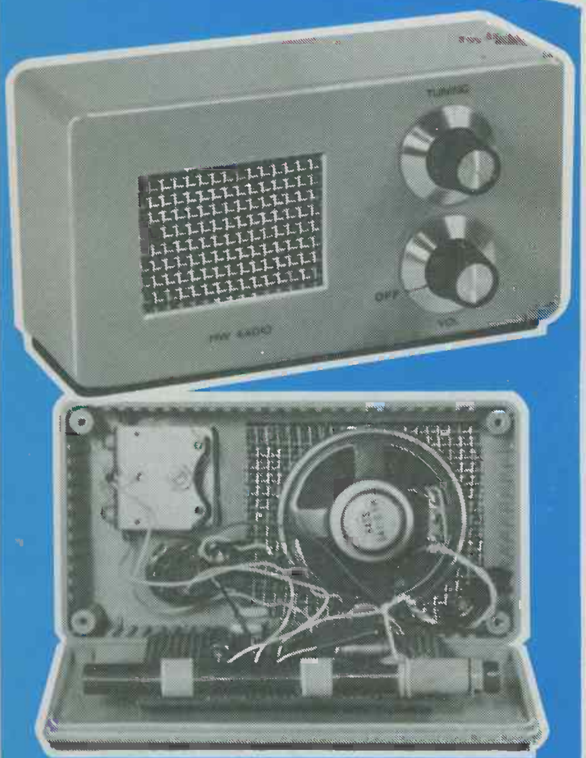
RADIO & ELECTRONICS CONSTRUCTOR

NOVEMBER 1979
50p



SINGLE CHIP M.W. RADIO

ULTRA SIMPLE MEDIUM WAVE
t.r.f. DESIGN

A.F. SIGNAL TRACER WITH
BUILT-IN AMPLITUDE ASSESSMENT

PEAK MILLIVOLT ASSESSOR

ALSO FEATURED

CMOS WIRE GUARD ALARM
ENVELOPE SHAPER

DIODES/ZENERS

QTY.	Part	Volts	Rating	Price
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zenner	.25
	1N4749	24v	1W	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N52448	14v	"	.25
	1N52458	15v	"	.25
	1N5349	12v	3W	.25

SOCKETS/BRIDGES

QTY.	Item				Price
	8-pin	pcb	.16	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.25	ww	.45
	18-pin	pcb	.30	ww	.95
	20-pin	pcb	.35	ww	1.05
	22-pin	pcb	.40	ww	1.15
	24-pin	pcb	.45	ww	1.25
	28-pin	pcb	.50	ww	1.35
	40-pin	pcb	.55	ww	1.45
	Molex pins	.01	To-3 Sockets		.35
	2 Amp Bridge	100-prv			.95
	25 Amp Bridge	200-prv			1.50

TRANSISTORS, LEDS, etc.

QTY.	Part	Description	Price
	2N2222M	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic)	.19
	2N3904	NPN (Plastic)	.19
	2N3054	NPN	.55
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.19
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.	Part	Price	QTY.	Part	Price
	9301	.85		9322	.65
	9309	.50		9601	.30
				9602	.45

MICRO's, RAMS, CPU's, E-PROMS

QTY.	Part	Price
	8T13	2.50
	8T23	2.50
	8T24	3.00
	8T97	1.75
	74S188	3.00
	1488	1.25
	1489	1.25
	1702A	4.50
	AM 9050	4.00
	ICM 7207	6.95
	ICM 7208	13.95
	MPS 6520	10.00
	MM 5314	4.00
	MM 5316	4.50
	MM 5387	3.50
	MM 5369	2.95
	TR 16028	3.95
	UPD 414	4.95
	Z 80 A	22.50
	Z 80	17.50
	Z 80 P10	10.50
	2102	1.45
	2102L	1.75
	21078-4	4.95
	2114	9.50
	2513	6.25
	2708	11.50
	2716 D.S.	34.00
	2716 (5v)	69.00
	2758 (5v)	26.95
	3242	10.50
	4116	11.50
	6800	13.95
	6850	7.95
	8080	7.50
	8085	22.50
	8212	2.75
	8214	4.95
	8216	3.50
	8224	4.25
	8228	6.00
	8251	7.50
	8253	18.50
	8255	8.50
	TMS 4044	9.95

