and d.c. voltage and current measurements. The a.c. current facility is particularly interesting; although not required very often, it can be a nuisance if you are using a meter that does not have this facility, as is the case with some earlier models from other makers. The main problem with this range is that its accuracy really depends upon the frequency of the current being measured because of the reactance effects of the meter coil. For inductive loads, it can be a little misleading unless the frequency is taken into account. In the absence of any other figures of measurement than the claimed accuracy of \pm 2.5 per cent for a.c. ranges, we assume this to apply within the quoted bandwidth.

RANGES

The d.c. current ranges are very useful for transistor circuits, being based on a common scale of 0 to 30 with

-continued on page 350

GOING BACK...



HIRTY-FIVE years ago this year the Zenith Trans-Oceanic was born.

Over the years new knowledge and improved technology have gone into successive improved versions. The latest—the Trans-Oceanic Royal D-7000Y — is equipped to tune to 11 wave bands. (1) a.m., 540-166MHz, (2) f.m., 88-108MHz, (3) l.w., 150-400kHz, (4) s.w., 1·6-3·5MHz, (5) 3·5-90MHz, (6) 9·4-10·1MHz, (7) 11·4-12·33MHz, (8) 14·6-15·8MHz, (9) 17·1-18·5MHz, (10) 20·6-22·4MHz and (11) 161-164MHz.

It is designed and treated to operate in extreme climatic conditions, and incorporates r.f. gain control, b.f.o., vernier tuning and battery level meter, illuminated dial and chart panel, telescopic aerial and personal earphone. Navigational benefits include a time zone indicator, logging scale and azimuth compass. A swivel base platform can be supplied to aid directional tuning. It operates on 9 standard U2 type batteries but also has a built-in a.c. power

supply for either 115V or 230V

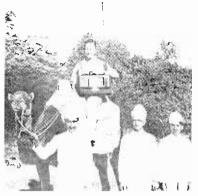
The Trans Oceanic theory was developed into practice in 1939, when Commander E. F. McDonald (Zenith's late founder-president), having asked the company's engineering department to produce a shortwave battery operated radio, found that he could sit in his Canadian fishing lodge and pick up both the weather forecast from Ohio and broadcasts from London.

After a combination broadcast and shortwave receiver with broad bandspread for easier tuning had been produced, McDonald took one to Northern Canada and sent another to Commander Donald B. McMillan in the Arctic. McMillan tested it on Baffin Island, and then further north on Ellesmere and Greenland. Finding it fully satisfactory, he radioed McDonald to express his approval.

When some further 20 experimental models had been tested and subsequent modifications



Experimental S.W. transmission with singing Eskimos (1925). Zenith's founder-president Commander McDonald is standing on the right.



An early "mobile" Trans-Oceanic

adapted, the set went into production several months before the Zenith factory was converted for the war effort in 1941. At that stage 100,000 Trans - Oceanic radios were on the order books, and though many of these were never completed, several thousand had been by the time the US entered the war. Members of the allied forces were frequently comforted throughout the duration of the war by broadcasts from their native countries, the radio set often being their only link with

About his Trans-Oceanic radio, a British army officer wrote,



First multiband receiver made in 1941

"During the whole war, it was either with me or close behind with my luggage. Besides being under enemy fire, it has stood in the open in blistering heat and sandstorms, likewise in monsoon rain and snow. I have watched it dropped into cargo holds by coolies and have sympathised with it after suffering a kick by a donkey. In, spite of such treatment, there has been no occasion during its ten years life that the set has failed to work."

Since introduction in 1941, a number of major improvements have taken place. Announced to yachtsmen in 1951, as a "king-size

-continued on page 350

SPECIAL PRODUCT REPORT—continued from page 348

appropriate range multiplication factors. The $30\mu A$ range enables low leakage currents to be detected, whilst the 3 amp range is useful for average thyristor d.c. load

measurement.

The voltage ranges are divided into two scales— 0 to 12 and 0 to 30 with appropriate multipliers. The advantage of using two scales is to maintain average meter indications between a half and full scale deflection, usually recommended for most measurements on load, without having to interpolate at the low end of the scale. The 1,200V ranges will cope with most applications except e.h.t. for cathode ray tubes; the optional extra probe will extend this range to 30kV d.c., sufficient for most oscilloscope or television c.r.t.s., for an additional £7·27 plus VAT.

The resistance ranges are from 0 to $2k\Omega$ (useful readings) on a $20k\Omega$ scale, up to 0 to $20M\Omega$ (useful readings) on a $200M\Omega$ scale. This will cater for a very wide range of measurements from 1 ohm to $20M\Omega$ d.c. but does not, as is usual, mean that "cold insulation" tests on capacitors or

wiring will necessarily give reliable results.

Two 1.5V batteries have to be fitted to give the low resistance ranges and one 22.5V battery for the high

resistance ranges.

Decibel measurements are based on the standard 0dB= ImW in 600 ohms, or 0.775V a.c., using the a.c. voltage circuit for measurements ranging from -10 to +63dB.

Using an interpolation scale in the instructions an indication of frequency is possible based on the use of the capacitance circuit and, in the case of the X100 range, it depends on an external accurate 4,700pF capacitor being applied. Both the frequency and capacitance ranges require this instrument to be connected to an accurate 50Hz mains supply of 220 to 240V for which a lead is provided. The meter uses a resistance measurement circuit to determine reactance, and hence interprets the result as a direct capacitance reading up to a maximum $0.5\mu\text{F}$. For most purposes the $10,000\mu\text{F}$ "ballistic capacitance" range is likely to be the maximum required, and this is achieved by interpolation of the d.c. AV scale using the chart given in the instructions.

The optional extra U.S.I. (Universal Signal Injector) is virtually a square wave signal generator using two transistors and mounted inside a "pen" type tube with a 1-5V battery. It provides a 1kHz "pulse" waveform from a blocking oscillator suitable for signal tracing and fault finding procedures in a wide range of radio, audio and TV equipment. The probe is claimed to withstand, on test, 500V d.c. and provide.20V peak-to-peak output.

In the event of repairs being needed, the manufacturers have appointed Coates-Clarke (Services) Ltd., of 110a St. Margarets Road, Hanwell, London W.7. to carry out

this service.

*Chinaglia (UK) Ltd., 19 Mulberry Walk, London SW3 6DZ

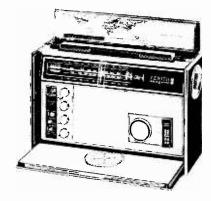
GOING BACK

-continued from page 349

aspirin for the headaches of amateur sailors" and "the world's newest aid to navigation," the new Trans-Oceanic had had added to it two new continuous tuning bands that covered the entire 38 to 150 metre band, (2 to 8MHz).

In 1954 another new version of the Trans-Oceanic was introduced and included a ferrite rod aerial which, in conjunction with new circuits, was said to "treble the range" for standard broadcast reception. Other additions included a horizontal slide-rule type tuning dial. Push-button band selection and a reel-away take-up on the power control. Inside the set's cover were located a series of flip charts, a world-wide time map and listings for all major short-wave stations.

McDonald's next challenge to his company engineers was to develop a transistorised Trans-Oceanic portable radio that would "equal or better the performance" of the valved version. Compactness was his stipulation to the engineers. Whether for yachts or expeditions, it was paramount that weight and bulk size was kept to a minimum but without the sacrifice of performance. There was not to be room for a teaspoon of sugar, or the engineers "would get it back." After three years of research and development Zenith announced "the world's first all-transistor band-spread short wave portable radio" in 1957.



The 1974 version of the Trans-Oceanic. Recommended retail price is £247·50 inc. VAT.

Components and circuitry were built into a case measuring $10^1_4 \times 12^1_2 \times 4^7_8$ in representing a major achievement in miniaturisation and space efficiency. It included a new rotary band switch and associated circuits for electrical band-spread tuning which occupied a fraction of the space required in valved short wave sets. The band selector switch rotated a "rolling pin" dial scale so that only one tuning band was visible at a time.

"The ultimate in personal radios" was announced in 1962—this was a 9-band Trans-Oceanic, the Royal 3000. This transistorised receiver combined superlative performance and virtually

"drift-free" tuning of the f.m. broadcast band with new sensitivity on short wave, long wave and standard broadcast bands. It was similar to the previous model but less the 13 metre band and plus the f.m. broadcast band (88 to 108MHz).

August 1964 saw the one millionth Trans-Oceanic portable radio roll off the Zenith production line.

