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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

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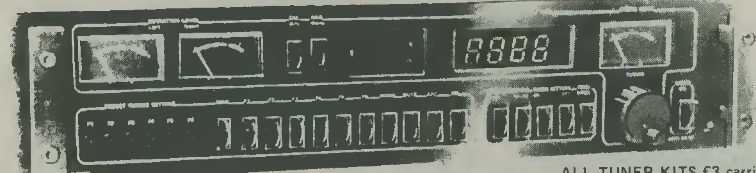
THE AUGUST ISSUE WILL BE PUBLISHED ON 4th JULY

Tecknowledgey for sale.

The Mark III FM Tuner

DIY Hi-Fi will never seem the same again. Ambit's Mark III tuner system is electrically & visually superior to all others. Some options available, but the illustrated version with reference series modules: £149.00 + £18.62 VAT

With Hyperfi Series modules £185.00 + £23.12



ALL TUNER KITS £3 carriage

Features of the system:

* Precision construction & design of all parts
* Time frequency display
* State of the art performance with facilities for updates, using modular plug in systems.
* Deviation level calibrator for recording
* All usual tuner features

Digital Dorchester All Band Broadcast Tuner: LW/MW/SW/SW/SW/FM stereo

A multiband superhet tuner, constructed using a single IC for RF/IF processing · but with all features you would expect of designs of far greater complexity. The FM section uses a three section (air gang) tuned FET tunerhead, with ceramic IF filters and interstation mute; AM employs a double balanced mixer input stage, with mechanical IF filters · plus a BFO and MOSFET product detector for CW/SSB reception. Styled in a matching unit to the Mark III FM only tuner, employing the same degree of care in mechanical design to enable easy construction. MW/LW reception via a ferrite rod antenna.

Electronics only (PCB and all components thereon)	**£33.00 + £4.12 VAT**
Complete with digital frequency readout/clock-timer hardware	**£99.00 + £12.37 VAT**
Complete with MA1023 clock/timer module with dial scale	**£66.00 + £8.25 VAT**

Hardware packages are available separately if you wish to house your own designs in a professional case structure. Please deduct the cost of electronics from complete prices.

LW/MW/FM LCD Digital Frequency Display - July PW feature

Update your old radio, or build this into a new design. Or use it as a servicing aid · this low power unit with LCD display reads direct frequency in kHz/MHz, or with usual AM/FM IF offsets for received frequency. Low power LCD means no RFI · 15-20mA at 9v even with the divide by 100 prescalar. FM resolution is 100kHz, AM 1kHz. Sensitivities better than 10mV

Complete kit £19.50 +*£1.56 VAT. Built and tested version £24.00 +*£1.92 VAT

Various other DFM systems described in our catalogue part 2 · including a one chip solution to providing digital display of FRG7 kHz dial, combined with clock/timers etc.

PW SANDBANKS PI METAL LOCATOR

Maintaining our professional approach to home constructor kits, we offer the pulse induction 'Sandbanks'. Now with injection molded casing for greatly improved enviromental sealing. £37.00+ *£2.96vat.

VHF MONITOR RX WITH PLESSEY IC

4/9 channel version of the PW design · but **using standard 3rd OT crystals**, and **TOYO 8 pole crystal filter** with matching transformers. Coil sets from our standard range to cover bands from 40 to 200MHz. **Complete module kit £31.25 +£3.90vat .**

ETI - REMCON RADIO CONTROL

A tried and tested RC system with a full set of supporting hardware from a well known manufacturer. Please send for details · and watch our ads for further news of developments in RC products.

Radio and Audio Modules : The biggest range/ best specs:

EF5801/3/4 6 stage varicap tunerheads with LO feed and various levels of sophistication. New 5804 include pin AGC loop 'on board'. 5801:£17.45+£2.18vat · 5803:£19.75+£2.47vat 5804:£24.95 +£3.18vat. *Frequencies in 40-180MHz on appcn.*

EF5402 4 stage varicap with TDA1062, compound FET/Bipolar input stage, low noise, balanced mixer, pin agc, osc output. A worthy successor to the 5400. £10.75+£1.34vat

The 5402 is available centred on a wide range of frequencies from 30MHz to 180MHz. Non standard units £14.75+£1.84 · 3 weeks.

8319 4 stage varicap tunerhead from Larsholt using MOSFET RF and mixer stages. New temperature compensated oscillator for wide ranges of ambient temperature £13.45+£1.68vat

7252 Complete Larsholt FM tuner less stereo decoder. £26.50+£3.31vat

7253 Stereo FM tunerset from Larsholt with FET head. (as 7252)

944378 Hyperfi stereo decoder. The very best. £19.95+£2.19vat

911223 Pilot cancel stereo decoder, priced to make the MC1310 as obsolete as it now deserves to be.£12.50+£1.56vat

Inotec 1-A fully DC tuned and switched LW/MW/FM stereo tuner to interface with synthesiser control etc.A first! Details OA

COMPONENTS for Radio and Audio ICs, HMOS etc.

The list is too long to attempt here, but AMBIT specializes in all types of semiconductor for radio reception, including devices operating from DC to 5GHz. New low cost SBL1 diode ring mixers (equiv case MD108 etc) -first with HMOS fets, now with a PCB for DC amplifier, and offset sense and protection relay for speakers. See catalogue and updates for most info, pse send an SAE for information on anything you cannot find in catalogues.

Radio ICs	cost	+ vat
CA3089E	1.94	24
CA3189E	2.45	30
HA1137W	2.20	27
SN76660	0.75	9
TDA1090	3.35	42
TDA1083	1.95	24
TDA1220	1.40	17
SL6640	2.75	34
MC3357	3.12	39
HA1197W	1.40	17
MC1496	1.25	16
LM373/4	3.75	49

Stereo ICs	cost	+ vat
MC1310P	1.50	19
uA758	2.20	27
CA3090A	2.75	34
HA1196	3.95	49
HA11223	4.35	54
KB4437	4.35	54
KB2224	2.75	34
Preamp ICs/switches		
TDA1028	3.50	44
TDA1029	3.50	44
TDA1074	4.14	52
KB4438	2.22	28

AF power ICs	cost	+ vat
LM380N	1.00	12
TBA810AS	1.09	14
TDA2002	1.95	24
TBA820M	0.75	9

from the general list:
LEDs:all colours and low prices
2SJ48/2SK134 HMOS 9.90 +£0.80 vat(Pair)
Signal fets/transistors and TOKO COILS & FILTERS!

OSTS: Remember all OSTS stocks are obtained from BS9000 approved sources - your assurance that all devices are very best first quality commercial types. Some LPSN TTL is presently in great demand, so please check by phone before ordering .

TTL:Standard AND LP SchottkY

All prices listed in pence *

	'N'	'LSN'
7400	13	20
7401	13	20
7402	14	20
7403	14	20
7404	14	24
7405	18	26
7406	38	
7407	38	
7408	17	24
7409	17	24
7410	15	24
7411	20	24
7412	17	
7413	30	
7414	51	
7415		24
7416	30	
7417	30	
7420	16	24
7421	29	24
7422	24	24
7423	27	
7425	27	
7426	36	27
7427	27	29
7428	35	32
7430	17	24
7432	25	24
7433	40	32
7437	40	24
7438	33	24
7440	17	24
7441	74	
7442	70	99
7443	115	
7444	112	
7445	94	
7446	94	
7447	82	89
7448	56	99
7449		99
7450	17	
7451	17	24
7453	17	
7454	17	24

	'N'	'LSN'
7455	35	24
7460	17	
7463		124
7470	28	
7472	28	
7473	32	38
7474	27	38
7475	38	40
7476	37	38
7478		38
7480	48	
7481	86	
7482	69	
7483A		110
7484	97	
7485	104	99
7486		40
7489	205	
7490	33	90
7491	76	110
7492	38	78
7493	32	99
7494	78	
7495A	65	99
7496	58	120
7497	185	
74100	119	
74104	63	
74105	62	
74107	32	38
74109	63	38
74110	54	54
74111	68	
74112		38
74113		38
74114		38
74116	198	
74118	83	
74119	119	
74120	115	
74121	25	
74122	46	57
74123	48	73
74124		137
74125	38	44

	'N'	'LSN'
74126	57	44
74128	74	
74132	73	78
74133		29
74136		40
74138		60
74139		60
74141	56	
74142	265	
74143	312	
74144	312	
74145	65	97
74147	175	
74148	109	191
74150	99	
74151	64	84
74153	64	54
74154	96	
74155	54	110
74156	80	110
74157	67	55
74158		60
74159	210	
74160	82	130
74161	92	78
74162	92	130
74163	92	78
74164	104	130
74165	105	
74166		
74167	20	
74168		
74169		200
74170	230	200
74172	625	
74173	170	
74174	87	120
74175	87	110
74176	75	
74177	78	
74180	85	
74181	165	350
74182	160	
74183		210
74184	135	

	'N'	'LSN'
74185	134	
74188	275	
74190	115	92
74191		
74192	105	180
74193	105	180
74194	105	187
74195	95	137
74196	99	110
74197	85	110
74198	150	
74199	160	
74247		90
74248		90
74249		93
74251		90
74253		105
74257		108
74258		153
74259		420
74260		153
74261		353
74266		40
74273		124
74275		312
74279		52
74283		120
74290		90
74293		95
74295		120
74298		100
74324		157
74325		242
74326		247
74327		237
74352		100
74353		100
74362		715
74365		49
74366		49
74367		43
74368		49
74373		77
74374		77
74375		60

	'LSN'
74377	124
74378	93
74379	130
74368	37
74390	140
74393	140
74395	139
74396	133
74398	180
74399	150
74445	92
74447	90
74490	140
74668	110
74670	249

VOLTAGE /PSU REGULATORS

7800 series	95p
7900 series	£1
78M series (TO220 pack)	90p
78LCP series	35p
78MGT2C	175p
79MGT2C	175p
723C	65p
NE550A	73p
L200	195p

MAINS FILTERS

1Amp IEC	4.83
6Amp IEC	5.83
5A wirein	3.87

All BS approved

Requests for the next issue of the catalogue now being "booked" for despatch immediately it is ready (about November). Please send 50p to reserve a copy. (Part 3)

IMPORTANT: ALL OSTS PRICES EXCLUDE VAT - CURRENTLY 8% - BUT MAY BE CHANGED BY THE TIME YOU READ THIS. PLEASE REMEMBER TO ADD VAT, and 25p POSTAGE !!

CD4000 CMOS

4000	17p
4001	17p
4002	17p
4006	109p
4007	18p
4008	80p
4009	58p
4010	58p
4011	17p
4012	17p
4013	55p
4014	95p
4016	52p
4017	80p
4018	80p
4019	60p
4020	93p
4021	82p
4022	90p
4023	17p
4024	76p
4025	17p
4026	180p
4027	55p
4028	72p
4029	100p
4030	58p
4031	250p
4032	100p
4033	145p
4034	200p
4035	120p
4036	250p
4037	100p
4038	105p
4039	250p
4040	83p
4041	90p
4042	85p
4043	85p
4044	80p
4045	150p
4046	130p
4047	99p
4048	60p
4049	65p
4050	55p
4051	65p
4052	65p
4053	65p
4054	120p
4055	135p

4059	563p
4060	115p
4063	109p
4066	53p
4067	400p
4068	25p
4069	20p
4070	20p
4071	20p
4072	20p
4073	20p
4075	20p
4076	90p
4077	20p
4078	20p
4081	20p
4082	20p
4085	82p
4086	82p
4089	150p
4093	50p
4094	190p
4096	105p
4097	372p
4098	110p
4099	122p
4160	90p
4161	90p
4162	90p
4163	90p
4174	104p
4175	95p
4194	95p
4501	23p
4502	91p
4503	69p
4506	51p
4507	55p
4508	248p
4510	99p
4511	149p
4512	98p
4513	206p
4514	260p
4515	300p
4516	125p
4517	382p
4518	103p
4519	57p
4520	109p
4521	236p

4522	149p
4527	157p
4528	102p
4529	141p
4530	90p
4531	141p
4532	125p
4534	614p
4536	380p
4538	150p
4539	110p
4541	141p
4543	174p
4549	399p
4553	440p
4554	153p
4556	77p
4557	386p
4558	117p
4559	388p
4560	218p
4561	65p
4562	530p
4566	159p
4568	281p
4569	303p
4572	25p
4580	600p
4581	319p
4582	164p
4583	84p
4584	63p
4585	100p

Micromarket

6800 series	
6800P	6.50
6820P	£6
6850P	2.75
6810P	£4
6852	3.65
8080 series	
8080	6.30
8212	2.30

8216	1.95
8224	3.50
8228	4.78
8251	6.25
8255	5.40
MEMORIES	
2102	£1 70
2112	£3 40
2513	£7.54
4027	£5 78

2114	£10
2708	£
Development	
MEK6800	£220
TK80	£306

AMI, Signetics, TI, Intersil, Harris etc OA

MISC. LSI/Scalars/DVMs

NE555 30p NE556 78p NE558 180p
LM3909 72p 95H90DC /320MHz / 80p
11C90DC /650MHz £14 00

ICM7216BIPI 8 decade 10MHz DFM/timer with direct LED drive and all counter features £19.82

ICM7217AIBI 4 decade programmable cntr.	£9 50
ICM7207 clock pulse generator IC	£4 95
ICM7208 7 decade counter/display driver	£14 95
ICM7106CP LCD DVM IC (3½ digit)	£9 55
ICM7106CPK LCD DVM KIT	£24 80
ICM7107CP LED DVM IC	£9 55
ICM7107CPK LED DVM KIT	£20 65
SP8629 divide by 100/200MHz scalar	£4 20
MSL2318 divide by 100 to 175MHz min divide by 10 to 45MHz min	£4 20

PLEASE REMEMBER TO ADD 8% VAT TO ITEMS LISTED UNDER OSTS

LINEARS non consumer

BIMOS	
CA3130E	84p
CA3130T	90p
CA3140E	
CA3140T	72p
CA3160E	90p
CA3160T	99p
Op amps	
LM301AH	67p
LM301AN	30p
LM308H	121p
LM308N	97p
LM318H	279p
LM318N	224p

LM324N	71p
LM339N	66p
LM348N	186p
LM3900N	60p
709HC to5	64p
709PC dil	36p
710HC to5	65p
710PC dil	59p
723CN	65p
741CH to5	66p
741CN 8dil	27p
747CN	70p
748CN	36p
NE531T	120p
NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:

5082	7650	red CA	233p
5082	7653	red CC	
5082	7660	yellow CA	
5082	7663	yellow CC	
5082	7670	green CA	
5032	7673	green CC	

0.3" Standard HP

5082	7730	red CA	147p
5082	7740	red CC	

0.5" Fairchild

FND500	red CC	150p
FND507	red CA	150p

Current news: Work continues apace on our HMOS PA kit, and by the time this is published · we expect to be about to launch the product in a style that matches the Mark III system. The Unit uses separate transformers and power supplies, and includes a DC offset sensing circuit combined with slow switch-on using a relay. We introduce the HyperFi FM IF with this advert · and a separate leaflet is available on request with an SAE. All new pricelist revision also available with an SAE. The Mullard DC controlled tone/volume and switch ICs with a 'more than HiFi' specification are in stock at last · together with reams of data (over 50 pages now). Also, RC enthusiasts will be interested to learn that we are supplying parts for various kits now.

Terms: CWO please. Account facilities for commercial customers OA. Postage 25p per order. Minimum credit invoice for account customers £10.00. Please follow instructions on VAT, which is usually shown as a separate amount. Overseas customers welcome · please allow for postage etc according to desired shipping method. Access facilities for credit purchases.

Catalogues: Ambit. Part 1 45p. Part 2 50p 90p pair. TOKO Euro shortform 20p. Micrometals toroid cores 40p. All inc PP etc. Full data service described in pricelist supplements.

Hours/phone: We are open from 9am -7pm for phone calls. Callers from 10am to 7pm. Administrative enquiries 9am to 4.30pm please (not Saturdays). Saturday service 10am to 6pm.

AMBIT catalogues are guaranteed to contain the most up-to-date and best informed comment on modern developments and advances in the field of radio and audio. There is no competetive publication that even approaches the broad range of parts/information on modern techniques.

ambit ® international
2 Gresham Road, Brentwood, Essex.

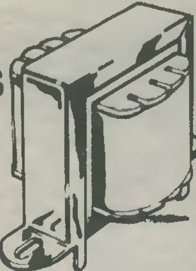
STEVENSON
Electronic Components

REGULATORS

78L05 30p	7805 60p	79L05 70p	7912 80p
78L12 30p	7812 60p	79L12 70p	7915 80p
78L15 30p	7815 60p	7905 80p	LM723 35p

HARDWARE

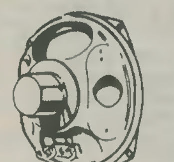
MINIATURE TRANSFORMERS



240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of:
6 · 0 · 6, 9 · 0 · 9 and
12 · 0 · 12. 92p. each.

LOUDSPEAKERS



56mm dia. 8 ohms	70p
64mm dia. 8 ohms	75p
64mm dia. 64 ohms	75p
70mm dia. 8 ohms	100p
70mm dia. 80 ohms	110p

TERMINALS

Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . . 22p

SWITCHES

Subminiature toggle. Rated at 3A 250V.
SPDT 70p SPDT centre off 75p
DPDT 80p DPDT centre off 95p

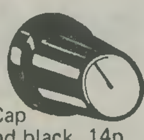
Standard toggle
SPST 34p DPDT 48p

Wavechange switches.
1P12W, 2P6W, 3P4W or 4P3W all 43p ea.

Miniature switches (non-locking)
Push to make 15p Push to break 20p

Slide switches (DPDT)
Miniature 14p Standard 15p

CONTROL KNOBS

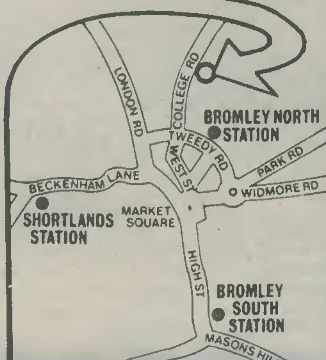


Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black. 14p

WHY NOT VISIT OUR

NEW SHOP

We welcome callers at our new premises at the address below (5 mins. from High St.) We are open Mon - Sat, 9am - 6pm. Special offers available.



Express telephone order service. Orders received before 5pm. are shipped first class on that day. Contact our Sales Office now!
Tel: 01-464 2951/5770.

TRANSISTORS

				ZTX109	14p
				ZTX300	16p
				2N697	12p
				3N1302	38p
AC127	17p	BCY71	14p	2N2905	22p
AC128	16p	BCY72	14p	2N2907	22p
AC176	18p	BD131	35p	2N3053	18p
AD161	38p	BD132	35p	2N3055	50p
AD162	38p	BD135	38p	2N3442	135p
BC107	8p	BD139	35p	2N3702	8p
BC108	8p	BD140	35p	2N3704	8p
BC109	8p	BF244B	36p	2N3705	9p
BC147	7p	BFY50	15p	2N3706	9p
BC148	7p	BFY51	15p	2N3707	9p
BC149	8p	BFY52	15p	2N3708	8p
BC148	9p	MJ2955	98p	2N3819	22p
BC177	14p	MPSA06	20p	2N3904	8p
BC178	14p	MPSA56	20p	2N3905	8p
BC179	14p	TIP29C	60p	2N3906	8p
BC182	10p	TIP30C	70p	2N4058	12p
BC182L	10p	TIP31C	65p	2N5457	32p
BC184	10p	TIP32C	80p	2N5458	30p
BC184L	10p	ZTX107	14p	2N5459	32p
BC212	10p	ZTX108	14p	2N5777	50p
BC212L	10p				
BC214	10p				
BC214L	10p				
BC477	19p				
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

1N914	3p	1N5401	13p
1N4001	4p	BZY88ser.	8p

Full spec. product.
1N4148 £1.40/100. £11/1000

LINEAR

THIS IS ONLY A SELECTION!

		CA3140	38p	NE555	21p
		LM301AN	26p	NE556	50p
		LM318N	85p	NE565	85p
		LM324	45p	NE567	170p
		LM339	45p	SN76003	200p
709	28p	LM380	75p	SN76013	140p
741	16p	LM382	120p	SN76023	140p
747	40p	LM1830	150p	SN76033	200p
748	30p	LM3900	50p	SN76477	220p
CA3046	55p	LM3909	65p	TBA800	70p
CA3080	70p	MC1496	60p	TDA1022	650p
CA3130	90p	MC1458	32p	ZN414	75p

CAPACITORS

TANTALUM BEAD

	each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V	8p
4.7, 6.8, 10uF @ 25V	13p
22 @ 16V, 47 @ 6V, 100 @ 3V	16p

MYLAR FILM

0.001, 0.01, 0.022, 0.033, 0.047	3p
0.068, 0.1	4p

POLYESTER

Mullard C280 series

0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1	5p
0.15, 0.22	7p
0.33, 0.47	10p
0.68	14p
1.0uF	17p

CERAMIC

Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF . . . 2p

RADIAL LEAD ELECTROLYTIC

63V	0.47	1.0	2.2	4.7	10	5p
			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	screened	unscreened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits. Red & black.
Plugs 6p each Sockets 7p each.

4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs 11p each Sockets 12p each

PHONO PLUGS AND SOCKETS

Insulated plug in red or black	9p
Screened plug	13p
Single socket 7p Double socket	10p

VERO

Size in.	0.1in.	0.15in.
2.5 x 1	14p	13p
2.5 x 3.75	42p	40p
2.5 x 5	52p	50p
3.75 x 5	60p	60p
3.75 x 17	195p	180p

Veropins - single sided per 100
0.1in 35p
0.15in 40p

BOXES

Aluminium boxes with lid and screws

	Length	width	height	
AL1	3	2	1	48p
AL2	4	3	1½	58p
AL3	4	3	2	65p
AL4	6	4	2	70p
AL5	6	4	3	85p
AL6	8	6	2	116p

THYRISTORS

Plastic cased Thyristors Texas

	4A	8A	12A
100V	36p	45p	62p
200V.	42p	53p	68p
400V	51p	66p	86p

TRIACS

Plastic cased Triacs. Texas.
All rated at 400V.

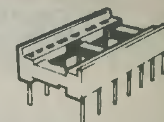
4A	70p	12A	90p	20A	185p
8A	80p	16A	95p	25A	215p

CMOS

		4018	55p	4050	25p
		4023	12p	4066	35p
		4024	40p	4068	18p
4001	12p	4026	90p	4069	12p
4002	12p	4027	30p	4071	12p
4007	12p	4028	48p	4081	13p
4011	12p	4029	50p	4093	45p
4013	28p	4040	60p	4510	65p
4015	50p	4042	50p	4511	65p
4016	30p	4046	90p	4518	65p
4017	48p	4049	25p	4520	60p

FULL DETAILS IN CATALOGUE!

SKTS



Low profile by Texas

8 pin	8p	16 pin	11p	28 pin	22p
14 pin	10p	24 pin	18p	40 pin	32p

Soldercon pins: 100 50p. 1000 370p

OPTO

LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	8p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

RESISTORS

Carbon film resistors. High stability, low noise 5%.
E12 series. 4.7 ohms to 10M. Any mix.

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

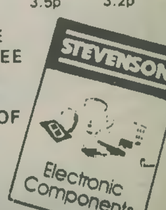
Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

METAL FILM RESISTORS

Very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix.

	each	100+	1000+
0.25W	4p	3.5p	3.2p

PLEASE WRITE FOR YOUR FREE COPY OF OUR NEW 64 PAGE CATALOGUE OF COMPONENTS. CONTAINS OVER 2500 STOCK ITEMS.



ORDERS DESPATCHED BY RETURN POST

Quantity discounts on any mix TTL, CMOS, 74LS and Linear circuits: 100+ 10%, 1000+ 15%. Prices VAT inclusive. Please add 30p for carriage. All prices valid to April 1980. Official orders welcome.

BARCLAYCARD & ACCESS WELCOME

Mail orders to: STEVENSON (Dept RE)

76 College Road, Bromley, Kent, England

TRADE COMPONENTS

PAY A VISIT — THOUSANDS MORE ITEMS BELOW WHOLESALE PRICE. CALLERS PAY LESS ON MANY ITEMS AS PRICES INCLUDE POSTAGE. PRICES INCLUDE VAT AND ADDITIONAL DISCOUNT IN LIEU OF GUARANTEE. GOODS SENT AT CUSTOMERS RISKS UNLESS SUFFICIENT ADDED FOR REGISTRATION OR COMPENSATION FEE POST.

OFFERS CORRECT AT 18/5/79 APPLICABLE TO ORDERS RECEIVED DURING JUNE.

VALVE BASES

Printed circuit B7G	7p
Chassis B7-B7G	11p
Shrouded Chassis B7G-B8A	13p
B12A tube. Chassis B9A	13p

Speaker 6" x 4" 5 ohm ideal for car radio £1.55
4¾" diam. 30 Ω £1.75
2½" diam. 32 or 8Ω £1.07

TAG STRIP—6 way 5p 9 way 10p Single 2p

5 x 50pF or 1000 + 300pF trimmers 35p

Car type panel lock and key 65p

Transformer 9V 4A £3.78

Aluminium Knobs for ¼" shaft. Approx. ⅝" x ⅞" with indicator Pack of 5 95p

BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **57p** clear perspex sliding lid, 46 x 39 x 24 mm **15p.**

ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **65p**; 80 x 150 x 50mm black **97p**; 109 x 185 x 60mm black **£1.52.**

DIECAST ALI superior heavy gauge with sealing gasket, approx 6½" x 2⅝" x 1⅜" **£1.50**; 3¾" x 2⅝" x 1⅜" **£1.25.**

VARIABLE CAMM PROGRAMMER 10, 12 or 15 pole 2 way, 50VAC motor — series with 1mfd, or 3k 10W or 15W pygmy bulb for mains operation. Ex equipment **£4.32**

SWITCHES

Pole	Way	Type	
1	2	Slide	15p
6	2	Slide	24p
2	1	Rotary Mains	28p
2	Alternating	Micro with roller	30p
2	3	Miniature Slide	20p
1	1	Toggle	42p
2	2	Sub-Min Toggle	75p
2	Alternating	2A Mains Push (⅜" hole)	43p
2	Alternating	Slide	15p

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **60p**; 1 pole 2 way 10 amp oblong clip in mains rocker appliance switch ... **38p**
Standard thumb-wheel switch 0-9 in 1248N or B.C.D., or Comp. 1242 also 2p co. **£1.20**
Standard Lever Key Switch D.P.D.T. locking plus D.P.D.T. and S.P.S.T. Heavy Duty non latching ... **82p**

RESISTORS

⅛-¼-½ watt ... 1½p
1 watt ... 3p
Up to 15w w/wound 10p
1 or 2% 4 times price

Cinch 8 way std 0.15 pitch edge connector 25p

RELAYS

RS/Alma reed relay, 3k Ω 18-30v d.c. coil, normally open ... 60p
12v d.p.c.o. heavy duty octal ... £1
700Ω, 11-13v Min. Sealed 2 p.c.o. £1. 4 p.c.o. £1.20.

POTS

Wirewound 38p
Log. or Lin., carbon rotary or slide. Single **30p** With switch **40p** Dual **45p** Dual switch **55p** 1.5m Edgetype 10 for **40p**

Skeleton Presets
Slider, horizontal or vertical standard or submin 8p

AUDIO LEADS

3 pin din to open end, 1⅓yd, twin screened	45p
5 pin din 180° to 2-phono	70p
3 pole jack plug to tag ends, 4ft	45p

COMPUTER & AUDIO BOARDS/ASSEMBLIES
VARYING CONTENTS INCLUDE ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES, INTEGRATED CIRCUITS, ETC.
3lb for £2 7lb for £3.70

1k horizontal preset with knob 10 for 40p

3" Tape Spools 5p
1" Terry Clips 5p
12 Volt Solenoid 40p

ENM Ltd. cased 7-digit counter 2¼ x 1⅞ x 1½" approx. 12V d.c. (48 a.c.) or mains **£1.10**

Auto charger for 12v Nicads, ex-new equipment ... **£5.19**

THERMISTORS and V.D.R's

CZ1/2/6/11/14, KR22, KT150, VA1005/6/8/1010/1033/4/7/8/9 1040/1053/5 /1066/7/1074/6/7 / 1082/6/1091/6/7/8 / 1100/3/8/8602. Rod with spot blue/fawn/green. E299DDP120 / 218 / 224 / 338 / 340 / 350 / 352 · YF020 · E220ZZ/02 · KR150 ... All 22p
E23 glass bead 85p
YG150-S534 bead, KB13, E299 DHP230, 116-121 401 (TH7, VA1104, OD10) 35p. R53 Glass £1.20

Miniature 0 to 5mA d.c. meter approx ⅞" diameter ... **£1.25**
RS Yellow Wander Plug Box of 12 ... **40p**
18 SWG multicore solder ... **3½p foot**
SAPHIRE STYLII. 15 different; dual and single point, current and hard to get types. My mix **£2.**

JAP 4 gang min. sealed tuning condensers **40p**

ELECTROLYTICS Many others in stock

MFD	Up to 10V	25V	50V	63-75V	100V	200-250V	300-350 V	450-500V
10	6p	7p	7p	10p	13p	15p	26p	32p
25	6p	7p	7p	10p	13p	18p	32p	37p
50	6p	7p	7p	12p	16p	23p	32p	37p
100	7p	8p	13p	15p	24p	26p	—	—
250	12p	13p	15p	22p	36p	—	£1.10	£1.30
500	13p	15p	22p	30p	55p	—	£1.48	£1.60
1000	16p	27p	50p	60p	—	£1.05	—	—
2000	28p	47p	55p	93p	£1.20	—	—	—

As total values are too numerous to list, use this price guide to work out your actual requirements 8/20, 10/20, 12/20, 22/50, 47/25. Tub. Tant **24p each** 16-32/275V, 100/150V, 100-100/275V **40p** 50-50/385V, 2+2/200V non polar, 32-32-50/300V, 20-20-20/350V 0.1+0.1/500V AC **80p** 200V, 100-200-60/300V **£1.30** 100-300-100-16/300V **£1.85**

RS 100-0-100 micro amp null indicator Approx. 2" x ¾" x ¾" ... **£1.85**

INDICATORS

Bulgin D676 red, takes M.E.S. bulb ... 38p
12 volt, or Mains neon, red pushfit ... 23p
R.S. Scale Print, pressure transfer sheet ... 12p

CAPACITOR GUIDE — maximum 500V

Up to .01 ceramic **4½p.** Up to .01 poly **6p** .013 up to .1 poly etc. **7p.** .12 up to .68 poly etc. **8p.** Silver mica up to 360pF **10p,** then to 2,200pF **13p**; then to .01 mfd **21p.**
.1/750 **13p.** .01/1000, 8/20, .1/900, .22/900, 4/16, 25/250 AC (600v/DC), 3/600 **15p.** 5/150, 10/150, 40/150 **50p.**
Many others and high voltage in stock.

SONNENSCHEIN/POWERSONIC DRI-FIT RECHARGEABLE SEALED GEL (Lead Antimony) BATTERY, 6V 1 amp.hr. (3⅞" x 2" x ⅞") **£3.70.** 6 amp. hr. (4½" x 2" x 3") **£7.60**
Ex-equipment, little used.

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. **9p each**

1¼ glass fuses 250 m/a or 3 amp (box of 12) 20p
Bulgin 5mm Jack plug and switched socket (pair) 40p

Reed Switch 28mm, body length 11p

Aluminium circuit tape, ⅛ x 36 yards—self adhesive. For window alarms, circuits, etc. **95p**

TV MAINS DROPPERS

5 assorted multiple units for ... **75p**

100pF air-spaced tuning capacitor ... **£1.30**
5¼" x 2¼" Speaker, ex-equipment 3 ohm **65p**
2 Amp Suppression Choke ... **10p**
3 x 2¼ x 1/16" } PAXOLINE 5 for **35p**
4⅝ x ½ x ⅛" } 10 for **15p**
PVC or metal clip on MES bulb Holder 5 for **30p**
VALVE RETAINER CLIP, adjustable 5 for **15p**

Sub-miniature Transistor Transformer **35p**
Valve type output transformer **90p**
POT CORES with adjuster
LA2508-LA2519 **43p per pair**
16 Watt Power Amp. Module
35v 1A power required, giving 16 watt RMS into 8 Ω **£3.45**
REGULATED TAPE MOTOR
Grundig 6V approx., 3" x 1½", inc. shock absorbing carrier: or Jap 9V, 1½" diam. **£1.05**
3.5mm metal stereo plug **30p**
Fane 8 ohm 3" sq. heavy duty communications speaker **£1.60**
RS neg. volt regulator 103, 306-099 (equiv. MPC900) 10A, 100 watt 4-30 volt. Adjustable short circuit protection. Normally £12.50+. **£6.65**

Digital count unit. Counts in steps of 1, 2, 5 or 10 with total limit switch (2 x D.I.L. BCD), reed relay remote output. Mains power supply, relay and delay unit. UNUSED. £5.40
Displays on 2 Minitron. 7 segments sold separately.