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4-1-79

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	7400	.20		7492	.45		74H20	.25		74LS76	.70
	7401	.20		7493	.35		74H21	.25		74LS86	.95
	7402	.20		7494	.75		74H22	.40		74LS90	.85
	7403	.20		7495	.60		74H30	.30		74LS93	.85
	7404	.20		7496	.80		74H40	.35		74LS96	2.00
	7405	.35		74100	1.15		74H50	.30		74LS107	.90
	7406	.25		74107	.35		74H51	.30		74LS109	1.50
	7407	.55		74121	.35		74H52	.20		74LS123	1.95
	7408	.20		74122	.55		74H53	.25		74LS138	2.00
	7409	.25		74123	.55		74H55	.25		74LS151	.95
	7410	.20		74125	.45		74H72	.35		74LS153	1.15
	7411	.25		74126	.45		74H74	.35		74LS157	1.15
	7412	.25		74132	.75		74H101	.95		74LS160	1.15
	7413	.45		74141	.90		74H103	.55		74LS164	2.90
	7414	.75		74150	.85		74H106	1.15		74LS193	2.00
	7416	.25		74151	.95		74L00	.30		74LS195	1.15
	7417	.40		74153	.95		74L02	.30		74LS244	2.90
	7420	.25		74154	1.15		74L03	.35		74LS259	1.50
	7426	.25		74156	.70		74L04	.40		74LS298	1.50
	7427	.25		74157	.65		74L10	.30		74LS367	1.95
	7430	.20		74161/9316	.75		74L20	.45		74LS368	1.25
	7432	.30		74163	.85		74L30	.55		74LS373	2.50
	7437	.20		74164	.75		74L47	1.95		74S00	.45
	7438	.30		74165	1.10		74L51	.65		74S02	.45
	7440	.20		74166	1.75		74L55	.85		74S03	.35
	7441	1.15		74175	.90		74L72	.65		74S04	.35
	7442	.55		74176	.95		74L73	.70		74S05	.45
	7443	.45		74177	1.10		74L74	.75		74S08	.45
	7444	.45		74180	.95		74L75	1.05		74S10	.45
	7445	.75		74181	2.25		74L85	2.00		74S11	.45
	7446	.70		74182	.75		74L93	.75		74S20	.35
	7447	.70		74190	1.25		74L123	1.95		74S22	.55
	7448	.50		74191	1.25		74LS00	.40		74S40	.30
	7450	.25		74192	.75		74LS01	.40		74S50	.30
	7451	.25		74193	.85		74LS02	.45		74S51	.35
	7453	.20		74194	.95		74LS03	.45		74S64	.15
	7454	.25		74195	.95		74LS04	.45		74S74	.70
	7460	.40		74196	.95		74LS05	.45		74S112	.60
	7470	.45		74197	.95		74LS08	.45		74S114	.85
	7472	.40		74198	1.45		74LS09	.45		74S133	.85
	7473	.25		74221	1.50		74LS10	.45		74S140	.75
	7474	.30		74298	1.50		74LS11	.45		74S151	.95
	7475	.35		74367	1.35		74LS20	.45		74S153	.95
	7476	.40		75491	.65		74LS21	.45		74S157	.98
	7480	.75		75492	.65		74LS22	.45		74S158	.80
	7481	.85		74H00	.20		74LS32	.50		74S194	1.50
	7482	.95		74H01	.30		74LS37	.45		74S196	2.00
	7483	.95		74H04	.30		74LS38	.65		74S257 (8123)	2.50
	7485	.75		74H05	.25		74LS40	.70		8131	2.75
	7486	.55		74H08	.35		74LS42	.95			
	7489	1.05		74H10	.35		74LS51	.75			
	7490	.55		74H11	.25		74LS74	.95			
	7491	.70		74H15	.45		74LS75	1.20			

C MOS

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	4000	.15		4017	.75		4034	2.45		4069/74C04	.45
	4001	.20		4018	.75		4035	.75		4071	.25
	4002	.25		4019	.35		4037	1.80		4081	.30
	4004	3.95		4020	.85		4040	.75		4082	.30
	4006	.95		4021	.75		4041	.69		4507	.95
	4007	.25		4022	.75		4042	.65		4511	.95
	4008	.75		4023	.25		4043	.50		4512	1.50
	4009	.35		4024	.75		4044	.65		4515	2.95
	4010	.35		4025	.25		4046	1.25		4519	.85
	4011	.30		4026	1.95		4047	2.50		4522	1.10
	4012	.25		4027	.35		4048	1.25		4526	.95
	4013	.40		4028	.75		4049	.65		4528	1.10
	4014	.75		4029	1.15		4050	.45		4529	.95
	4015	.75		4030	.30		4052	.75		MC14409	14.50
	4016	.35		4033	1.50		4053	.95		MC14419	4.85
							4066	.75		74C151	2.50

I²L, LINEARS, REGULATORS, ETC.