In 1968 the Trans-Oceanic was again altered quite significantly with the addition of the wave bands. The Royal 7000, as the new model was called, featured 11 bands and incorporated a v.h.f. fixed crystal U.S. "weather" band at 162.55MHz. The set was tuned to the weather position to hear up-to-the-minute weather reports. The second band addition was short wave (a division of the earlier 2-9MHz spread), making a total of seven short wave bands, long wave, f.m. a.m. and weather band. Other improvements in the Royal 7000 included a b.f.o. and manual r.f. gain controls.

In 1971, the Royal 7000 was further refined with replaceable crystals for the weather band, enabling the listener to receive weather stations assigned to frequencies other than the common 162·55MHz (U.S.), in 1972 the Royal D-7000Y was improved again with the addition of the adjustable weather band and minor cabinet changes. The 1974 version is shown in our picture.

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1		Ohms		Ohms
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d	0-100 micro A.	580	0-100 micro A	. 730
1	0-500 micro A.	170	0500 micro A	. 200
ı	0-1 m A	170	0-1 mA	200
1	0 -5 mA	170	0-1 mA 0-5 mA 0-10 mA	500
J	0 -10 mA	15	0-10 mA	6
1	0-50 mA	0.5	0-50 tnA	0.5
	0 -100 mA	0:5	0-100 mA	
	0 -500 mA	0.5	0-500 mA	0.5
			0-1 AMP	0.5
ľ	0-2 AMP	0.5	n=2 A MP	
	u-25 Volt	15 K	0 25 Velt	
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	0/240V	LATING Sec. 120/	240♥. Cen	ire Tap		olts 200-240V. , 25, 33, 4	40. 50♥.		Sec. 24,	00-240V. 30, 40, 4		Po-d
VA (watts) 60 100 200 250 350 500 1000 2000	Ref. No. 149 150 151 152 158 154 156 158	£9-48 12-05 14-00 15-80 30-70 60-95 79-53	Open #3.74 4.16 7.48 9.57 11.44 13.20 27.46 55.44 72.49	Post £ 0-38 0-52 0-52 0-65 0-80 1-00 1-20	Amps 0.5 1 2 3 4 6 8	Ref. No. 102 103 104 105 106 107 118	1 rice £ 2·11 3·08 4·29 5·77 7·48 11·00 14·19 17·60	Post £ 0-30 0-38 0-42 0-52 0-52 0-67 0-97	Ampa 0:5 1 2 3 4 5 6 8 10	Ref. No. 124 126 127 125 123 40 120 121 122 180	Frice £ 2-10 2-97 5-77 7-15 9-35 11-55 13-57 16-00 19-40 21-62	Post £ 0-38 0-38 0-42 0-52 0-67 0-87 1-00 1-10

12 8	24 Vo	its Prim	. 200-240V.		MINIATURE	AND EQL	JIPMENT
Arons		Ref.	1'rice	Post	Prim. 240V with Volts	screen.	Mi
12 V 0:3	24V 0-15	No. 242	£ 1:34	0.22	Sec. 1	Ber. 2	Sec. 1
0.5	0.25	111	1.34	0.22	3-0-3	0.6	500
1 2	0.5	213 71	1 59 2 09	0.22	0.6	0-6	1000
4	2 3	18 70	2:75 3:56	0.38	9-0-9	0-9	330
. 8	4	108	3.96	0.52	0-8-9	0.8-9	500 1000
10	5 6	72 116	4·67 5·67	0.52	15-0-15		40
16	8	17	6 64 10 23	0.69	0.15	015	200
20 30	15	187	13.75	0.97	0 20 0-15-20	0-20 0-15-20	150 500
40 60	20 30	232	18-26 22-52	1-00	0-20	0-20	300
		-		-	0.20 26.19.0-19-90		3500 D/C

Amps 12V	24V	Ref. No.	l'rice £	Post £
0.3	0.15	242	1.34	0.22
0.5	0.25	111	1.34	0.22
1	0.5	213	1.59	0.22
2	1	71	2.09	0.22
4	2	18	2.75	0.38
6	3	70	3.56	0.42
8	4	108	3.96	0.52
10	5	72	4.67	0.52
12	6	116	5.67	0.52
16	8	17	6.64	0.52
20	10	115	10 23	0.69
30	15	187	13.75	0.97
40	20	232	18-26	1-00
60	30	226	22.52	1.10
30 V	olts			

226	22.52	1.10	0-20 0 20 20-12-0-12-20 0 15-20 0 15-27	0-15-20 0-15-27	3500 700 (1 1000 500	NO SCREEN	1116 221 206 203	3 00 1 55 8 80 3 08 2 24
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				0-90		150	237	1.30
				0-10		200		1.23
				0.15		900		1.30
72				0-8-9		17770		1.23
108	3.96							3 08
70	3.56	0.42	0-9					2.28
	2.75	0.38	9-0-9					1.23
		0.22	0.6	0-6				1.68
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			3-0-3	_	500			1.23
	108 72 116 17 115 187	11	111 1.34 0.22 213 1.59 0.22 71 2.09 0.22 71 2.09 0.22 18 2.75 0.38 70 3.56 0.42 108 3.96 0.52 72 4.67 0.52 117 6.64 0.50 117 6.64 0.50 118 10.23 0.69 187 13.75 0.97 232 18.26 1.00	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	111	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$

Prim.	200	240V.	Sec.	12, 15,	20.	24,	80V.
Ampa		Ref.		Price			Post
		No.		£			£
0.5		112		1.58			0.55
1 1		79		2.20)		0.38
2		3		8-19			0.38
2 3		20		3.96			0.42
4		21		4.68			0.52
5		51		5-80			0.52
6		117		6-98			0.52
8		88		9.00			0.67
10		89		10.00)		0.67

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. , . (Caseri	Open	
		£	£	
Tapped a	U115, 200, 22	 9, 240 Volts 		
20	113		1.32	0.55
75	64		2.63	0.30
Tapped a	f 115, 220, 24	0 Volts		
150	-4		3.29	0.39
200	65	5 56	3.96	0.40
300	66		4.64	0.52
500	67	9.50	8.03	0.67
1000	84	15 92	13.50	0.80
2000	9.5	29.70	25:30	1.50
3000	73		33 00	1.20
20VA ver	sion uncoater	l, no fuse:		
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SHORT WAVE DX by MALCOLM CONNAH

'Radio Australia Listeners' Club Group' has been formed by George Hewlett of 22 Park Hill Road, Torquay, Devon and Miriam Bryant of 2 Broad Street, St. Columb, Cornwall. The club is not only for members of the official Listeners' Club but for anyone interested in listening to Radio Australia.

Although the club will mainly serve the South West of England the founders are prepared to answer any queries about the reception of Radio They would appreciate a stamped Australia. addressed envelope with any query requiring an answer.

Readers' Logs

The first two logs this month come from the husband and wife team of Douglas and Rita Malpus from Cumberland. Douglas uses a 5 valve domestic receiver and a 25 foot end-fed antenna, which is often used at an alternative address in Scotland. Rita uses a Ferguson-Caravelle Transportable with a 120 feet long-wire and ATU. The results achieved were as follows.

Douglas Malpus

6205 R. North Sea International at 1900.

9670 IBRA Radio noted at 2100.

11775 R. Nacional D'Espana at 1715.

15185 R. Finland noted at 1820.

15295 ORTF, Paris, France at 1110.

15305 SBC, Berne, Switzerland at 1100.

15415 R. Kuwait noted at 1850.

15440 WYFR, USA noted at 2230.

17770 Radio Sweden at 1400.

17885 HCJB, Quito, Ecuador at 2130.

Rita M. Malpus

9525 AIR, General Overseas Service at 2020.

9535 SBC, Berne, Switzerland at 2200.

9650 Deutsche Welle, Cologne at 2145.

9690 R. Bucharest, Rumania at 1315.

9833 R. Budapest, Hungary noted at 2230.

9750 R. Vilnius, Lithuania at 2230.

11810 V. of Turkey, Ankara noted at 2230.

15185 R. Finland noted at 2030.

Christopher L. Hodgson of Sunderland used his

Codar MultiBand 6 with a 50 foot end-fed, 9 metre inverted vee and an ATU to hear:

9455 Radio Pyongyang noted at 2015.

9540 Radio Australia, S/on at 1800.

9695 Trans World Radio, Monte Carlo at 0820.

11720 R. Nacional, Brazilia at 2315.

11905 UN Radio, Greenville at 2205.

15084 R. Tehran, Iran in Farsi at 1030.

15310 BBC, Far East Relay (Malaysia) at 1530.

15410 UN Radio, Greenville at 1625. 15570 Radio Pakistan, S/on at 1530.

17820 Radio Canada Int. in Czech. at 1715.

17885 BBC, Cyprus relay at 1155.

21685 Radio Kuwait, S/off in Arabic at 1505.

William F. Kitching of Telford in Shropshire has a Grundig Satellit 2000 receiver and using only the telescopic aerial he heard the following:

3980 VOA, Munich noted at 2100.

3985 SBC, Berne, Switzerland at 0700.

6015 ORTF, Paris, France noted at 0515.

11730 Radio Nederland, Bonaire relay at 0630.

15012 Voice of Vietnam at 1800.

15195 R. Afghanistan noted at 1130.

17855 NHK, Radio Japan at 0900.

21535 RSA, South Africa noted at 1500.

21655 R. Norway (Sundays) at 1400.

21740 VOA, Greenville at 1700.

25790 RSA, South Africa noted at 1330.

Albert E. Ord of South Shields again used his Trio 9R59DS with a Joystick antenna and Hamgear preselector the log for this month including:

3905 AIR, India in English at 2330.

4955 R. Nacional, Colombia in Spanish at 0530.

5990 HCJB, Quito, Ecuador in English at 0645.

9410 R. Pyongyang in English at 2140.

9570 R. Australia noted at 0800.

9620 S.O.D.R.E., Uruguay in Spanish at 2200.

11775 R. Bucharest in English at 0430.

11780 R. New Zealand heard at 0730.

11825 V. of Free China, Taiwan, English at 1930.

15415 R. Kuwait, Pop Music at 1945.

17755 HCJB, Quito, Ecuador in English at 1900.

21540 R. Ghana heard in English at 1500.

Trevor Bland of Lea, near Gainsborough in Lin-

colnshire, used his Telton TF-182 to log the following:

5960 R. Canada Int. in English at 1030.

6030 AFRTS, Washington in English at 0130.

6040 VOA, Washington in English at 1935.

7280 R. Moscow in English at 2025.

9022 R. Tehran, Iran in English at 2005.

9585 R. Finland in English at 2030.

9625 R. Canada Int. in English at 2400.

11815 TWR, Bonaire relay in English at 0100.

15385 R. Nacional, Brazil in English at 2015. 15430 AFRTS, Washington in English at 1730.

17880 HCJB, Quito, Ecuador in English at 2015.



MEDIUM WAVE BROADCASTS by CHARLES MOLLOY

ICHOLAS Taylor who lives at Sunbury-on-Thames does his medium wave DXing with an Ultra 4175 receiver and a medium wave loop antenna. Local radio stations logged include IBA London on 719kHz; BBC Radio Blackburn on 854kHz: Solent on 998kHz; Medway on 1034kHz; Leeds on 1106kHz: Derby on 1115kHz; London on 1457kHz; Brighton on 1484kHz; Nottingham on 1520kHz; Bristol on 1546kHz. Nicholas has been hunting-out the stations on the American Forces Network in West Germany and he reports hearing AFN Frankfurt on 872kHz; Berlin on 935kHz; Munich on 1106kHz: Stuttgart on 1142kHz; Heidelberg on 1304kHz; Augsburg on 1394kHz and low power relays on 611kHz and 1502kHz. Karlsruhe on 1034kHz is another outlet to look for. The Armed Forces Radio and Television Service (AFRTS) operates in many countries other than Germany. Stations heard occasionally in the UK are Keflavik, Iceland on 1484kHz; Lajes, Azores on 1500kHz; Kenitra, Morocco also on 1484kHz and Athens, Greece on 1594kHz.

Kevin Peel (Hornchurch, Essex) has been busy with his Astrad receiver and 100ft outdoor aerial. He reports hearing BBC Radio Derby on 1115kHz; AFN Munich on 1106kHz; AFN Stuttgart 1142kHz and the 1000kW station at Cluj in Romania on 1151kHz. During the summer months Cluj along with Lugof on 755kHz carry a multi-lingual programme for

tourists at 2230hrs GMT with programmes of Romanian music and announcements in English, French and German. Both stations will verify a correct reception report with a QSL card.

Brendon McNamee reports again from Portrush in N. Ireland. With his Sharp BZ-23 receiver and whip antenna he has logged BBC Radio Derby 1115kHz at 2338hrs; Manx Radio, Isle of Man on 1295kHz at 1655hrs; Radio Sweden 1178kHz with its international service at 0020hrs.

Our regular reporter Brian Murray (Edinburgh) has been concentrating on the local radio networks. With his Astrad VEF 204 receiver connected to an externally mounted TV aerial he has heard IBA Birmingham on 1151kHz with close down at 0105hrs; IBA Manchester also on 1151kHz testing at 0130hrs; BBC local radio stations at Carlisle on 755kHz at 1415hrs; Blackburn on 854kHz at 1410hrs; Sheffield on 1034kHz at 0100hrs; Medway 1034kHz at 2245hrs; Leeds 1106kHz at 2350hrs; Derby 1115kHz at 2240hrs; Bristol 1546kHz at 2258hrs and Leicester 1594kHz at 2255hrs. Brian also reports hearing two stations from the Iberian peninsula. From Spain, Radio Centro, Madrid on 1385kHz at 0155hrs and from Portugal CSB2, Radio Club Portugues in Lisbon on 1034kHz at 0020hrs. Externally mounted TV aerials often give good results as a medium wave antenna. Try connecting both the inner and the outer of the co-axial down lead to the aerial socket of the MW receiver. The outer (shield) will make a good vertical aerial in localities free from electrical interference.

Radio Algeria can be heard on 251kHz (1195m) on the long waves in English between 1900hrs and 1930hrs GMT every evening. The signal, which comes from a 750kW transmitter at Tipaza, is heard well in the UK. The station asks for reception reports which should be sent to Radio Algeria, 21 Boulevard des Martyrs, Algiers, Algeria.

VHF/FM DXING

by SIMON DAVID

F we could forecast, with a useful degree of accuracy, likely openings for f.m. DXing then one could assume that we would be able to tune in together and all obtain near perfect results. It is easy to assume this, but the facts are different. What one DXer may pick up at one instant may be very different from the fortunes of another 100 miles or more away. It is sometimes forgotten that some British local radio stations may be as far away as some of the continentals, for example, North France and North England are approximately the same distance from Bristol or Oxford.

Here is a useful idea that could be helpful to f.m. DXers. For 50p you can buy the new large British Rail timetable. Now why should this be of any value to DXing? Well, included with it are two large double-sided maps—one of Gt. Britain and the other of Europe as far east as the Black Sea. These are clearly marked with the main towns and railways and make a very clear f.m. DXers map. (These maps are worth the 50p alone in my opinion.) If you cannot get one then any other flat map of Europe will do. ("Global" maps tend to distort distance lines.)

Now use a large pair of compasses, or the cottonand-pencil technique, to draw concentric circles about the centre point representing your home town. These circles can be drawn to the scale of the map to represent distances of 25, 50, 75, 100 etc. miles from your home. Next go over the map thoroughly and pick out all the known f.m. transmitting stations and draw a box around the place name to help it to stand out. When you have received any of these stations on your f.m. radio receiver, you can fill in the box with a light coloured pencil.

If your aerial is installed in a fixed position, determine as accurately as possible the compass point or transmitter towards which it is directed. Draw a straight line on the map through your home town representing this aerial direction and continue that line as far as possible across the map. You now have a quick reference chart to locate any station that comes in within a reasonable distance of that aerial line. If you want a reference for marking f.m. transmitters on the map you can either do it the hard way by going through all the radio station details in the World Radio and TV Handbook or use the f.m. station list that I mentioned last month.

My thanks to all readers who have written to me including **Bob Bonsall** of Buxton, **F. Walshe** of Southport who has picked up the Isle of Man, R.T.E., Lille and several northern local stations using a Stolle rotator. **Geoffrey Tyrell** writes from Aylesbury who (I am delighted to learn) has come back to P.W. after four years in the wilderness. He makes some observations about stations that he can pick up with only a single dipole arrangement and a Hacker Hunter portable radio. These include BRMB, LBC, Capital, BBC Radio London, Medway, Birmingham, Oxford and Stoke.