RELAY 6 amp changeover. Mains coil £1.10
200μA F.S.D. level Meter 1⅝" x 1½" £3.25

DEAC rechargeable NICAD 450K. Capacity 6V 450 m.a.h. at 10 hour rate. Ex-new equipment £4.11

Crouzet 30-minute timer-programmer, multi-variable contacts £7.56

ACOS DUST JOCKEY Automatic record cleaner £1.30

Mail Order
Over £50 deduct 10%
Over £100 deduct 20%

McMurdo 4 or 8 way plug and socket ex-equipment 50p

"Makaswitch" 1p 10-way wafer 15p
Wood cased 8-12V buzzer £2.50

2.5A r.f. thermo-couple and meter 2¼" square £3.80

BRIAN J. REED

161 ST. JOHNS HILL, BATTERSEA, LONDON SW11 1TQ
Open 10 a.m. till 7 p.m. Tuesday to Saturday. VAT receipts on request.
Terms: Payment with order Telephone: 01-223 5016

100 Capacitors £2.50
100 Resistors up to ¾W £1.00
100 Resistors 2-5W £3.00
100 1% & 2% Resistors £3.50

100 Electrolytics £3.00
100 Resistors 1W £2.00
100 Wirewound Resistors £4.50
Well mixed values and voltages

C90 Cassette Tape 62p

Mullard +12-0-12V 1A, 4A stabilized, regulated, power supply. £12.00

27V 5A Double section bobbin transformer £4.32

50 ohm BNC plug, through connector or round or flanged chassis socket. TNC plug or N plug or through connector 65p each

UK — Postal Orders for same day service. Cheques require 8 days from a Tuesday banking to ensure clearance: export — banker's draft (sterling) same day service. Foreign currency money orders etc. can lose value and take 4-6 weeks to clear.

250 Ω 50 watt + Resistor 40p

SEMICONDUCTORS Full spec. by Mullard etc. Many others in stock

AC126/128/176	20p
ACY20	30p
ACY29	22p
AD161/2 match pr.	85p
ADZ12	£4.00p
AF124/6/7	28p
AF139	23p
AF178/80/81	35p
AF239	35p
ASY27/73	35p
AU110/113	£2.50
BC107/8/9 + A/B/C	8p
BC147/8/9 + A/B/C	8p
BC157/8/9 + A/B/C	8p
BC173	8p
BC178A/B 179B	14p
BC182/184C/LC	11p
BC186/7	23p
BC204	12p
BC212	13p
BC213L/214B/238	13p
BC327/8 337/8	10p
BC547/8+A/B/C	13p
BC556/7/7B/8/9	11p
BCX32/36	15p
BCY31	90p
BCY40	55p
BCY70/1/2	14p
BCZ11	32p
BD113	57p
BD115	35p
BD116(BRC116T)	£1.15
BD130Y	£1.50
BD131/2/3	40p
BD135/6/7/8/9	35p
BD137/138 match pr	82p
BD140/142	35p
BD201/2/3/4	92p
BD232/3/4/5/8	55p
BDX77	£1.15
BD437	58p
BF/115/167/173	18p
BF178/9	23p
BF180/1/2/3/4/5	18p
BF194/5/6/7	8p
BF194A, 195C	8p
BF200 258 324	23p
BF262/3	35p
BF336/274	31p
BFS28 Dual Mosfet	£1.15
BFT61	40p
BFW10/11 F.E.T	46p
BFW30	£1.15
BFW57/58	21p
BFX12/29/30	23p
BFX84/88.89	20p
BFY51	16p
BFY90	57p
BR101	34p
BRY39/56	29p
BSV64	36p
BSV79/80 F.E.T.s	90p
BSV81 Mosfet	£1.00
BSX20/21/78	16p
BSY40	30p
BSY95A	14p
BU204+Mount Kit	£1.85
BU208	£2.26
CV7042 (OC41/44 ASY63)	12p
GET111/E112	45p
OC45(ME2)	13p
ON222	23p
R2008B/2010B	£2.30
TIP30	50p
TIS43 (2N2646)	39p
uA7805	£1.85
ZT1486	£1.15
ZTX300/341	9p
2N393 (MA393)	35p
2N456A	57p
2N706A	18p
2N918	30p
2N929	16p
2N987	45p
2N1484	£1.15
2N1507/2219	18p
2N1613	24p
2N2401	35p
2N21412	80p
2N2483	28p
2N2904/5/6/7/7A	18p
2N3053	16p
2N3055 R.C.A.	60p
2N3133/4062	24p
2N3553	56p
2N4037	39p
2N5484 FET	39p
2N5956	87p
2SA141/2/360	36p
2SB135/6/457	24p
40250(2N3054)	35p

OTHER DIODES

1N916	8p
1N4009	9p
1N4148	4p
BA145	17p
Centercel	29p
BZY61/BA148/OA81	12p
BB103/110 Varicap	24p
BB113 Triple Varicap	43p
BA182	15p
OA5/7/10	17p
BZY88 up to 43 volt	10p
BZX61 11 volt	17p
AA133	10p
BZY96C 10V	34p
BZY95C 33V or 15V	34p

CATALOGUE

38, 11 x 8 ins illustrated sheets, listing approx. 5,250 items, photo printed on day requested, from constantly updated masters, to ensure latest stock position, 75p (refundable with orders) plus 24p s.a.e. or label.

RS *Irravin* high temperature wire, 19/0.16, minus 55° to 105°C, 600V 3A, white, black or red. Half trade price at 54p 10M coil.

PVC QUALITY TAPE

Lasso 10m x 15mm grey 38p
33m x 33mm green £1.13p

Trimmer: Post stamp type 3-30pF 16p
10-80pF 19p
30-140pF ... 23p

GARRARD

GCS23T Crystal Stereo Cartridge £1.20
Mono (Stereo compatible) Ceramic or crystal £1

TRANSFORMERS

Ferromag C core. Screens 95-105-115-125-200-220-240v input output 17v ½A x 2 + 24-0-24v 1.04A+20v 1mA. These current ratings can be safely exceeded by 50%. £4.90

Cassette Dynamic Microphone with switch and twin plug £1.80

Telephone Pickup, sucker with lead and 3.5 plug 70p

BRIDGE RECTIFIERS

Amp	Volt		
1	1,600	BYX10	34p
½	140	OSH01-200	30p
5	100	Ex Equip	73p
0.6	110	EC433	20p
5	400	Texas	£1.10
2½	100	I.R.	48p
3½	100	B40C 3200	58p

RECTIFIERS

	Amp	Volt	
M1	½	68	5p
1N4005/6	1	6/800	6p
1N4007/BYX94	1	1250	8p
BY103	1	1,500	21p
SR100	1.5	100	9p
SR400	1.5	400	10p
REC53A	1.5	1,250	16p
LT102	2	30	15p
BYX22-200	1½	300	25p
BYX38-300R	2.5	300	48p
BYX38-600	2.5	600	52p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX49-300R	3	300	35p
BYX49-600	3	600	42p
BYX49-900	3	900	47p
BYX49-1200	3	1,200	60p
BYX48-300R	6	300	47p
BYX48-600	6	600	60p
BYX48-900	6	900	70p
BYX48-1200R	6	1,200	92p
BYX72-150R	10	150	42p
BYX72-300R	10	300	52p
BYX72-500R	10	500	65p
BYX42-300	10	300	36p
1N5401	3	100	16p
1N5402	3	200	18p
MR856	3	600	24p
BYX42-900	10	900	92p
BYX42-1200	10	1,200	£1.07
BYX46-300R*	15	300	£1.19
BYX46-400R*	15	400	£1.75
BYX46-500R*	15	500	£2.00
BYX46-600*	15	600	£2.30
BYX20-200	25	200	72p
BYX52-300	40	300	£2.05
BYX52-1200	40	1,200	£2.90
RAS310AF*	1.25	1,250	48p

*Avalanche type

TRIACS

Amp	Volt		
25	900	BTX94-900	£4.50
25	1200	BTX49-1200	£6.75

Diode Characteristic, Equiv., and Substitution Book 82p
Transistor equivalents and substitution Book 1 38p Book 2 82p
Chrome Car Radio facia 28p
Rubber Car Radio gasket 10p
DLI Pal Delayline 90p
Relay Socket miniature 2PCO ... 20p
28 pin d.i.l. socket low profile ... 38p
Colour EHT Tray 3000/3500 .. £5.50
Nylon self-locking, 3¼" tie clips ... 3p
1.5, 10, 22 or 750 μh choke 12p
0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive 4¼" dia. 13p
Mullard Semiconductor, Valve & Component Data Book 1976-78 50p

OPTO ELECTRONICS

Diodes

BPX40 ...	57p
BPX42 ...	92p
BPY10 ...	92p

(VOLTIAC)

BPY68	
BPY69 ...	92p
BPY77	

Wire end neons 9p

Photo transistor

BPX29 ...	92p
OCP71 ...	75p

L.E.D.'s

.2" Red 16p
TIL209 .125" Red 14p
Green 16p

PHOTO SILICON CONTROLLED SWITCH
BPX66 PNPN 10 amp £1.15

THYRISTORS

Amp	Volt		
	40	BTX18-200	.35p
	400	BTX18-300	.41p
	240	BTX30-200	.35p
4	500	40506	.80p
15	500	BT107	£1.14
6.5	500	BT109-500R/SCR957/BRC4444	£1.14
20	600	BTW92-600RM	£3.40
15	800	BTX95-800R Pulse Modulated	£8.75

3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 19m/a segment, common anode 95p
RS 0.6in. green £2.25
Minitron 0.3in 3015F filament £1.25

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One fifth of trade

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0.25MFD	800 volt	87p
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Dark grey plastic for recessed shaft (quarter inch) with free shaft extension 8p

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Car Aerial 11p, Coax 8p, 5 pin 180°, 11p, 5 or 6 pin 240° din 8p, speaker din switched 13p, 3.5 mm switched 7p, stereo ¼" jack enclosed 20p.

R.S. Battery Holder for 4 x HP/SP 11 .... 30p

McMurdo PP108 8 way edge plug 12p
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New unmarked, or marked ample lead ex new equipment

ACY17-20	10p
ASZ20	10p
ASZ21	35p
BC186	13p
BCY30-34	24p
BCY70/1/2	10p
BY126/7	5p
HG1005	12p
HG5009	4p
HG5079	4p
L78/9	4p
M3	12p
OA81	4p
OA47	4p
OA200-2	4p
OC23	27p
OC200-5	24p
C106 THY	38p
TIC44	28p
2G240	£1.17
2G302	6p
2G401	6p
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2N2926	6p
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2N1091	10p
2N1302	10p
1N1907	£1.17
Germ. diode	2p
2N3055 Motorola	36p
GET120 (AC128 in 1" sq. heat sink	22p
GET872	15p
2S3230	34p
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MINIATURE EDGE METERS

100uA f.s.d., scaled 0.5. 12V Illuminated blue perspex front, 35mm x 14mm £3.45
200uA level meter, clear front. 10 x 18mm £1.20

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2500 mfd. 40v 56p
0.1 mfd. 350/500v 10 for 50p
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32+32/275v 3 for 90p
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8+8 mfd. 375v4 for 90p
1 mfd. non-polar 350v 10 for £1.19
25000 mfd. 25v 65p
12000/12v 3 for £1.16
G.E.C. 5% Hi-stab capacitors 013, 061, 066, 069, 075, 08 10 for 65p
AY5 8300 10 for £6
BC548B 500 for £28.50
BC556 500 for £28.50
BCY71 500 for £43.50
BD437 50 for £13.75
2N2906 500 for £43.50
TBA920 10 for £11.50
Vero card handle 10 for 65p
62 Ω ½W Resistor 2,000 for £6.75
ON222 (superior matched BF181) 10 for £1.20
68 Volt 10 Watt Zener Diodes......5 for £2.50

INTEGRATED CIRCUITS

TBA920 TCA270	£2.20
TAA700	£2.40
TBA800	£1.24
741/7490/7473	28p
uA702/LM3900	53p
709	40p
74107/74122	38p
SN76228N	£2.03
SN76131/75110	£1.55
SN76013N/ND	£1.40
TAD100 AMRF	£1.22
CA3001 R.F. Amp	£1.58
CA3132	£2.22
74151	45p
CD4069	24p
TAA300 1 wt Amp	£1.15
TAA550 Y or G	28p
TAA263/74LS192	70p
TAA320	£1.15
7400/7401	16p
7402/4/10/20/30	16p
7414/74132N	64p
7438/7474/7432	27p
AY5 8300	£1.00
7483/74S20	79p
7493/CD4013	41p
LM300 2/20V reg	£1.15
LM1303N	£1.15
74154/TBA810	£1.02
TBA550Q/74S112	£1.80
ZN414	£1

HANDLES

Rigid light blue nylon 6¼" with secret fitting screws 11p

Belling Lee white plastic surface coax outlet box 40p

Miniature Axial Lead Ferrite Choke formers 5 for 13p

RS 10 Turn pot 1% 250 500 Ω 1K. £1.70

Copper coated board 18¼" x 2¾" 40p

Geared Knob 8-1 ratio, 1¼" diam., black 93p

KLIPPON 25A 440v TERMINAL BLOCKS
Professional leaf spring clamp, twin with clip-over cover 11p
Strip of 4, 40A 440V 16p

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Rated 10amp 100V
Metal Brand New
Two for 35p

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Red **30p** Amber **32p** Green **32p**
Clear lens red glow **22p**
ALL BRAND NEW!

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Transistorised 4-12v
Can be run from TTL
Brand New 74p each

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All modern types, carbon tracks. 60% long shafts, all new

10K Lin **18p**	DUAL
47K Lin **18p**	100K Lin **24p**
50K Lin **18p**	100K Log **24p**
250K Lin **16p**	22K Log **24p**
	1K+500K Lin **20p**

WIREWOUND RESISTORS
All brand new modern types

1.5ohm 5w **5p**	560 ohm 5w **5p**
2.7ohm 2w **4p**	1K 10w **5p**
30 ohm 5w **5p**	1K2 5w **5p**
51 ohm 5w **5p**	2K2 5w **5p**
56 ohm 5w **5p**	6K8 5w **5p**
500 ohm 5w **5p**	

POLYSTYRENE CAPACITORS
47pF/400v
60pF/350V
163pF/125v
390pF/150v
395pF/350v
1000pF/350v
3070pF/125v
4000pF/125v
ALL AT 4p EACH

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250pF air spaced **40p**
350pF + 350pF approx double gang, slow tune, air spaced **60p**
Both types are new

SUPER TESTED PAKS

30 Uncoded BC107	70p
30 Uncoded BC108	70p
30 Uncoded BC109	70p
30 AC128 branded	70p
20 Vari-Cap diodes uncoded	35p
40 Asstd transistors	70p
30 2W Zener diodes uncoded	42p
6 asstd pre-set pots	30p
20 wirewound resistors	42p
25 C280 Capacitors	30p
25 Polystyrene Capacitors	30p
25 Ceramic Capacitors	30p
25 asstd Capacitors	30p
6 P-channel FET's	60p
6 N-channel FET's	60p
6 Photo transistors uncoded	60p
10 Stud diodes asstd types	30p

SENSATIONAL SCOOP!

LED — DISPLAYS
Brand new devices, 7 segment, common anode and common cathode types, these are not full spec but are 100% functional. Data supplied, we cannot select display colours or c.a. or c.c. types.

0.3" single display	35p
0.6" single display	45p
0.5" double display	65p
0.5" Special +1 and 7 segment displays	70p

ONLY LIMITED STOCKS

TRIMMERS
Compression types, all brand new. 10pF, 30pF, 50pF, 1,000pF **All 15p each**
Tubular solder-in types, brand new. 3pF, 6pF, 8pF, 12pF **All 10p each**
Dau semi-air spaced
2 to 9pF **16p**
6 to 45pF **16p**
8 to 125pF **18p**

I.C. TOOL
Insertion or extraction plastic, new **55p each**

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All primaries 240V:

24V tapped	
14V lamp	£1.80
22-0-22V 500ma	£2.00
16V 2 amp	£2.10
12V 1 amp	£1.70
24V 1.75 amp	£2.00
30V 1 amp	£2.10
13-0-13V 1 amp	£2.20
22V 500ma	£1.40
32-0-32V 500ma	£2.20

Please add P&P 40p on transformers

ELECTROLYTIC CAPACITORS
All brand new modern transistor types mostly, all values, voltages marked

1uF/75v	5p
2uF/40v	5p
4uF/300v	5p
6.8uF/25v	6p
12uF/25v	5p
25uF/12v	5p
25uF/30v	4p
32uF/40v	5p
32uF/160v	6p
40uF/16v	5p
47uF/25v	5p
56uF/25v	5p
64uF/10v	4p
64uF/70v	5p
75uF/9v	4p
100uF/6.3v	4p
100uF/40v	5p
125uF/10v	5p
125uF/10v	5p
150uF/6.3v	4p
150uF/16v	5p
150uF/25v	5p
200uF/10v	5p
250uF/16v	5p
300uF/9v	5p
300uF/25v	5p
320uF/18v	5p
320uF/18v	5p
330uF/25v	5p
400uF/10v	5p
400uF/25v	5p
470uF/6.3v	5p
470uF/16v	5p

TBA 120S FM DETECTOR
I.C.'s new with data but untested **18p each**

WIDEBAND AMPLIFIER
I.C.'s new with data but untested **18p each**

LDR's
ORP 12 Equiv **50p**
ORP61 **60p**
Both brand new

35 amp FUSES
1¼" **Six for 20p**

PUSH BUTTON BANKS
All new, ratchet type switches

Single d.p. changeover	12p
Three banked all d.p. changeover	20p
Three banked, one d.p. changeover, two with four d.p. changeovers	24p
Three banked, one d.p. changeover, two d.p. changeovers	18p
Five banked, two d.p. changeovers, three single changeover	25p

MULLARD TAA320
M.O.S.T. PRE-AMP I.C. with circuits brand new, tested **48p each**

13 AMP RUBBER Fly-lead extension sockets. Black **40p**

INFLATION BEATERS

I.C. SOCKETS
Low profile d.i.l. brand new types
8 pin **12p**
14 pin **13p**
16 pin **14p**

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32+32uF 275v wkg	20p
32+32uF 350v wkg	25p
100+200uF 275v wkg	25p
150+150+75uF 350v wkg	34p
200+200+100+32uF 325v	35p

All types brand new

SUPER BUY
CARBON FILM RESISTORS
5% ¼w and ½w
All brand new but with preformed leads
PAK OF 150
ONLY 60p

REED RELAYS
Small types **10p each**

¼" COIL FORMERS
With cores **9p**

N-CHANNEL FET's
16p each

P-CHANNEL FET's 16p

PHOTO-TRANSISTORS
New, uncoded **18p each**

INLINE FUSEHOLDERS
1¼" fuse type **16p each**

13 amp PLUGS
Black rubber new **38p**

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4-way 5A **12p**

RELAYS
12v dc min new **70p**

RELAYS
24v dc min. new. S/T **70p**

PANEL FUSEHOLDERS
20mm type **30p each**

BD187 TRANSISTORS
4 amp full spec **28p**

★ ★ ★
STAR PACK
Twenty asstd I.C.'s. All sorts 8 pin, 14 pin, 16 pin all types. Many coded but all untested at only **24p**

SLIDER POTS
All new smooth track plastic coded types
470R lin
1K lin
4.7K lin
5K lin
10k log
25K log
100K lin
250K lin
All **22p each**

BARGAIN PAK
TEN POWER TRANSISTORS
All new and marked numbers, plastic and metal types, tested working Only **£1.00**

NUTS/BOLTS
6BA nuts 40 **30p**
6BA 1" Bolts 40 **35p**
4BA nuts 40 **32p**
4BA 1" bolts 40 **36p**
6BA solder tags 40 **28p**

PRESSIL SWITCH
Single/pole, new, 2 amp
18p

TO3 TRANSISTOR
Insulation Covers Nylon **4 for 24p**

TO3 WASHERS
Melinex for heat-sinks **4 for 16p**

THYRISTOR
10 amp 100 PIV metal stud
35p each

BATTERY HOLDERS
Takes 6 x HP7 **24p each**

SUMMER OFFER
★ ★
COMPRESSION TRIMMERS
10 to 100pF
Only 12p each

50 PIV 2½ amp Wire End Diodes 4p

MAGNETIC EARPIECES
8 ohm new **28p each**

ROTARY SWITCH
Miniature 2 pole 4 way **30p each**

★ ★ ★
DIODE PAK
50 Silicon types new **only 35p**

CRYSTALS
Ten asstd types 10XAJ
Only 60p

TRANSISTORISED INVERTERS
All units ready assembled in blue rexine covered aluminium cases, plain bottoms, features include: on/off switch, output via 13A type rubber socket, silicon power transistors, all new components used throughout. 12v or 24v inputs as listed — output 240v AC off load, square wave, frequency between 45/54Hz approx

12v in — 25 watts out. 6"x5"x4"	£7.50
12v in — 40 watts out. 6"x5"x4"	£10.80
12v in — 120 watts out. 11"x6"x5"	£21.00
24v in — 25 watts out. 6"x5"x4"	£8.80
24v in — 50 watts out. 6"x5"x4"	£12.60
24v in — 100 watts out. 11"x6"x5"	£21.00
24v in — 150 watts out. 11"x6"x5"	£26.00
24v in — 200 watts out. 11"x6"x5"	£34.00
24v in — 300 watts out. 11"x6"x5"	£42.00

P&P £2.00 Extra

PLEASE ADD **15p** post/packing. Minimum order £1.50. Payment by cheques, postal orders etc. Overseas postage at cost. It is very helpful if you print your name and address clearly.
Goods ordered now sent by return of post except where indicated.

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SEMICONDUCTORS POTS & IRONS

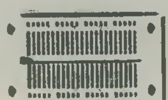
EXPERIMENTER BREADBOARDS

FROM CSC

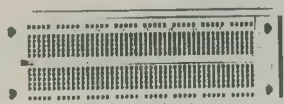
No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build breadboard of any area.
All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP.4B.

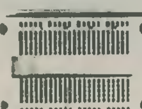
EXP.325. The ideal breadboard for 1 chip circuits. Accepts 8,14,16 and up to 22 pin IC's.
ONLY £1.73.

EXP.350. £3.40.
270 contact points with two 20-point bus-bars.



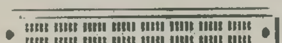
EXP.300.
550 contacts with two 40-point bus-bars.
£6.21.





EXP.650 for Micro-processors. **£3.89.**

EXP.4B.
More bus-bars.
£2.48



ALL EXP.300 Breadboards mix and match with 600 series.

THYRISTORS

600ma — TO 18 Case

Volts	No.	Price
10	THY600/10	£0.16
20	THY600/20	£0.17
30	THY600/30	£0.22
50	THY600/50	£0.24
100	THY600/100	£0.27
200	THY600/200	£0.41
400	THY600/400	£0.43

1 amp — TO 5 Case

Volts	No.	Price
50	THY1A/50	£0.28
100	THY1A/100	£0.30
200	THY1A/200	£0.35
400	THY1A/400	£0.41
600	THY1A/600	£0.49
800	THY1A/800	£0.63

3 amp — TO 66 Case

Volts	No.	Price
50	THY3A/50	£0.30
100	THY3A/100	£0.32
200	THY3A/200	£0.36
400	THY3A/400	£0.45
600	THY3A/600	£0.54
800	THY3A/800	£0.70

5 amp — TO 66 Case

Volts	No.	Price
50	THY5A/50	£0.39
100	THY5A/100	£0.49
200	THY5A/200	£0.54
400	THY5A/400	£0.62
600	THY5A/600	£0.75
800	THY5A/800	£0.87

5 amp — TO 220 Case

Volts	No.	Price
400	THY5A/400P	£0.62
800	THY5A/600P	£0.75
800	THY5A/800p	£0.87

7 amp — TO 48 Case

Volts	No.	Price
50	THY7A/50	£0.52
100	THY7A/100	£0.55
200	THY7A/200	£0.62
400	THY7A/400	£0.67
600	THY7A/600	£0.84
800	THY7A/800	£0.99

10 amp — TO 48 Case

Volts	No.	Price
50	THY10A/50	£0.55
100	THY10A/100	£0.62
200	THY10A/200	£0.67
400	THY10A/400	£0.77
600	THY10A/600	£0.97
800	THY10A/800	£1.32

16 amp — TO 48 Case

Volts	No.	Price
50	THY16A/50	£0.58
100	THY16A/100	£0.63
200	THY16A/200	£0.67
400	THY16A/400	£0.83
600	THY16A/600	£0.97
800	THY16A/800	£1.50

30 amp — TO 94 Case

Volts	No.	Price
50	THY30A/50	£1.27
100	THY30A/100	£1.54
200	THY30A/200	£1.76
400	THY30A/400	£1.93
600	THY30A/600	£3.78

No.	Price
BT101/500R	£0.86
BT102/500R	£0.86
BT106	£1.35
BT107	£1.00
BT108	£1.06
2N3228	£0.76
2N3535	£0.83
BTX30/50L	£0.36
BTX30/400L	£0.50
C106/4	£0.65

SOCKETS

1611	8 pin DIL	£0.12
1612	14 pin DIL	£0.13
1613	16 pin DIL	£0.14
1614	24 pin DIL	£0.27
1615	28 pin DIL	£0.32
1616	TO18 Transistor	£0.13
1617	TU3 Transistor	£0.38
16117	TO5 Transistor	£0.13

POTENTIOMETERS

CARBON POTS (Linear Track)
Single gang with wire end terminations. 6mm x 50mm plastic shaft 10mm bushes supplied with shake proof washer and nut. Tolerance 20% of resistance.

1831 1k ohms — 1832 2k2 ohms — 1833 4k7 ohms — 1834 10k ohms — 1835 22k ohms — 1836 47k ohms — 1837 100k ohms — 1838 220k ohms — 1839 470k ohms — 1840 1 Meg — 1841 2M2
All at 29p each

CARBON POTS (Log Track)
1842 4k7 ohms — 1843 10k ohms — 1844 22k ohms — 1845 47k ohms — 1846 100k ohms — 1847 220k ohms — 1848 470k ohms — 1849 1 Meg — 1850 2M2
All at 29p each

DUAL CARBON POTS (Log Law)
1860 4k7 ohms — 1861 10k ohms — 1862 22k ohms — 1863 47k ohms — 1864 100k ohms — 1865 220k ohms — 1866 470k ohms — 1867 1 Meg — 1868 2M2
All at 97p each

SINGLE GANG SWITCHED (Lin Law)
These potentiometers are fitted with double pole on-off switches. The switch is incorporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1.5 amps at 250v AC.
1870 4k7 ohms — 1871 10k ohms — 1872 22k ohms — 1873 47k ohms — 1874 100k ohms — 1875 220k ohms — 1876 470k ohms — 1877 1 Meg — 1878 2M2
All at 73p each

SWITCHED POT (Log Track)
Specification as VC2 but track having (log) law.
1879 4k7 ohms — 1880 10k ohms — 1881 22k ohms — 1882 47k ohms — 1883 100k ohms — 1884 220k ohms — 1885 470k ohms — 1886 1 Meg — 1887 2M2
All at 73p each

DUAL GANG LOG-ANTI-LOG POT
Track specification as dual gang pots VC3, but tracks mounted to log-anti-log action
1888 100k ohms **£0.84**

SPECIAL VOLUME CONTROLS
A miniature 16mm type replacement volume control incorporating single pole on-off switch. Resistance value 5k ohms. Tolerance + 20% ¼ watt rating
1889 **£0.30** VC8

MINIATURE ROTARY VOLUME CONTROL
5k ohms log law with on-off switch. 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.
1890 **£0.61** VC9

WIRE WOUND POTS
A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shake-proof washer and nut. VC6
1891 10 ohms — 1892 22 ohms — 1893 47 ohms — 1894 20 ohms — 1895 220 ohms — 1896 470 ohms — 1897 1k ohms — 1898 2k2 ohms — 1899 4k7 ohms
All at 90p each.

PRE-SET POTS HORIZONTAL MOUNTING
Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screw driver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2.54mm. All tracks are linear law. VC7.
1801 100 ohms — 1802 220 ohms — 1803 470 ohms — 1804 1k ohms — 1805 2k2 ohms — 1806 4k7 ohms — 1807 10k ohms — 1808 22k ohms — 1809 47k ohms — 1810 100k ohms — 1811 220k ohms — 1812 470k ohms — 1813 1M ohms — 1814 2M2 ohms — 1815 4M7 ohms
All at 10p each.

PRE-SET POTS VERTICAL MOUNTING
Miniature type for transistor circuits. Wiper adjustment is made by a screw driver slot. Designed to fit 2.54mm pitch board. All tracks are linear law. VC7.
1816 100 ohms — 1817 220 ohms — 1818 470 ohms — 1819 1k ohms — 1820 2k2 ohms — 1821 4k7 ohms — 1822 10k ohms — 1823 22k ohms — 1824 47k ohms — 1825 100k ohms — 1826 220k ohms — 1827 470k ohms — 1828 1 Megohms — 1829 2M2 ohms — 1830 4M7 ohms
All at 10p each.

SILICON RECTIFIERS

200mA	
IS920 50v	£0.07
IS921 100v	£0.08
IS922 150v	£0.09
IS923 200v	£0.10
IS924 300v	£0.11
1 Amp	
IN4001 50v	£0.05
IN4002 100v	£0.06
IN4003 200v	£0.07
IN4004 400v	£0.08
IN4005 600v	£0.09
IN4006 800v	£0.10
IN4007 1000v	£0.11
1.5 Amp	
IS015 50v	£0.10
IS020 100v	£0.11
IS021 200v	£0.12
IS023 400v	£0.14
IS025 600v	£0.15
IS027 800v	£0.18
IS029 1000v	£0.22
IS031 1200v	£0.27
3 Amp	
IN5400 50v	£0.15
IN5401 100v	£0.16
IN5402 200v	£0.17
IN5405 400v	£0.18
IN5406 600v	£0.23
IN5407 800v	£0.27
IN5408 1000v	£0.32
10 Amp	
IS10/50 50v	£0.21
IS10/100 100v	£0.23
IS10/200 200v	£0.25
IS10/400 400v	£0.38
IS10/600 600v	£0.45
IS10/800 800v	£0.55
IS10/1000 1000v	£0.60
IS10/1200 1200v	£0.74
30 Amp	
IS30/50 50v	£0.60
IS30/100 100v	£0.74
IS30/200 200v	£1.00
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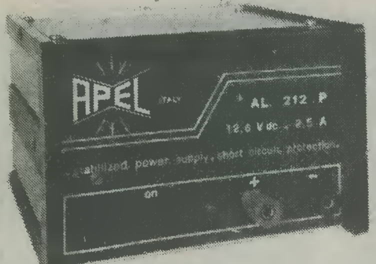

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INPUT VOLTAGE	220 V ac ± 10% 50-60 Hz
OUTPUT VOLTAGE RANGE	12,6 V dc
OUTPUT CURRENT MAX	2,5 Amp
LOAD REGULATION	<0,3% 0÷2,2 Amp
RIPPLE	<5mV 2,2 Amp
DIMENSIONS (mm)	W140 × H90 × D140
WEIGHT	1,490 Kg.