QTY.	Part	Price	QTY.	Part	Price	QTY.	Part	Price
	MCT2	.95		LM320K24	1.65		LM373	3.95
	8038	3.95		LM320T5	1.65		LM377	3.95
	LM201	.75		LM320T12	1.65		78L05	.75
	LM301	.45		LM320T15	1.65		78L12	.75
	LM308	.65		LM323K	5.95		78L15	.75
	LM309H	.85		LM324	1.25		78M05	.75
	LM309 (340K-5)	1.50		LM339	.75		LM380 (8-14 Pin)	1.19
	LM310	.85		7805 (340T5)	1.15		LM709 (8-14 Pin)	.45
	LM311 (8-14 Pin)	.75		LM340T12	.95		LM711	.45
	LM318	1.50		LM340T15	.95		LM723	.40
	LM320H6	.79		LM340T18	.95		LM725	2.50
	LM320H15	.79		LM340T24	.95		LM739	1.50
	LM320H24	.79		LM340K12	1.25		LM741 (8-14)	.45
	7905 (LM320K5)	1.65		LM340K15	1.25		LM747	1.10
	LM320K12	1.65		LM340K18	1.25		LM1307	1.75
	LM320K15	1.65		LM340K24	1.25		LM1458	.65
							LM3900	.95
							LM75451	.65
							NE555	.45
							NE556	.85
							NE565	1.15
							NE566	1.25
							NE567	.95
							TA7205	6.95
							76477	2.95
							95H90	9.95

CABLE ADDRESS: ICUSD

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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.

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THE DECEMBER ISSUE WILL BE PUBLISHED ON 5th NOVEMBER

MOTORS
1.5-6VDC Model Motors **22p.** Sub. Min. 'Big Inch' 115VAC 3 rpm Motors **32p.** 12VDC 5 Pole Model Motors **37p.** 8 track 12V Replacement Motors **55p.** Cassette Motors 5-8VDC ex. equip. **70p.** Geared Mains Motors (240V) 2.5 rpm **75p.** 115VAC 4 rpm Geared Motors **95p.**

SEMICONDUCTORS
C106D 400V 2.5A SCR **20p.** 2N5062 100V 800mA SCR **18p.** BX504 Opto Isolator **25p.** CA3130 **95p.** TBA800 **50p.** 741 **22p.** 741S **35p.** 723 **35p.** NE555 **24p.** LM3400 **40p.** AD161/2 **70p.** 2N3055 **38p.** ZN414 **75p.** BD238 **28p.** BD438 **28p.** IN4005 **10 for 35p.** TIL305 alpha numeric displays **£2.50.** TIL209 Red Leds **8p each.** 0.5" 7 segement Led display. Comm. Cathode, green, full spec. **85p each.**

PROJECT BOXES
Sturdy ABS black plastic boxes with brass inserts and lid. 75 x 56 x 35mm **54p.** 95 x 71 x 35mm **65p.** 115 x 95 x 37mm **75p.**

AMP MULTIWAY IN-LINE PLUGS AND SOCKETS,
3 way 35p, 6 way 45p, 12 way 55p, per pair.

CHANGEOVER REED SWITCH
2½" Long **35p.** Glass Mercury Switch ½" x ⅛", long leads, **35p.**

MULTIMETERS
NH55 2,000 o.p.v. IKV AC/DC. 100ma DC current, 2 resistance ranges to Imeg. **£5.95. MODEL 72606** 20,000 opv 1,000 volts AC/DC., 250ma DC current, resistance 3 ranges to 3meg, dimensions 127 x 90 x 32mm, mirror scale **£11.75p.** HANSEN AT210 100,000 opv 1.2KV AC/DC., 12 amps AC/DC current, resistance to 200 meg in 4 ranges, capacitance 200pf-0.2mfd, 1,00pf-Imfd., decibel range, internal safety fuse, dimensions 160 x 105 x 50mm, an excellent meter, **£34.50p.**

MORSE KEYS
Beginners practice key **£1.05.** All metal fully adjustable type. **£2.60.**

MINIATURE LEVEL METERS
1 Centre Zero 17 x 17mm **75p.** 2 (scaled 0-10) 28 x 25mm **75p.** 3 Grundig 40 x 27mm **£1.25.**

STEREO HEADPHONES 8 ohms adjustable headband with lead and stereo jack, **£2.95.**
CAR AERIAL 5 section telescopic, wing mounting with 2 pull up keys **£1.35.**

JUMPER TEST LEAD SETS
10 pairs of leads with various coloured croc clips each end (20 clips) **90p per set.**

TRANSFORMERS
All 240VAC Primary (postage per transformer is shown after price). MINIATURE RANGE: 6-0-6V 100mA, 9-0-9V 75mA and 12-0-12V 50mA all 79p each (15p). 12-0-12V 100mA **99p (15p).** 0-6V 0-6V. 280mA **£1.20 (20p).** 0-4-6-9V 200mA these have no mounting bracket, **70p (15p).** 12V 500mA **99p (22p).** 12V 2 amp **£2.75 (45p).** 15-0-15V 3 amp Transformer at **£2.85 (54p).** 30-0-30V 1 amp **£2.85 (54p).** 20-0-20V 2 amp **£3.65 (54p).** 0-12-15-20-24-30V 2 amp **£4.75 (54p).** 20V 2.5 amp **£2.45 (54p).**

TRIAC/XENON PULSE TRANSFORMERS
1:1 (gpo style) 30p. 1:1 plus 1 sub. min. pcb mounting type 60p each.