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504, 507, 508	£10 · 01	80 · 63	Ħ
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watt 5% carbon	1p
1 watt 10% carbon	2∮p
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# watt m/o 2 %	4p
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100µF	8 p	3311F	6 p	100µF	9p
$220 \mu F$	₿å₽	150µF	6 p	68µF	10p
330µF	6 t p	150µF	8p	220µF	11p
1000µF	18p	220µF	9p	470µF	19p
4700) F	29p	680µF	17p	680µF	25p
6.3.VO		1000µF	17p	1000µF	25p
6-3 AO		1500µF	25p	2200µF	44p
33μF	6 p	2000µF	48p		-
68µF	6 p	25 140	1		
150µF	6 p	25 V O			
470µF	11p	$10\mu F$	Bip		
680µ F	13p	$22\mu F$	6 p	63 VO	LT
1500µF	18p	47µF	β∳p	1μF	6ip
2200µF	18p	100µF	8р	2·2µF	6 p
3300µF	26p	150µF	8p	4.7µF	6 p
10 VO	T	220µF	10p	6.8µF	6 p
22µF	б∔р	470µF	13p	10µF	6 p
47μF	6 p	680µF	20p	00.12	6 p
100µF	6 p		22p	0010	10p
220μF	8p		89p	100µF	11p
330µF	10p	5000µF	68p	150µF	18p
330μF 470μF	10p	40 VC	LT	220µF	19p
1000µF	11p	6-8µF	6 p	330µF	22p
1500µF	20p	15μF	6 p	470µF	26p
2200µF	24p	33μF	6 g p		44p
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C296 SERIES
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0-047, 0-068, 0-1 4ip. 0-15 8ip. 0-22 8ip. 0-33 12p. 0-47 14ip.
160V: 0-01µF, 0-015, 0-022, 0-033, 0-047, 0-068 3ip. 0-1 4p. 0-15 4p. 0-1 4ip.
0-15, 0-22 5ip. 0-33 7p. 0-47 9ip. 0-68 12p. 1µF 14ip. 1-5uF 22p. 2-2µF 24p.

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4 x 12" (illustrated above)	31" x 31" x 13" x ¾	£24.50	£17.50
4 x 12" P.A. Column	48" x 27" x 13" x ¾	£30.00	£21.50
1 x 18"	31" x 31" x 13" x ¾		£17.50
1 x 15" with two top horn cutouts	36" x 20" x 13" x ¾		£13.50
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ZTX212	140	ZTX383	15p	ZS120	810	ZS274	19p
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by Eric Dowdeswell G4AR

HURRAH! First past the post to drop a report into my lap was Stanley Sharred (Birmingham) who is no newcomer to this page. To refresh your memories he has a CR100 with a horizontal centre-fed aerial, feeding an aerial tuning unit I am glad to note! An ATU will produce more extra 'S' points on the meter than anything else! The 60ft legs of Stan's aerial are in a Vee configuration so the aerial becomes quite a useful beam at the higher frequencies. His Morse is obviously pretty good so it's high time he went off to get his RAE, providing he doesn't neglect his reports of course!

Dave Patrick (Carlisle) at 15 is a regular reader of PW and honoured this page with his first-ever report. His set-up of an R1475 plus two 150ft wires 25ft up should pull in most signals. Try combining the aerials Dave, with an ATU, as does Stanley, above. Switch in one or the other or both. If they can be arranged more or less at right angles good all-round coverage can be obtained. I suppose many readers of this page wouldn't mind being able to get just one 150 footer hanging on the aerial socket!

John Porter (Baslow, Derbys.) wrote an extremely short note with his list of goodies, but very welcome, nevertheless. All I can say about John is that he uses the 9R59DS and 33ft of aerial which is obviously a good combination in the right hands. Incidentally, I am sending out some log sheets which I have run off to those who kindly report in to this feature, hoping that they will jot down for me any worthwhile DX that they hear, at the time they hear it. I know only too well what a bore it is to copy out logs especially some time after the event when interest has waned. A sheet of carbon paper slipped in the log is also a good way of saving time if a copy is wanted. As I point out on the log sheets, it is the rare country or prefix or QRP stations that I would like to know about.

It seems that BV2A on Taiwan (Formosa of old) now has the OK from the authorities to operate and is active on 14218 SSB and 14025 CW. QSL's

have been forthcoming from BV land in the past but this ought to make it very much easier now. You might like to get excited over OJ0MA who is expected on from Market Reef with SSB on 14 and 21MHz. The number of these DX-peditions that do eventually get on the air seems to be quite small compared to the number of rumours that one hears and I long ago learnt to wait until the pileup hits the headphones before letting the blood pressure rise at the thought of a 'new one' for the log!

I expect to hear from some of you on the Royal Signals Amateur Radio Society expedition to the British Honduras spot of English Cay, active midJune as VP1B probably. QSL's to the Society's head-

quarters station G4RS.

Don't despair of conditions on the HF bands—the information-crammed 160m DX Bulletin of Stew Perry W1BB reckons that things have not been so good last season on our 'DC' band possibly due to too many sunspots around! They would indeed come in useful on the higher frequencies. In spite of all this, however, Stew still lists many prefixes worked on 160m that would grace any 20m log. How about 4S7, VP2, VP8, ZP9, PJ8, ZP1 etc? 'Worked All Continents' is always an exciting achievement, even on the HF bands, but W5RTQ almost did it in one evening on 160m! Only missed out on Africa.

Log Extracts

- S. Sharred:—160m GC5BGV GD4BEG G13YFY GM6CH OE5ANL OH1SJ VE2DN VP2EEL W1HGT (599) WB8APH 80m 7X2AH 9K2DC HC8GI HI8EJH OA4OS ZL2BCG ZL4KF 40m 3D6AW G4AKQ/7Q7 JY3ZH M1C OH2BGM/OH0 T12SW VK2WC VP9AO ZP5AR ZS6ME 20m CR4BS WA2ZDF/CP1 KL7BJW KM6DZ OA3XI PJ2CW PJ9JR VE6RP VK7PR VK8OM VP2AB VP2MW VP2VBH VP8LP VR1AC ZL4AD 4S7PB 5X5NK 6Y5ED 8P6EX 15m CR7EK FM7WG HK3CTJ JH3GET KG4FX SV0MEE (Crete) TJ1EZ TU2DV.
- D. Patrick:—80m CR4BS EP2VJ OY1M 9H4L 40m CR6CD JW8IL 20m CP1DN CR4BS PJ9DI 9Y4MA.
- J. Porter:—15m 9G1AR 9W1BX 20m CP1QCC CP3BY EL5C HK3BET JA0CRL PJ9EE T12CF ZB2CJ CR4LA
- S. Sharred again:—160m KZ5AA VE1MX VP2LPJ (St. Lucia) 80m CP1EU EP2VJ (0200) HZ1AB (0200) KV4FZ (2300) VP8NP (0030) ZS6DW (0330) 40m JY3ZH (Amman 0400) KV4FZ (0130) LU8AHW (2330) TR8DG (2130) 20m HM1AQ (1330) KH6BB (1000) KS6UA (1600) FL8BH (1900) PJ9EE (2130) TA2SC (1530) VE8RCS (0900) YB1AY (1730) ZL1AXT (1030) 5U7HA (1730) 15m A51PN (1230) CX8BZ (2030) EL2KS (1230) FG0BAR (1800-QSL to F6CXL) KZ5CZN (2130) VP2SQ (1800-St. Vincent) VP2VBU (1300-Tortola)

CW stations in bold, remainder SSB.

BROADCAST BANDS

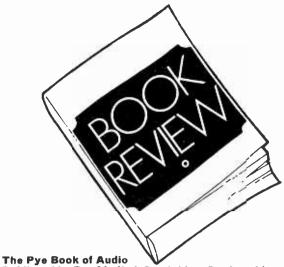
Short Wave Reports by 15th of the month to Malcolm Connah, 27 Lismore Road, Highworth, Swindon, Wiltshire, SN6 7HU.

Medium Wave Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3 JG.

VHF/FM Reports to Simon David, c/o Practical Wireless, Fleetway House, Farringdon Street, London, EC4A 4AD.

AMATEUR BANDS

Logs covering any amateur band/s in band/alphabetical order by the middle of the month to Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.



Published by Pye Limited, Cambridge. Produced by Daily Mirror Books, 79 Camden Road, NW1 9NT 124 pages, 12 x 8½in. Price 95p.

HEN I first heard about the Pye Book of Audio, I thought "Oh no, another advertising gimmick," but how wrong I was.

This book is a profusely illustrated guide to audio in general and is aimed at the beginner and possibly first-time buyer rather than the man with all the gear already installed in his Hi-Fi den.

The contents are divided into thirteen chapters and there is a foreword written by Benny Green the musician. Chapter 1, The Original Sound, by Tom Stephenson describes what goes on at the recording studio and explains how a record is made.

Chapter 2, written by John Borwick delves into the whys and wherefores of pickups, and illustrates how sound is reproduced from tape or record.