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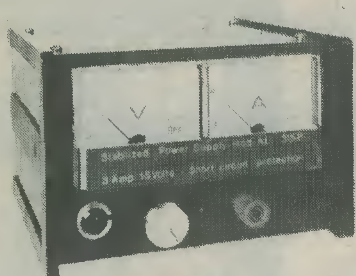
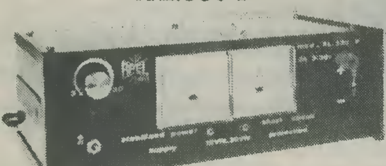


£29.50

INPUT VOLTAGE	220 V ac ± 10% 50-60 Hz
OUTPUT VOLTAGE RANGE	1,7÷15 V. dc
LOAD REGULATION	<0,2% 0÷2,8 Amp
DIMENSIONS (mm)	W140 × H90 × D155
RIPPLE	3mV 2,8 Amp
WEIGHT	2,330 Kg.

AL.330 P



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INPUT VOLTAGE	220 V ac ± 10% 50-60 Hz
OUTPUT VOLTAGE RANGE	3,4÷30 V. dc
OUTPUT CURRENT RANGE MAX	3 Amp
LOAD REGULATION	< 5% 0-2,8 Amp
RIPPLE	10mV 2,8 Amp
DIMENSIONS (mm)	W270 × H90 × D155
WEIGHT	4,250 Kg.

STOCKISTS

Alpha Sound Service,
50 Stuart Road, Waterloo, Liverpool L22 4QT. England.

Anson Electronics,
1133 Hessle High Road, Hull, England.

Amateur Radio Shop,
13 Chapel Hill, Huddersfield, HD1 3ED. England.

Brent Electronics,
Seaview Street, Cleethorpes, Lincolnshire, England.

J. Birkett,
26 The Strait, Lincoln, England.

Bradford Consultants Limited,
25 Regent Parade, Harrogate, Yorkshire, England.

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235 Boundary Road, "Saint Helens," Lancashire, England.

Electronic Services Limited,
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G. W. M. Radio,
Portland Road, Worthing, Sussex.

Leeds Amateur Radio,
27 Cookridge Street, Leeds LS2 3AG, England.

Target Electric Limited
16 Cherry Lane, Bristol, England.

New Cross Radio,
6 Oldham Road, Manchester, England.

Progressive Radio,
93 Dale Street, Liverpool L2 2JD. England.

R. E. Pitt Electrical Services Limited,
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Stewarts Radio,
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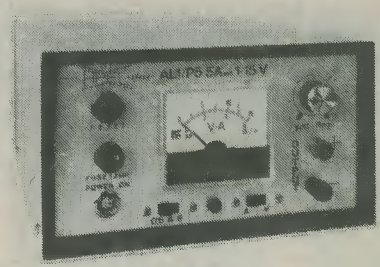
AL.1 P5



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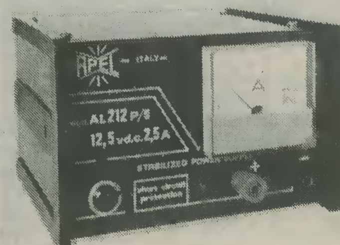
INPUT VOLTAGE	220 ± 10% 50 Hz
OUTPUT VOLTAGE RANGE	1 ± 15 V. dc
OUTPUT CURRENT MAX	5 Amp
LOAD REGULATION	< 0,1% 0-45 Amp
RIPPLE	< 2mV 4,5 Amp
DIMENSIONS (mm)	W210 × H155 × D250
WEIGHT	5,100 Kg.

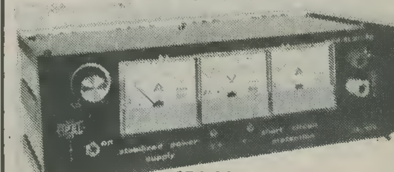
AL.212 PS



£18.00

INPUT VOLTAGE	220 V ac ± 10% 50-60 Hz
OUTPUT VOLTAGE RANGE	12,6 V dc
OUTPUT CURRENT MAX	2,5 Amp
LOAD REGULATION	<0,3% 0÷2,2 Amp
RIPPLE	<5mV 2,2 Amp
DIMENSIONS (mm)	W140 × H90 × D140
WEIGHT	1,490 Kg.
AMPEROMETER	

AL.315 P2



£54.00

INPUT VOLTAGE	220 V ac ± 10% 50-60 Hz
OUTPUT VOLTAGE RANGE	± 1,7 ± 15 V dc
OUTPUT CURRENT RANGE MAX	3 Amp
LOAD REGULATION	< 0,2% 0-2,8 Amp
RIPPLE	< 3mV 2,8 Amp
DIMENSIONS (mm)	W270 × H90 × D155
WEIGHT	4,140 Kg.

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Phase Locked 200kHz Calibrator

by

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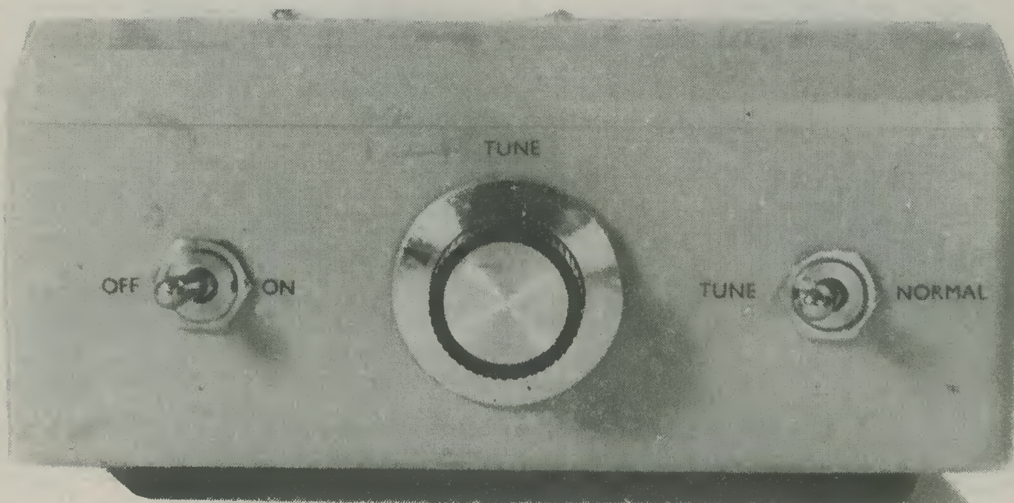


A calibrator with BBC Radio 4 accuracy

The normal type of frequency calibration oscillator consists of a crystal or very stable L-C circuit which operates at some convenient fundamental frequency such as 100kHz or 1MHz, and which has an output rich in harmonic content. The harmonics provide calibration signals on multiples of the fundamental frequency; thus a 100kHz oscillator provides calibration points at 100kHz, 200kHz, 300kHz, 400kHz and so on, usually up to at least 30MHz.

Normally, calibration generators have some form of fine frequency adjustment so that the oscillator may be "zero-beated" against a standard frequency transmission, as for example the BBC Radio 4 long wave transmission on 200kHz. The oscillator will then have a very high degree of accuracy.

This approach can be taken a stage further by having the oscillator actually locked to the standard transmission frequency, using a phase locked loop (p.l.l.) circuit. It is a fairly simple p.l.l. design locked to 200kHz which forms the basis of this article.

BASIC ARRANGEMENT

The basic arrangement used in the calibrator is shown in block diagram form in Fig. 1. A ferrite aerial picks up the BBC 200kHz signal and applies it to an r.f. amplifier employing two high gain transistors. A considerable degree of amplification is needed to bring the signal up to the level required for p.l.l. operation, particularly in areas where the Radio 4 transmission is received at poor strength. The r.f. gain is enhanced by means of positive feed-

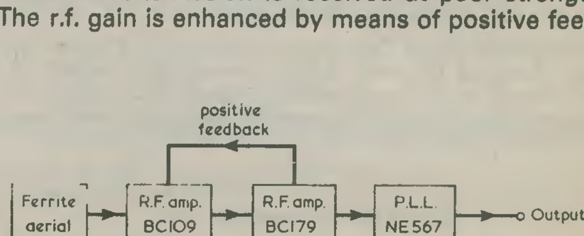


Fig. 1. Block diagram showing the stage line-up of the 200kHz calibrator

COMPONENTS

Resistors
(All $\frac{1}{4}$ watt 10%)
R1 1.2MΩ
R2 3.3kΩ
R3 1.2MΩ
R4 3.3kΩ
R5 15kΩ

Capacitors
C1 250pF mica trimmer (see text)
C2 3,300pF ceramic plate
C3 1,500pF ceramic plate
C4 680pF ceramic plate
C5 0.1μF type C280
C6 0.015μF type C280
C7 150pF ceramic plate
C8 1.8pF ceramic plate or silvered mica
C9 500pF mica trimmer
C10 100μF electrolytic, 10V. Wkg.
C11 0.01μF ceramic plate

Inductors
L1, L2 Long wave aerial coil type LWC1, on ferrite rod type FRA (140mm. x 9.5mm. dia.) and 2 mounting clips type FRPC (see text)

Semiconductors
TR1 BC109
TR2 BC179
IC1 NE567

Switches
S1 s.p.d.t. toggle
S2 s.p.s.t. toggle

Miscellaneous
Plastic case (see text)
9-volt battery type PP3
Battery connector
Control knob
Trimmer converter (see text)
Output socket
4 rubber feet
Materials for printed board
Aluminium (for C1 bracket and battery clamp)
Wire, solder, etc.

back, and this is set up such that the r.f. amplifier is taken beyond the threshold of oscillation. By means of careful tuning, the oscillating amplifier will then itself lock onto the 200kHz signal, using an elementary form of p.l.l. operation.

The result is a considerably enhanced 200kHz signal at the output of the r.f. amplifier, but this is not in itself suitable for calibration purposes since the harmonic content is low, and usable multiples of the fundamental do not extend beyond a few MHz. The amplified signal is in consequence applied to a true p.l.l. circuit, and it is the current controlled oscillator in the latter which provides the calibrator output. The p.l.l. is an NE567.

FULL CIRCUIT

The full circuit of the calibrator appears in Fig. 2. L1 is the tuned winding of the ferrite rod aerial, with C1 as the variable tuning capacitor. The low impedance winding, L2, couples the aerial signal to the base of the first r.f. transistor via C2. TR1 is wired as a conventional common emitter device with a resistive collector load. At the relatively low frequency of 200kHz it is possible to obtain high gain with resistive loads.

The second r.f. transistor is used in a circuit which is virtually identical, apart from the fact that a p.n.p. transistor is employed. Interstage coupling is provided by C3.

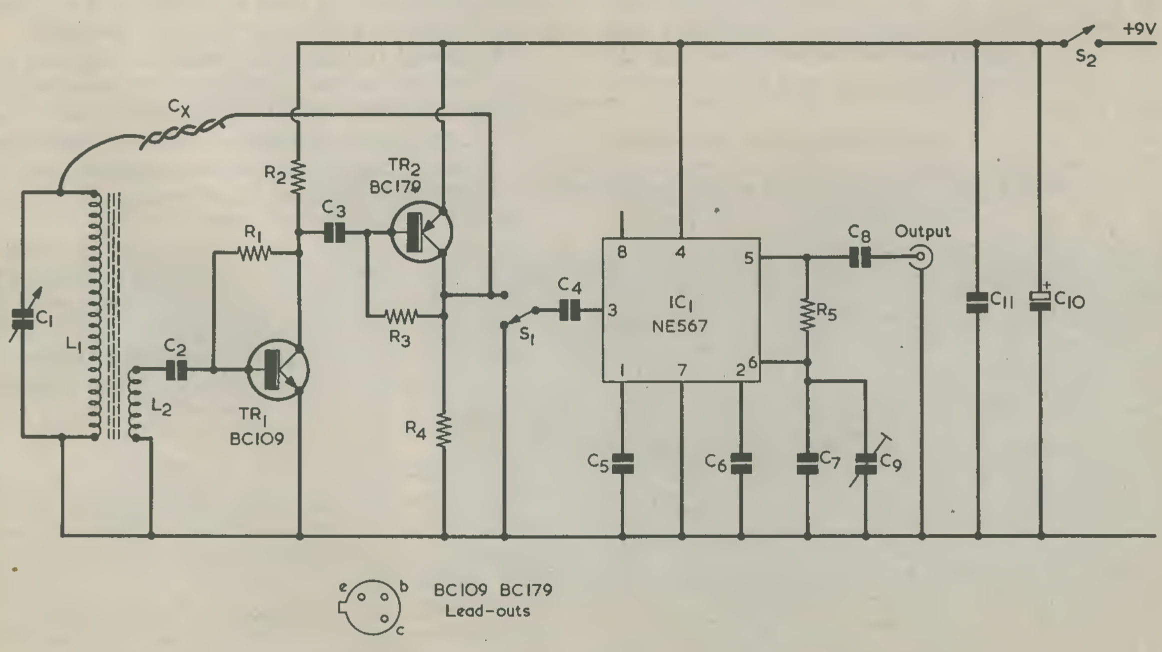
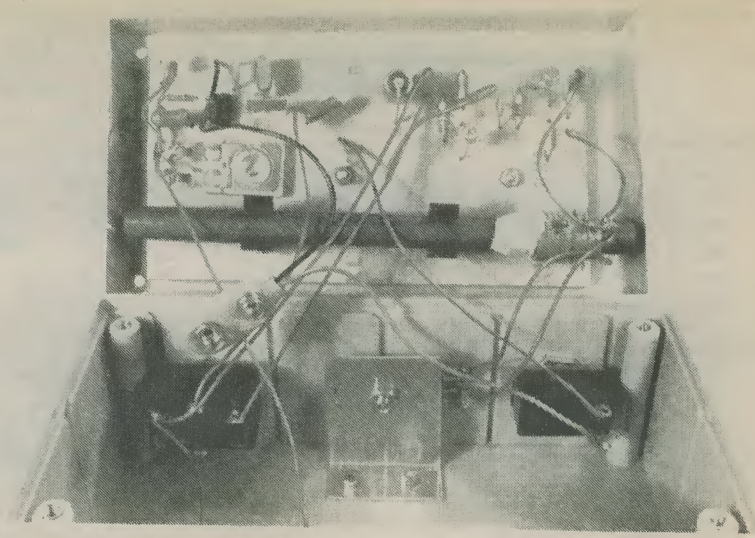


Fig. 2. The circuit of the calibrator. S1 is set to connect the input of the NE567 to the negative rail when it is desired to adjust the i.c. oscillator to 200kHz

The printed board and ferrite aerial assembly are secured to the lid of the plastic case. The aluminium bracket on which is mounted C1 is positioned centrally behind the front panel



Regeneration from TR2 collector to the emitter of TR1 is provided by CX. This is simply the capacitance given by two wires positioned close to each other. In some instances the stray capacitances in the circuit will be sufficient on their own to provide the positive feedback required.

The output of the r.f. amplifier is passed via S1 and C4 to the input of the p.l.l., IC1. The functioning of the NE567 has been described in previous articles in this magazine, and so it will not be dealt with here in detail. The centre frequency determining components are R5, C7 and C9, and the last can be adjusted to give a centre frequency of 200kHz. S1 allows the NE567 input to be disconnected from the r.f. amplifier and connected to the negative supply rail in order that C9 can be adjusted to the correct setting. C4 provides d.c. blocking at the input, whilst C8 performs a similar function at the output. C5 and C6 are low pass filter components. Pin 8 is an output which goes low when lock has been achieved. This facility is not required in the present application, and no connection is made to pin 8.

C10 and C11 are supply decoupling capacitors and S1 is the on-off switch. The current consumption of the unit is approximately 16mA from a 9 volt supply, and the prototype employs a PP3 battery. The fundamental frequency output is a square wave with a nominal peak-to-peak amplitude of the order of 7.5 volts.

CONSTRUCTION

The prototype is housed in a plastic box which has approximate inside dimensions of 90 by 160 by 71 mm. This is a case type 1003, available from Goddard's Components, 110 London Road, St. Albans, Herts, AL1 1NX. A plastic case as opposed to a metal case is essential, since a metal case would screen the ferrite rod aerial and prevent the calibrator from working. Any other plastic case of about the same size may be employed.

One of the long sides of the box is used as the front panel. S2 is mounted on the left of the front panel with S1 balancing it symmetrically on the right. The control spindle for C1 is in the centre of the panel. C1 is a 250pF trimmer with its adjusting screw removed and replaced by a "trimmer converter." The latter consists of a length of $\frac{1}{4}$ in. diameter rod with a section threaded 6BA at one end. This end screws into the trimmer, enabling it to be adjusted by a standard control knob passed over the $\frac{1}{4}$ in. diameter section. The trimmer and the "trimmer converter" are both available from Home Radio (Components) Ltd.

The rear of the trimmer has a bush and nut enabling it to be secured in position, and in the calibrator the trimmer is mounted on a small home-constructed L-shaped aluminium bracket secured to the base of the box by two 6BA bolts and nuts. The bracket may be seen in the photograph of the interior of the calibrator. Its precise dimensions are not important provided that it holds the trimmer steadily at the required height. A hole is required in the front panel of the case to allow the $\frac{1}{4}$ in. section of the "trimmer converter" to pass through.

It would, of course, be possible to use any other variable capacitor having a maximum capacitance of the order of 250pF which is physically small enough to fit into the space available. However, the trimmer and "trimmer converter" are inexpensive, and they also have the advantage of having what is effectively a built-in slow-motion drive.

The output socket, or sockets, are mounted on the rear panel of the case. The author employed two wander plug sockets, one connecting to the negative rail and the other to C8, but a coaxial socket may alternatively be employed if desired. The box is fitted with four rubber feet at the corners of the base.

PRINTED BOARD

The remaining components are assembled on a printed circuit board, the relevant details being provided in Fig. 3, which illustrates both sides of the board actual size.

Two plastic clips hold the ferrite rod in place, and these are mounted to the board by means of two short 6BA bolts about 6 mm. long with nuts. The aerial coil, ferrite rod and mounting clips are all available from Ambit International. A mounting hole

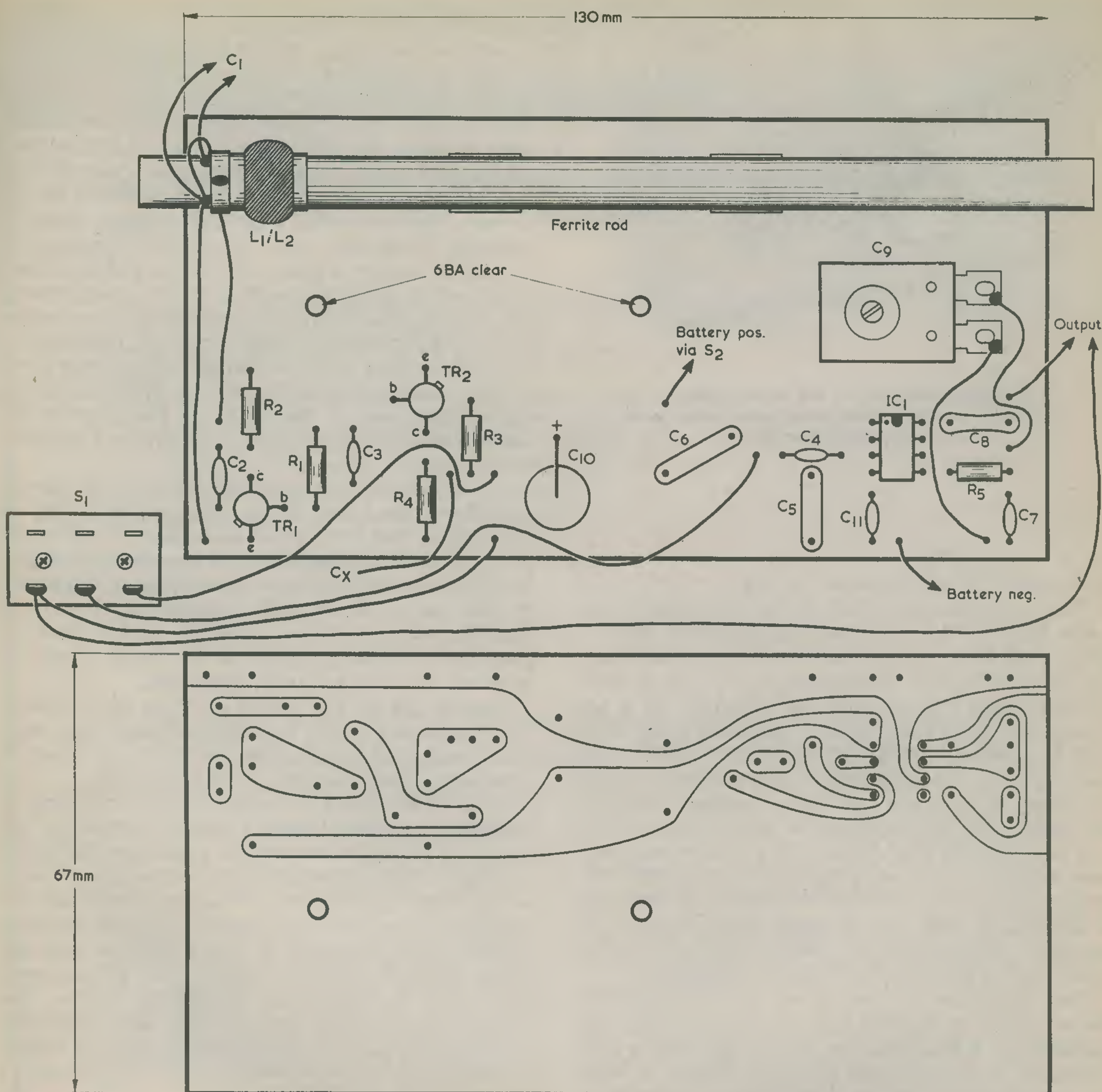
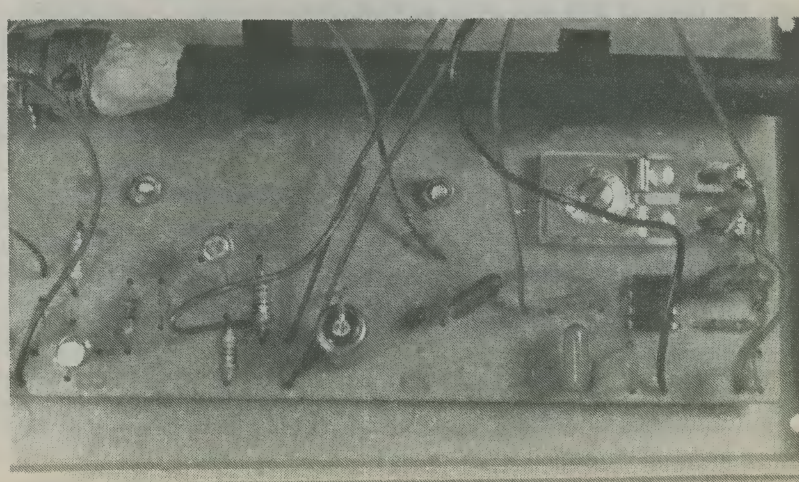
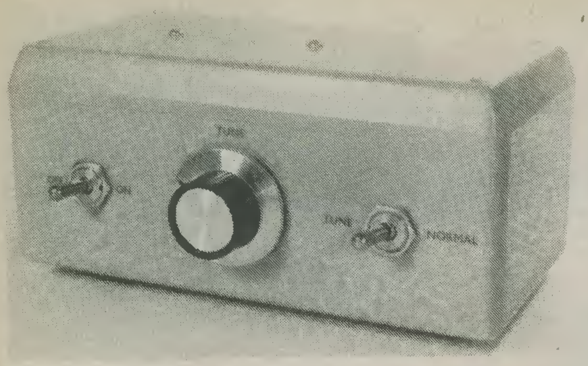


Fig. 3. The component and copper sides of the printed board, which is reproduced actual size. Not shown in the lower view are the mounting holes for the ferrite aerial clips and for C9

The components on the printed board are laid out with comfortable spacing





An angled view of the calibrator. The legends on the front panel are taken from "Panel-Signs" Set No. 4

in the board is also needed for C9.

The lead indicated "CX" in Fig. 3 is one of the leads forming the r.f. feedback capacitor. It is a single-core p.v.c. covered wire which is placed near the non-earthy lead connecting to C1. The amount of capacitance inserted into the circuit by CX is not critical and there may well be sufficient stray feedback to produce oscillation without the need for the lead from the printed board. It will probably not be necessary to twist the two leads together, although this might just be necessary in a few cases.

It is advisable not to use very much more feedback than is necessary to make the circuit oscillate, as this may make it difficult to lock the r.f. amplifier to 200kHz if only a fairly week Radio 4 signal is available. Adjustments to CX, if required, can be made during the initial setting-up process.

The completed printed circuit board is wired to the remainder of the unit before it is mounted on the underside of the plastic box lid. It is secured by two 6BA bolts and nuts, with spacing washers to keep the board underside clear of the inside surface of the lid. The ferrite aerial coil former is held in place on the rod with adhesive tape so that about 10 mm. of the rod projects outside the edge of the former. The PP3 battery rests flat on the bottom of the case, and can be held in position with a small home-made aluminium clamp.

ADJUSTMENT AND USE

It is first necessary to adjust C9 so that the free-running p.l.l. oscillator operates at 200 kHz. S1 is set to connect the p.l.l. input to the negative rail. The unit is then placed close to an ordinary portable radio tuned to the BBC transmission on 200kHz and C9 is adjusted to produce a heterodyne whistle with the BBC transmitter carrier. C9 is adjusted for the lowest frequency tone from the receiver which is possible. Make sure that it is the true fundamental of the p.l.l. which is being picked up, and not a harmonic which is beating with a spurious response of the receiver (as could occur at an image frequency). If it is the fundamental which is being received the heterodyne note will not change in frequency if the receiver tuning is slightly altered. With harmonics slight alterations to the tuning of the receiver will cause considerable changes in heterodyne frequency.

S1 is now set to connect the p.l.l. to the r.f. amplifier output and C1 is adjusted. It should be possible to find a range of settings in C1 in which the p.l.l. oscillator signal can be made to vary slightly either side of 200kHz. C1 is adjusted to the centre of this range of settings, whereupon the circuit should lock onto the 200kHz carrier and no heterodyne whistle should be produced from the receiver, indicating a true "zero-beat."

During use of the unit it must be remembered that the ferrite aerial is directional and that maximum pick-up is given when the ferrite rod is broadside on to the direction of the transmitter.

When calibrating a receiver it should not be necessary to make a direct connection between the output of the calibrator and the aerial terminal of the receiver. Usually, adequate coupling will be given by connecting a short wire to the aerial terminal and placing it close to the calibrator. If a tighter coupling proves to be necessary an insulated lead from the aerial terminal may be twisted with an insulated lead from the calibrator non-earthy output, the resultant capacitance between the leads providing the required coupling. It may occasionally be helpful to connect the receiver earth terminal to the earthy output of the calibrator.

The output from the calibrator will not be completely free of the modulation products in the Radio 4 transmission. This is of no great practical importance and confers the advantage of making the output signal more easily distinguished from other signals which are received. ■

RSGB NATIONAL AMATEUR RADIO EXHIBITION

The RSGB's National Amateur Radio Exhibition was held at Alexandra Palace, London, on the 11th, and 12th May, and as usual a good attendance of visitors was recorded. This venue is a good one from the point of view of space, there being plenty of room to move around and to see what is on display.

The usual Component surplus salesmen were there, in force, and new gear was on display on the well known Traders' Stands, offering an opportunity of making comparisons between the equipment shown. Aerials and masts were also on display, which is useful in judging the actual size of these items — often difficult to do when one only has the sizes quoted in the catalogues to go by.

The RSGB had an impressive Stand, and various other organisations such as RAYNET, AMSAT-UK, RAIBC also put on interesting displays and there was of course the usual Talk-in station in operation.

One always finds something new at these exhibitions and this year it was microprocessors applied to RTTY and also a PET microprocessor on the AMSAT-UK Stand illustrating the use of this type of equipment for predicting OSCAR orbital parameters.

RECENT PUBLICATIONS

PROJECTS IN RADIO AND ELECTRONICS. By Ian R. Sinclair. 96 pages, 215 x 130mm. (8½ x 5in.) Published by the Butterworth Group. Price £2.25.

The author of this book will be no stranger to regular readers of ***Radio & Electronics Constructor*** who have followed his "Double Deccer" and "Tune-In To Programs" series. The same helpful and descriptive style apparent in his articles is similarly evident in "Projects in Radio and Electronics".

Intended mainly for the beginner, the book starts with an introduction to the more common electronic components after which it proceeds to the projects themselves. There are fourteen of these and they include two receivers, a short wave converter, a bench power supply and a bench a.f. amplifier. Also to be found are simple items of test equipment such as a transistor tester, a signal injector, an electronic ohmmeter, a high resistance voltmeter and an a.c. millivoltmeter. The constructional information shows how the various circuits may be assembled on Veroboard or on any other stripboard.

The book is attractively produced with black and green illustrations having excellent registration. It should be of considerable help to anyone who intends to devote spare time to the enjoyable hobby of electronics.

IC LM3900 PROJECTS. By H. Kybett, B.Sc., C. Eng., M.I.E.E., M.I.E.R.E., M.I.T.E., C.E.T. 119 pages, 180 x 110mm. (7 x 4¼in.) Published by Bernard Babani (Publishing) Ltd. Price £1.35.

The LM3900 is a quad Norton operational amplifier, the i.c. chip containing four "current-differencing" amplifiers. Unlike the more familiar operational amplifiers which have voltage inputs, the Norton amplifier functions with current inputs. Amongst its advantages are the ability to run from a single supply voltage and the fact that its output swing extremes closely approach the supply rails.

The book under review is devoted entirely to the LM3900 and the circuits in which it may be employed. These consist of audio applications, linear applications and digital applications, as well as signal generator circuits and special miscellaneous applications. The last include a squaring amplifier circuit, a peak detector and a low frequency mixer.

The text is very concise and use is made of simple mathematics wherever necessary. The book offers useful information in its particular corner of the general op-amp scene.

UNDERSTANDING ELECTRONICS. By R. H. Warring. 175 pages, 220 x 135mm. (8½ x 5¼in.) Published by Lutterworth Press. Price £3.95.

We all of us have to start somewhere, and this applies just as much to electronics as to any other human activity. "Understanding Electronics" is designed for the complete newcomer who, whilst fascinated by the possibility of taking up electronics as a hobby, is discouraged at encountering a world where components in a circuit are represented by symbols having little resemblance to their actual shape and where all the currents and voltages which make the circuit function are completely invisible.

The book under review starts right at the beginning by listing the most commonly encountered electronic units, abbreviations and symbols. It then carries on to direct and alternating current, basic circuits and circuit laws, resistors, capacitors, RC circuits, coils and transformers. The text then turns to semiconductors, neons, l.e.d.'s, valves and integrated circuits. Further sections in the book discuss circuit diagrams, circuit construction, printed circuits, radio and television reception, batteries and power supplies.

The whole is clearly written in a simple down to earth manner and the book represents a good primer on the subject which it covers.

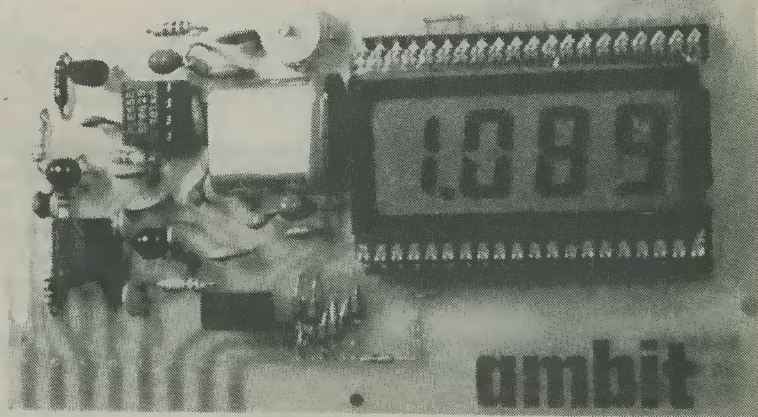
NEWS . . . AND

LCD FREQUENCY DISPLAY FOR AM/FM AND DIRECT READING

Ambit International's range of OKI frequency counter LSI includes devices for driving standard LCD units, to provide direct readout of received frequency in the LW/MW and FM bands, with a wide choice of all standard IF offsets — as well as a direct count facility.