MICROPHONES
Min. tie pin. Omni, uses deaf aid battery (supplied), **£4.95,** ECM105 low cost condenser, Omni, 600 ohms, on/off switch, standard jack plug, **£2.95.** EM507 Condenser, uni, 600 ohms, 30-18kHz., highly polished metal body **£7.96p.** DYNAMIC stick microphone dual imp., 600 ohms or 20K, 70-17khz., attractive black metal body **£7.75p.** EM506 dual impedance condenser microphone 600 ohms or 50K, heavy chromes copper body, **£12.95.** CASSETTE replacement microphone with 2.5/3.5 plugs **£1.35.** INSERT Crystal replacement 35X10mm **40p.** GRUNDIG electric inserts with FET preamp, 3-6VDC operation **£1.00.**

LIGHT DIMMER
240VAC 800 watts max., wall mounting, has built in photo cell for automatic switch on when dark **£4.50**

RIBBON CABLE
8 way single strand miniature **22p per metre.**

SPEAKERS
5" Round 8 ohms 5 watts **£1.35.** 6" round 6 watt 8 ohms with cambric surround **£2.75.** Elac 8" 8 ohm long throw speaker, 18 watts twin cone **£4.75.** Mid-Range 5" speaker 850-7khz 20 watts **£1.45.**

INTERCOM UNITS (can be used as baby alarm) supplied with 60' cable, with call button, 2 station model **£5.25,** 3 station model **£7.25.**

PANEL METERS
Ferranti 0-600VAC 3.5" square **£2.95.** Japanese type 60 x 47 x 33mm clear plastic type; 50 micro, 100 micro, 1Ma, 2 amp, 25 volts, 300 VAC, 'S', 'VU', all **£5.25 each.** Larger type 110 x 82 x 35mm; 50 micro, 100 micro **£6.35 each.**

CAR STEREO SPEAKERS
Shelf mounting in black plastic pods with 5" 5 watt speaker available in 4 or 8 ohms **only £3.95 per pair.**

MURATA MA401
40kHz Transducers. **Rec./Sender £3.50 pair.**

ELECTRICAL ITEMS
13 amp 3 pin plugs plastic **27p,** rubber **62p,** 13 amp rubber extension sockets **42p,** 12 way flexible terminal blocks; 2 amp **20p,** 5 amp **24p,** 10 amp **33p,** 15 amp **47p.** Standard batten (BC lampholders **27p.**

PUSH BUTTON TV TUNERS
UHF, not varicap, transistorised new **£2.25**

TELEPHONE PICK UP COIL
Sucker type with lead and 3.5mm plug **62p.**

RELAYS
Plastic Encap. Reed Relay, 0.1 matrix. 1kΩ coil, 9-12VDC normally open, **35p.** Miniature encapsulated reed relay 0.1 matrix mounting, single pole make, operates on 12VDC **50p each.** Continental series, sealed plastic case relays, 24VDC 3pole change over 5 amp contacts, new **65p.** Printed circuit Mtg., Reed relay, single make. 20mm x 5mm, 6-9VDC. coil, **33p each.** Metal Cased Reed Relay, 50 x 45 x 17mm, has 4 heavy duty make reed inserts, operates on 12VDC **35p each.** Magnets ½" long ⅛" thick with fixing hole, **10 for 40p.**

Dalo 33PC Etch Resist printed circuit maker pen, with spare tip, **79p.**

TERMS:
Cash with Order (Official Orders welcomed from colleges etc). 30p postage please unless otherwise shown. VAT inclusive.
S.a.e. for new illustrated lists.