Clement Brown, in Chapter 3 writes on pickups and motors and John Gilbert in Chapter 4 expounds on tuners and amplifiers. Chapter 5 is written by Michael Mayer of the BBC's Engineering Information Department. It's entitled The Broadcast Signal and the title really speaks for itself. Chapter 6, by Pat Hawker is called Commercial Radio and includes a useful question and answer section.

Chapter 8 is on tape recorders for the home and car. Chapter 9 on purchase and care of records and tapes and Chapter 10 describes the ins and outs of 4-channel sound. Chapter 11 helps the reader decide which system to use and how to get value-for-money and Chapter 12 explains how your audio unit is manufactured.

The final chapter helps you decide where to place your audio set-up in your home, and the end of the book contains a useful little glossary of audio terms.

There's only one strange thing in this work that I spotted and that is where a beautiful colour picture of a vintage Thorens phonograph is shown. There is a disc on the turntable but the caption tells us that the machine had a cabinet with facilities for storing the playing cylinders—strange!

Well, Messrs Pye, you are to be congratulated on producing a very well written, well illustrated book which I know will be of great interest and help to many people who are thinking about or are just entering the world of audio.

With the price of 95p, this book just cannot go wrong and I thoroughly recommend it. Excellent value.—Colin Riches

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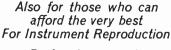
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Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.

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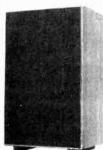
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OUR PRICE £3.25 P&P 15n

AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ease with edgwise of the community of th

OUR PRICE £3.50 P&P 15p

MODEL TH12 20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/ 50/150/1000V DC. 0/16 50/250/1000V AC. 0/16 50uA/25/250mA DC. 0/3k/30k/300k/3 Mego +50dB. ns -20 to

OUR PRICE £5.95 P&P 30c

HIOKI Model 720X VOM

HTURI Model / A versatile, accurate measur-ing instrument. 20,000 opv. 0/ 5/25/100/500/ 1000V DC. 0/10, 50/250/1000V AC. 0–50uA/ 250mA. 0–20k/ 2 Megohms. OUR PRICE P&P 30p



MODEL PL436 20,000 opv DC. 8000 opv AC. Mirror scale -6/3/12/30/120/ 600V DC. 3/30/ 120/600V DC. 50/600µA/60/

10/100K/1 Meg/10 Meg Ohm OUR PRICE £6.97 P&P 30p. **U4323 MULTIMETER**

20,000 pv, Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/ 500/1000V DC

500/1000V DC.
2.5/10/15/250/500/1000V AC. 0.05/
0.5/5/50/500mA DC. Resistence:
x 10, x 100, x 1,000, x 10,000, 500,
500(x,56x), 56k(x) centre scale)
Bettery operated. Size: 160 x 97 x
40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.00 P&P 30p

MODEL HIOKI 730X 30,000 apv. Over-load protection. 6/30/60/300/600/ 120/600/1200V AC. 60/µA/ 30mA/300mA.

2K/200K/ 2 Meg Ohm. 10 to 63 r 63 AB OUR PRICE £7.50

U4324 MULTIMETER

U4324 MULTIMETER
High snsitivity, overload protected,
20,000opv, Ranges;
0.6/1.2/3/12/30/
60/120/600/1200V
DC. 3/6/15/60/150/
300/600/900V AC.
Current: 0.06/0.6/
6/80/600mA/3A DC.
03A AC. Resistence;
0.5/1.2/60/150/600K ohms/5
Mohms. Decibels: -10 to +12dB. Size
167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £8.00 P&P 30p

U435 MULTIMETER

U435 MULTIMETER
20,0000pv. Overload
protected. Ranges:
75m/Y2.5/1075/
100/250/500/1000/
500/50/1000/000/
500/50/1000/00/50/50/
50/100mA/05/25A
DC. 5/25/100mA/05/25A
DC. 5/25/10 **OUR PRICE £8.75**

U4312 MULTIMETER

U4312 MULTIMETER
extremely sturdy
instrument for
general electrical
of 0.3/1.5/7.5/30/
60/150/300/600/
900V DC & 75mV
0/0.3/1.5/7.5/30/
60/150/300/600/
900V AC .0/300uA
1.5/6/15/150/60/
600mA/1/1.5/6A
0.5/0.900 CC
0/200/34/30k ohms. DC
coursey 1%. AC 1.5%. Kinfe edge
pointer, mirror scale. Complete with
sturdy metal carrying case, leads and
instructions.

OUR PRICE £9.75 F&P 50p

U91 Clamp VOLT AMMETER

ARMITE E H For measuring AC voltage and current without breeking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses. OUR PRICE £10.50



P8:P 30p

HIOKI 750X VOLT-OHM-MILLIAMETER

MILLIAMETER
37 rangers 0-0.3/0.6/
15/3/6/12/30/60/150/
300/600/1200/
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OUR PRICE £11.95 P&P 40n

M00EL 500 MODEL 500 30,000 opv with overfoad protect-tion. Mirror scale. 0/0.5/2.5/10/25/ 100/250/500/ 1000V DC. 0/2.5/10/25/100/ 250/500/1000V AC. 0/50uA/5/50/ 500mA. 12A DC. 0/60k/6 meg/60 m

OUR PRICE £ 13.95 Carr. paid ner case for above £1.75

HIOKI MODEL 700X HIO KI MODEL 70UX 100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/ 12/30/60/120/300/ 600/1200V DC. 1.5/3/6/12/30/60/150/ 300/600/1200V AC. 15/30uA/3/6/30/60/ 150/500mA/6/12A DC. 2k/200k/2W/20MOhms. –20 to +63dB.

OUR PRICE £14.95

Model HT100B4 MULTIMETER

Model HT100B4 MULTIMETER
Overload protected,
shock proof circuits.
9,5uA Meter with
mirror scale. Sensitivity
100kV. Polarity change
switch. Ranges: 0.5/2.5/
1,50/250/500/1,000
Volts DC. 2.5/10/50/
250/1,000 Volts AC.
DC resistenca 0.200.4/2.5/25/250
mA/10A. AC current: -0.10A. -20
to +52dB. Operates from 2 x 1,5V
batteries. Size: 180 x 134 x 79mm.

OUR PRICE £17.50 P&P 40p

MODEL AS. 100D VOM

100,000 opv. Mirror scale. Built-in meter protection. 0/3/ 12/60/120/300/ 600/1200V DC 0/6/30/120/300/ 600V AC. 0/10uA/ 7) (6/60/300mA/ 12 Amp. 0/2K/ 200K/2M/200 Meg Ohm. - 20 to 17 dB OUR PRICE £17.50 P&P 30p.

KAMODEN TT35 TRANSISTOR TESTER

TRANSISTOR
High quality
instrument to
test reverse leak
current and DC
current. Amplification factor of
NPN, PNP, diodes,
transistors, SCR
cet. 4" square
clear scale meter.
Complete with
instructions, leads
carrying handle.
DIR PRIFE 6"

DUR PRICE £17.50 P& PAGE

KAMODEN 360 MULTIMETER |

KAMODEN 360 MULTIMETER
High sensitivity of 100kohm/V
AC 10kohm/V
5" mirror scale, overload protected, Ranges: 0.5/
2.5/10/50/250/1000V
AC, Current:
0.01 ma/0,5/5/50/
500mA/10A.01/
1/10/100 ohms/
1/10/100k ohms/

test leads etc OUR PRICE £17.50 P&P40p

TMK 100K LAB TESTER TMK 100K LAB TESTER
100,000pv. 6%"
scale. Buzzer
scale. Buzzer
scale. Buzzer
scale. Buzzer
pop. 100,000
pop. 05. 5k/V AC
DC Volts: 0.5/2.5/
DC Vol

OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER

370WTR MULTIME Features AC current ranges. 20,000.pps 9(0.51/2,510/50) 250/500/1000V DC 9(2,5110/50/250) 500/1000V AC 9(50u,A)110/10 mA/1/10A DC 9(100mA/1/10A AC, 0/5k/50k/500k/ 5 Meg/50 Meg.

OUR PRICE £19.95

P&P 30p KAMODEN 72.200 Multitester

KAMODEN 72.200
High sensitivity
tester. 200,000 opv
Overload protected.
Mirror scale.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER

U4317 MULTIMETER
High sensitivity
Instrument for field
and laboratory work.
Knife edge pointer,
Knife edge pointer,
Senm. mirror scale.
5.572:107.25/50/1007.250/500/1000
V DC. 0.572:5102/550/1007.250/500/1000
V DC. 0.572.5102/550/1007.250/500/1000
V DC. 0.572.5102/550/1007.250/500/500/500/500/500/500/500/1000/V AC. Current: 50u.4/0.5/
15/10/50/250mA/1/5A DC. 0.25/
0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/
30/300k ohms. Decibels: -510+10dB
Battery operated. Size: 210 x 115 x
90mm. Supplied in carrying case complete with leads.