The DFM2 unit (pictured) includes all interface electronics for the unit to be used in conjunction with virtually any/FM receiver circuitry, since the sensitivity of 5mV permits proximity coupling to the oscillator signals.

Full details from Ambit International Ltd., 2 Gresham Road, Brentwood, Essex.



SEMINARS AT GREAT BRITISH ELECTRONICS BAZAAR

A series of 14 seminars is scheduled to run in parallel with the Great British Electronics Bazaar, to be held at the Alexandra Palace on 28, 29, 30 June 1979.

Top level lecturers will talk on a very wide range of subjects. One session will deal with the theory and practical applications of microprocessors and will include demonstrations: A well-known University lecturer will be talking about "How to become a Radio Amateur": On another occasion, a top Mullard expert will describe "Teletext for the Hobbyist": Electronic Keyboard Instruments is another lecture to be delivered by a well-known exponent in the field: The managing director of a leading Consultancy will talk about "Professional Programming for the Amateur": Other areas covered include "Designing and Making your own Printed Circuit Boards" — complete with a demonstration of how-to-do-it; Microcomputer Bus Systems, and Radio Technologies in the 1980s. In the exhibition hall, the Radio Society of Great Britain is to run a special Amateur Radio station with a unique call sign, and many demonstrations of building electronics circuits are planned. Tickets for the Great British Electronics Bazaar are available, free, from the organisers on receipt of a stamped addressed envelope. The address for free tickets is, The Great British Electronics Bazaar, 34-36 High Street, Saffron Walden, Essex, marking the envelope "Bazaar". Groups, Clubs or Societies requiring a number of tickets for parties can obtain all the tickets they need by writing to the above address.

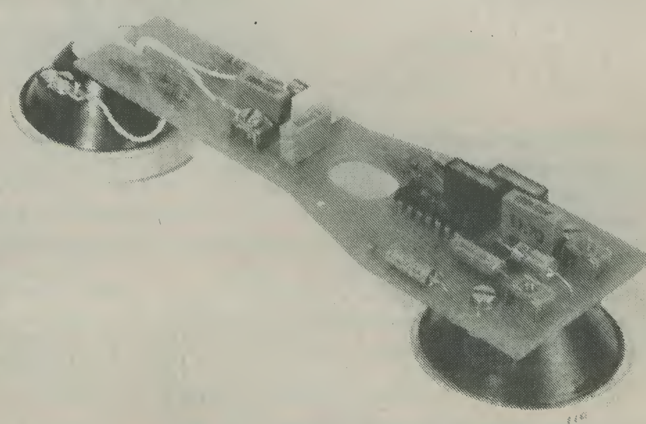
TELEPHONE AMPLIFIER

SGS-ATES is currently in volume production of a linear integrated telephone speech circuit which has been developed by the company for L. M. Ericsson, one of the world's leading telephone equipment manufacturers. Only a small number of additional components is needed in the handset, as is well demonstrated by the second photograph.

The new circuit eliminates the differential transformer and automatically performs the "local effect" suppression function. It also includes a transmitting amplifier which allows the standard carbon capsule to be substituted by a moving-coil microphone or by other transducer types.

Another amplifier is used for the receiving path and the gain of both amplifying sections is automatically controlled as a function of the distance between the user and the exchange. Gain precision is better than 2dB.

The U.K. representatives of SGS-ATES are SGS-ATES (United Kingdom) Ltd., Planar House, Walton Street, Aylesbury, Bucks.



Developed by SGS-ATES for L. M. Ericsson, this telephone handset assembly incorporates electronic circuits for transmitter and receiver amplification as well as "local effect" suppression

. . . COMMENT

HAND-HELD DIGITAL MULTIMETER

The 935 LCD multimeter just announced by Data Precision has, claim Farnell International — the U.K. distributor, the lowest price tag of any high performance hand-held digital multimeter (DMM) currently available in the U.K.

Designed primarily for field use, the 935 is a full function, 3½ digit DMM with 0.1% basic accuracy. It has 29 ranges for d.c. or a.c. voltage and current and resistance measurements, including both high and low resistance excitation. Ranges, functions and hi (2.8V) and lo (250mV) ohms are selected using push button switches ergonomically designed to permit single handed operation using left or right hand, leaving the other hand free for probe use. Measurements including appropriate polarity sign and decimal points and a warning indicator for low battery voltage are displayed on a high contrast 0.5" high liquid crystal display.

The 935 is priced at £99 exc. V.A.T. U.K. mainland delivered, including test leads, battery, instruction manual, one year guarantee, certificate of conformance to NBS standards and U.S. factory final QC test report. Farnell International, who offer full repair and recalibration facilities for this and all the Data Precision range are prepared to offer substantial discounts for quantity orders and further information is available from: Farnell International Instruments Ltd., Sandbeck Way, Wetherby, West Yorkshire, LS22 4DH.

MICROELECTRONICS SYMPOSIUM ON CHIPS

"The past five years have seen a staggering reduction in cost and hence availability of microelectronic "chips". These tiny circuits seem certain to find ubiquitous application in work and leisure, bringing automation on an unprecedented scale. What are microprocessors likely to do to the existing economic structure of our society? Are they really as flexible as those who fear mass unemployment say? What possible uses could they have?"

So ran the introduction to an invitation to attend a one day Symposium organised by the Norwich and Norfolk Branch of the British Association for the Advancement of Science, at the University of East Anglia, Norwich, recently.

The Chairman, Professor Sir Sam Edwards, F.R.S., in his introduction said that the B.A. still concentrated on presenting new scientific ideas to the public. He said we have to export to live and the only way we can do this, is to continue to be one of the leading countries in "high technology" and everyone must come to terms with it.

Dr. A. J. Robinson, Director of the Warren Springs Laboratory, was the first speaker, and he dealt with "Automation in Factories". He said he liked to think of a microprocessor as being much the same as a computer and doing much the same as a computer does, but at a relatively trivial cost. It was necessary that employees and management should know the possibilities of microprocessor techniques and their useage, in order that routine procedures could be taken up by these instruments, thus enabling workers to do the more interesting jobs, leaving the boring repetitive work to machines.

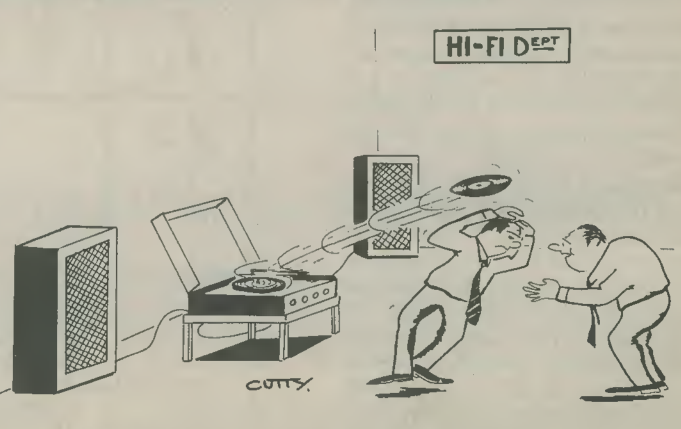
Lectures were also given on "Microprocessors in Transport", "Microprocessors in Education" and "Social Implications of Microprocessors". It was obvious from the discussion following the lectures that the application of the "new technology" in the work-a-day world will lead to much change and controversy.

IMPORTANT SERIES

Starting with our next issue, we shall be commencing one of the most important series that we have ever published.

Called the DATABUS series, the articles will describe how microprocessors work. A comprehensive and jargon-free explanation of microprocessors written specifically for the electronics enthusiast.

The remarks of Professor Sam Edwards F.R.S., as stated in our brief report on the symposium above, underline the importance of this series to all electronics enthusiasts.



"The reject system on this model is very positive"

SUGGESTED CIRCUIT

CAR VOLTAGE - MONITOR

By G. A. French

The circuit described in this article is primarily intended to function as a warning device to indicate low voltage in a 12 volt car battery, but it can also be used as a voltage monitor for any equipment operating from a nominal battery supply voltage ranging from 9 to 12 volts. The circuit is not suitable for 6 volt car systems.

The unit employs two inexpensive integrated circuits and causes a green light-emitting diode to glow steadily when the battery voltage being monitored is higher than a pre-determined level. Should the battery voltage fall below that level the green l.e.d. extinguishes and a red l.e.d. flashes continually.

CIRCUIT DIAGRAM

The circuit of the voltage monitor appears in Fig. 1. In this diagram the voltage to be monitored is applied to the positive and negative supply points and can be switched on and off by S1. For reasons which are explained later, diodes D3 and D4 in the positive rail drop the voltage being checked by approximately 1.2 volts. The voltage drop across these two forward biased diodes can be assumed to be constant.

The voltage is then applied to op-amp IC1, which operates as a voltage comparator. A stabilized voltage of about 5.1 volts appears across zener diode D1 and is applied to the non-inverting input of the op-amp, whilst a proportion of the voltage across the supply rails is tapped off at the slider of pre-set potentiometer VR1 and is passed to the inverting input. When the supply voltage is high the inverting input is positive of the non-inverting input and the output of the op-amp swings negative. With a low supply voltage the op-amp inverting input is negative of the non-inverting input and the output swings positive.

A negative output from the op-amp causes the green light-emitting diode, LED1, to light up and glow continuously. It also applies a negative input to pin 1 of the CMOS quad 2-input NAND gate, IC2. The output of the gate at pin 3 is consequently high, causing the output at pin 4 to be low. As may be seen, the NAND gate associated with pins 4, 5 and 6 of IC2 is employed simply as an inverter. So also are the remaining two NAND gates associated with pins 8 to 13. When the pin 4 output is low, the pin 11 output is similarly low. No voltage is applied to the red light-emitting diode, LED2, and this is extinguished.

When the output of IC1 swings positive LED1 extinguishes and the

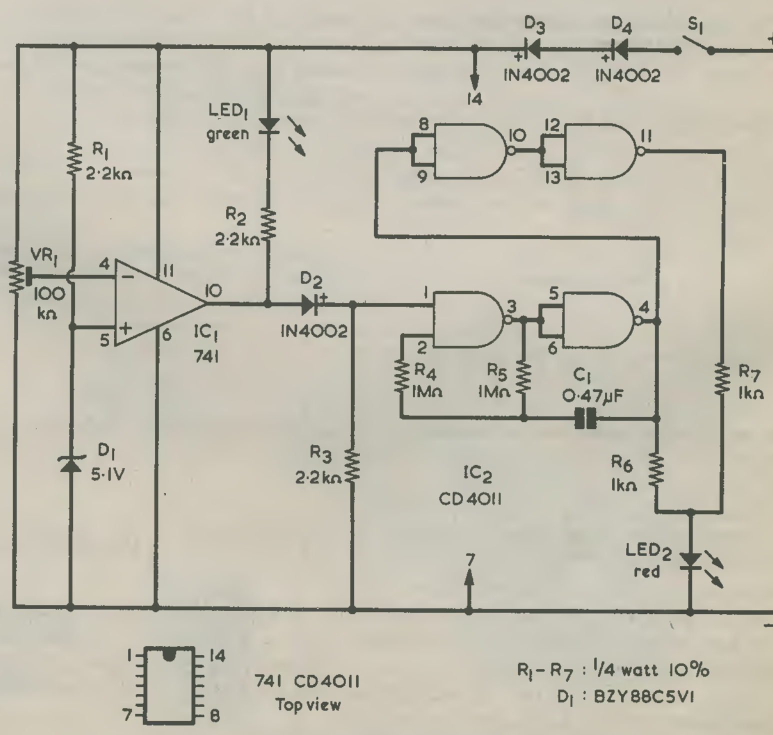


Fig. 1. The circuit of the monitor. IC1 functions as a voltage comparator and IC2, when enabled, as an oscillator which causes the red l.e.d. to flash continually

input of IC2 at pin 1 is taken high. The first NAND gate can now function effectively as an inverter, with pin 3 going low when pin 2 goes high and vice versa. The first two NAND gates then commence to run as an oscillator, the oscillation frequency being controlled mainly by C1 and R5. With the component values shown, the oscillator produces a square wave at pin 4 which has a frequency slightly higher than 1Hz. The red l.e.d. lights up when the output at pin 4 is high. Since the output at pin 11 will then also be high, the l.e.d. receives additional current from this second output. Thus, the l.e.d. passes twice the current which would be available from a single NAND gate output and, in consequence, produces a brighter glow.

Summing up circuit operation so far, it can be seen that a high supply voltage causes the op-amp output to be low, whereupon the green l.e.d. is lit and the NAND gate oscillator is inhibited with the red l.e.d. extinguished; a low supply voltage results in a high op-amp output which extinguishes the green l.e.d., enables the NAND gate oscillator and produces a continual flashing of the red light-emitting diode.

Diode D2 is needed because the op-amp output, when negative, is still about 2 volts positive of the negative rail. The small voltage dropped across the diode ensures that the input to pin 1 of IC2 is taken adequately negative for CMOS functioning.

COMPONENTS

The components required are all readily available. The two l.e.d.'s are not specified by type numbers as there is nowadays a very wide range of suitable l.e.d.'s available to the constructor. The pre-set potentiometer may be a skeleton type of 0.1 watt rating. The pin numbers for IC1 apply to the 741 in a 14-pin d.i.l. package. If an 8-pin 741 is employed, pin 2 is the inverting input, pin 3 is the non-inverting input, pin 6 is the output, pin 4 is for negative supply and pin 7 is for positive supply. As is indicated in Fig. 1, pin 7 of the CD4011 takes its negative supply and pin 14 takes its positive supply.

The CD4011 is available in two types, one having the suffix "AE" and the other having the suffix "BE". The "AE" type is suitable for supply voltages up to a maximum of 15 volts, whilst the "BE" type has a maximum voltage rating of 20 volts. If an "AE" i.c. is employed in the circuit for IC2, diodes D3 and D4 permit safe operation up to 16.2 volts, and this should be adequate when the unit is used to monitor the voltage of a 12 volt car battery. With a "BE" i.c. the two diodes are not necessary and the positive supply may be fed directly to the remainder of the circuit, as illustrated in Fig. 2. The two diodes are also not necessary if the unit is intended to monitor the voltage of a dry battery having a nominal voltage in the range of 9 to 12 volts, and in this last application IC2 may be either "AE" or "BE". Most CD4011's available at present should be "BE" types, but it is necessary to check this point when employing the monitor with a car battery. The suffix letters are normally marked on the case of the device.

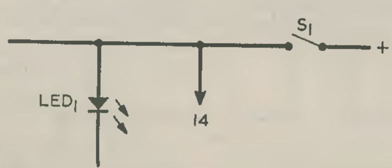


Fig. 2. In some instances the two voltage-dropping diodes, D3 and D4, are not required, and the positive input is applied direct to the main positive rail

The current drawn from a 12 volt supply is about 7mA when the green l.e.d. is lit, rising to an average of about 15mA when the red l.e.d. is flashing. These currents are negligibly low when the monitor is connected to a car battery, but it is still desirable to have an on-off switch available. This is because a continually flashing red l.e.d. could in some circumstances prove distracting to the driver. The currents drawn by the monitor are of a significant level when it is connected to a dry battery, and it need only be switched on when it is desired to check battery voltage.

VR1 is set up by connecting the unit to a source of voltage corresponding to the minimum level that the monitored battery should have. With a 12 volt car battery this could be, say, 10.5 volts and with a 9 volt dry battery it could be 7.5 volts. These setting-up voltages can be provided by a variable voltage power supply or by an appropriate number of 1.5 volt dry cells. VR1 is then adjusted to the point at which the green l.e.d. just extinguishes, giving way to the flashing red l.e.d. No further adjustment is necessary. The monitor can be adjusted for minimim voltages down to 6 volts.

The speed of flashing may be varied by changing the value of C1. Reducing its value to 0.22μF will, for instance, increase the flashing rate to about 2Hz.

When used in a car, all the components should be fully enclosed in a plastic case with the switch and the two l.e.d.'s mounted on the front panel. Having the circuit completely insulated in this manner ensures that it can be safely connected to either a positive or a negative earth electrical system. The plastic case may be positioned at any convenient point on or near the car dashboard. ■

C.S.C. APPOINT SOUTHERN AREA DISTRIBUTORS

With effect from 1st May, Lawtronics Ltd., of 139 High Street, Edenbridge, Kent, have been appointed southern area distributors for Continental Specialists Corporation range of instruments and breadboarding equipment.

In keeping with the Lawtronics policy of offering cost effective portable test instruments, the C.S.C. range includes hand held frequency counters up to 550MHz as well as small mains powered function generators and pulse generators.

Stocks of the established C.S.C. products, i.e. logic probes and solderless breadboards, will be available for both the professional and hobby market.

This new franchise and the increased ranges from N.L.S. and Lawtronics extends the number of portable test instruments to 46, plus over 120 various digital panel meters from N.L.S.

MAINS TOUCH SWITCH

By A. P. Roberts

Active switching on and off of 240 volt a.c. loads up to 1 amp.

A large number of touch switch designs have been published in recent years, and these have mainly been for the control of small d.c. loads. Such designs can be made to operate a mains powered a.c. load via a relay, but this nullifies one of the main advantages of touch switch operation: the absence of moving parts which can wear out, and the consequent high reliability.

It is possible to produce a simple mains touch switch having no mechanical switching of any kind by using a thyristor or triac as the switching element in the circuit, and employing an opto-isolator device to isolate the touch contacts (and hence also the operator) from the mains supply.

A simple design of this nature forms the subject of the present article. It has three touch contacts which are mounted close together in a line. Touching the centre contact and one of the outer contacts causes the load to be switched on, while touching the centre contact and the other outer contact results in the load being switched off again. The unit can handle load currents of up to 1 amp or, in other words, loads of up to 240 watts, with the standard U.K. mains voltage of 240 volts.

THE CIRCUIT

The complete circuit of the mains touch switch is shown in Fig. 1. This breaks down into three main

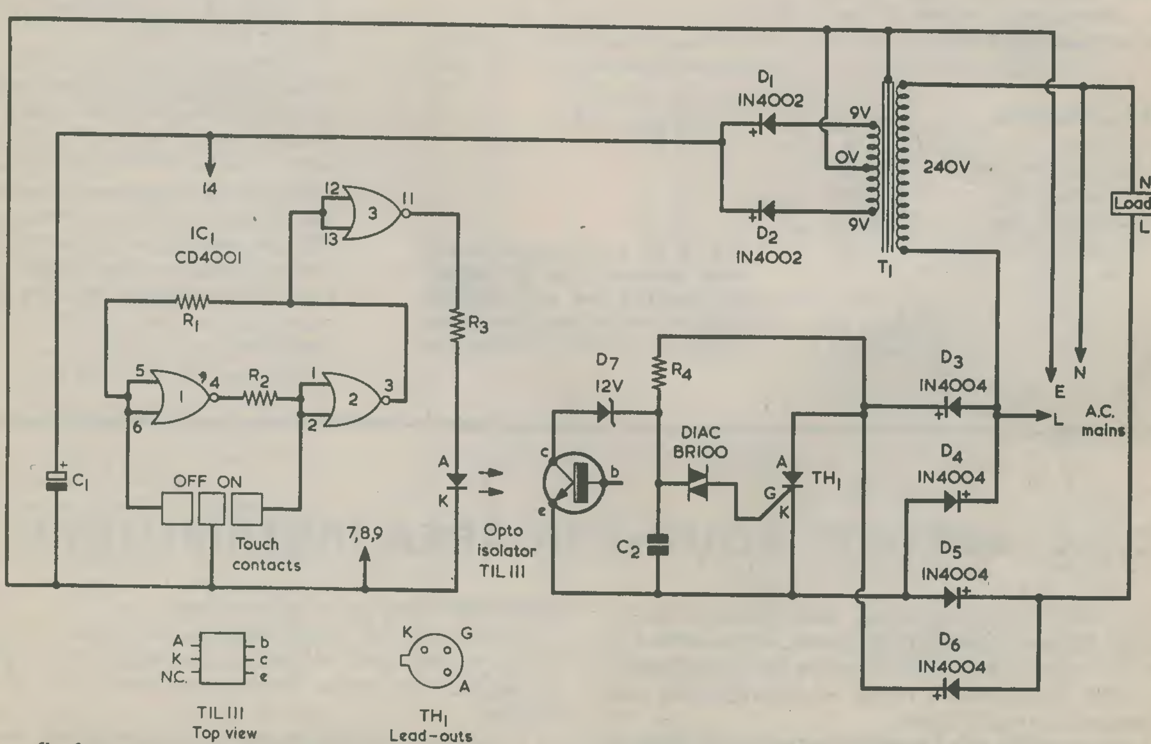
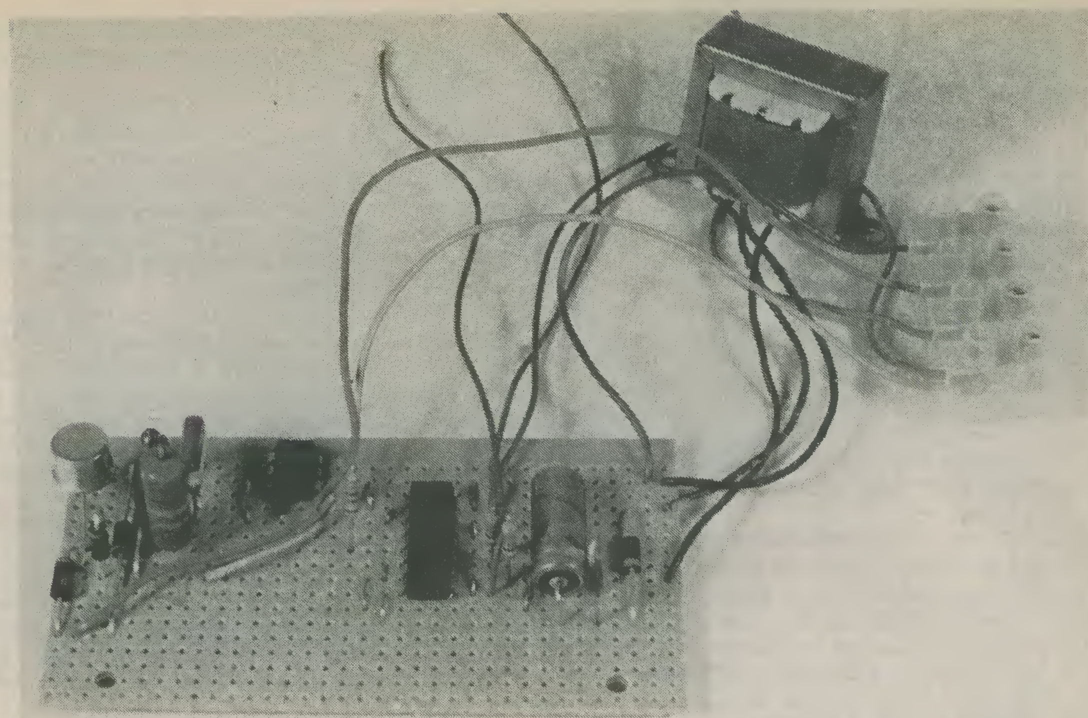


fig 1

The circuit of the mains touch switch. The load is turned on when the centre and right hand contacts are bridged by a finger, and is turned off when the centre and left hand contacts are touched



The complete assembly of mains transformer, Veroboard panel and 4-way terminal block

sections, a bistable control circuit coupled to the touch contacts, a mains power supply for the bistable, and a mains switching circuit controlling the load.

The bistable employs two of the gates in a CMOS CD4001 quad 2-input NOR gate. These are shown in Fig. 1 as Gates 1 and 2, and they each have their two inputs connected together so that they operate as inverters. Cross-coupling between the inputs and outputs is provided by R1 and R2.

When the circuit is first switched on the inputs of both Gate 1 and Gate 2 will obviously be in the low state. The outputs will therefore start to go high. However, the gates will not have identical switching speeds, and one output will go high faster than the other. There is no way of predicting which gate will have the faster operating speed, but for the sake of this explanation we will assume that it is Gate 1.

As Gate 1 output goes high it takes Gate 2 inputs high due to the coupling through R2. Gate 2 output goes low, and this low voltage state is passed to the inputs of Gate 1 by way of R1.

The circuit remains stable in this state. An alternative stable state is given when Gate 2 output and Gate 1 inputs are high, with Gate 1 output and Gate 2 inputs being low. The term "bistable" derives from the fact that the circuit has only these two stable states.

Following our assumption, Gate 1 output and the inputs of Gate 2 are high. The circuit can be changed to the alternative state by applying a finger to the "On" touch contacts. Although the skin resistance between the two contacts may be high, even up to the level of a megohm or so, this will still be much lower than the value of R2, and the inputs of Gate 2 will be taken low. Gate 2 output then goes high, causing Gate 1 output to be low. The circuit

COMPONENTS

Resistors
(All $\frac{1}{4}$ watt 5% unless otherwise stated)
R1 10MΩ, 10%
R2 10MΩ, 10%
R3 680 Ω
R4 82k Ω, 1 watt

Capacitors
C1 100μF electrolytic, 25 V.Wkg
C2 0.1μF type C280

Transformers
T1 Mains transformer, secondary 9-0-9 V at 60mA or more

Semiconductors
IC1 CD4001
TH1 thyristor, 400V at 1A (see text)
Diac BR100 or equivalent
Opto-Isolator TIL 111 or equivalent
D1 1N4002
D2 1N4002
D3 1N4004
D4 1N4004
D5 1N4004
D6 1N4004
D7 BZY88C12V

Miscellaneous
Veroboard, 0.1in. matrix
4-way terminal block (see text)
Materials for touch contacts (see text)
Mains wire, connecting wire, etc.

will therefore remain in this state when the finger is removed from the touch contacts. In practice, the "On" contacts need to be touched only momentarily to achieve the change in bistable state.

To return the bistable to the previous state, the finger is applied to the "Off" touch contacts. This takes the inputs of Gate 1 low and the output of Gate 1 high.

The output of Gate 2 is used to drive a light-emitting diode by way of a third gate in the CD4001. This gate also has its inputs connected together and it functions as an inverting buffer stage. When the output of Gate 3 is high it causes the l.e.d. to be illuminated by way of current limiting resistor R3. When the output of Gate 2 is high, as occurs after touching the "On" contacts, the output of Gate 3 is low. In consequence, bridging the "On" touch contacts causes the l.e.d. to be unlit. Touching the "Off" contacts results in the l.e.d. being turned on.

The l.e.d. is not a discrete device but, in company with the transistor, it forms an opto-isolator. The two are encapsulated in a single light-proof housing with the illumination from the l.e.d. falling on the transistor. The latter is photosensitive and exhibits a low resistance between its emitter and collector when it is illuminated, and a very high resistance when it is not. The advantage afforded by an opto-isolator of this type is that the l.e.d. and the transistor are completely insulated from each other.

The bistable and l.e.d. circuit are powered by the very simple mains supply consisting of transformer T1, full-wave rectifier D1 and D2, and reservoir capacitor C1. The direct voltage across C1 is approximately 12 volts. The unused gate in the CD4001 has its inputs (pins 8 and 9) connected to the negative rail. No connection is made to its output at pin 10. The presence of transformer T1 ensures that there is no direct connection between the bistable and l.e.d. circuitry and the mains supply.

MAINS SWITCHING

The transistor in the opto-isolator cannot, of course, control a mains load directly. Instead, it controls a thyristor which appears in a conventional lamp dimmer type of circuit which is pre-set for maximum output. We shall next consider its operation when the transistor in the opto-isolator exhibits a very high resistance (as it does after the "On" contacts have been touched).

D3 to D6 form a bridge rectifier in series with the live mains feed to the load, and they cause succeeding a.c. half-cycles to be passed to the anode and cathode of the thyristor, TH1, such that the anode is always taken positive and the cathode is always taken negative. At the start of any half-cycle the voltage across the thyristor will be zero, and the thyristor will be turned off. As the half-cycle proceeds, the voltage across the thyristor rapidly increases, as also does the voltage applied to R4 and C2. The values of R4 and C2 are chosen so that the voltage across C2 lags only slightly behind that across the thyristor. At an early instant in the half-cycle the voltage across C2 will be of the order of 32 volts, whereupon the diac will trigger and present a low resistance, resulting in C2 discharging into the gate and cathode of the thyristor. The thyristor at once turns on, switching on the load by way of two of the diodes in the bridge rectifier. The thyristor remains conductive until the end of the half-cycle, when the voltage across it falls to zero. The whole process then repeats at the start of the next half-cycle.

The circuit incurs some losses in the power applied to the load: there are small forward voltage drops across the thyristor and the conducting diodes in the bridge rectifier; also, the thyristor does not switch on at the very beginning of each half-cycle. However, these combined losses are minimal and, for all practical purposes, can be considered insignificant.

In the explanation just given, the transistor in the opto-isolator has not affected circuit operation because it has exhibited a high resistance. If the "Off" touch contacts are now bridged by a finger the opto-isolator l.e.d. turns on and the transistor exhibits a low resistance between its collector and emitter. In this state it prevents the voltage across C2 from reaching the level needed to trigger the diac and thereby turn on the thyristor. The thyristor simply remains non-conductive during the a.c. half-cycles and the load is turned off.

Thus, touching the "On" contacts turns off the opto-isolator l.e.d. and transistor, but causes the load to be turned on. Bridging the "Off" contacts turns on the l.e.d. and transistor, thereby switching off the load.

The 12 volt zener diode in series with the collector of the opto-isolator transistor plays no significant part in circuit operation, and the circuit will in fact function if the zener diode is short-circuited and the transistor collector connected direct to the diac. However, the transistor has an absolute maximum VCE0 rating of 30 volts, whereas the diac triggering voltage is 32 plus or minus 4 volts. A direct connection between collector and diac could therefore cause the transistor voltage rating to be exceeded. The zener diode merely ensures that this cannot happen.

The components required in the circuit require a few comments. A suitable equivalent for the TIL 111 is the 6-pin d.i.l. opto-isolator listed by Maplin Electronic Supplies. The mains transformer can be the sub-miniature component offering 9-0-9 volts at 67mA which is also available from Maplin. The thyristor should be a 400 volt 1 amp type in a T039 case, such as the THY1A/400 retailed by Bi-Pak Semiconductors.

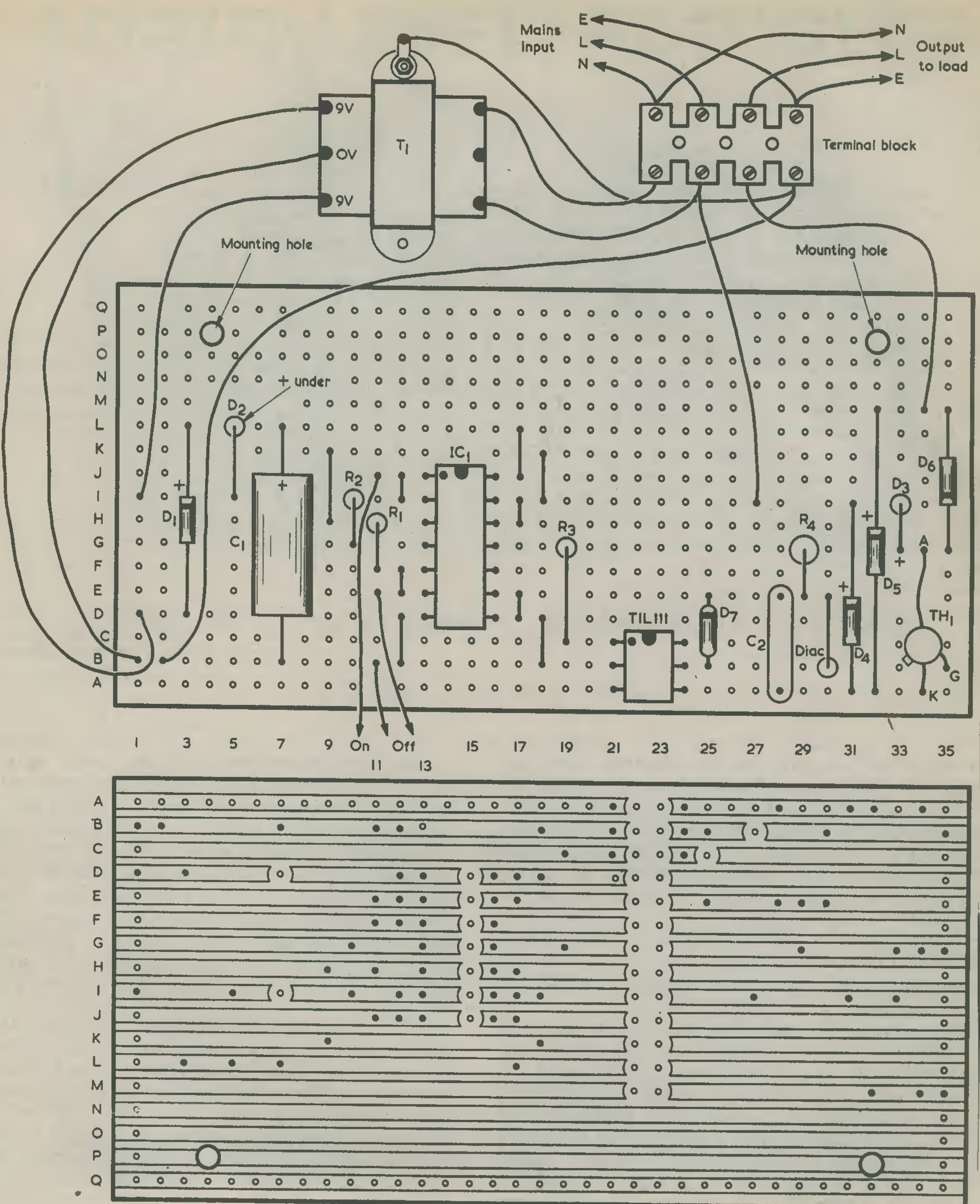
In the diagrams, the letter "K" is employed to indicate "cathode" instead of the more usual "C". This prevents confusion with the letter "C", for "collector", at the appropriate terminal of the opto-isolator.