AEROSOL SERVICE AIDS, SERVISOL
Switch Cleaner 226gm **60p.** Freezer 226gm **70p.** Silicone Grease 226gm **70p.** Foam Cleanser 370gm **60p.** Plastic Seal 145gm **60p.** Excel Polish 240gm **47p.** Aero Klene 170gm **55p.** Aero Duster 200gm **70p.**

SURPLUS BOARDS
No. 1. this has at least 11 C106 (50V 2.5A) plastic SCR's, one relay a unijunction transistor and tantalum capacitors **£1.95.** No. 2 I.F. Boards, these are a complete I.F. board assembly made for car radios, 465Khz, full set of I.F.'s and oscillator coils, trimmers etc., **40p each.** No. 3 Board with two BDY60 Power Transistors, **45p each.**

POWER SUPPLIES
SWITCHED TYPE, plugs into 13 amp socket, has 3-4.5-6-7.5 and 9 volt DC out at either 100 or 40 0mA, switchable **£3.45.** HC244R STABILISED SUPPLY, 3-6-7.5-9 volts DC out at 400mA max., with on/off switch, polarity reversing switch and voltage selector switch, fully regulated to supply exact voltage from no load to max. current **£4.95.**

AMPHENOL CONNECTORS
(PL259) PLUGS **47p.** Chassis sockets **42p.** Elbows PL259/SO239 **90p.** Double in line male connector (2XPL259) **65p.** Plug reducers **13p.** PL259 Dummy load, 52 ohms 1 watt with indicator bulb **95p.**

BUZZERS
MINIATURE SOLID STATE BUZZERS, 33 x 17 x 15mm white plastic case, output at three feet 70db (approx), low consumption only 15mA. four voltage types available, 6-9-12 or 24VDC, **80p each. LOUD** 12VDC BUZZER, Cream plastic case, 50mm diam. x 30mm high **63p.** GPO OPEN TYPE BUZZER, adjustable works 6-12VDC **27p.** 12VDC siren, all metal rotary type, high pitched wail, **£7.50.**

TOOLS
SOLDER SUCKER, plunger type, high suction, teflon nozzle, **£4.99** (spare nozzles **69p each).**
Good Quality snub nosed pliers, insulated handles, 5" **£1.45.**
Antex Model C 15 watt soldering irons, 240VAC **£3.95**
Antex Model CX 17 watt soldering irons, 240VAC **£3.95.**
Antex Model X25 25 watt soldering irons, 240VAC **£3.95.**
Antex ST3 iron stands, suits all above models **£1.65.**
Antex heat shunts **12p each.**
Servisol Solder Mop **50p each.**
Neon Tester Screwdrivers 8" long **43p each.**
Miyarna IC test clips 16 pin **£1.95.**

SWITCHES
Sub. miniature toggles; SPST (8 x 5 x 7mm) **52p.** DPT (8 x 7 x 7mm) **62p.** DPT centre off 12 x 11 x 9mm **77p.** PUSH SWITCHES, 16 x 6mm, red top, push to make **14p each,** push to break version (black top) **16p each.** G.P.O. Telephone handsets **£1.95p.** Electrolytic Caps, can type, 2,200mfd and 2,200mfd 50VDC **35p each.**

MICRO SWITCHES
Standard button operated 28 x 25 x 8mm make or break, new **15p each.** Roller operated version of the latter, New **19p each.** Light action micro, 3 amp make or break 35 x 20 x 7mm, **12p each.** Cherry plunger operated micro, 2 normally open, 2 normally closed, plunger 20mm long (40 x 30 x 18mm) **25p each.**

PUSH BUTTON UNITS
6 way, 3 DPDT, 3 4 pole c/o **55p,** 8 way, 5 DPDT, 3 4 pole c/o **70p.** RANK ARENA magnetic cartridge pre-amplifier modules, new with connection details **£1.95p.**

TAPE HEADS
Mono cassette **£1.75.** Stereo cassette **£3.90.** Standard 8 track stereo **£1.95.** BSR MN1330 ½ track **50p.** BSR SRP90 ¼ track **£1.95.** TD10 tape head assembly – 2 heads both ¼ track R/P with built in erase, mounted on bracket £1.20.

PROGRESSIVE RADIO
31 CHEAPSIDE, LIVERPOOL 2.
ALL ORDERS DESPATCHED BY RETURN POST

STEVENSON
Electronic Components

CMOS

		4020	50p	4050	25p
		4022	50p	4060	80p
		4023	13p	4066	30p
		4024	40p	4068	13p
4001	13p	4025	13p	4069	13p
4002	13p	4026	90p	4070	13p
4007	13p	4027	28p	4071	13p
4009	30p	4028	45p	4072	13p
4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
4015	50p	4042	55p	4511	60p
4016	28p	4043	50p	4518	65p
4017	47p	4046	90p	4520	60p
4018	55p	4049	25p	4528	60p

FULL DETAILS IN CATALOGUE!

TTL

		7473	20p	74141	55p
		7474	22p	74145	55p
7400	10p	7475	25p	74148	90p
7401	10p	7476	20p	74150	55p
7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

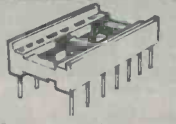
OPTO

LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
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

SKTS



Low profile by Texas

8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
16pin	11p	22pin	17p	40pin	32p

3 lead T018 or T05 socket. 10p each
Soldercon pins: 100:50p 1000:370p

PCBS

VEROBOARD

Size in.	0.1in.	0.15in.	
25 x 1	14p	14p	Vero Cutter 80p.
2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion tool 108p
3.75 x 5	64p	64p	
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

Top quality fibre glass copper board Single sided Size 203 x 95mm. 60p each.
'Dalo' pens 75p each.
Five mixed sheets of Alfac 145p per pack.