OUR PRICE £15.00

MDOEL U4311 Sub-standard Multi-range Volt-Ammeter

Multi-range Volt-Ammeter
Sensitivity 330
Ohms/Volt AC
and DC.
ACCURA VOL SWA
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OUR PRICE £49.00 P&P 50s

TE65 VALVE VOLTMETER 1855 VALVE VI 28 ranges. DC voits 1.5–1500V. AC voits 1.5–1500V. Resistance up to 1000 Megohms, 200/240V AC operation. Com-plete with probe and instructions.

OUR PRICE £17.50 Additional probes available: RF £2.12, HV £2,50

LB3 TRANSISTOR TESTER Tests ICO end B. PNP/NPN. Operates from 9V battery. Instructions supplied. **OUR PRICE** £3.95 P& P 20n

MODEL AF. 105 VOM

50,000 opv, Mirror scale. Meter protection. 0/-3/3/12/60/120/ 300/600/1200V D.C. 0/8/30/120/ 300/600/1200V DC 300/600/1200V DC. 0/30µA/6/ 60/300 mA/ 12 Amp. 0/10K/ 1m/10m/100 Meg Ohms. – 20 to + 17 dB.

OUR PRICE £12.50 PEP 30p. **LB4 TRANSISTOR**

TESTER
Tests PNP or NPN
transistors. Audio
indication. Operates
on two 1.5V
batteries. Complete
with instructions etc OUR PRICE £4.50 P&P 20p

U4341 Multimeter & Transistor Tester

Transistor Tester
27 ranges. 16,700op.
Overload protected.
Ranges: 0,371.5/6
350.01/60/3200/900V
30.01/60/300/900V
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40.01/60/300W
40.

OUR PRICE £10,50 P&P 30p

S100TR MULTIMETER TRANSISTOR TESTER

TRANSISTOR TESTER
100,000apv, Mirror
scals, Overload
protection, 0/0, 12/
0.6/3/12/30/120/
120/600V AC.
0/12/6004 A/12/
300m A/6/12A DC
0/10k/1 Meg/
100 Meg.
-20 to +50dB,
0.01-0.2 MFC
remsists tester measures Alpha, Beta
scattering and leads.

OUR PRICE £19.95

KAMOOEN HMG500

Insulation resistance tester
Range 0-1,000
Megohms, 500V.
Battery operated.
Wide range clear
meter 4"x4%".
Complete with
deluxe carrying
case, batteries and instructions

OUR PRICE £19.95

CIS PULSE OSCILLOSCOPE

C15 PULSE OSCILLOSCOPE
For display of pulsed
and periodic wave
forms in electronic
circuits. VERT. AMP.
Bandwidth: 10MHz.
Sensitivity at 100kHz
VRMS/mm: 0.1–25;
HOR. AMP. Bandwidth: 500kHz
VRMS/mm: 0.3–26
PURMS of 100kHz
Ling of 10

OUR PRICE £39.00 Carr, paid

RUSSIAN CI16 Double Beam

OSCILLOSCOPE DSCILLOSCOPE
5 MHz pass band,
Separate Y1 and Y2
amplities. Rectangulas 5": 4" CRT.
Calibrated triggared
sweep from 0.2usec.
10 00 mill-swe/cm.
Free running time
base, 50Hz-1 MHz.
Bull-in time base
Calibrator and amplitude
Supplied complete with all
and instruction meanual.

OUR PRICE £87.00

MODEL TE15 GRID DIP METER GRID OIP METE Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Prequency range 440kHz—250kHz in six coils. 500u A meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £19.95



P&P 30p

Also see following pages



SWR METER Model SWR3 Handy SWR meter for transmict or antonius align-ment, with lauit-in field strongth meter. Accuracy 9%, Impedence 52' Indic-ster 100uA DC. Full ster 100um co., state 5 section collapsite entenna, Size 145 x 50 x

OUR PRICE £4.25 P&P 30p

AT201 Decade ATTENUATOR

Frequency range 0— 200kHz, Attenuator 0—111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm, Size: 180 x DO x B

OUR PRICE £12.50 P&P 50p

TRANSISTORISED L.C.R. A.C. **BR/8** MEASURING BRIDGE



An ew portable bridge offering except a country of the country of

6" x 2" OUR PRICE £25.00 P&P 30p

TE16A TRANSISTORISED SIGNAL GENERATOR

orumal utrit to 30 MHz. An inaspensive instrument for the heady-man, Operates on 9V bettery. Wide sery to read scale. 800kHz modelectors.



P&P 50p

seletion. 149 x 149 x 92mm, Complete OUR PRICE F8.97 P&P 30p

MODEL TE20 RF SIGNAL GENERATOR

Sk bends. 120kHz— 280MHz. Dual output RF terminals. Separate variable audio output. Accuracy 2-2%. Audio output to 8V. Power requirements: 105—125V. 220—240V AC. Size:193 x 285 x 150mm. Complete with test leade str.

OUR PRICE £17.50 TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bends. librated.

utmet. Xtel encket for ealthration, 220/240V a.c.
Brand new with instructions,
Stat 140mm x 215mm x 170mm OUR PRICE £17.50 PMP 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20ape to 200kHz on 4 bends Square 20 ops to 30 kHz, Output 5000 Ohms. 200/250V



operation. Supplied brand anteed, with instruction ma OUR PRICE £24.95 P&P 50p

ARF 300 AF/RF SIGNAL

GENERATOR All trans All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output 5quard/Sins wave 10V. P.P.RF 100kHz to 2008MHz. Curtextor

200/260V AC operation. Complete **OUR PRICE £37.50** P&P 50t

Also see previous page 😓

MOOEL MG 100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000 Hz Sie Wave 19—100,000 Hz Squere Wave.
Output Sine or Squere wave 10v. P. to
Size 180 x 90 x 90mm. Operation
220/240v. & C. m ways 10v. P to F

PS200 Regulated POWER SUPPLY UNIT Solid state. Veriable output 5—20V DC up to 2 Amp. Independent meters to monitor voltage an current. Output 220/240V AC.
Size: 190 x 136 x 986mm.

OUR PRICE £19.95

P&P 50p

P& P 50p

OUR PRICE £19.95

POWER RHEOSTATS PUWER HHEUSTATS
High quality ceramic
construction. Windings embedded in
vitreous enamel.
Heavy duty brush
wiper, Continuous
rating. Wide range
available ex-stock.
Single hole fixing. X'' diameter shafts.
Bulk quantities available.

25 WATT 10/25/50/100/500/1000/ £1.15 P&P 10p 2500 ohms. 50 WATT 10/50/100/250/500/ 1500/5000 ohms. £1.62 P&P 10p

100 WATT 1/5/10/25/50/250/500/ 2500 ohms.300 Ohms

£2 34 PRP 150

YAMABISHI VARIABLE

YAMABISHI VARIABLE
VOLTAGE TRANSFORMERS
Excellent quality at low cost. Input:
230V 50/80Hz, Output 0 – 260V.

MODEL S260 BENCH MOUNTING
PAP
1.A £10.50 50p
2.5A £12.00 80p
6.A £23.55 £1.00
2.A £35.40 £1.00
2.A £85.00 £1.50
4.A £120.00 £1.50

MODEL S2608 PANEL MOUNTING 1A £10.00 50p 2.5A £12.00 50p

240' Wide Angle 1mA METERS MW 1-6 60x60mm

P&P 15p

£6.50



CP110 CHASSIS PUNCH SET



Carefully machined top grade steet. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories. **OUR PRICE £3.00** P&P 40p

HITACHI FLUORESCENT LANTERN LISOI A portable bettery operated lantern ideal for home, motoring, camping etc. Approx. 10" tall. Provides brilliant light from 9 1,5v batteries (not



KE630 3 Station INTERCOM



Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries OUR PRICE £5.25

SINCLAIR ICI2 **INTEGRATEO** CIRCUIT **AMPLIFIER** complete with printed circuit **OUR PRICE £2.35**

P & P 15p.

DT55G DIGITAL CLOCK

MECHANISM 1000 A PACHE

and auto alarm 'sleep' switch. Illuminated rot-ary dial with hours, minutes and sec-onds. Automatically turns off radio, TV, light stc. and with auto-switch-ing will turn on again when required. 240Y AC operation. Switch rating 250V-3 Amp.