CONSTRUCTION

The mechanical construction of the touch switch depends upon the application for which it is to be used. In some instances it could be assembled in a case on its own and connected in the mains lead to the controlled item of electrical equipment. In other applications it could be built into the controlled equipment itself.

In either case the electrical construction can be as shown in Fig. 2. Apart from the mains transformer and a terminal block all the components are wired up on a 0.1in. Veroboard having 17 copper strips by 35 holes.

First cut out a board of the required size and then drill out the mounting holes with a 3.2mm. twist drill to take M3 or 6BA bolts. Next, make the 24 breaks in the copper strips. Note that the 13



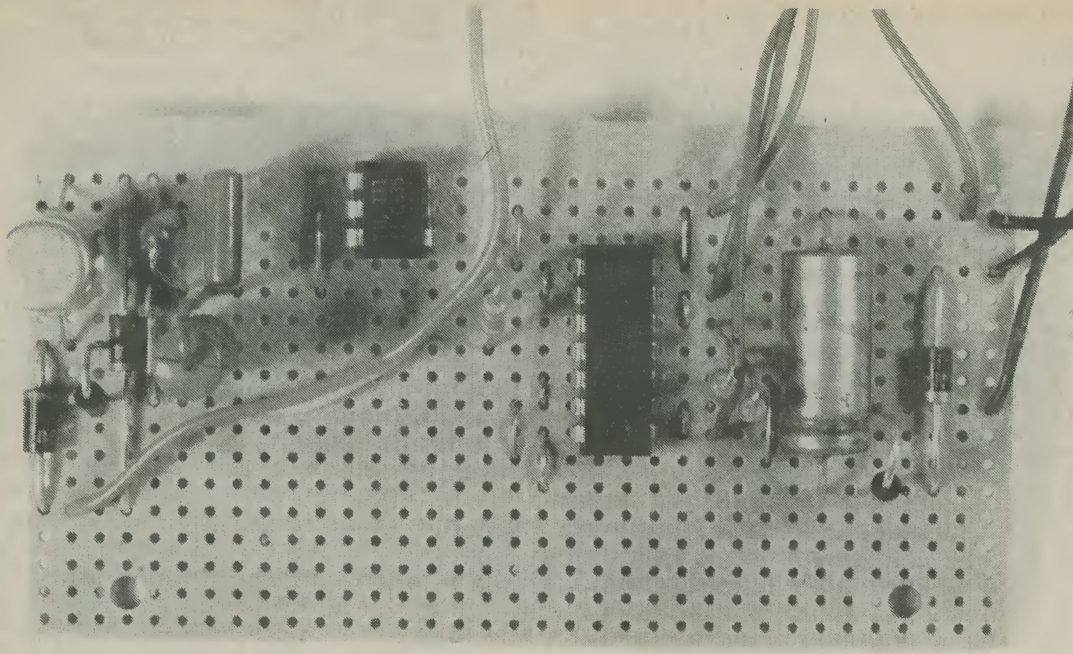
Wiring up the touch switch components on the Veroboard panel

breaks which isolate the touch button section of the circuit from the mains wiring are two holes wide. Any copper between the two holes in each strip may be removed by means of a sharp knife. The components and link wires are soldered to the board, including the flying leads to T1 secondary, the 4-way terminal block and the touch contacts, with IC1 being fitted after all other soldering has been completed. IC1 is a CMOS device and it should be left in its protective packing until it is required, and it must be soldered to the board by means of an iron having a reliably earthed bit.

The diac can be connected either way round.

Finally, the primary of T1 and the 4-way terminal block are connected into circuit. The terminal block is cut from a 12-way screw terminal strip of the type which is intended for 5 amp mains circuits.

With a little ingenuity it should not be difficult to fabricate the touch contacts. They should be made of a metal which does not oxidise readily and could, for instance, consist of the heads of panel-headed chrome-plated screws mounted on a piece of insulating material.



The components on the Veroboard panel. Zener diode D7 was added after this photograph was taken

It is most important to ensure that all precautions against accidental shock are observed. The switch components and wiring should not be accessible without the removal of a cover secured with screws; a lid which merely clips into position is not adequate. All accessible metalwork, apart from the two outside touch contacts, must be reliably connected to the mains earth. This earth connection must be taken over to the bistable and its power supply, as shown in Figs. 1 and 2. It is not recommended that the touch switch be employed in any significantly damp location.

Before initially connecting to the mains check that there is full isolation between the control and mains sections of the circuit by means of an ohmmeter set to a high ohms range. It is also advisable to check for accidental short-circuits between copper strips and to ensure that there are no wiring mistakes. Remember that the wiring around the thyristor and the diac, etc., is connected direct to the mains and must not be touched when the mains is applied.

The prototype works reliably with very inefficient touch contacts. When the mains is first applied the bistable may take up either the "On" state or the "Off" state, but subsequent control is entirely by means of the touch contacts. Simple thyristor circuits of the type used here can generate noticeable levels of r.f. interference, but the amount of interference produced by the prototype was quite insignificant. This is because the thyristor is triggered on very early in the a.c. half-cycle, when the mains voltage is at a comparatively low level.

It is likely that the switch will be left connected continuously to the mains, but the extra current it consumes is virtually negligible. It is desirable to employ a good quality component for T1, as an inferior transformer may tend to overheat even though it is used well within its specified voltages and currents. An inexpensive transformer can be kept cooler, incidentally, if it is mounted on a metal case or metal chassis, which will act as a heatsink. ■

LOGIC LEVEL AUDIBLE ALARM

Wonderboard T.T.L. Project

It is frequently necessary to provide an audible alarm in digital systems, and this usually requires interfacing the digital logic circuit with an analog amplifier-oscillator. The circuit presented here uses a t.t.l. i.c. to directly drive a speaker.

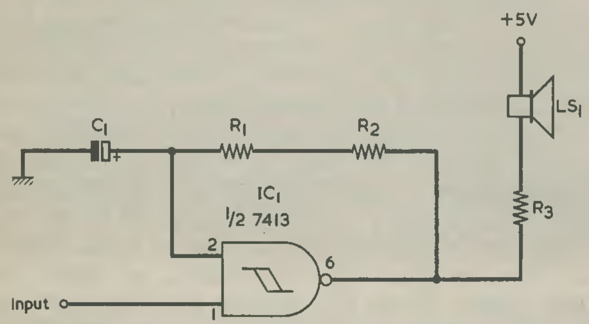


Fig. 1. The circuit of the logic level alarm

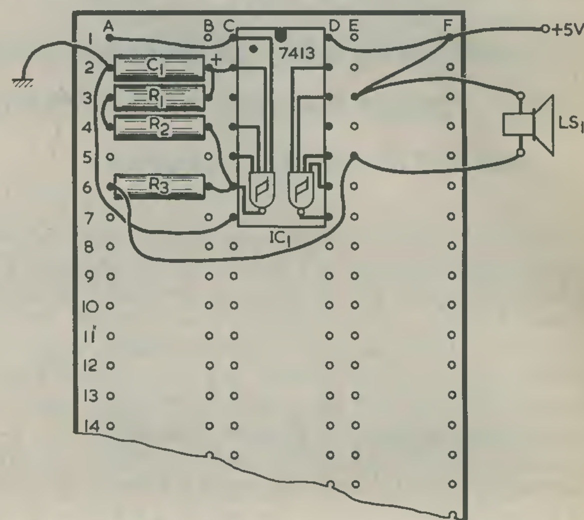


Fig. 2. The components are assembled at one end of a Wonderboard

The circuit employs a Schmitt trigger connected as an oscillator. This produces low frequency logic pulses which drive a miniature speaker. A logic 1 at the input turns on the alarm. The frequency of the sound produced in the speaker can be varied by fitting different values of resistance in the R1 position, these ranging from zero (a piece of wire) to 500 Ω .

COMPONENTS

Resistors
(All 10%)
R1 see text
R2 47 Ω ¼ watt
R3 100 Ω ½ watt

Capacitor
C1 4.7 or 5μF electrolytic, 10 V. Wkg.

Integrated Circuit
ICI 7413

Speaker
LS1 15 Ω miniature

Circuit Board
Orcus Wonderboard

TABLE

Wire Links	
1A-1C	4B-6C
1D-1F	6B-6C
2B-2C	6A-5E
2B-3B	1F-3E
3A-4A	2A-7C

ASSEMBLY

Insert the 7413 i.c. in the Wonderboard with pin 1 at hole 1C. Fit C1 between 2A and 2B, R1 between 3A and 3B, R2 between 4A and 4B, and R3 between 6A and 6B. Add the wire links under the board which are shown in the Table.

Connect the speaker between 3E and 5E, apply 5 volts positive to 1F and connect 2A to ground. The input is connected to hole 1A and the alarm is then all set to operate. ■

DOUBLE DECCERS

A SPECIAL SERIES FEATURING S-DeCs

No. 8

By Ian Sinclair

SLEEPER-BLEEPER

Three astables produce a series of bleeps with frequencies and timing adjustable by choice of components

Circuits which give various sound outputs are common enough and are the delight of school electronics clubs, but this is rather an unusual one which gives several short bleeps, then stops before repeating. It makes a useful paging signal or even a useful sound effect (where are you, R2D2?) and several circuits can be built of which no two will give the same pattern of tone or bleeps.

Basically, the circuit consists of three astable multivibrators and an output stage, and it is easier to describe the action of the circuit if we look at the astables in reverse order, output first.

OUTPUT ASTABLE

TR5 and TR6 are connected as an astable with a considerably shorter time constant than the other two. The component values chosen give a frequency of around 2kHz, with the unusual feature that a single resistor charges the two cross-coupling capacitors, with the diode D2 providing isolation. The diode also limits the amplitude of the wave at the base of TR6, and has an effect on the frequency, which is higher than that of an astable using separate base resistors. By using different values for C5 and C6 we can change the note produced by this astable, but R9 should not be changed to any large extent.

TR5 and TR6 will therefore produce a bleep tone, but only when point 21 on DeC 2 is returned to a positive voltage via R9. Bleeps are produced by coupling R9 to the collector of TR4. TR3 and TR4 form another astable which runs at a much lower frequency because the cross-coupling capacitors are 10μF. When the collector current of TR4 is cut off, current flows through R8 into R9, so activating the tone oscillator. When TR4 is turned on, the voltage at its collector is too low to allow current to flow to the tone oscillator, so that the note stops. Diode D2 ensures that the tone oscillator does shut off under these conditions because of the need to have at least 0.6 volt across the base-emitter junction of a conducting silicon transistor. If a conventional two-resistor circuit is employed for TR5 and TR6, shut-off is not reliable because the oscillations tend to be self sustaining.

The bleep-producing astable incorporating TR3 and TR4 is itself not allowed to run continuously. The bases of these transistors are returned, through separate resistors this time, to the collector of TR2 which is half of yet another astable. Diode D1 is a catching diode and prevents the base of TR4 being driven more than about 0.6 volt negative of its emitter. This again is necessary to ensure reliable switching on and off.

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 1.8kΩ
R2 56kΩ
R3 56kΩ
R4 1.8kΩ
R5 56kΩ
R6 56kΩ
R7 1.8kΩ
R8 1.8kΩ
R9 56kΩ
R10 4.7kΩ
R11 4.7kΩ
R12 12kΩ

Capacitors
C1 100μF electrolytic, 16V. Wkg.
C2 100μF electrolytic, 16V. Wkg.
C3 10μF electrolytic, 16V. Wkg.
C4 10μF electrolytic, 16V. Wkg.
C5 0.01μF polyester or mylar
C6 0.01μF polyester or mylar

Semiconductors
TR1-TR7 2N697 or 2N2219 or BFY50
D1, D2 1N914 or 1N4148

Loudspeaker
LS1 60Ω to 80 Ω (see text)

Miscellaneous
2-off S-DeC
6V battery

TR1 and TR2 are in the third astable, which oscillates very slowly because of the 100μF cross-coupling capacitors. This oscillator operates continuously because the transistor bases are returned to the positive supply through the 56k Ω resistors, R2 and R3. When TR2 is cut off, current flows through R4 into R5 and R6 to operate the bleep astable. When TR2 is bottomed the voltage at point 7 of DeC 1 is too low to feed current into the bases of TR3 and TR4, so that the bleeps stop.

Looking now at the other end of the circuit, TR7 is a loudspeaker driver. R12 limits the amount of signal drive fed to the base of TR7, this transistor being turned on when TR6 cuts off, and turned off when TR6 is turned on. The loudspeaker should preferably be a high resistance type of 60 Ω to 80 Ω impedance. Lower impedance speakers, down to 15 Ω, may also be used without damage to the transistor.

Variations in the tone of the bleep have already been discussed. The number of bleeps in each cycle can be altered by changing the frequency of the bleep astable around TR3 and TR4. This is best done by changing the values of capacitors C3 and C4 rather than by changing the values of R5 and R6.

Finally, the time between bursts of bleeping can be altered by changing the time constants at TR1 and TR2. Here, the values of resistors R2 and R3 can be changed provided that values less than 22k Ω or greater than 100k Ω are not used. Very long times may be impossible to obtain because of leakage current through the electrolytic capacitors, but values of 1,000μF for C1 and C2 were used along with 56k Ω resistors in the prototype and gave excellent results.

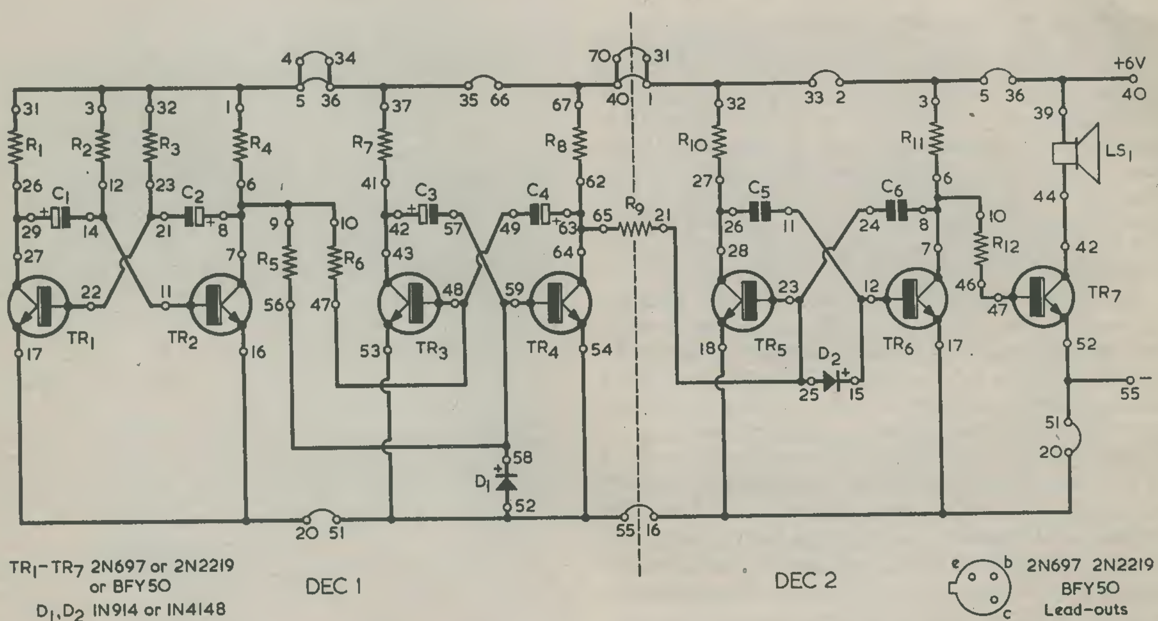
CONSTRUCTION

Clip the two S-DeCs together to form one long DeC, and plug in the wire links which join the circuit sections together. Now connect the loudspeaker, using single core wire. If stranded wire is used (because of an existing flex) then the wire ends should be twisted tightly and soldered to prevent strands from breaking off inside the DeC. Plug in R9, which links the two DeCs by taking signals from DeC 1 to DeC 2.

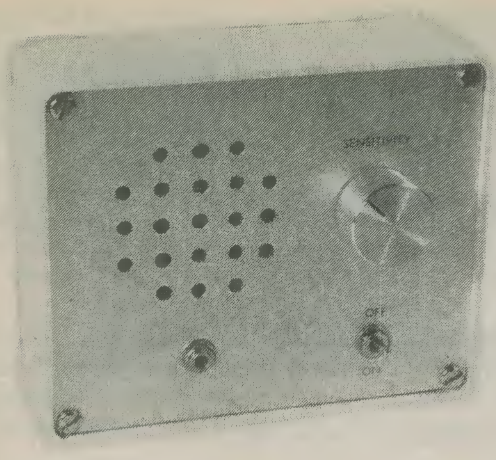
Insert the capacitors, noting that C1, C2, C3 and C4 are electrolytic types for which correct polarity must be observed. The diodes are then plugged into place, also noting polarity. If the completed circuit gives a continuous tone or none at all, the polarity of the diodes should be suspected.

The transistors are all n.p.n. types with the same lead-out layout and they can now be inserted into their places in the DeCs, making sure that the emitter and collector leads are not reversed in this symmetrical layout. Some care is needed in building astable circuits of this type where the transistors are "back-to-back," being placed with their emitter leads on a central line with one collector on a lower numbered line and the other on a higher numbered line, because one transistor is "upside-down" compared with its neighbour. No problems should arise if the diagram is faithfully followed, however.

The remaining resistors can now be plugged into place. Next add a pair of single core wires to the 6 volt battery and your Sleeper-Bleeper is ready to sing for you. ■



The Sleeper-Bleeper, which produces a series of bleeps at timed intervals. The bleep audio and repetition frequencies, together with interval timing, may all be varied by altering component values in the three astable oscillators



AUDIO CO
TESTER

SIGNALS CONTIN
RESPONDS ONLY TO D

When a continuity tester is required it is common practice to use a multimeter switched to a low ohms range. However, this is far from ideal as the indication of continuity is visual, making it necessary to continually look back and forth between the test prods and the meter. The procedure is inconvenient, to say the least, particularly when the test points are awkwardly placed or when there are a large number of tests to be made.

A continuity tester which provides an audible indication of continuity is much more convenient, and in its simplest form could consist of an audio oscillator coupled to a speaker or earphone, with the test leads inserted in one of the oscillator supply lines. Unfortunately, an arrangement of this nature is not capable of discerning between a fairly low resistance and a direct connection, and in many instances the oscillator will give an indication of continuity where, in fact, there is a resistance of several hundred ohms between the test prods. A performance of this nature can lead to misleading and confusing results.

A better approach is to have the audio oscillator controlled by a discriminator circuit which will only switch on the oscillator when the resistance between the test prods is a few ohms or less. It is a simple instrument of this type which is described here.

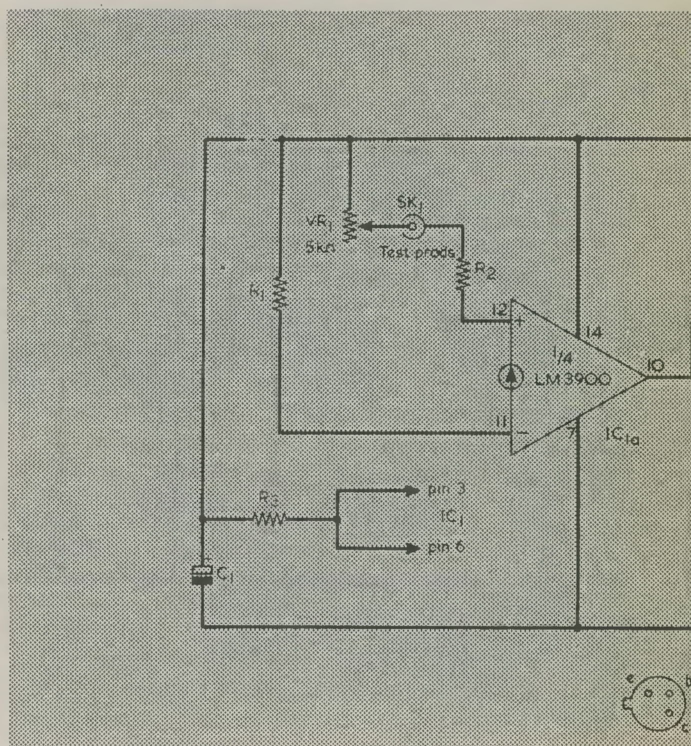


Fig. 2. The circuit of the audio continuity test
LM3900 are used, one as a current co

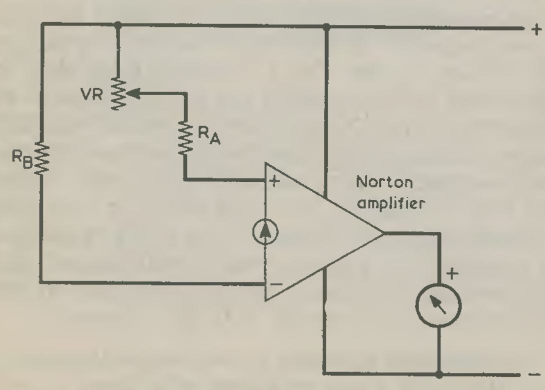


Fig. 1. A Norton amplifier employed as a current comparator

CURRENT COMPARATOR

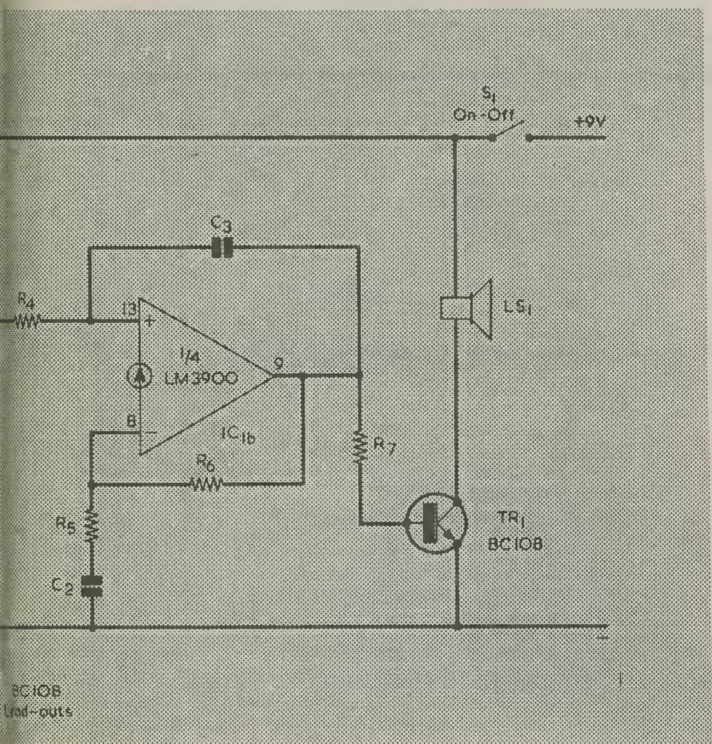
The unit employs two Norton amplifiers in a single i.c., one functioning as a current discriminator and the other as an audio oscillator. A Norton amplifier is in many ways similar to an ordinary operational amplifier, with the major difference that it amplifies the difference between two input currents rather than two input voltages.

The discriminator part of the circuit is shown in Fig. 1., it being assumed that the amplifier output is monitored by a voltmeter. A steady reference current passes from the positive supply through RB to the inverting input of the amplifier. A second current flows through VR and RA to the non-inverting input. RA is lower in value than RB, whilst the total value of RA and VR is greater than RB.

NTINUITY

By I. M. Attrill

ITY BY AUDIBLE TONE
RECT TEST CONNECTIONS



er.Two of the amplifiers in a quad Norton i.c. type nparator and the other as an a.f. oscillator

If VR is adjusted to insert zero resistance into circuit, a greater current will flow into the non-inverting input than into the inverting input and the amplifier output will go positive, as indicated by the voltmeter. VR may then be gradually adjusted to present a continually increasing resistance. The current flowing into the non-inverting input will fall until it becomes slightly less than that flowing into the inverting input, whereupon the amplifier output will swing negative. It will remain negative as the current flowing into the non-inverting input reduces further.

There will be a range of resistance in VR corresponding to about exactly equal currents at the inputs, at which the amplifier output will be between the positive and negative states. However, due to the high gain in the amplifier this range of resistance will be very small and difficult to resolve. The general effect given as VR is adjusted will be a quick output swing from positive to negative as the potentiometer reaches and passes the equal current setting. The amplifier output will swing positive again if the potentiometer is adjusted to insert reducing resistance and once more passes the equal current position.

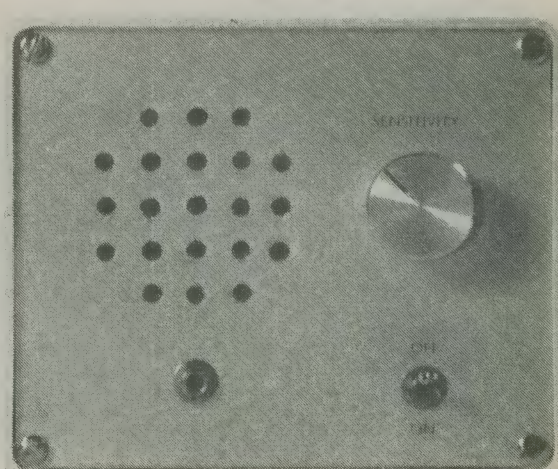
In the full continuity tester circuit, the test prods are inserted in series with VR and RA. VR is adjusted to the maximum resistance which allows the amplifier output to be positive with the test prods short-circuited together. If a significant resistance of even just a few ohms is presented to the test prods the current at the non-inverting input will be below that at the inverting input and the amplifier output will be negative. The amplifier output is connected, not to a voltmeter as in Fig. 1., but to the audio oscillator, and it turns the oscillator on when it goes positive. Thus, the presence of continuity between the test prods is indicated by an audible output from the oscillator.

COMPLETE CIRCUIT

The full circuit of the continuity tester is given in Fig. 2. The two amplifiers here are both contained within the same i.c., an LM3900. The LM3900 has four amplifiers, but the remaining two are not employed. A small bias current is fed to their inverting inputs via R3 in order to slightly reduce their current consumption, and no other connections are made to them.

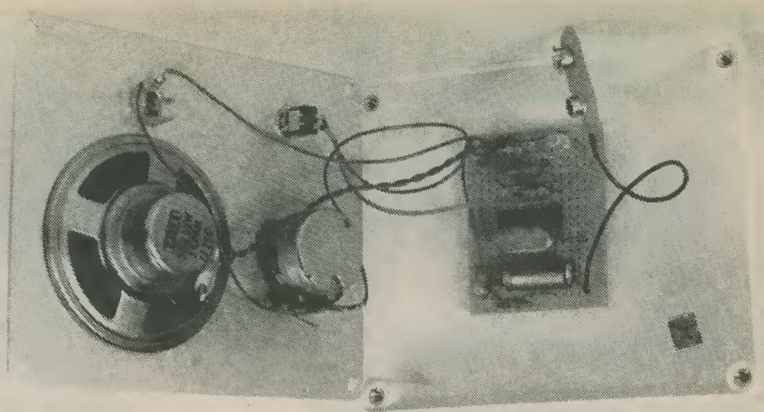
IC1(a) is the current comparator, and its operation has already been discussed. The values specified for R1, R2 and VR1 result in a current of about 4mA flowing into each comparator input. If VR1 is carefully set up, the circuit will not respond to resistances of more than about 2 or 3 ohms across the test prods. These are connected into the circuit at jack socket SK1.

IC1(b) is the oscillator amplifier. A negative feedback loop from the output to the inverting input is given by R6 and R5, and these set the voltage gain at about three times. C2 provides a bypass at a.f. without preventing d.c. flowing into



Front panel of this useful item of test equipment. The speaker is to the left, with the jack socket for the test prods below it. To the right are the sensitivity control and the on-off switch

The Veroboard assembly is secured to the rear panel of the case, connecting to the front panel components by means of flexible wiring



COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
- R1 2.2kΩ
- R2 1.5kΩ
- R3 820kΩ
- R4 68kΩ
- R5 18kΩ
- R6 33kΩ
- R7 8.2kΩ
- VR1 5kΩ potentiometer, log

Capacitors
- C1 100μF electrolytic, 10V. Wkg.
- C2 0.22μF type C280
- C3 0.1μF type C280

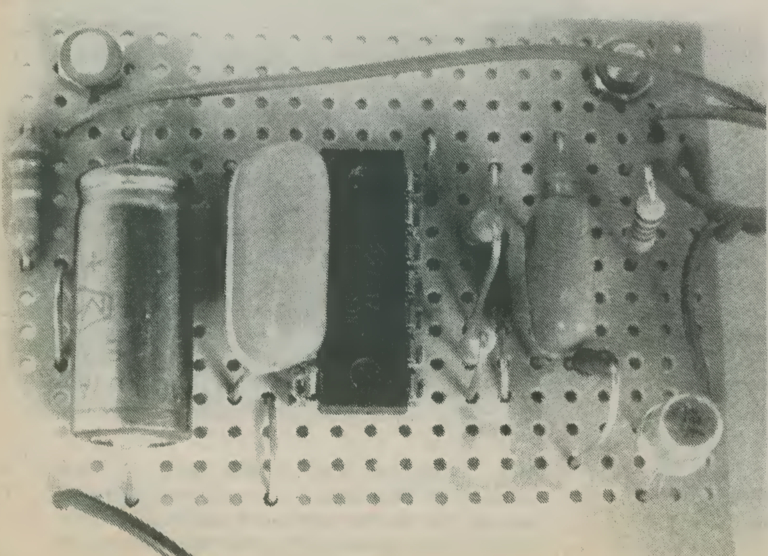
Semiconductors
- IC1 LM3900
- TR1 BC108

Switch
- S1 s.p.s.t., miniature toggle

Speaker
- LS1 miniature speaker, 50Ω or more

Socket
- SK1 3.5mm. jack socket

Miscellaneous
- Case (see text)
- 9-volt battery (see text)
- Battery connector
- 3.5mm. jack plug
- 2 test prods and leads
- Control knob
- Veroboard, 0.1in. matrix
- Nuts, bolts, wire, etc.