RESISTORS

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

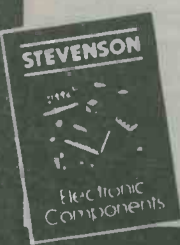
	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

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



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		LF356	80p	NE531	98p
		LM301AN	26p	NE555	23p
		LM308	60p	NE556	60p
		LM318N	75p	NE567	100p
		LM324	45p	RC4136	100p
709	35p	LM339	45p	SN76477	230p
741	16p	LM378	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
7106	850p	LM3900	50p	TL081	45p
7107	900p	LM3909	65p	TL084	125p
CA3046	55p	LM3911	100p	ZN414	80p
CA3080	70p	MC1458	32p	ZN425E	390p
CA3130	90p	MM57160	590p	ZN1034E	200p

TRANSISTORS

				ZTX500	16p
				2N697	12p
		BCY72	14p	2N3053	18p
AC127	17p	BD131	35p	2N3054	50p
AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
BC212	10p				
BC212L	10p				
BC214	10p				
BC214L	10p				
BC477	19p				
BC478	19p				
BC548	10p				
BCY70	14p				
BCY71	14p				

DIODES

1N914	3p	1N4006	6p
1N4001	4p	1N5401	13p
1N4002	4p	BZY88 ser.	8p

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

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

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

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ANTEX X25 (25W) or ANTEX CX (17W) 390p each
Reel of solder (39.6M) 240p each

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56mm dia. 8ohms. 70p 64mm dia. 64ohms. 75p
64mm dia. 8ohms. 75p 70mm dia. 8ohms. 100p
Magnetic earpiece including 2.5 or 3.5mm plug. 15p each
Crystal earpiece including 3.5mm plug. 30p each

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Subminiature toggle. SPDT 70p. DPDT 80p.
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Slide switches (DPDT) miniature or standard 15p.
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Wavechange switches: 1P12W, 2P6W, 3P4W, 4P3W. 43p

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Connection cable available in single or stranded packs of eight colours.

	Single	Stranded
8 metre pack	18p	18p
40 metre pack	85p	80p

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Battery clips for PP3 with lead. 6p each.
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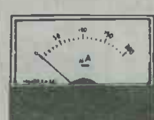
Murata Ultrasonic Transducers. 180p each. 350p pair.

PANEL METERS



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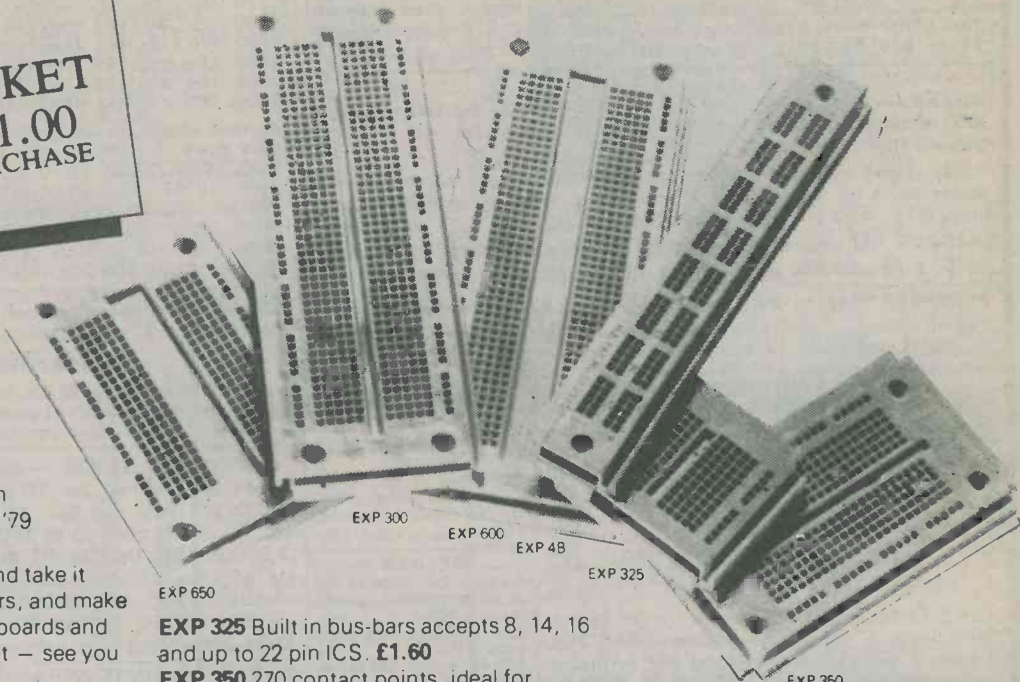