OUR PRICE £5.95 P&P 30p



LHO2S STEREO HEADPHONES Light weight head-phones with padded ear pieces, 4/16 ohms 20--20,000Hz. with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

DHO2S STEREO HEADPHONES Wonderful val and excellent and excellent performance combined, Adjust-able head band, impedence 8 ohms, 20–12,000Hz, Complete with lead and plug. DUR PRICE £2 25 P&P 30p

TE1035 Stereo HEAOPHONES Low cost with exc-ellent response. Foam rubber earcups. Adjust-able headband. 8 ohms impedence, Frequency response 25Hz—18kHz. Complete with cable and stereo jack plug. Most OUR PRICE £2.60

P&P 30p SHROV MONO/STEREO HEADPHONES Volume control for aach channel, 4/16 ohms impedance. For mech channel, 4/16 ohm: impedence, Frequency response 20Hz-18kHz, Complete with 10ft, coiled lead and lack plus plug. **OUR PRICE £4.97** P&P 30p

BH001 HEADSET and Boom Microphone Microphone
Moving coil. Ideal
for language
teaching.
communications etc.
Headphone impedence 16 ohms. Microphone impedence 200 ohms.

OUR PRICE £5.95 P&P 30p EMI LOUDSPEAKERS

Model 350 13 x 8" with single tweeter/crossover. 20-20,000Hz. 15 watts RMS. Available 8 or 90 1 OUR PRICE £7,50 each P&P 37p Model 450 13 x 8" with twin tweeter/crossover, 55-13,000Hz, 8 watts RMS, Available 8 or 15 ohn

OUR PRICE £3.62 each P&P 35p

SPECIAL PURCHASE Tannoy 12" DR/8 Bass Speakers 8 ohms. 30 watt. Heavy duty, ideal for Hi-Fi P.A. Group. OUR PRICE £12.50 P&P 50p.

SPECIAL BARGAIN **FERGUSON** 3406 HI-FI

SPEAKERS High quality 2 way speaker systems 25 Wetts. 4—8 ohms. 40Hz-18kHz Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts OUR PRICE £26.95 PR, P&P £1

SPECIAL BARGAIN!! STEREOSOUND SPEAKERS

Matched pair of steres bookshelf speakers. Deluxe task veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 wetts RMS, 16 watts peak.



OUR PRICE £12.95

FM TUNER CHASSIS



tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 85–108MHz. Ready bull, resdy for use. Fantastic value for money.

OUR PRICE £8.95 itereo Multiplex Adaptor £5.95 extra

Model A1018 **EMTUNER** ble tun

For use with most amplifiers. Cov 88-108MHz, Powered by 9V bette OUR PRICE £13.50 P&P 3 P&P 30p multiplex adapter £5.95 extra.

SINCLAIR "SCIENTIFIC" CALCULATOR

B digit display. Four functions plus logarithms to base 10, antilog, sine, cosine, tangent, arcSine, arcCosine and arcTangent arcTangent Complete with instructions, case and batteries, Rec. Price

OUR PRICE £44.50 P& P 25p plus VAT

SINCLAIR SYSTEM 2000 STEREO AMPLIFIER ANO TUNER



AMPLIFIER

Amplifier output 8 watts per channel RMS. Distortion less than 0.06%. Silicon transistors. Two pick-up plus radio and tape inputs, tape output and scratch filter.

OUR PRICE £28.50 P& P 60p.



FM THNFR

Excellent selectivity and sensitivity. Twin dual-vericap tuning-4 pole ceramic filter. 19 transistor stereo demodulator giving 40 dB separation. Distortion 0.2% output. Fentastic Value. OUR PRICE £28.50 P&P60p

SINCLAIR Project 80 Modules
Z40 Power Amp £5.45 P & P 15p
Z60 Power Amp £6.95 P & P 15p
Stereo 80 Pre-Amp £11.95 P & P 15p
Active Filter Unit £6.95 p & P 15p
Project 805£26.95 P & P 50p
PZ5 Power Supply £4.98 p a P 30p
PZ6 Power Supply £7.98 P & P 10p
PZ8 Power Supply E7.98 P & P.30p
Transformer for PZ8, £4.05 P & P 50p
SINCLAIR Project 80 Packages
2 x Z40/Stereo 80/PZ5 £25.00
2 x Z40/Stereo 80/PZ6 £27.75
2 x Z60/Stereo 80/PZ8 £30.45
POST & PACKING 35p each.

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50-0-50u A	 €3.75	1	4	
100-0-100u A	 £3.70	10000		
1mA	 ₹3.65			
5mA	 £3.85			
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50mA	 £3.85	10V DC		£3 65
100mA	 £3.85	20V DC		€3.65
500mA	 £3.65	50V DC		£3.65
1A DC	 €3.65	300V DC		£3 65
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500uA	£4 30	
50-0-50u A	£4.50	
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200u A			£5.35
500u A			€5.25
50-0-50u			€5.40
100-0-10			£5.35
500-0-50	10u A	۱	£5.20
1mA			€5.20
1-0-1mA			€5.20
5mA			₹5.20
10mA			₹5.20
50mA			€5.20
100mA			€6.20
500mA			₹5.20
1A DC			€5.20
5A DC			€6.20



5.20	CHARLE	Mi.	30	9.5	17	Đ,
5.20	-		_	_	_	•
5.20						
6.20	300V DC				£5	2
5.20	15V AC				25	3
5.20	300V AC				£5	3
5.20	S Meter 1		٠		£5.	2
5.20	VU Meter	r			£5	
5.40	1A AC			•	£5.	2
5.20	5A AC			۰	£Б.	2
5.20	10A AC			•	£5	2
5.20	20A AC				£5.	
6.20	30A AC			۰	£6.	2

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Size: 110 x 83m	m		
50uA ,,	£4 30		
100uA	£4 25		- 1
200u A	£4.20	1.4	
500uA	£4 15	100	- 1
50-0-50u A	£4 25	0.5	
100-0-100u A	£4 20	Appen	
1mA	£4 10	100000	
5mA	€4 10		
10mA	£4 10		_
50mA	£4 10	10V DC	€4 10
100m A	£4 10	20V DC	£4 10
500mA	£4 10	50V DC	€4 10
1A DC	£4 10	300V DC	£4 10
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Size: 50 x 50r	nm	
50uA	. £3 20	1
100u A	. £3 15	1.
	£3 10	110000000
500u A	£3 00	1000000
50-0-50u A	£3 15	** A
100-0-100u A	. £310	The Republican
500-0-500u A	. (2.95	1000
	. £2 95	31000
	. £2 95	
10mA	£2 95	101111
	£2 95	CHIMPS
	. £2 95	
500m A	. £2.95	300V AC
1A DC	. £2.95	S Meter 1m A
	. (2 95	VU Meter
10V DC	£2 9E	14.40

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2156. 45 x 45111	im	
50uA		
100u A	. £3 05	V
200uA	. £3 00	100000000000000000000000000000000000000
500uA	. (2 85	Contracts
50-0-50u A	63.05	120
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1mA	62.00	1000
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2mA	62.00	2011
E-A	(3.00	BALLIA
10 m A	63.00	
20-m A	67.00	
E0- A	62.00	2017 00
100m A	62.00	20V DC
150mA	£2 80	50V DC
200 0		100V DC
		150V DC
300mA		300V DC
500mA		500V DC
750mA		750V DC
1A DC		15V AC
2A DC		50V AC
5A DC		150V AC
10A DC	£2 80	300V AC
3V DC	£2 80	500V AC
10V DC	£2 80	S Meter 1mA
15V DC	£2 80	VU Meter

22 00	30000	
£2 80	183118	
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£2 80		
£2 80	20V DC	£2 80
£2 80	50V DC	£2 80
£2 80	100V DC	£2 80
£2 80	150V DC	£2 80
£2 80	300V DC	£2 85
£2 80	500V DC	£2 85
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£2 80	15V AC	£2 90
£2 80	50V AC	€2 90
£2 80	150V AC	£2 90
£2 80	300V AC	£2 90
£2 80	500V AC	£3 00
£2 80	S Meter 1mA	£2 80
£2 80	VU Meter	63 20