Wiring is considerably simplified by the use of a Veroboard panel. This is shown here in close-up

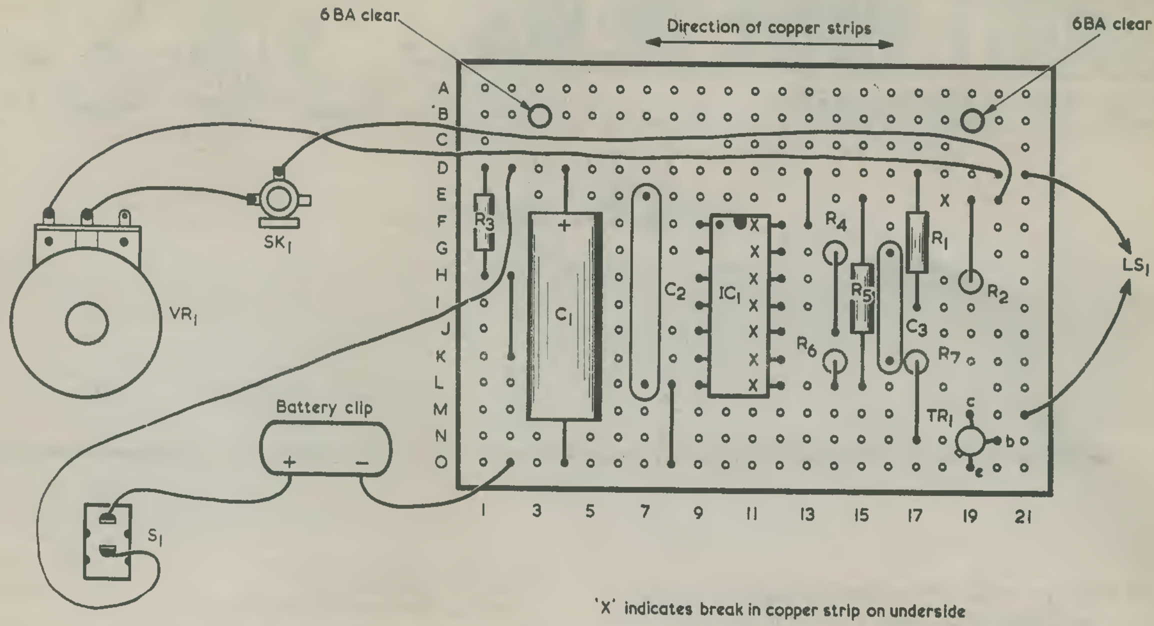


Fig. 3. Component layout on the Veroboard module. Also shown here is the wiring to the remaining components

the inverting input. Positive feedback to the non-inverting input is provided by C3 and, with the component values specified, the amplifier oscillates at a frequency slightly in excess of 1kHz.

The non-inverting input is biased by R4, which is returned to the output of IC1(a). When IC1(a) output is high IC1(b) oscillates, and when IC1(a) output is low oscillation ceases. The output of IC1(b) also goes low. The oscillator output is coupled via R7 to the base of transistor TR1, and this transistor drives the speaker in its collector circuit.

S1 is the on-off switch and is needed because, unlike many continuity testers, this design consumes a current from the battery when a continuity indication is not being given. C1 is the supply decoupling capacitor. The current drawn from the 9 volt battery is approximately 10mA with the test prods open-circuit, and approximately 30mA when they are short-circuited together.

CONSTRUCTION

The continuity tester may be housed in any small case capable of taking the components and the 9-volt battery to be used. The prototype, which uses a PP3 battery, is housed in a plastic case with aluminium front panel having approximate outside dimensions of 120 by 100 by 43mm. If the continuity tester is to be used extensively, it will be desirable to employ a larger battery, such as the PP6, whereupon a larger case will be required. The speaker is a miniature type with an impedance of 50Ω or more. A speaker with an impedance of less than 50Ω should not be used.

The front panel layout for the prototype can be seen in the photographs. The speaker is mounted behind a grid of twenty-one 4mm. diameter holes drilled in a symmetrical pattern. It is glued in place using a high quality adhesive, care being taken to ensure that none of the adhesive becomes applied to the speaker diaphragm. Jack socket SK1 is below the speaker. to the right of the speaker is mounted VR1, with S1 below it.

The remaining components are assembled, as shown in Fig. 3, on a piece of 0.1in. Veroboard having 21 holes by 15 copper strips. This board is secured to the rear panel of the case by two 6BA bolts and nuts, with spacing washers on the bolts to keep the underside of the board clear of the inside surface of the case. Connection to the front panel components is made by flexible wires which are just long enough to allow the case to be disassembled with the panel laid alongside the case body.

ADJUSTMENT

After the continuity tester has been completed, the battery and test prods may be connected and VR1 set to a fully anti-clockwise position. The unit is then switched on, and it should produce an audible tone when the test prods are connected together. If there is no tone, switch off at once and check for wiring errors.

When all is well, VR1 can be set up. It is simply adjusted, with the test prods short-circuited together, to the most clockwise position which does not cause oscillation to cease. It may very occasionally be necessary to readjust VR1 in order to maintain the tester at maximum sensitivity. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

● **EGYPT**
Cairo on **17670** at 1423, OM with station identification followed by a programme of Arabic-type music. This is the Domestic Service which operates here from 1300 through to 1830.

● **CZECHOSLOVAKIA**
Prague on **17775** at 0917, OM with a talk about local affairs in the English programme directed to Africa, the Far East, South Asia and the Pacific area, scheduled on this channel from 0830 to 0900 (to 0930 on Saturday and Sunday).

● **FINLAND**
Helsinki on **21495** at 0935, OM with a newscast mostly about local affairs in the English programme for Europe, North Africa, the Far East and Australia, scheduled from 0930 to 1030.

● **ROMANIA**
Bucharest on **17805** at 0705, OM and YL announcers with the Dx programme "Listeners Club" in the English programme for the Pacific area, scheduled here from 0645 to 0715.

● **VENEZUELA**
"Radio Bolivar", Ciudad Bolivar, on **4770** at 0353, local-style dance music, YL with songs in Spanish. The schedule is from 1000 to 0300 (Saturday and Sundays until 0400) and the power is 1kW.
"Radio Universidad", Merida, on **3395** at 0409, OM with a newscast in Spanish. The schedule is from 1000 to 0400 (weekends until 0500) and the power is 1kW.

● **AUSTRALIA**
Melbourne on **11870** at 1520, OM with U.K. pop records in the English programme to the Asia and Pacific areas (announced).

● **NORWAY**
Oslo on **17840** at 1404, OM with news of local affairs in the English programme 'Norway this Week', scheduled for Sundays only from 1400 to 1430.

● **VATICAN**
Vatican City on **17825** at 1517, YL with news of Vatican affairs in the English programme intended for South Asia, scheduled from 1515 to 1530.

● **EAST GERMANY**
Radio Berlin International on **17880** at 1408, YL with a newscast in the English transmission intended for South East Asia, scheduled from 1400 to 1455.
Radio Berlin International on **17755** at 1350, YL with the programme in English beamed to Central Africa, scheduled from 1315 to 1400.

● **U.S.S.R.**
Radio Moscow on **17765** at 1358, YL with station identification in the English language World Service.
Radio Moscow on **17825** at 1400, YL with identification and a newscast in the World Service. Note — the World Service is entirely in English and is on the air from 0400 through to 2300 continuous on many channels and bands.
Radio Moscow on **17855** at 1524, OM with news of Korea in the World Service.

● **FRANCE**
Paris on **17865** at 1445, U.K. pop records with announcements in French in the programme for Africa, scheduled from 0600 through to 1600.

● **ALBANIA**
Tirana on **7080** at 1800, YL with a newscast in the Italian programme to Europe, scheduled here from 1800 to 1830.
Tirana on **9375** at 1450, YL with the programme in Polish for Europe, scheduled from 1430 to 1500.
Tirana on **11985** at 1412, YL with a talk about foreign policy in the English programme to South East Asia, scheduled from 1400 to 1430.

● **PAKISTAN**
"Radio Pakistan", Karachi, on **17640** at 1420, YL and OM announcers with the World Service in Urdu to the Middle East and Persian Gulf, scheduled from 1330 to 1430 on this channel.
"Radio Pakistan" Islamabad, on **17665** at 0718, OM and YL announcers with the Urdu programme for the U.K., scheduled from 0715 to 0830.

● **SWITZERLAND**
Berne on **9535** at 1330, OM with a programme

in English for the Far East, Australia, South and South East Asia, Europe, North and Central America, scheduled here from 1315 to 1345.

● WEST GERMANY
Cologne on **9650** at 0950, OM with a talk about ice skating in the Federal Republic in the English programme for Asia and Australia, scheduled from 0930 to 1030.

● GREECE
Athens on **17830** at 1515, YL with identification and newscast in English directed to North America, scheduled from 1515 to 1530.

● ISRAEL
Jerusalem on **17630** at 1413, light music in a relay of the Domestic Service B programme for listeners abroad. The service is entirely in Hebrew and is scheduled here from 0400 through to 2315.

● NORTH KOREA
Pyongyang on a measured **6251** at 1600, OM with identification in Korean after a programme of classical music. Not scheduled at this time — programmes should commence at 2000 in Korean to South Korea.

● SOUTH KOREA
Seoul on **6240** at 1607, light music, U.K. made pop records, YL announcer in Korean. This was a test transmission on an unlisted channel.

● CHINA
"Radio Peking" on **11675** at 1450, Tamil music and songs in the Tamil programme, scheduled from 1430 to 1500. This channel is jammed.

Peking on **9965** at 1530, YL and OM announcers at the end of the Bengali programme scheduled from 1530 to 1600.

Peking on **9880** at 1534, YL with the programme intended for Nepal, scheduled here from 1530 to 1600.

Peking on **11040** at 1120, YL with a talk in the Tibetan programme, scheduled from 1000 to 1155.

Peking on **6590** at 1820, YL with Chinese songs in the English programme for South Asia, scheduled from 1800 to 1900.

Peking on **9440** at 1540, YL with the Standard Chinese programme for South Asia and South East Africa, scheduled from 1500 to 1600.

Peking on **17680** at 1332, Chinese music, YL announcer with the Standard Chinese programme for South East Asia, scheduled here from 1300 to 1400.

Peking on **11650** at 1400, OM with news of Chinese foreign affairs in the English programme for South Asia, scheduled here from 1400 to 1500.

Peking on **11675** at 1405, YL with the Tamil programme to South Asia, scheduled here from 1400 to 1430.

Peking on **11685** at 1409, YL with the programme for Indonesia, scheduled from 1400 to 1430.

● CHINA — REGIONAL
CPBS Qinghai on **6500** at 2305, OM with songs in Chinese. Schedule unknown.

● TIBET
Lhasa on **9490** at 1134, OM and YL announcers in a relay of the Radio Peking Tibetan programme, scheduled from 1000 to 1155.

● CUBA
Havana on **17855** at 2133, OM with identification at the end of the English transmission to Europe, scheduled from 2010 to 2140.

● INDIA
AIR (All India Radio) Delhi on **9950** at 1435, YL with identification at the end of a newscast in English in the Domestic Service News Broadcasts Service. This particular bulletin is scheduled from 1430 to 1435.

AIR Delhi on a measured **7412** at 1530, OM with identification and a newscast in English, scheduled from 1530 to 1545. Listed on **7415.**

● ECUADOR
HCJB Quito on **17865** at 2100, OM with announcements and identification in English.

● NORWAY — 2
Oslo on **9605** at 1415, OM with a programme about winter and wildlife in North Norway. This English programme is scheduled from 1400 to 1430 and is intended for Europe, Africa, the Middle East, North and Central America.

● TANZANIA
Dar-es-Salaam on **5050** at 1807, OM with the world news in Swahili, many place names mentioned — i.e. Islamabad etc. This is the Commercial Service in Swahili and is scheduled here from 1300 to 2015, the National Service on this channel being scheduled from 0300 to 0500.

● U.S.S.R.
"Radio Peace and Progress", Moscow, on **17860** at 0714, OM and YL with the Standard Chinese programme to China, scheduled here from 0500 to 0900. Also logged in parallel on **17890.**

● SOUTH AFRICA
Johannesburg on **17780** at 2140, OM with the English programme for Europe and West Africa, scheduled from 2100 to 2150 on this channel.

NOW HERE THIS
"Voice of Democratic Kampuchea" on **11600** at 1206, YL in Cambodian to Kampuchea (formerly Cambodia). The schedule of this transmission is from 1200 to 1255 and was also logged in parallel on **11990.** The transmitter is thought to be located in China and the programme content is pro-Pol Pot regime. This transmitter is classed as Clandestine.

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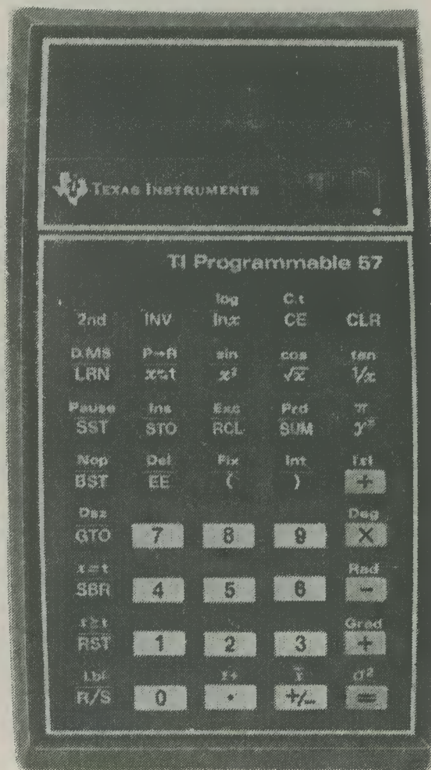
EXCLUSIVE SERIES

TUNE-IN TO PROGRAMS

Part 6 By Ian Sinclair

GETTING INTO ROUTINE



The keyboard of the Texas Instruments TI-57 programmable calculator. Most keys have a second function, whereupon facilities are nearly double the number of keys provided

So far, our programs have used either a straight run — going from one program step to the next from beginning to end of the program — or a loop, going round and round the same piece of program several times under the control of the [x=t] or [Dsz] keys. The ability of the calculator to carry out these program instructions is useful and important, but there is another facility available on the TI-57 (but not on the PR-100) which is even more useful. It's called the subroutine facility, and it's fetched up by the key marked [SBR].

SUBROUTINES

A subroutine is a little bit of program which can be used more than once in the course of a long calculation. The subroutine is identified by the [Lbl] key at the start, and by [INV] [SBR] or a [GTO] at the end. The most valuable point about a subroutine is that it avoids the need to write a piece of program twice over. For example, suppose we were writing a program to find the total resistance of a series-parallel circuit of five resistors connected as shown in Fig. 1. The procedure is to find the sum of each parallel pair (R1 and R2, R4 and R5) first, then to add the value of the series resistor. Now to find the resultant of parallel resistors we need to find the inverse of the quantity 1/R1 + 1/R2, so that we need a piece of program which might read as in Fig. 2. This uses memory 1 for R1 and memory 2 for R2, and it sums the final answer, after the last [1/x] step, into memory 3 to add to the value of R3.

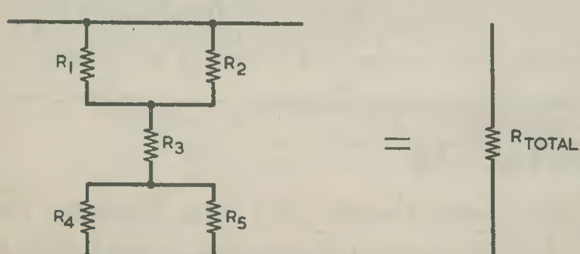


Fig. 1. A series-parallel network of resistors and their total effective resistance

Now it would be rather a chore and a waste of valuable program steps to write out all this again to carry out on R4 and R5. What we do, therefore, is to write out this piece of program at the end of the main program (after the [R/S] instruction) starting with a label, such as [Lbl] [0] and ending with the instruction [INV] [SBR]. This converts the piece of program into a subroutine which we use (the phrase is "call up") at any part of the main program by the instruction [SBR] [0] (or [1] or [2] or whatever the label number is). The subroutine will

For parallel resistor calculations:

RCL 1 1/x + RCL 2 1/x) 1/x SUM 3

Note the use of [)] in place of [=]. This point is dealt with later in the text.

Fig. 2

run whenever called up in this way, and at the instruction [INV] [SBR] the program takes up where it left off. We can use such instructions as [+] [SBR] [1], meaning "add the number in the display to the result of the subroutine calculation", or [X] [SBR] [1] ("multiply by the result of the subroutine calculation") treating [SBR] [1] as if it were [RCL] [1]. If, at the end of the subroutine, we want to move to some other part of the program we can end the subroutine with [GTO] [°] or wherever we want the to pick up. If we do not have any instruction at the end of a subroutine, the next part of the program carried out will be the step which follows the last step of the subroutine.

The program in Fig. 3 shows the use of a simple

Program	Procedure
LRN SBR 0 RCL 4 STO 1 RCL 5 STO 2 SBR 0 RCL 3 R/S Lbl 0 RCL 1 1/x + RCL 2 1/x) 1/x SUM 3 INV SBR LRN	Place resistor values (using the same units for all the resistors) into stores. Then CLR RST R/S. Display shows R total.

Fig. 3

routine in the calculation for the circuit of Fig. 1. In the subroutine the value of two resistors in parallel is found, and added to the value of series resistance. The parallel resistance values have been stored in memories 1 and 2, and the series resistance value in memory 3. In the course of the subroutine the total value of the resistors in parallel is worked out, and the [SUM] [3] step adds this to the value of the series resistance stored in memory 3. Now if we shift the values of R4 and R5 into memories 1 and 2, using the steps [RCL] [4] [STO] [1] and [RCL] [5] [STO] [2], we can simply repeat the subroutine, finding this time the parallel sum of R4 and R5 and adding this also to the number stored in memory 3. The program ends by bringing this total out of memory 3 and stopping the program to display the final result. There are eight steps to the subroutine, but the instruction is only [SBR] [0], so that seven steps are saved on each repetition of this subroutine.

Now there are several important points about subroutines which have to be observed with some care. One point which is not at all obvious is that it's best to avoid using the [=] key to complete a calculation inside a subroutine. The reason is that if there is a calculation waiting to be completed in the main program the [=] instruction will complete that calculation, even if the numbers are not correctly worked out. For example, if we had a program which had got to a stage where the displayed number was 7 and the next instructions were [+] [SBR] [O] [=], then the 7 is held waiting for the subroutine to be completed so that the number which has to be added to the 7 is calculated. This is called a pending operation ("pending" literally means "hanging about") and the use of the [=] sign completes such an operation, so that in our example 7 will be added to whatever number is in display just before the [=] sign appears. For instance, if [SBR] [O] had at some stage the instructions [RCL] [2] [+] [RCL] [5] [=], with 3 in memory 2 and 4 in memory 5, what would be carried out would be 3+4+7=14, because the pending 7 would be added in. inside subroutines it's better to get into the habit of using the close parenthesis sign, [)], to complete a calculation instead of [=].

SHORT PROGRAMS

Subroutines are also a useful way of storing several short programs in one chunk. Since each subroutine has its own label number, the calculator can be instructed to go through the subroutine by the instruction [SBR] (label number) [R/S]. and the [INV] [SBR] instruction will then have the same effect as the [R/S] instruction in a complete program, stopping the action. This way, several separate bits of program can be kept together so that each can be called up as required for as long as the calculator is switched on. This is particularly important when the larger machines like the TI-58 and TI-59 are used, because vast program lengths can be stored; the TI-59 can also record programs on magnetic cards, so that programming, once the card is recorded, is instant.

Any program with a reasonable number of steps can be made into a subroutine and thereafter used, called up, inside another program provided that there is room for all the steps of the program plus the subroutine.

To illustrate how useful this can be, recall the point that was made in Part 3 regarding memory storage. You remember (I) that we could store two numbers in one memory using the [Int] and [INV] [Int] steps and employing a decimal point to separate the numbers. We can write a subroutine to carry out the separation, and then whatever steps are needed (such as multiplication of the numbers) to process the numbers. Fig. 4 shows a subroutine

This subroutine assumes that the numbers to be processed are three-figure numbers; the number written after the decimal point *must* be a three-figure number, though a final 0 need not be keyed. For example, 2 and 3 are coded as 2.003, 14 and 15 as 14.015, 150 and 120 as 150.12 and so on.

The subroutine for extracting the numbers and multiplying is:

Lbl 0 STO 6 Int X RCL 6 INV Int X
1 EE 3) INV SBR

Fig. 4

which will carry out the steps of extracting two four-figure numbers in this form out of a memory, and multiplying them together ready for returning to a memory. We can pack all the memories with numbers written in this form, and the program for

The complete program for multiplying six sets of figures and placing the products in the original memories now reads:

Program

```
LRN RCL 0 SBR 0 STO 0
RCL 1 SBR 0 STO 1 RCL 2
SBR 0 STO 2 RCL 3 SBR 0
STO 3 RCL 4 SBR 0 STO 4
RCL 5 SBR 0 STO 5 Lbl 0
STO 6 Int X RCL 6 INV
Int X 1 EE 3 ) INV SBR
LRN
```

Fig. 5

multiplying them would now read as in Fig. 5. At the end of the program we can read out the products by using [RCL] [O]. [RCL]. [1] [RCL] [2], etc.

Going a step further with this, we can now look at a program for finding resonant frequencies, using L in μH, C in pF, and finding f in MHz. Each LC combination is written as a decimal, with the value of L before the decimal point and the value of C after the point, so that the pair of values 150μH and 850pF comes out as 150.85. At the end of the program, each memory contains the value of resonant fre-

Resonant frequencies are calculated for values of L and C stored in the memories in the form of a decimal number with three digits each side of the decimal. The value of L in μH is written first, then the decimal point, then the value of C in pF.

Program	Procedure
LRN 0 STO 7 RCL 0 SBR 0 STO 0 RCL 1 SBR 0 STO 1 RCL 2 SBR 0 STO 2 RCL 3 SBR 0 STO 3 RCL 4 SBR 0 STO 4 RCL 5 SBR 0 STO 5 GTO 5 Lbl 0 STO 6 x=t GTO 5 RCL 6 Int X 1 EE 3 X RCL 6 INV Int) $\sqrt{x}$ 1/x X 159) INV SBR LRN	Key in values of L and C into memories 0 to 5. CLR Fix 3 RST R/S At the end of the calculation, the display flashes (due to the impossible [GTO] [5] instruction). The values of resonant frequency (in MHz) can now be taken from each memory by pressing [RCL] [O], [RCL] [1], etc.

Fig. 6

quency for the pair of L and C values which was originally stored in that memory. The program itself consists of the subroutine and the shifting instructions which recall each pair of values, and then load the result back into the same memory at the end of the subroutine. This is an example of a program which is much shorter because of the use of a subroutine. If we were to have to write out the instructions for extracting the L and C values from each memory, we would run out of program space long before we had completed the program.

RESONANT FREQUENCY

Fig. 7 shows another program which makes use of a subroutine. The program this time is to find the impedance of a resistance R, inductance L and capacitance C in series, with the values of R, L and C stored in separate memories. To show resonance the value of impedance, Z, should be plotted against

This program finds the impedance, resonant frequency and phase angle for a series LCR circuit. The first press of [R/S] gives the impedance at the resonant frequency, which is simply equal to the resistance in the circuit. Memory 4 now stores the resonant frequency (in Hz). On the next press of [R/S], the frequency is incremented by 1kHz, and the display shows impedance in ohms. Pressing [x⇄t] will give the phase angle in degrees. The frequency can be checked after a number of runs by the sequence [RCL] [5] [÷] [2] [÷] [π] [=].

Program	Procedure
LRN SBR 1 Lbl 3 RCL 1 STO 7 SBR 2 INV P→R x⇄t R/S 2 EE 3 X π = SUM 5 GTO 3 Lbl 1 RCL 2 X RCL 3) 1/x $\sqrt{x}$ STO 5 ÷ 2 ÷ π) STO 4 INV SBR Lbl 2 RCL 5 X RCL 2 — (RCL 5 X RCL 3) 1/x) INV SBR LRN	The value of R (ohms) is stored in 1, L (in H) in 2, C (in F) in 3, followed by [CLR] [RST]. Test data: 10 STO 1 150 EE 6 +/– STO 2 850 EE 12 +/– STO 3 CLR RST [R/S] gives 10, [RCL] [4] gives 445722.99, [R/S] gives 10.17, etc. Note the use of [INV] [P→R] which calculates impedance and phase angles automatically when the resistive part is in memory 7 and the reactive part in the display.

Fig. 7

frequency, so that the program finds the resonant frequency and displays it. The program then stops. When the [R/S] key is pressed again, the resonant frequency is stored and the program then calculates values of Z at the frequency of resonance and at every 1 kHz above the frequency of resonance in turn. At each pause the value of impedance, Z, is read out so that the graph can be plotted. Since the resonance curve is symmetrical the values of Z for each kHz below the frequency of resonance can be plotted without the use of the calculator. The subroutine in this case is that for finding the value of Z, with the values taken out of store each time and the frequency altered on each loop. The first part of the program, to find the resonant frequency, is not used again unless new values of C, L and R are placed into store and the [RST] key used to reset the program.

Using [Dsz] more than once. Note that the steps [Dsz] [GTO] [1] *must* be inside the subroutine. If these steps are used outside the subroutine, the loop will be carried out correctly first time, but will be entered from the [GTO] [1] instruction on the next time round. This in turn will mean that the subroutine will return the program to the step following [GTO] [1] instead of going round the loop again as was intended.

Program	Procedure
LRN 4 STO 0 SBR 1 4 +/– STO 0 SBR 1 R/S Lbl 1 RCL 1 + (RCL 0 X .05 X RCL 1)) Pause Pause Dsz GTO 1 INV SBR LRN	Set value of resistor R into store 1. Program shows values of resistor with tolerances of +20%, going down in 5% steps to 5%; then –20%, going up in 5% steps to –5%.

Fig. 8

Oh yes, remember (in Part 5) we mentioned using a [Dsz] routine more than once in a program. Fig. 8 shows the program which was used in Fig. 4 of part 5 re-written as a subroutine.

To be continued

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IN OUR AUGUST ISSUE

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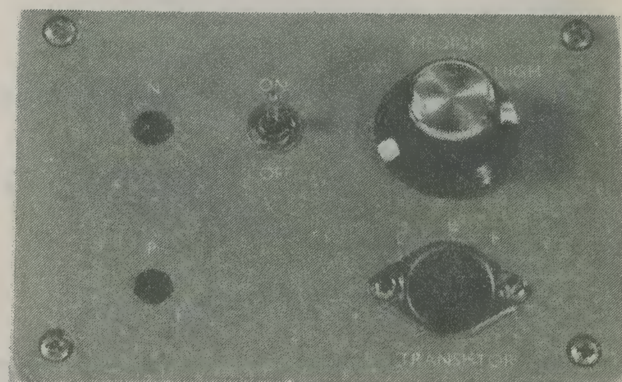

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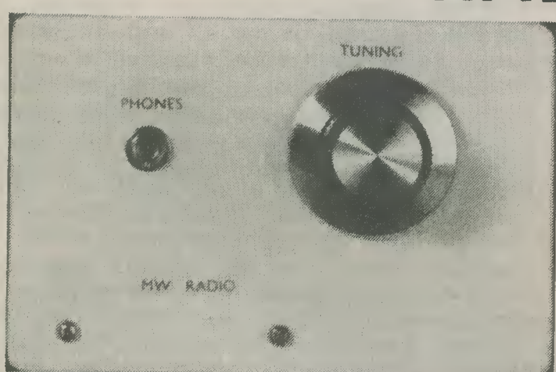

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2 WATT CLASS A AMPLIFIER

By John Baker

Quality a.f. amplifier with positively no crossover

Most audio amplifiers these days, whether of low, medium or high output power, are of the solid-state Class B variety. There are obvious advantages with Class B output stages, what is probably the most important of these being their high efficiency and the consequent generation of minimal heat. The high efficiency enables compact amplifiers of quite considerable output power to be produced using standard readily available transistors.

Of course, where only a fairly modest output power is needed and the equipment is mains supplied, Class B operation is less advantageous. So indeed, is the use of solid-state devices rather than valves. Under such circumstances there are points in favour of employing valves and/or Class A operation.

VALVE AMPLIFIERS

The major point in favour of valve amplifiers is that, when overdriven, they do not produce such sharp clipping as do standard solid-state designs but offer, instead, a rounded output waveform which is relatively free from high frequency harmonics. Such harmonics tend to give the most noticeable distortion, and so their absence results in a comparatively "clean" output.

Class A amplifiers are completely free from crossover distortion, which can become more and more evident with a Class B amplifier as the output level decreases. Since distortion is most objectionable when it occurs at low volume levels, and since crossover distortion is itself particularly unpleasant, a circuit which is entirely free from it has an obvious attraction.

This fact prompted the author to experiment with some simple Class A designs, and the amplifier finally evolved forms the subject of this article. It is a transistor amplifier having an output power of about 2 watts r.m.s. without clipping occurring. Components for valve amplifiers have become rather difficult to obtain and, primarily for this reason, no valve circuits were tried. It is, in any case, possible to give transistor amplifiers the so-called "valve sound", by employing a soft clipper circuit, and was described in "Soft Audio Limiter" by A. Foord in the June 1975 issue of *Radio & Electronics Constructor.*

Total harmonic distortion with the present amplifier is well below 1% at all power output levels below the onset of clipping. Above clipping level the t.h.d. naturally rises very quickly. When used with a well smoothed power supply the amplifier has a wideband signal-to-noise ratio of about -76dB with the input left open-circuit. The input impedance is of the order of 10kΩ and the output is intended to drive an 8Ω speaker. The use of other speaker impedances is not recommended. With the components specified, the amplifier has a sensitivity of about 240mV r.m.s. for maximum output power, but this can be easily altered, if necessary, by adjusting the value of one resistor. The frequncy response of the amplifier is approximately 30Hz to 250kHz at the -3dB points.

SIMPLIFIED CIRCUIT

A simplified version of the amplifier circuit, showing the basic configuration employed, appears in Fig. 1.

There are just three stages of amplification, these consisting of a common emitter input stage using TR1, a common emitter driver stage using TR2 and an emitter follower output stage incorporating TR3. Direct coupling is employed between stages.

The configuration is basically similar to one commonly used for Class B designs, with the exception that a single emitter follower output transistor is employed instead of a complementary pair. The

COMPONENTS

AMPLIFIER

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)

R1 2.2kΩ
R2 8.2kΩ
R3 22kΩ
R4 18kΩ
R5 1.2kΩ
R6 1.2kΩ
R7 56Ω
R8 12kΩ
R9 10Ω
R10 680Ω
R11 1.8Ω ½ watt
R12 1.8Ω ½ watt
VR1 22kΩ potentiometer, log

Capacitors

C1 4.7μF electrolytic, 16V. Wkg.
C2 0.1μF type C280
C3 100μF electrolytic, 25V. Wkg.
C4 100μF electrolytic 16V. Wkg.
C5 270pF ceramic plate
C6 100μF electrolytic, 16V. Wkg.
C7 10μF electrolytic, 10V. Wkg.
C8 1,000μF electrolytic, 16V. Wkg.

Semiconductors

TR1 2N3702
TR2 BFR81
TR3 BFR41
TR4 BC109C
TR5 TIP41A
TR6 TIP41A
D1 1N4148
D2 1N4148

Miscellaneous

Control knob
Materials for printed circuit board
Heatsink (see text)

POWER SUPPLY

Resistor

R1 4.7kΩ pre-set potentiometer, 0.1 watt, horizontal

Capacitors

C1 2,200μF electrolytic, 25V Wkg.
C2 0.1μF type C280
C3 0.1μF type C280

Transformer

T1 mains transformer, secondary 15V at 1A

Semiconductors

IC1 μA7805
D1-D4 1N4001

Indicator

PL1 panel-mounting neon with integral series resistor, 240V A.C.

Switch

S1(a)(b) d.p.s.t. toggle

Miscellaneous

Materials for printed circuit board
Heatsink (see text)

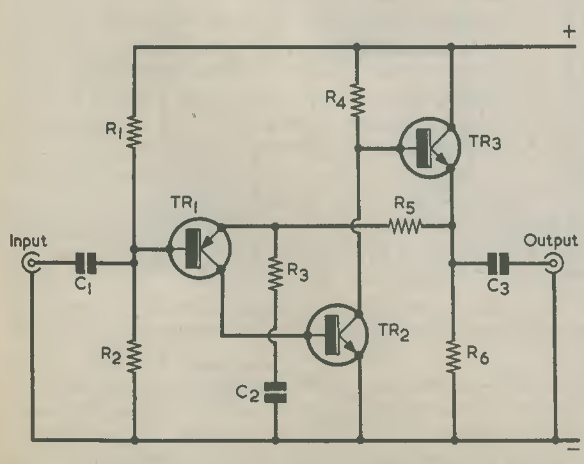


Fig. 1. Simplified circuit illustrating the basic configuration of the amplifier

output stage gives the low output impedance needed to drive a loudspeaker, whilst the input and driver stages provide the necessary voltage gain.