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   A matchboard pre-drilled PCB £1.32
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Printed circuit B7G	7p
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Speaker 6" x 4" 5 ohm ideal for car radio £1.55
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Car type panel lock and key 65p

Transformer 9V 4A £4.00

Aluminium Knobs for $\frac{1}{4}$" shaft. Approx. $\frac{5}{8}$" x $\frac{7}{8}$" 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 **10p**

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.**

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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 **£4.50.**

SWITCHES

Pole	Way	Type	
1	2	Slide	15p
6	2	Slide	24p
2	1	Rotary Mains	$14\frac{1}{2}$p
2	Alternating	Micro with roller	30p
2	3	Miniature Slide	20p
2	1	Toggle	42p
1	2	Sub-Min Toggle	75p
2	Alternating	2A Mains Push ($\frac{3}{8}$" hole)	43p
2	Alternating	Slide	15p

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **39p**, 1 pole 2 way 10 amp oblong clip in mains rocker appliance switch **30p**
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 **73p**

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E299DDP120 / 218 / 224 / 338 / 340 / 350 / 352 · YF020 · E220ZZ/02 · KR150 All 22p
E23 glass bead 85p
YG150-S534 bead, K813, E299 DHP230, 116-121 401 (TH7. VA1104, OD10) 35p. R53 Glass £1.20

Miniature 0 to 5mA d.c. meter approx $\frac{7}{8}$" diameter **£1.25**
RS Yellow Wander Plug Box of 12 **40p**
18 SWG multicore solder **$3\frac{1}{2}$p 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

Up to MFD	10V	25V	50V	63–75V	100V	200–250V	300–350 V	450–500V
10	6p	7p	7p	8p	13p	15p	26p	27p
25	6p	7p	7p	8p	13p	18p	32p	37p
50	6p	7p	7p	9p	16p	23p	32p	37p
100	7p	8p	13p	10p	24p	31p	–	–
250	12p	$11\frac{1}{2}$p	15p	22p	36p	–	45p	90p
500	13p	15p	22p	30p	55p		£1.48	90p
1000	16p	25p	50p	54p	25p	66p	–	–
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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 **£1.70** 200-200-100-32/350V **85p**

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R.S. Scale Print, pressure transfer sheet 12p

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(VOLTIAC)

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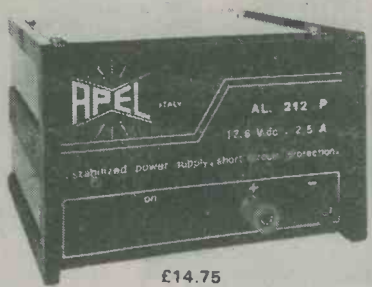
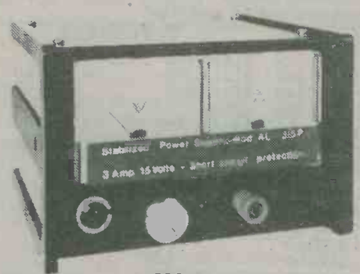


£14.75

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.

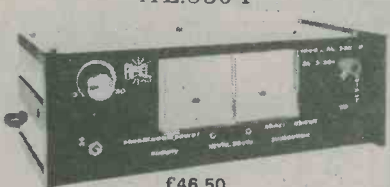
AL.315 P



£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



£46.50

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

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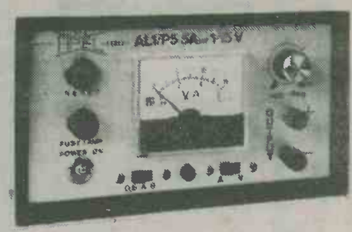
AL.1 P5



£78.00

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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SUGGESTED CIRCUIT

CMOS GUARD WIRE ALARM

By G. A. French

It is a common sight nowadays to see guard wires threaded through the handles or other apertures of expensive items offered for sale in the larger stores. Shoplifters cannot then steal these items because to do so they would have to cut or otherwise break the circuit completed by the guard wire, with the result that an alarm would be given.

It is possible to construct a comprehensive guard wire system at quite low cost, and this month's "Suggested Circuit" article describes a design in which the protective logic is carried out by two inexpensive CMOS chips. The system is entirely battery operated and draws a quiescent current of the order of 40μA from the battery which supplies the CMOS circuitry. This small current means that the battery needs to be replaced only after a very long period of service, with consequent low running costs. The alarm is given by an electric bell which is powered by a separate battery. A feature of the circuit is that the bell is successively turned on and off in 1 second periods, a factor which is even more capable of drawing attention than is a continuous ringing.