CLEAR PLASTIC MODEL SD460

Size: 59	46	mm		000 00 100	
50u A			£3 50		
100u A			£3 45	***************************************	
200uA			£3 40		
500u A			£3 35	1.1	9.4
50-0-50u			£3 45	A	10.7
100-0-10	Ου A	۱	£3 40	10 1 200 177 112	. 11
1mA			£3 30		
5m A			£3 30	STATE OF THE PERSON NAMED IN	
10mA			£3 30	THE R. LEWIS CO., LANSING	ALC: UNK
50mA			€3 30	10V DC	£3 30
100mA			£3 30	20V DC	£3.30
500m A			£3 30	50V DC	£3 30
1A DC			£3 30	300V DC	£3 30
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200u A	£3 80	1 0
500u A	£3 75	10 A 30
50-0-50u A	£3 85	X. A.
100-0-100u A	£3 80	Company of the Company
500-0-500u A	£3 70	A STATE OF THE PARTY OF THE PAR
1mA	£3 70	
1-0-1 mA	£3 70	3111
5mA	£3 70	CONTRACTOR OF STREET
10m A	£3 70	300 V DC £3 70
50m A	£3 70"	15V AC £3 80
100mA	£3 70	50V AC £3.80
500mA	£3 70	150V AC £3 80
1A DC	£3 70	300V AC £3 90
5A DC	£3 70	500V AC £3 80
10A DC	£3 70	S Meter 1mA., £4 10
15A DC	€3 70	VU Meter £3.70
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50V DC	£3 70	200mA AC * £3 70
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	Size. 80 x 80mm		_
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	100u A	£4 45	_
	500u A .	£4 20	
	50-0-50u A	£4 45	37.77
	100-0-100u A .	£440	
	1mA	£4 20	Sec. 14
	1A DC	£4 20	m _A
	5A DC	£4 20	1.
	20V DC	£4 20	STATE OF BUILDING
	50V DC	£4.20	*
	300V DC	£4 20	100
	300V AC	£4 30	
	VU Meter	£4 70	
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CLEAR PLASTIC MODEL MR 52P

Size. bu x bumm			
50u A	€3 70		
100u A	€3 50		- 3
500u A	£3 35	111-240	9 1
50-0-50u A	£3 50	100 h	2
100-0-100u A	£3 45	AM.	200
1mA	£3 30		
5mA	£3 30		E. C. C.
10mA	£3 30		1.638
50mA	£3 30		1.52
100m A	€3 30	11111	CEE.
500mA	£3 30	4	
1A DC	£3 30		
5A DC	£3 30	S Meter 1mA	£3 30
10V DC	£3 30	VU Meter.	€3 80
20V DC	£3 30	1A AC	°£3 30
50V DC	€3 30	5A AC	°£3 30
300V DC	£3 30	10A AC	° £3.30
15V AC	£3 40	20A AC	° £3 30
300V AC	£3 40	30A AC	°£3 30
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BAKELITEM	DDELN	AR 65 Size. 80 x 80mm
25uA	€5 25	A STATE OF THE PARTY OF THE PAR
50u A	€4 00	
100u A	£3 95	A SECTION OF THE PARTY OF THE P
500u A	€3 65	100
50-0-50u A	€3 95	*^
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500-0-500u A	£3 60	The State of
1mA	€3 60	
1-0-1mA ~	£3 60	
5mA	€3 60	AND DEPOSIT OF
10mA	£3 60	THE REAL PROPERTY.
50mA	£3 60	300V DC £3 60
100mA	£3 60	30V AC * £3 60
500mA	£3 60	50V AC * £3.60
1A DC	£3 60	150V AC £3 60
2A DC	£3 60	300V AC ' £3 60
5A DC	£3 60	500V AC £3 60
10A DC	£3 60	VU Meter £4 10
15A DC	£3 60	1A AC £3 60
30A DC	£3 60	5A AC * £3 60
50A DC	£3 80	10A AC £3 60
5V DC	£3 60	20A AC # £3 60
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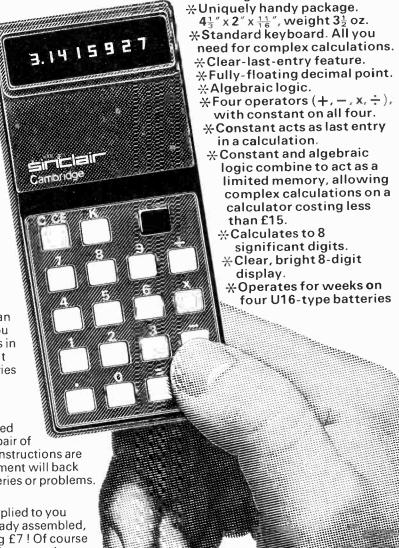
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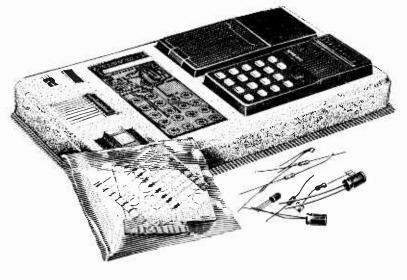
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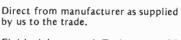
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A. H. Supplies				286
Ambit Internationa Amphenol		•••		316
A.S.P. Ltd	•••	• • •	• • • •	290 352
Audiotronics		3	63, 364	365
	•••		,	,
Baker Loudspeaker	Ltd.			376
Baron Electronics				371
Barrie Electronics			•••	300
Bentley Acoustics		•••	•••	321
Beta Devices	***		•••	371
B.H. Component F		1.		298
Bi-Pak Semiconduct Bi-Pre-Pak Ltd.	tors	•••		3, 289 351
Boffin Projects	•••	•••	•••	372
British Institute of	Engineer	 in #	•••	3/4
Technology			284	. IBC
British National Ra	dio & Ele	ctroni	cs	, ,,,,
School	•••		15, 340	, 356
Bull, J. (Electrical) I	Ltd	•••	• • •	287
Caranna, C Chiltmead Ltd	•••			371 340
Chromasonic Electr		•••		294
Codar	•••			32!
Colomor (Electroni	ics) Ltd.			358
C.T. Electronics	•••	•••	• • •	285
Custom Cabinets	•••	•••	•••	356
Dabar Electronic Pr				300
Davian	oquets	• • • •	•••	356
D.E.W. Ltd	•••		•••	372
D.E	•••	•••	•••	3/2
Eagle International				301
Electronic Brokers				372
Electronic Design				376
Electronics Mailord				373
Electrospares			•••	286
Electro-Tech	•••	• • •		374
Electrovalue Ltd.	•••	• • •	•••	IFC
Elvins				292

VERTISERS	Felstead Electronics Foulsham Tab	•••	376 290
286 316 290 352 363, 364, 365	Gregg Electronics Greenweld Electronics Group Three	•••	352 359 373
376 371 300 321 371 td 298	HAC (Shortwave) Products Harverson Surplus Co. Ltd Heath (Gloucester) Ltd Henry's Radio Ltd H.M. Electronics Home Radio (Components) Ltd.	295, 	320 362 340 OBC 372 294
288, 289 351 372 284, IBC	I.C.S	•••	370 293 370 367 373
315, 340, 356	Jermyn Industries Ltd J.H. Associates Johnsons (Radio)		319 372 371
340 294 321 358 285	Kensington Supplies Keytronics		370 320
356	Lewis Radio Linear Products Ltd London Computer Operators Training Centre		374 359 370
356 372	London Electronics College Maplin Electronic Supplies Marco Trading		370 343 371
301 372 376 373 286	McGarva, D Milward, G. F Minikits Electronics Mullhall Electronics	•••	372 362 372 344
374 IFC 292	Multicore Solders Newmart Electronics	•••	286 347

Padgetts Radio Store	300
Partridge Electronic Ltd	344
Pembridge College of Electronics	292
BCC B - L -	244
RCS Products	366
Radio Components Specialists	296, 297
R.D.I	371
Radio Exchange Ltd	339
Radio Society of Great Britain	284
RSC (Hi-Fi) Centres Ltd	282, 283
RST Valve Mail Order Co	299
D C TV Common or to Lot	360, 361
District Control of the control of t	202
Riversdale Electronics	292
Saxon Entertainments Ltd	291
Silhill Products	374
Sinclair (Cambridge) Ltd	368, 369
and the second of the second o	302, 303
C	
Sound Systems of Surfolk	372
Surpletronics Surplus Electronic Trading	320
Surplus Electronic Trading	366
Swanley Electronics	320
Teleradio	371, 372
Totalisia Consumo	247
	367
Thacker, A. H. & Sons Ltd	344
Tidman Mail Order	370
Trampus Electronic	359
Trannies	355
TUAC Ltd	298
Tweedy Ltd. (J.A.)	370
Vero	366
Watford Electronics	375
West Hyde Developments Ltd	355
West Hyde Developments Ltd. Wheelhouse, C. W. & Son	200
Wilmslow Audio	316
Xeroza Radio	374
V. Fl	246
Yates Electronics	366
Z & ! Aero Services Ltd	376

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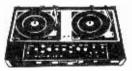
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