R5 provides 100% d.c. negative feedback between the output at TR3 emitter and the emitter of TR1. This gives the circuit a d.c. voltage gain of unity and simplifies amplifier biasing since it is only necessary to give TR1 base a suitable bias voltage, by means of R1 and R2, to cause the output emitter to be at half supply voltage above the negative rail. The output emitter can then swing by equal voltages positive and negative before clipping occurs, thereby giving optimum output power for a given supply voltage.

A voltage gain of more than unity is, of course, needed at a.c., and this is accomplished by using R3 to decouple some of the feedback introduced by R5. C2 is the decoupling capacitor and R3 limits the amount of feedback that is removed. In company with R5, R3 controls the voltage gain of the amplifier, and this is approximately equal to R5 divided by R3.

C1 and C3 provide d.c. blocking at the input and output respectively. In the simplified circuit of Fig. 1, R4 is the collector load for TR2 and R6 is the collector load for TR2 and R6 is the load resistor for TR3 emitter.

FULL CIRCUIT

The full working circuit of the 2 watt Class A amplifier is given in Fig. 2. At a quick glance this may seem to be the circuit of a Class B amplifier, but a closer examination of the circuit will soon reveal that it is not. It looks superficially like a Class B design due to the use of constant current loads for the driver and output stages.

For a high gain voltage amplifier such as the driver, TR3, a constant current load has the advantage that the transistor is operating at a fixed collector current so that, in theory at any rate, its gain remains virtually constant and it introduces little distortion. In practice, a certain amount of distortion will be introduced, if only because the constant current generator does not have a perfect performance. Nevertheless, a constant current load gives a considerable improvement in performance as compared with a straightforward resistive load.

The emitter follower output stage has unity voltage gain only, and the use of a constant current load may therefore seem unnecessary since variations in the gain of the transistor will not affect the voltage gain. However, it has to be remembered that the output stage is driving a very low impedance load, and that variations in the gain of the output transistor will cause corresponding changes in the output impedance of the amplifier. The loading effect of the speaker would result in the variations in output impedance causing a certain amount of distortion.

A constant current load also provides a more efficient coupling to the speaker than does a simple resistor load since the constant current source offers an apparently infinite impedance to a.c. output signals, and therefore wastes none of the a.c. output current. All the a.c. output current is thus available to drive the speaker, provided the quiescent output current is greater than the peak speaker current. There is obviously a rather poor efficiency in the output stage in terms of output power and the supply power required, but such inefficiency is an inherent feature of all Class A designs. If a load resistor were to be used instead of the constant current source it would need to have a low value, comparable with the impedance of the speaker, in order to bring the output transistor into suitable operating conditions. The consequence would be that as much of the a.c. output signal flows in the load resistor as flows into the speaker, resulting in an even lower efficiency.

Maximum efficiency would be given by directly connecting the speaker as the output stage load, but this would result in a high quiescent current flowing through the speaker and, at the currents involved in the present amplifier, is not to be recommended. An output transformer could also be used, but a suitable component might be hard to obtain, could easily restrict the quality of the amplifier and would probably offer an efficiency between the output stage and the speaker of only about 60% anyway.

A further advantage of a constant current output stage is that it requires a constant drive current, and does not therefore have an adverse effect on the constant current driver stage.

The use of constant current output stages was, incidentally, covered in more detail in "Constant Current' Class A Amplifier" by G. A. French in the December 1974 issue of *Radio & Electronics Constructor.*

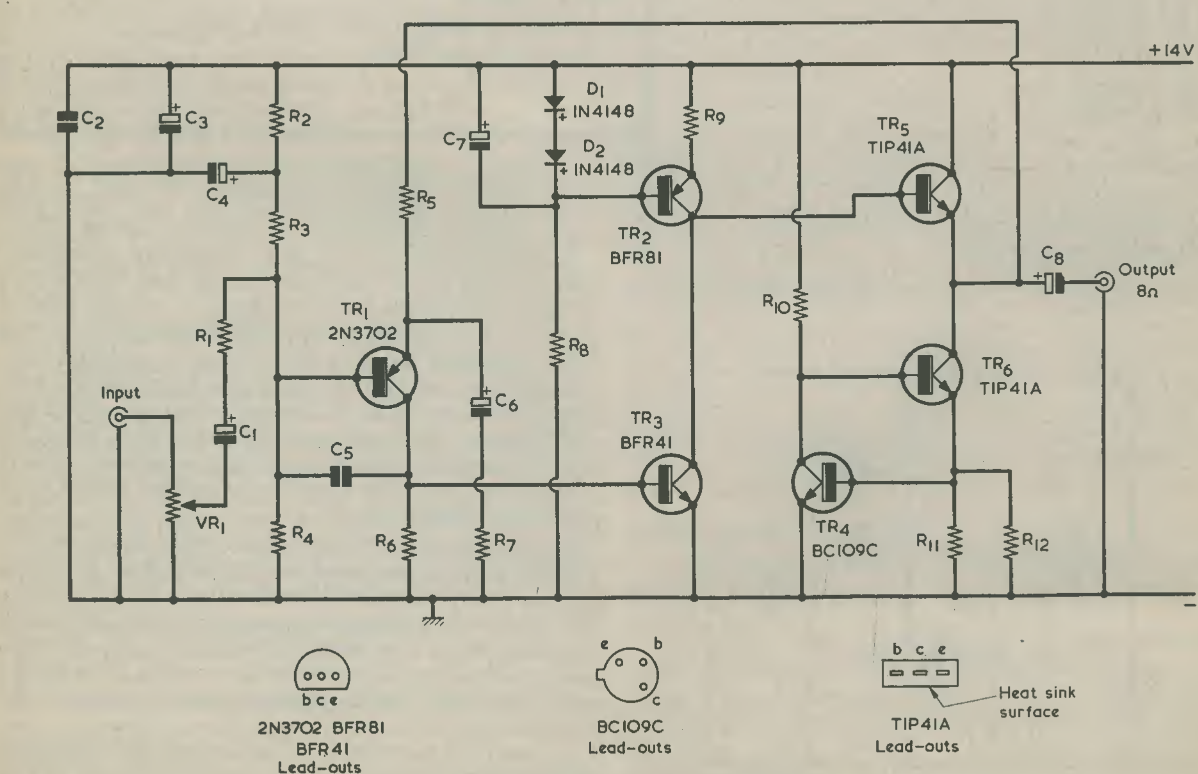
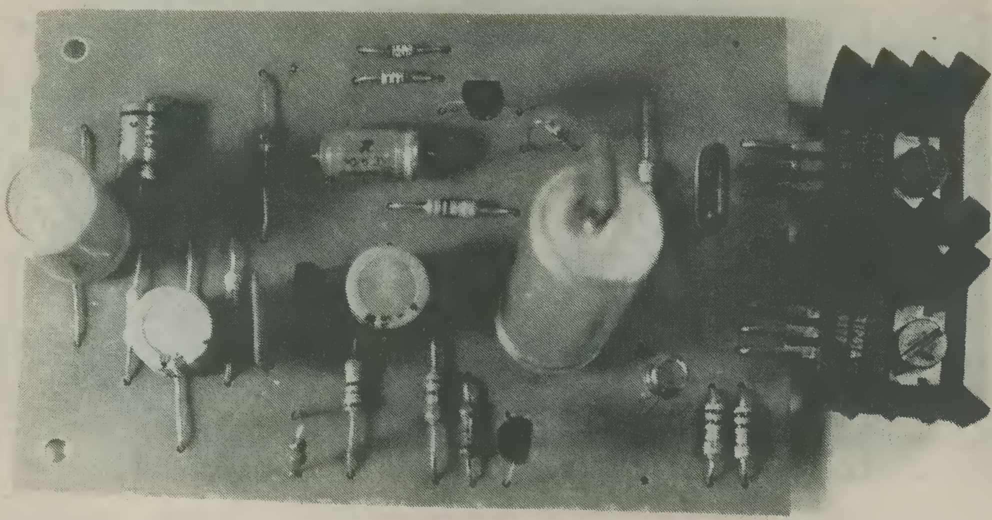


Fig. 2. The full working circuit of the Class A amplifier



Top view of the amplifier module. The heatsinks fitted to the output transistors were adequate for testing the prototype, but larger heatsinking is required for continual use of the amplifier

DETAILED OPERATION

In Fig. 2, the input signal is coupled to volume control VR1, from which it passes to the base of TR1 via C1 and R1. The latter assists in maintaining stability by attenuating the very high frequency response of the amplifier, as also does C5. R2 and R3 in series form the upper half of the bias potential divider for TR1 base, the lower half being given by R4. Bypass capacitor C4 connects to the junction of R2 and R3, and prevents hum and noise on the supply line reaching the input of the amplifier.

The driver stage constant current source incorporates TR2 in a standard constant current circuit. TR2 base is held at about 1.3 volts negative of the positive supply rail by the forward biased silicon diodes, D1 and D2. About 0.65 volt is dropped across the base-emitter junction of TR2, leaving 0.65 volt across the 10Ω resistor, R9. Provided TR2 has a suitably low impedance load in its collector circuit, the emitter and collector currents will then remain virtually constant at about 65mA.

A different configuration, incorporating TR4 and TR6, is used for the output stage constant current source. TR6 is held conductive by the base current it receives via R10, causing a current to flow through the emitter resistance formed by R11 and R12 in parallel. The voltage across the emitter resistance stabilizes at about 0.65 volt, since a higher voltage would cause TR4 to conduct heavily and starve TR6 of base current. The emitter current (and hence also the collector current when the load impedance is suitably low) then becomes about 720mA.

This gives a peak output current of 720mA, or 510mA r.m.s. The r.m.s. output power then calculates at slightly more than 2 watts, and tests on the prototype bear this figure out in practice.

The BFR81 and BFR41 transistors specified for TR2 and TR3 are available from several suppliers, including Electrovalue.

CONSTRUCTION

The amplifier is constructed on a printed circuit board which measures 98 by 64mm. The copper backing pattern and component layout of this board are illustrated actual size in Fig. 3. The board is etched and assembled in conventional manner. In the prototype the lead-outs of TR5 and TR6 are bent so that the transistor bodies are horizontal, as shown in the photographs.

It is important that TR5 and TR6 be provided with adequate heatsinking as they will otherwise overheat and be destroyed after a few minutes' operation. The author used "Plastic Power Vaned Heatsinks" (as supplied by Maplin Electronic Supplies) for testing the prototype circuit, but these are not really large enough for continuous normal usage. Either a larger commercially made heatsink should be employed, or the amplifier can be housed in a metal case with the latter acting as a heatsink. In either instance it will be necessary to insulate the transistors from the heatsink using the usual mica washer and insulating bush, and it is advisable to check that this insulation is fully effective with the aid of an ohmeter before connecting the amplifier to a power supply. When a metal case is used as the heatsink it may be found more convenient to bend the lead-outs of TR5 and TR6 so that their bodies are vertical, allowing the heatsink pads to be bolted to one side of the case.

If necessary, the gain of the circuit can be altered by adjusting the value of R7. Decreasing its value will give a proportional increase in sensitivity and increasing its value will similarly decrease the sensitivity. It would be preferable not to make R7 less than about 12Ω, however, as the reduced negative feedback could seriously degrade the amplifier performance. Nevertheless, the prototype produces reasonably good results even when used "open loop".

The output power of the amplifier is not very high by modern standards, but two amplifiers in a

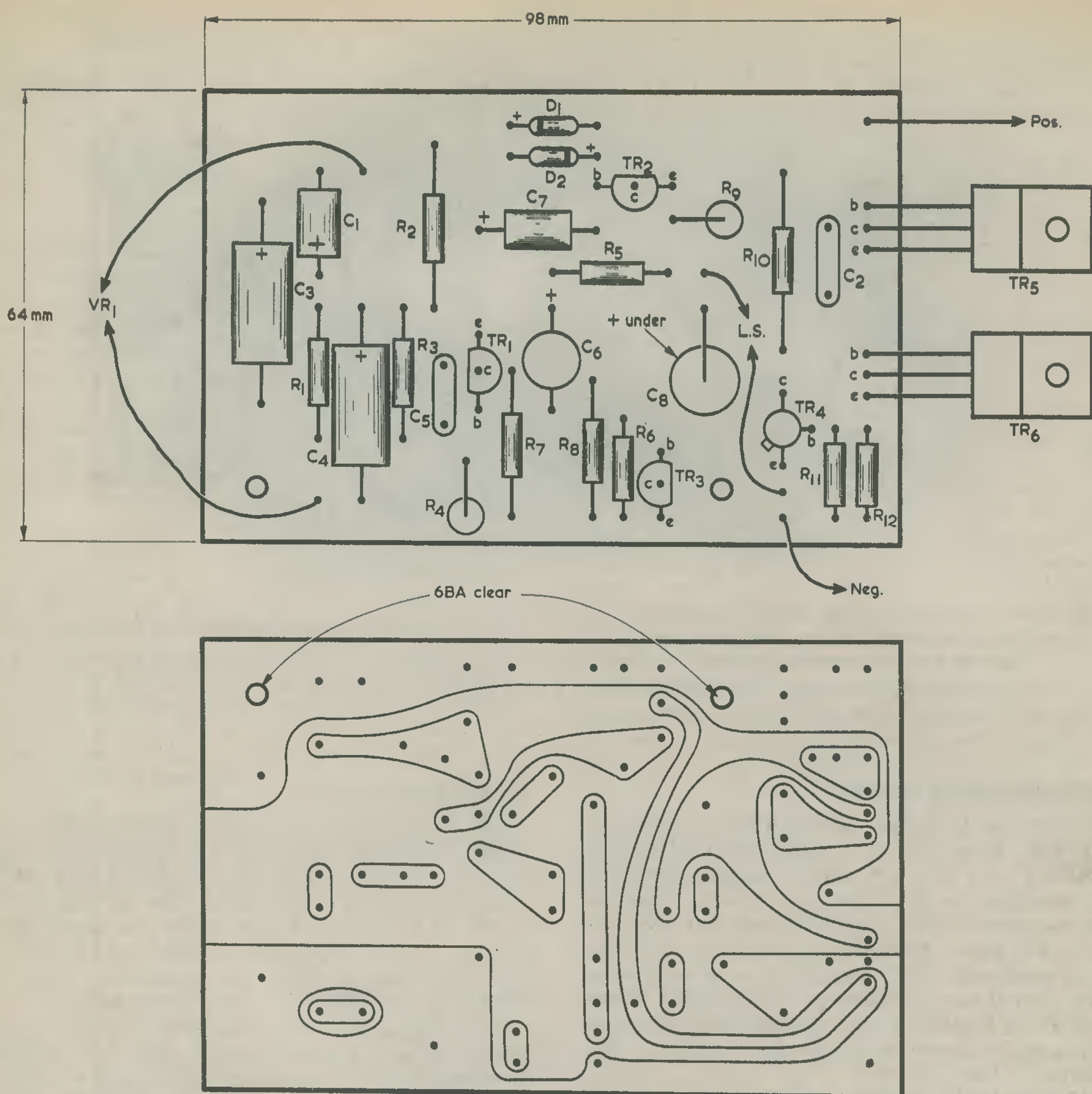


Fig. 3. Details of the printed circuit board on which the amplifier is constructed. The two leads to VR1 connect to its slider and to the earthy end of its track

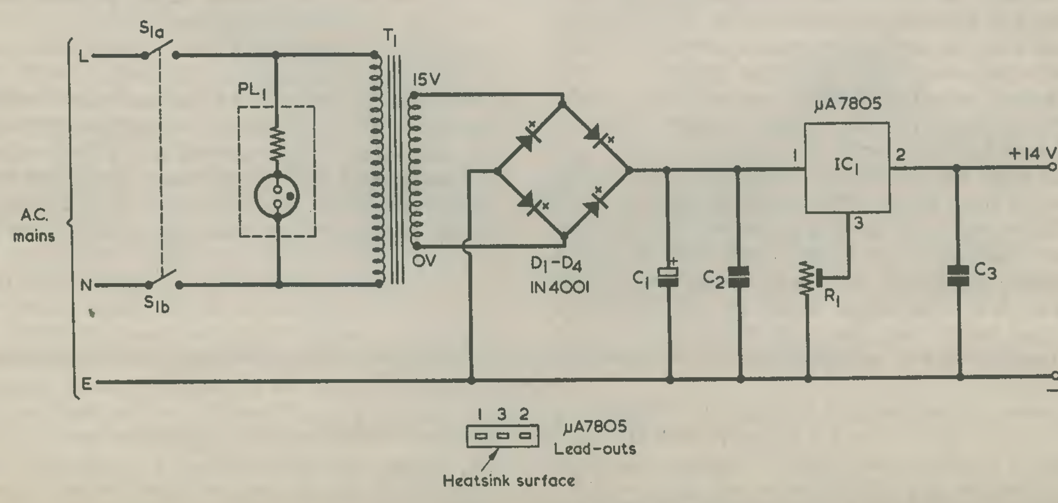
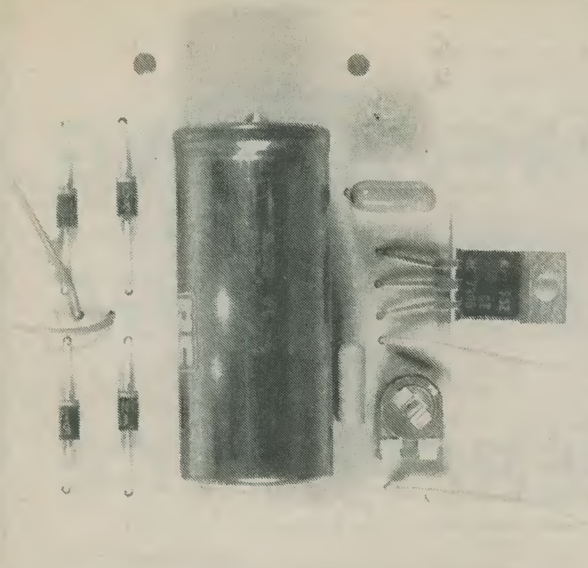


Fig. 4. A suitable power supply for the amplifier. IC1 is a 5 volt regulator whose output voltage is raised to 14 volts by R1



The power supply printed board assembly. Details of the heatsink required for the regulator i.c. are given in the text

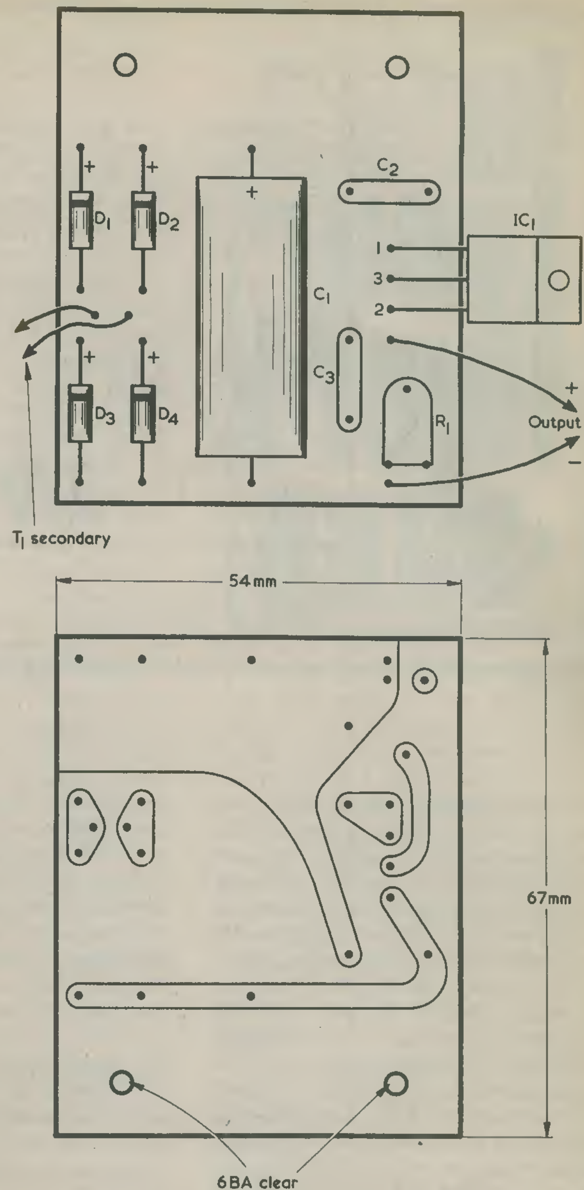


Fig. 5. The power supply components following the secondary of the mains transformer are assembled on another small printed circuit board

stereo system driving different loudspeakers will supply enough power for most domestic purposes.

POWER SUPPLY

The circuit of a simple mains power supply is given in Fig. 4, and this provides the 14 volts at about 800mA which is required by a mono version of the amplifier. For stereo operation a mains transformer having two 15 volt 1 amp secondaries may be used, each secondary feeding its own rectifier, smoothing and regulating circuit, and thereby providing a separate supply for each channel. If difficulty is experienced in obtaining transformers with single or dual 15 volt 1 amp secondaries, transformers with tapped 1 amp secondaries which include a 15 volt tap are available from Maplin Electronic Supplies.

The power supply circuit is quite straightforward, with the bridge rectifier given by D1 to D4 being followed by the high value smoothing capacitor C1. There is a loaded supply potential of 17 volts across C1, and this is regulated to 14 volts and given additional smoothing by the voltage regulator, IC1. The regulator i.c. is actually a 5 volt device, but the inclusion of pre-set potentiometer R1 in its common terminal circuit enables the output to be adjusted to the required voltage. C2 and C3 aid the stability of the i.c.

The rectifier, smoothing and regulating circuitry is assembled on a small printed circuit board and details of this are illustrated, again actual size, in Fig 5. IC1 should be fitted with at least a small finned heatsink, more substantial heatsinking being employed if available. If an amplifier metal case is used as a heatsink the i.c. must be insulated from this, as its heatsink pad connects to its common terminal. The power supply is not easily damaged since IC1 incorporates both thermal shutdown and output short-circuit protection, but the supply cannot withstand an indefinite short-circuit on the output.

■

"Designing Reflex Circuits"

By Sir Douglas Hall, Bt., K.C.M.G.

In Fig. 6(a) of this article, which appeared on page 609 of the June issue, the positive supply is applied to the junction of the interstage transformer primary and the r.f. choke. This is incorrect, and the positive supply should be fed to the junction of the primary and the 33kΩ resistor

In your work-shop

PREVENTING A.M. IMAGE INTERFERENCE

Dick snapped into place the plastic back of the neat little medium and long wave radio and then switched it on. He selected medium waves and tuned it over the band. Radios 1, 2 and 3 turned up at their allotted points on the tuning sçale, although Radio 1 and Radio 3 were marred by an irritating background whistle which changed in pitch as he tuned through the signals. He then checked the long wave band, to find that Radio 4 came in at reasonable strength. Cheerfully, he switched off the set and proceeded to take it over to the "Repaired" rack.

"Hey!"

Puzzled, Dick stopped in mid-stride.

"I said, hey!"

Dick located the sound as coming from Smithy's bench on the other side of the Workshop. Smithy had his back towards his assistant and appeared to be completely engrossed in a colour television chassis which lay before him on his bench.

Dick frowned.

"Did you say anything, Smithy?"

"Of course I said something," replied Smithy without looking round. "Am I to understand that you look upon the radio I've just been hearing as being fully serviceable?"

"Blimey, it must be," replied a confused Dick. "All that was wrong with it was that one of the leads from the medium wave coil on the ferrite rod aerial had come adrift from the printed board. The aerial is positioned close to the board and the leads from the coil consist of the thin coil wire itself. I should imagine that the set had been given a bump which had caused the wire to break. At any rate I simply soldered the wire back to the board, checked out the set and found it was working all right again."

QUICK REPAIR

"It sounded pretty horrible to me," commented Smithy. "Even over here I could hear what seemed to be quite strong image frequency whistles on two of the stations you tuned in. Bring it over here and let's take a butcher's at it."

Smithy pushed the television chassis to one side of his bench and accepted the radio which Dick handed him. He set it to medium waves again and checked its performance. The whistles were still very noticeable.

"Just a few whistles," commented Dick. "So what?"

"It's daytime now," stated Smithy, "and the medium wave band is pretty quiet. If you get image frequency whistles during daytime conditions the aerial tuned circuit of this radio must be quite some way off trim. At evening and night-time, when the medium wave band is absolutely chock-full with signals, you'd probably get whistles on nearly every signal you tune in."

"Why are you so sure that these whistles ***are*** image frequency ones, anyway?"

"Well," confessed Smithy, "I'm not a hundred per cent certain. But everything points to it. One of the major problems of medium wave reception with a simple superhet of the type we've got here is to avoid image frequency whistles, and this can only be done successfully by ensuring that the aerial tuned circuit gives maximum selectivity at the wanted signal frequency. You have yourself said that this radio has probably had a bump which caused a wire from the ferrite aerial medium wave coil to come adrift from the printed board. Following from this, and taking in the presence of those whistles, it seems quite probable also that said bump caused the medium wave aerial coil to be dislodged from its proper position on the ferrite aerial rod."

"Blow me," exclaimed Dick. "I never thought of that."

Smithy opened the back of the receiver and placed an experimental finger on the medium wave ferrite aerial coil.

"Hmm," he commented, "it's not all that tightly secured on the rod."

He tuned to the low frequency end of the medium wave band and found a station, with the tuning capacitor vanes nearly fully enmeshed, which was only just audible. He slowly pushed the medium wave coil along the rod, whereupon signal strength increased considerably. He soon found a point for the coil on the rod which corresponded to maximum signal strength. (Fig. 1).

Fig. 1. Smithy brought the receiver serviced by Dick into more accurate alignment by sliding the medium wave coil along the ferrite aerial rod

"That's more like it," he said, "let's see how the set performs now."

He tuned across the medium wave band. The set was noticeably more lively and the whistles on the BBC1 and BBC3 signals had magically disappeared.

Dick was supremely impressed by this display of electronic legerdemain on the part of Smithy.

"Gosh Smithy, you're a genius!"

"Nonsense," retorted Smithy, "just a bit of elementary servicing, that's all."

"But why did moving that ferrite rod aerial coil clear those whistles?"

"Because," said Smithy patiently, "it made the aerial input tuned circuit peak more accurately at the required signal frequencies. Now look, as I've already said, this little set is a simple superhet, and it has an intermediate frequency which will be in the range of 455 to 475kHz or so. Let's say, for the sake of argument, that the i.f. is 460kHz. Right?"

"Right!"

"On medium waves," continued Smithy, "the signal coverage will be of the order of 550kHz at the low frequency end to 1,500kHz at the high frequency end. 550kHz is, rough check, the same as about 540 metres, and 1,500kHz is exactly the same as 200 metres. So we set up an aerial tuned circuit and an oscillator tuned circuit which are both tuned by a 2-gang capacitor. These are normally coupled, in a transistor radio, to a single transistor mixer-oscillator, and the tuned circuits are aligned so that the oscillator always runs at the intermediate frequency of 460kHz higher than the frequency to which the aerial circuit is tuned." (Fig. 2).

"I know all about that," protested Dick impatiently, "it's elementary superhet theory. The oscillator frequency beats with the incoming signal in the oscillator-mixer to produce sum and difference frequencies. It's the difference frequency we're interested in here and that goes into the 460kHz intermediate frequency amplifier."

"Which," said Smithy, "provides most of the gain and most of the selectivity in the receiver. Right?"

"Right!"

"Good. Now having got that settled, the next thing we have to realise is that it is the oscillator frequency which ***chooses*** the aerial signal which is going to go into the 460kHz i.f. amplifier. If we set the oscillator to run at, say, 1,460kHz then the signal which the oscillator selects to enter the i.f. amplifier will be one at 1,000kHz. Changing the oscillator frequency has the same effect as operating the tuning control of the receiver, because you're then selecting the signals which are going to be allowed to go into the highly selective i.f. amplifier. And we now come to a snag."

"D'you mean the image frequency business?"

"I do. If the oscillator is running at 1,460kHz, it will let in a 1,000kHz signal all right because there's a 460kHz difference between them. But if there happens to be another signal at 1,920kHz the oscillator will let that one in too because, once again, there is a 460kHz frequency difference between the two. The 1,920kHz signal is called the 'image' signal. It's also called a 'second channel' signal and it always appears at the frequency which is on the opposite side of the oscillator frequency to the desired signal, and which is spaced away from the oscillator frequency by the intermediate frequency. In a.m. medium and long wave radios the oscillator frequency is higher than the required signal frequency, and so the image signal appears above it."

"I suppose," said Dick, "that it's the job of the signal frequency tuned circuit to stop the image signal getting through to the mixer."

"That's right," confirmed Smithy. "In high performance receivers you will have several tuned circuits resonant at signal frequency to stop the image signal, but in simple medium and long wave radios you have to rely on just a single tuned circuit to do the job. Fortunately, the coil in the tuned circuit is the one in the ferrite rod aerial and, because of the ferrite rod, it has a very high Q. In practice it doesn't actually ***prevent*** an image signal from getting through to the mixer, because with only a single tuned circuit a strong image signal can still manage to force its way past. Instead, the ferrite rod aerial tuned circuit ***boosts*** the desired signal so that its amplitude is much greater than that of the image signal."

"Hey, hold on a bit — you're getting away from me now!"

"Think about it," said Smithy. "Let's go back to our example in which the oscillation is running at 1,460kHz. Now, if the receiver has been aligned correctly the aerial tuned circuit will then be resonant at 1,000kHz. Suppose that, due to the receiver having had a bump, the medium wave ferrite aerial coil has become displaced on its rod, so that the signal tuned circuit resonant frequency has changed to 900kHz."

Dick frowned.

"Come off it Smithy, there's no need to rub it in."

"The response curve of the signal frequency tuned circuit," went on Smithy sternly, ignoring his assistant," will now have a very high peak at 900kHz, but the skirts of the response will extend well up to the second channel frequency of

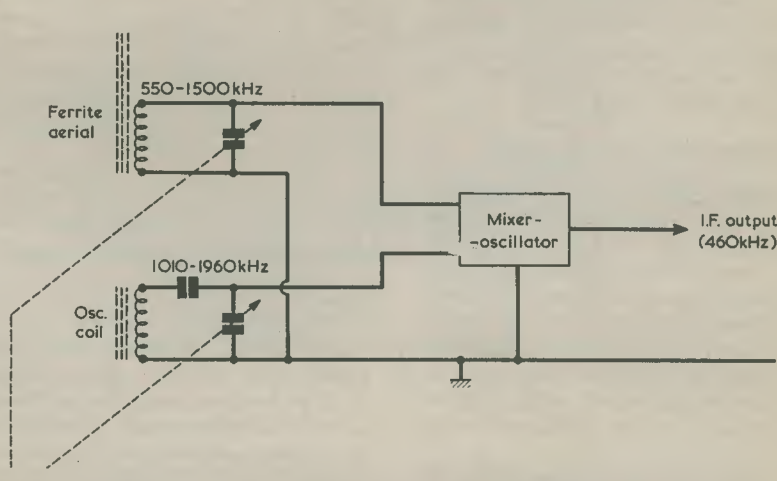


Fig. 2. On medium waves the signal frequency and oscillator tuned circuits are coupled to the mixer-oscillator. Both are tuned by a 2-gang capacitor, with the oscillator running 460kHz higher than signal frequency

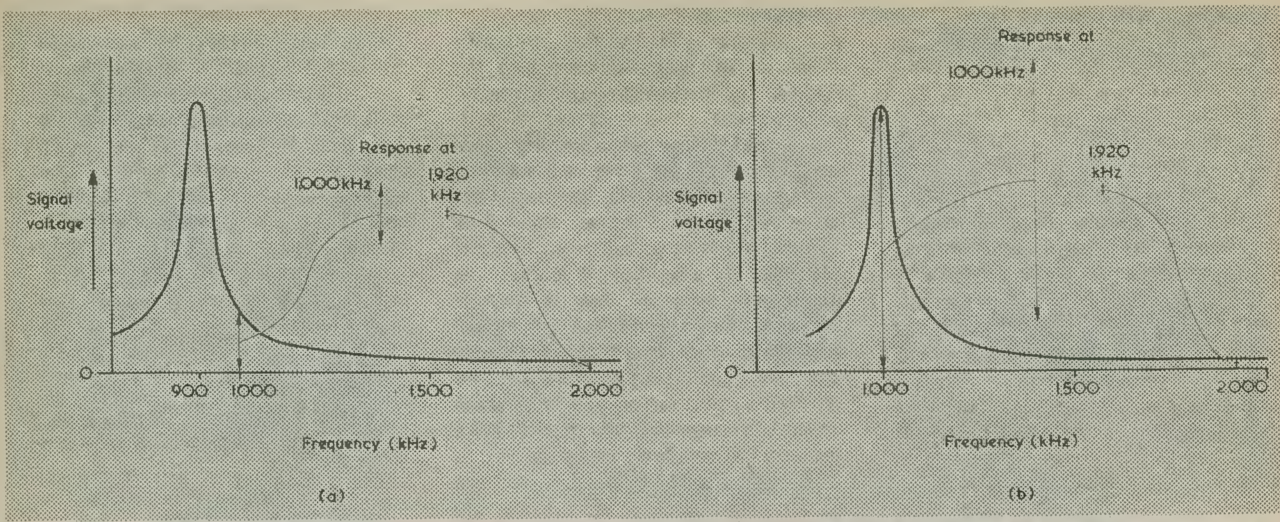


Fig. 3(a). A single ferrite aerial tuned circuit cannot completely eradicate image signals. The response curve shown here is for an aerial circuit incorrectly tuned to 900kHz when the desired input frequency is 1,000kHz. The response at 1,000kHz is not very much greater than the response at the image frequency of 1,920kHz

(b). When the aerial tuned circuit is correctly aligned to 1,000kHz, the response at this frequency is very much greater than that at the image frequency

1,920kHz. And so an image signal at that frequency will get through. As also, of course, will the desired 1,000kHz signal but, due to the detuning, its amplitude won't be very much greater than the amplitude of the image singnal. Do you get the picture?" (Fig. 3(a).)

"Yes," replied Dick, "I think I can see what you're driving at."

"Well," said Smithy, "if we now readjust the aerial signal tuned circuit so that it resonates properly at 1,000kHz, we won't make any very noticeable difference to the amplitude of the second channel signal. But we will very greatly increase the amplitude of the required 1,000kHz signal so that, even though the second channel signal is still present, its amplitude will be so small relative to that of the required signal that it will in most instances have no audible effect in the receiver at all." (Fig. 3(b).)

TRIMMING CIRCUITS

"Stap me," said Dick slowly. "I've never looked upon the signal frequency tuned circuit of a medium and long wave superhet like that before. To get rid of image frequency whistles, then, you have to ensure that it's giving maximum boost to the desired signal so that any unwanted image signal fades into insignificance when compared with it."

"That's the idea," agreed Smithy. "You probably won't be able to get rid of ***all*** the second channel whistles on the medium wave band of a simple a.m. superhet receiver by careful alignment of the signal frequency tuned circuit. But you will certainly get rid of most of them."

"What about long waves?"

"The same situation applies," stated Smithy, "but due to the frequencies involved the problem is not quite so acute. Say you want to pick up Radio 4 on 1,500 metres, or 200kHz. With an i.f. of 460kHz the image pops up at 200 plus 920, or 1,120kHz. This is relatively further removed in terms of frequency ratio from the desired signal frequency than occurs with medium wave images and so the difficulties are not so great. With the less expensive sets you often find that more attention is paid on medium waves to ensuring that the signal resonant frequency is accurately peaked at all settings of the tuning control than is paid on long waves. With poor designs you may even find that, if the long wave signal resonant frequency is correct at the Radio 4 frequency of 200kHz, this is considered good enough."

"Why," asked Dick, "do the image signals give these whistles? Why don't you actually hear the sudio modulation which is present on the image signal?"

"You would do," replied Smithy, "if its amplitude were extremely strong. But the most audible effect is given by the image carrier, after conversion in frequency at the mixer, beating with the i.f. carrier of the required signal. The whistle changes in frequency as you vary the receiver tuning, by the way, because of the different frequencies at the output of the mixer. If oscillation frequency rises, for instance, the image carrier intermediate frequency decreases whilst the required signal intermiediate frequency increases."

Dick pondered on this for a moment.

"What did you mean just now," he queried, "when you said that medium and long wave sets usually have greater attention paid to correct signal frequency peaking on medium waves than occurs on long waves?"

MIXER CIRCUIT

Smithy leaned forward and picked up a sheaf of papers at the rear of his bench. He thumbed through these and gave a grunt of satisfaction as he located a service sheet on which was printed a receiver circuit diagram. He showed this to Dick, pointing to the mixer-oscillator section. (Fig. 4.)

"This," he commented, "is representative of what you get in a medium and long wave receiver when the circuitry is really cut to the bone."

"The wave-change switching certainly seems to be very basic," said Dick. "All it needs is a 2-pole 2-way switch."

"Exactly," confirmed Smithy. "Now let's see what happens when that switch is set to medium waves. The left-hand section of the switch takes the lower end of the medium wave ferrite rod coupling coil down to chassis via the 0.47μF capacitor, C1. That capacitor is virtually a dead short at r.f., and it also allows the mixer-oscillator transistor to receive d.c. base bias by way of R1 and R2. Right?"

"Right!" said Dick smartly. "And the right-hand section of the switch shorts out the long wave tuned winding on the ferrite aerial rod. So, everything is set up in the aerial department for medium wave reception."

"Quite so," said Smithy. "The prime requirement which has next to be met is to ensure that the ferrite aerial signal tuned circuit is always resonant at a frequency which is lower by the i.f. than the oscillator frequency at all settings of the 2-gang tuning capacitor, VC1(a) and (b). This is known, of course as 'tracking'. The aerial winding is tuned directly by VC1(a) and the trimmer TC2. The oscillator tuned winding has the padding capacitor, C4, between it and VC1(b). Another trimmer, TC4, is connected across VC1(b). The oscillator circuit is pretty straightforward, with positive feedback being given from the transistor collector back to its emitter."

"Does the padding capacitor cater for the fact that the oscillator tuning range is lower than the signal frequency tuning range?"

"It does. If we had a medium wave coverage of 550 to 1,500kHz, the oscillator range, with a 460kHz i.f., would be 1,010kHz to 1,960kHz. There is a lower ratio between maximum and minimum frequency, and so the oscillator tuned winding requires less tuning capacitance. The tuning capacitance is reduced by putting C4 in series with VC1(b). Now, the medium wave aerial and oscillator circuits can be aligned very accurately to give almost perfect tracking over the whole range by adjusting TC2 and TC4 at the high frequncy end of the band, and the inductance of the medium wave aerial coil and the inductance of the oscillator tuned winding at the low frequency end. You vary the aerial coil inductance by sliding the aerial coil along the ferrite rod and you vary the oscillator inductance by adjusting the core in the oscillator coil. Let's next move the switch to the long wave position."

"Righty-ho! Well, the switch section on the left connects C1 to the top end of the medium wave ferrite aerial coil via trimmer TC1. And the right-hand switch section takes the short off the long wave tuned winding."

"With the result," broke in Smithy, "that both tuned windings on the ferrite rod are in series for long wave reception as are both the coupling windings. The lower end of the coupling windings now effectively couples to chassis via R1 and R2. These resistors will offer some attenuation at long waves, which can be taken up by having a few more turns on the long wave coupling coil. The most important thing to notice takes place in the oscillator circuit. What happens here on long waves is that there is no change in tuning inductance at all. Instead, the right hand switch section simply puts C3 and the trimmer TC3 across VC1(b). These capacitors bring the oscillator frequency down to the range required for long wave tuned circuits, by means of TC1 and TC3, and you ***can*** adjust the inductance of the long wave aerial coil by sliding it along the ferrite rod. But you ***cannot*** adjust the inductance of the long wave oscillator tuned winding."

"Why not?"

"Because if you do you'll mess up the alignment on medium waves. You can only align the receiver by first lining up the medium wave range and ***then*** going to the long wave band. If the receiver is a good design, the result of the medium wave alignment will be such that you can get good tracking on long waves with the limited long wave adjustments which are available to you. Ideally, you should align the medium and long wave bands exactly as detailed in the receiver service manual. With the better class of receiver there will be precise frequency indications at the high and low frequency ends of the tuning scale to enable you to get the medium wave alignment spot-on. The situation for long waves will then be that which the receiver designer has decided will give optimum tracking on that band."

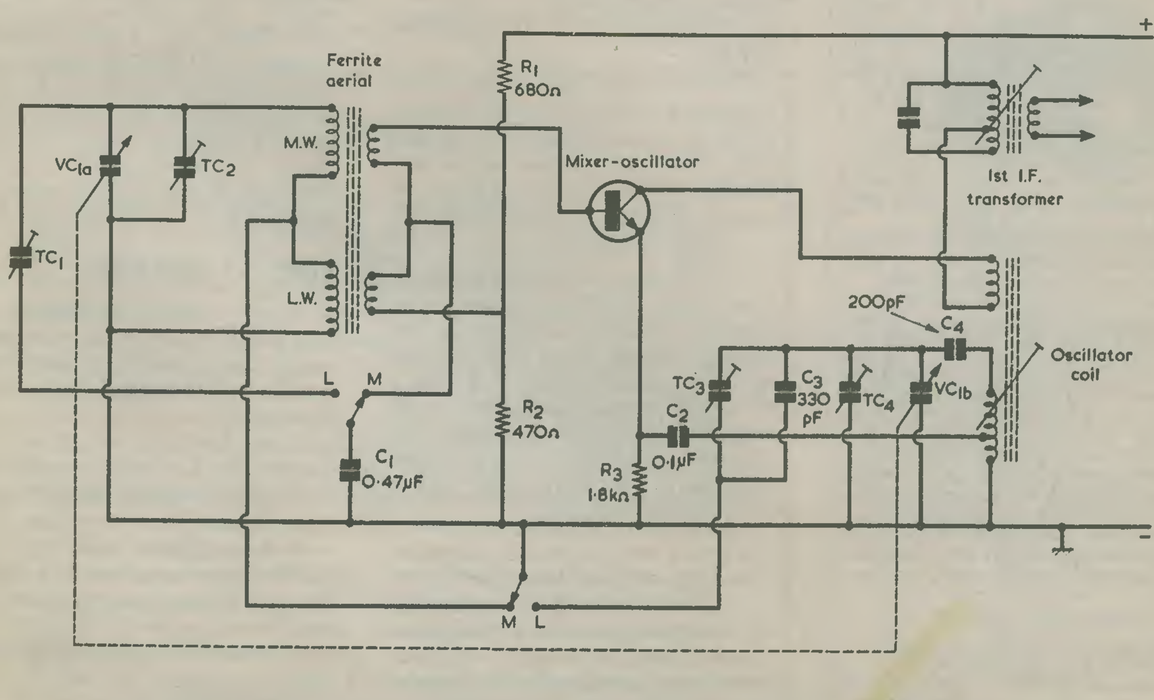


Fig. 4. Representative medium and long wave mixer-oscillator circuit as encountered in less expensive receivers. The most important point to note is that, on long waves, additional capacitance io connected across the medium wave oscillator tuned circuit

CROSS MODULATION

"Is that mixer-oscillator circuit you've shown me given in all medium and long wave receivers?"

"You'll find the same basic approach in most," replied Smithy. "The main variations will be in the way the ferrite rod windings are switched into circuit on the two bands. But you'll nearly always find that, on long waves, extra capacitance is added across the oscillator tuned circuit. Whereupon, once again, the medium wave band has to be aligned first."

Dick grinned.

"Do you realise," he said, "that all this discussion has arisen just because that little radio I serviced had image frequency whistles on it!"

Despite himself, Smithy grinned also.

"I can see that I've fallen into the usual trap," he chuckled. "Still, if I've given you some idea on how to avoid image interference on a.m. receivers the time has been well spent. I'd suggest you take that set you fixed back to your bench and give it a full line-up on medium and long waves before you consider it properly serviced."

"Okay-doke, Smithy."

A thought suddenly occurred to Smithy.

"Before you go," he remarked, "let me tell you about another sort of radio interference. This one disappears when the ***required*** signal ceases transmission!"

"Come on, Smithy. You're pulling my leg."

"No, I'm not. It's a form of interference which is mainly troublesome on communications receivers and which can cause some real design headaches. It's known as cross modulation interference."

"Cross modulation?"

"That's right. A strong a.m. signal can cross modulate another a.m. signal if they're applied to an amplifier stage which doesn't have a linear characteristic. If it has a non-linear characteristic the stage distorts the signal it amplifies, and this allows the two signals to beat together so that one cross modulates the other."

"I'm a bit lost here," confessed Dick. "Give me an example."

"All right," said Smithy obligingly. "Imagine you have a real super-duper communications receiver with two r.f. stages. Say it is tuned to 10MHz on the short wave bands, and that the aerial input tuned circuit has a useful selectivity of about 500kHz on either side of the required signal. The selectivity improves as you proceed through the set. After the first r.f. amplifier it is about 100kHz and after the second r.f. amplifier it is down to about 20kHz. Following that it goes through the mixer to the i.f. amplifier, whereupon the selectivity can be kept down to a very low figure." (Fig. 5 (a).)

"I'm with you so far."

"Well," continued Smithy, "let's next assume that the required signal at 10MHz is weak and that there's a whacking great broadcast transmitter pumping out a signal nearby at 10.3MHz. This will get through to the first r.f. amplifier quite easily and, if this amplifier has a non-linear response, the strong signal will then cross modulate the weak one. There is no way in which you can remove that cross mudulation after it has occurred at the first r.f. amplifier, even if the subsequent effective selectivity is nearly down to zero frequency on either side of the required signal. Cross modulation interference can be recognised because it disappears when the required signal goes off the air." (Fig. 5(b).)

"Blimey," said Dick, impressed, "that's something to think about. How d'you get over the trouble?"

"The only solution is to design the receiver so that all the amplifier stages in the early part of the receiver have very linear characteristics. Funnily enough, nobody worried too much about cross mudulation in communications receivers in the old valve days, because valves can easily be made to have quite linear characteristics. Cross modulation only started to cause real unhappiness when the communications receiver designers changed over to transistors."

END OF SESSION

"Well," said Dick happily, "at least communications receiver design isn't something which need trouble us too much here in the Workshop."

"True, true."

"In fact, we need not get at all uptight or angry about cross modulation."

Smithy sighed.

"And we can cheerfully whistle our way through second channel interference."

Smithy rummaged around on his bench.

"On reflection," persisted Dick mercilessly, "all we have to do is to present an acceptable image!"

Whereupon Dick ducked expertly

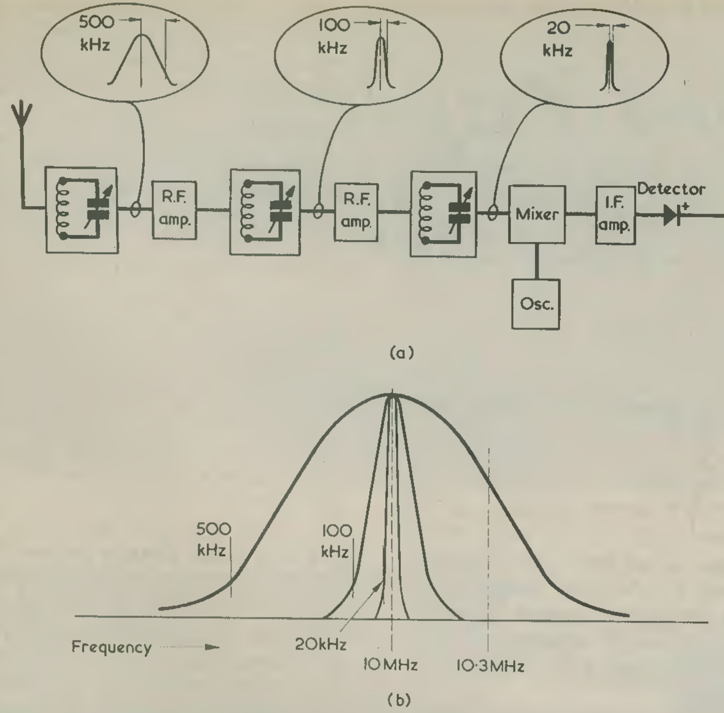


Fig. 5(a). The selectivity offered by a communications receiver with two r.f. amplifier stages increases after each tuned circuit

(b). The selectivity curves of the receiver superimposed on each other and centred on a desired reception frequency of 10MHz. If, due to non-linearity in the first r.f. stage, an interfering signal at 10.3MHz cross modulates the 10MHz signal, the interference cannot be removed by the subsequent tuned circuits even though they reject the 10.3MHz signal itself

as the 2,200μF 25V. Wkg. electrolytic sailed harmlessly past his right ear, after which he carried the medium and long wave receiver back to his bench for a full and final re-alignment. ■

NEW CATALOGUE

Readers will already, from our advertisement pages, be aware of the very wide range of low cost components available from Brian J. Reed of 161 St. John's Hill, Battersea, London SW11 1TQ. Brian J. Reed now inform us that after a mammoth stocktaking and compilation operation they have produced a 38 sheet (11 by 8 in.) catalogue listing approximately 5,250 items. The sheets are photocopied from masters, which can be amended daily to allow additions of new stocks and keep entries up to date.

Apart from many varied lines of resistors, capacitors and transformers, the catalogue includes semiconductors, valves, hardware and a considerable number of other items, some of which are not normally encountered in home constructor retail sales.

Without even considering machinery and labour costs, the paper alone costs about 80p per catalogue. In consequence a charge of 75p per catalogue has to be made, plus 24p postage. Readers requiring copies of the catalogue from Brian J. Reed should enclose a stamped addressed envelope or label. Vouchers are included with the catalogue to refund purchase price with orders.

Radio Topics

By Recorder

An elderly aunt of mine recently decided to buy a new radio, as her existing receiver did not have long waves for reception of Radio 4. Being a bit long in years but short in the purse she bought a very cheap medium and long wave job priced at only £8.95 retail. And to my mind she got quite a bargain, too.

The radio was one of those "made in Hong Kong" models in which costs had obviously been cut to the very bone. But, for its price, it performed well. There was excellent tracking on medium and long waves, and very few second channel whistles on either of these bands. The quality was a little lower than mid-fi, but you could still listen to serious music on it without wincing too much.

CIRCUIT DIAGRAM

With the instruction leaflet the makers had obligingly included a circuit diagram. After the mixer-oscillator transistor there were two i.f. stages, allowing the use of three single-tuned i.f. transformers. These had an acceptable and symmetrical passband. You can always get a good idea of the i.f. response of a radio of this nature by tuning slowly through a reasonably powerful signal in the middle to lower frequency end of the medium wave band. The background hiss should rise by equal amounts for equal movements of the tuning capacitor on either side of the central correctly tuned setting.

After the last i.f. transformer came the detector, with the volume control as load. Which means that that volume control will probably start to get scratchy in use at some time in the future. Then an a.f. amplifier transistor feeding an interstage push-pull transformer, followed by the two output transistors driving the speaker by way of another push-pull transformer. And nary the faintest whiff of negative feedback.

I confess to being a little baffled at the fact that these very low cost radios still employ transformers in the a.f. stages instead of the more modern transformerless circuits. Surely, the cost of two transformers having many turns of very fine wire is considerably greater than the price of the few resistors and capacitors that the more recent circuits would require. Still, somebody must have costed the production of this receiver and concluded that the transformers were cheaper. There must be a very cut-rate transformer factory out there in Hong Kong!

VOLUME CONTROL

Why, incidentally, did I say that the volume control could get scratchy in use because it was also the detector diode load? The answer is that, in addition to a.f., there will also be a direct voltage across the volume control track, partly due to the detected signal and partly due to the receiver a.g.c. circuitry.

Now a volume control, particularly one which has seen a good deal of use, does not give a perfectly smooth change of volume as it is adjusted. Instead, there are tiny little discrete hops in the changing resistance which is tapped off by the volume control slider. With a good control these changes are far too small to give an audible effect as the control is adjusted. Indeed, when there is only a.f. and no direct voltage across the track quite large hops in resistance can pass unnoticed by a listener. But when there is a direct voltage across the track, the result is a series of quick changes in ***voltage*** on the slider. These then pass through the following a.f. amplifier and become audible as a rushing noise as the control is adjusted. Fortunately, the effect has irritation value only, as the sound ceases when the control slider is stationary. On the other hand, the presence of the noise sometimes indicates that it won't be very long before contact between the slider and the track becomes actually intermittent at places, whereupon there is complete loss of audio at some settings of the volume control.

VARIABLE SPEED DRILL

Of interest to the do-it-yourself fraternity will be the new Skil electric ratcheting drill shown in the accompanying illustration. This is the Model 1471H, with a ½in. chuck and an input rating of 420 watts. A particularly attractive feature is the Skil patented electronic variable trigger speed control. Increasing pressure on the trigger accelerates the speed whilst less pressure reduces the number of revolutions per minute. Speed control also adds to the applications of the tool because the operator can start from zero and gradually increase the speed. Thus the drill bit will not skid off and damage the work piece, a point of considerable importance when drilling smooth surfaces or critical materials, such as ceramic or tile.

A speed control is also extremely useful for driving screws. With little effort many screws can be installed swiftly and accurately, exactly where they are wanted. For drilling holes into ceramic tiles into concrete, a variable speed ratchet-drill is virtually indispensable. On the tile the drilling action only is used, starting from zero and increasing the speed carefully; as soon as the concrete is reached the ratcheting system is switched on.

The no-load speed of the Model 1471H can be adjusted from zero to 2,600 r.p.m. and from zero to 36,000 blows per minute. Its weight is just about 2kg, and the drill is supplied with a side handle which mounts on either side of the body for right and left hand users. Further details may be obtained from Skil (Great Britain) Ltd., Fairacres Industrial Estate, Dedworth, Windsor SL4 4LE.

pretty swift operator with a soldering iron, but, even so, the transistors were manufactured to be soldered into circuit once only.

I wish that d.i.l. integrated circuits were as physically robust. I always use i.c. holders for checking out experimental circuits incorporating these devices but they can stand up to only a limited number of insertions and removals from the holders before one of the pins starts to take on the appearance of a dog's hind leg. The pin can be straightened out, of course, but after that there's always a lingering doubt that it will buckle up completely at the next insertion in a holder.

Still, these risks are all part of the game of experimental electronics. Some types of i.c. holder are surprisingly more difficult to use than others; if you have an awkward one it's a good plan to get used to it by plugging in some i.c.'s for which you have no further use. I keep a few old t.t.l. 7400 types on hand just for this purpose.

THAT SILICON CHIP

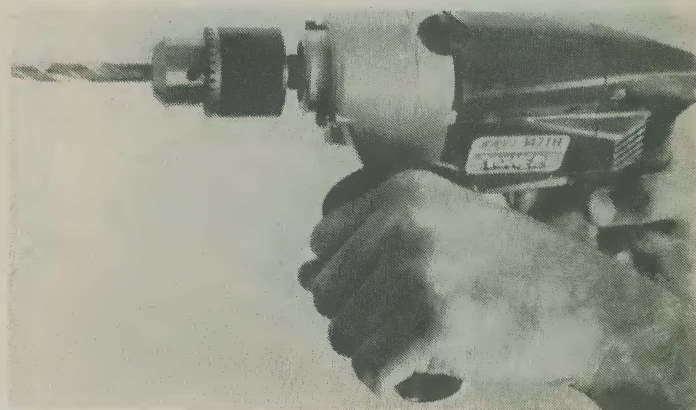
We are certainly entering the silicon chip revolution with a vengeance these days. You don't need a microprocessor to discover the fantastic computing power provided by current-day chip technology, you can find out by simply playing around with a relatively inexpensive programmable calculator. When our series "Tune-In To Programs" commenced I went out and bought myself a Texas Instruments TI-57, and I find myself marvelling more and more at the capabilities of this machine.

The programmed silicon chip has already taken over many jobs which previously relied on man's expertise, and there is no shadow of doubt that it will continue to do so. However, the chip has to be interfaced with the world around it. For mechanical production processes, the chip has to be coupled into the work being produced by transducers which assess dimensions, shapes and even quality. Somebody has to design and make the interfacing equipment.

Sadly, many traditional human skills, and the satisfactions which go with excercising them, will be lost in the day of the silicon chip. But the need for new skills and expertise will surely increase, to at least partly compensate for the loss. What, I think dismays many people about the advancing ascendancy of the chip is that it's all happening so darned ***quickly.***

The day of the robot worker approaches rapidly. Controlled, perhaps, by a silicon chip on its shoulder? ■

The new Skil Model 1471H ratcheting drill. This has the very useful feature of variable speed control, the drill revolutions being varied by the pressure exerted on the trigger



RE-USE OF PARTS

Electronic components are normally intended to be fitted once to the equipment for which they are destined and left there, only to be removed if at any time they should become faulty. And so the more experimentally minded amongst us must not grumble too much when we find, say, that the type numbers rub off transistors due to continual handling. As originally envisaged by their makers, transistor type number marking is quite acceptable if it withstands the handling of the operator on the production line who inserts them into their printed card.

I've got some BC107's which have been in so many experimental lash-ups that it's a wonder their locating lugs haven't worn away in addition to the type number printing! These transistors stand up to a fantastic amount of maltreatment including, in particular, continual bouts of heating as they are soldered first into one temporary circuit and then removed from that to be soldered into another. I'm a

VETERAN TRANSMITTERS

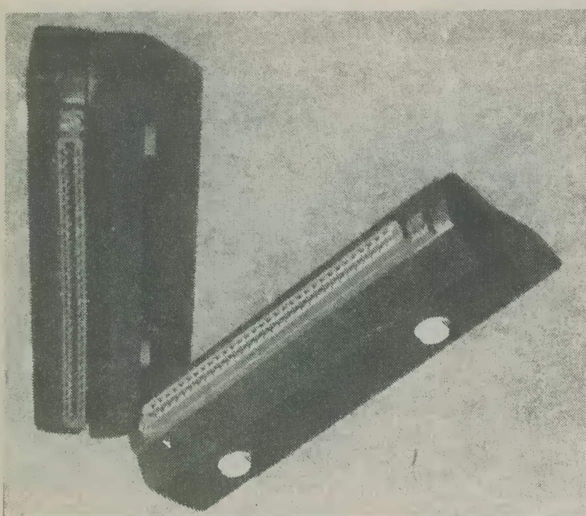
Did you realise that, before last November, you may have been listening to a.m. radio signals from B.B.C. transmitters which were installed before 1930? Incredible as it may seem, this little item is part of a Marconi release concerning the medium and long wave frequency changes of last year. The B.B.C. took advantage of the changeover to put into honourable retirement some very early Marconi transmitters which were installed nearly 50 years ago, and to open up a number of brand-new transmitters supplied by Marconi Communication Systems Limited.

P.C.B. WIRING JIGS

by T. F. Weatherley

An aid to printed circuit board assembly

The author is currently building a visual display unit, a project which involves assembling some 50 integrated circuits onto four double sided printed circuit boards. The wiring jigs described here have made the task much simpler, and they also ensure that there is less risk of dry soldered connections at any of the 800 i.c. pins. Soldering is certainly easier than is given with the more usual method of balancing the board on its components while working on the bench or kitchen table.

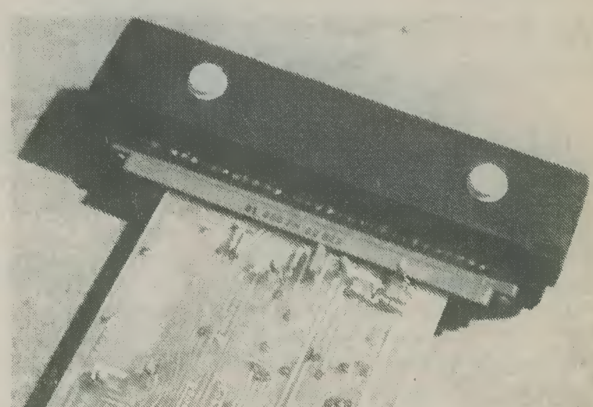


The two printed circuit board wiring jigs. The edge connectors are screwed to the inner edges of two of the pieces of wood, the remaining two lengths then being screwed to the first two pieces. Finally, eight white plastic stick-on feet are added, as shown

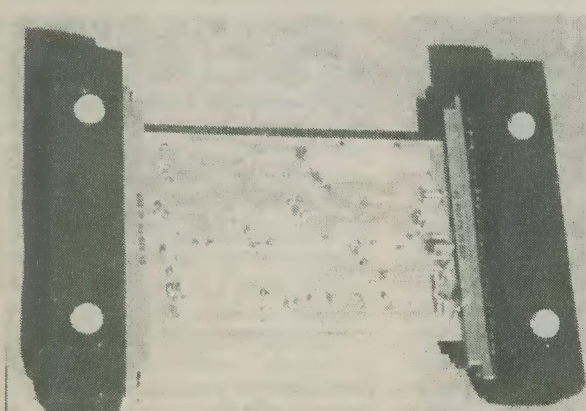
EDGE CONNECTORS

The main parts of the jigs are two edge connectors intended for making contact to double sided boards. They should have 32 or more pairs of contacts. The author's edge connectors were obtained ex-equipment and some of the tags were broken.

Also needed is about 27in. of softwood measuring about $\frac{3}{4}$ by $1\frac{1}{4}$in. The wood is cut into four equal lengths and, at this stage, these may be sprayed matt black, if desired. The edge connectors are screwed to the top edges of two of the pieces. The two remaining pieces are then screwed to the first two pieces in the manner shown in the photographs, using $1\frac{1}{4}$ by No. 6 countersunk woodscrews positioned about $1\frac{1}{4}$in. in from each end. There are two woodscrews for each pair of wood pieces.



Each end of the printed circuit board is held securely by the edge connector contacts



A printed circuit board secured to the two jigs. The four stick-on feet on the underside rest on the workbench surface. The whole assembly is simply turned over for work on the other side of the printed board

The finishing touch is provided by eight plastic stick-on feet, available from Maplin Electronic Supplies. These have an adhesive surface which is revealed by peeling off a backing sheet, and four of them are fitted to cover the heads of the woodscrews. The remaining four are mounted in corresponding positions on the opposite side of each jig.

The printed circuit board being worked on is held at each end by the edge connectors and can be turned over when necessary. With these jigs, work on a circuit board becomes a real pleasure. ■

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7421	20p	7470	25p	74108	100p	74153	45p	74179	120p	7423	20p
7422	15p	7472	20p	74109	25p	74154	70p	74180	[illegible]0p	7425	[illegible]
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LM308DIL	100p	MM5316	480p	TBA641A12	250p	XR4212	150p
LM309K	100p	NE529K	150p			XR4739	150p
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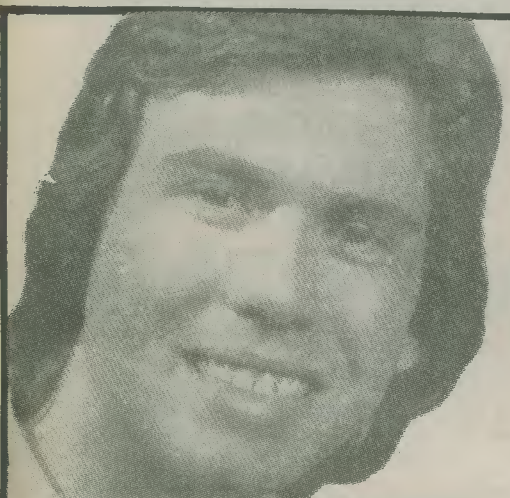

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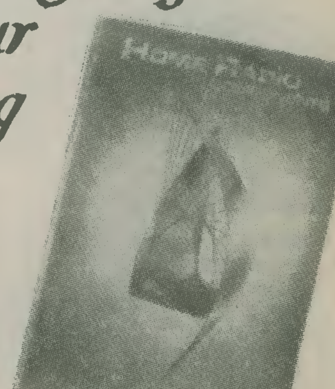

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