THE GUARD WIRE

The guard wire could consist of a single flexible wire through which a current flows continually. The current would then be interrupted, and the alarm consequently given, if the wire were cut. However, such an approach provides little protection from a thief having even an elementary knowledge of electricity, as it is merely necessary to bridge the wire on either side of a point at which it is intended that it be cut. The bridging could be carried out by means of a second piece of wire connected to pins at each end which would merely need to be passed through the guard wire insulation to make contact with the wire itself. Obviously, a more sophisticated approach is required.

The guard wire technique employed in the present design is illustrated in Fig. 1. Here, the guard wire consists of a length of flexible insulated audio screened wire, in which the outer conductor is braided rather than lapped. The wire is terminated in two coaxial plugs with, of course, the centre wire connecting to the centre conductor of each plug and the braiding connecting to the outer conductor of each plug. The plugs are fitted into sockets SK1 and SK2, The 9 volt supply is that which feeds the CMOS devices in the alarm system.

Under normal conditions the positive supply rail connects via SK1, the screened wire braiding and SK2 to point B which is, in consequence, normally high (i.e. at the potential of the positive rail). If, for any reason, the circuit provided by the braiding is interrupted, resistor R2 causes point B to be taken low. A second circuit from the negative rail is given through R3, SK2, the centre wire of the screened cable, SK1 and R1, terminating at the positive rail. Because R3 has a much lower value than R1, the voltage at point A is normally very close to the negative supply rail and is consequently low. Should the centre conductor circuit be interrupted, R1 causes point A to go high.

A third eventuality is that the centre wire and the braiding of the screened wire could be short-circuited together, due possibly to a thief passing a pin through the wire or otherwise meddling with it. If this should happen, a circuit is com-

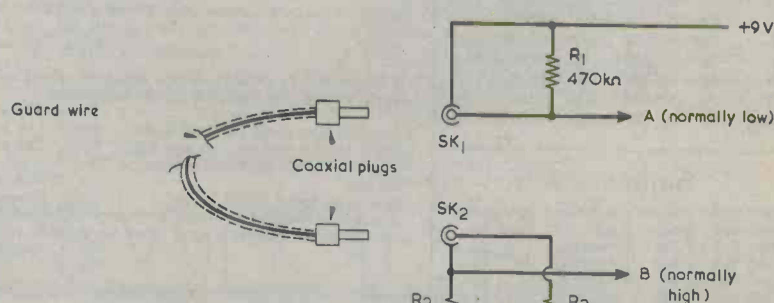


Fig. 1. The basic guard wire circuitry. The potentials at points A and B change to the alarm state if either the screened wire braiding or centre conductor are cut or if they are short-circuited together

pleted from the positive rail to the negative rail through SK1, the screened wire braiding, the short-circuit, the centre conductor of the screened wire, SK2 and R3. The result of the short-circuit is that point A is taken high. The short-circuit current is limited to slightly less than 1mA by R3.

To sum up, point B is normally high and point A is normally low. If the screened wire braiding is cut, point B goes low. Should the screened wire centre conductor be cut, point A goes high. Point A also goes high if the screened wire braiding and centre conductor are short-circuited together. A voltage change at point A or at point B is detected virtually instantly by the CMOS circuitry to which the points connect, and a CMOS latch is tripped which causes the alarm to sound continually even if the circuit break or short-circuit is subsequently made good. The alarm can only be silenced by switching off the 9 volt supply.

The only way the guard wire system of Fig. 1 can be defeated is by removing the screened wire insulation at two points, making gaps in the braiding at these points without cutting it, and then bridging over the braiding and centre conductor by two separate wires before cutting the screened wire between the two points. This bridging process would, furthermore, have to be carried out without accidentally short-circuiting together the screened wire centre conductor and braiding. Hardly a task which would commend itself to even the most dedicated of shoplifters!

The normal quiescent current drawn from the 9 volt supply by the guard wire circuit is that which flows through R1, R2 and R3. This calculates out as 38μA. An incidental advantage of the screened wire approach is that the screened wire braiding is directly connected to the positive supply rail. Neither the braiding nor the centre conductor can, as a result, pick up stray random electrical noise and give false triggering of the alarm.

COMPLETE CIRCUIT

The complete circuit of the alarm system is given in Fig. 2, and it will be seen that the circuit detail of Fig. 1 appears at the left hand end. Gates G1 to G4 are the four NAND gates in a CD4011 CMOS i.c., and all are used as inverters. Gates G3 and G4 form a latch, and the presence of C1 ensures that, at switch-on, the latch takes up the state where the input to G3 is low. The output of this gate is then high

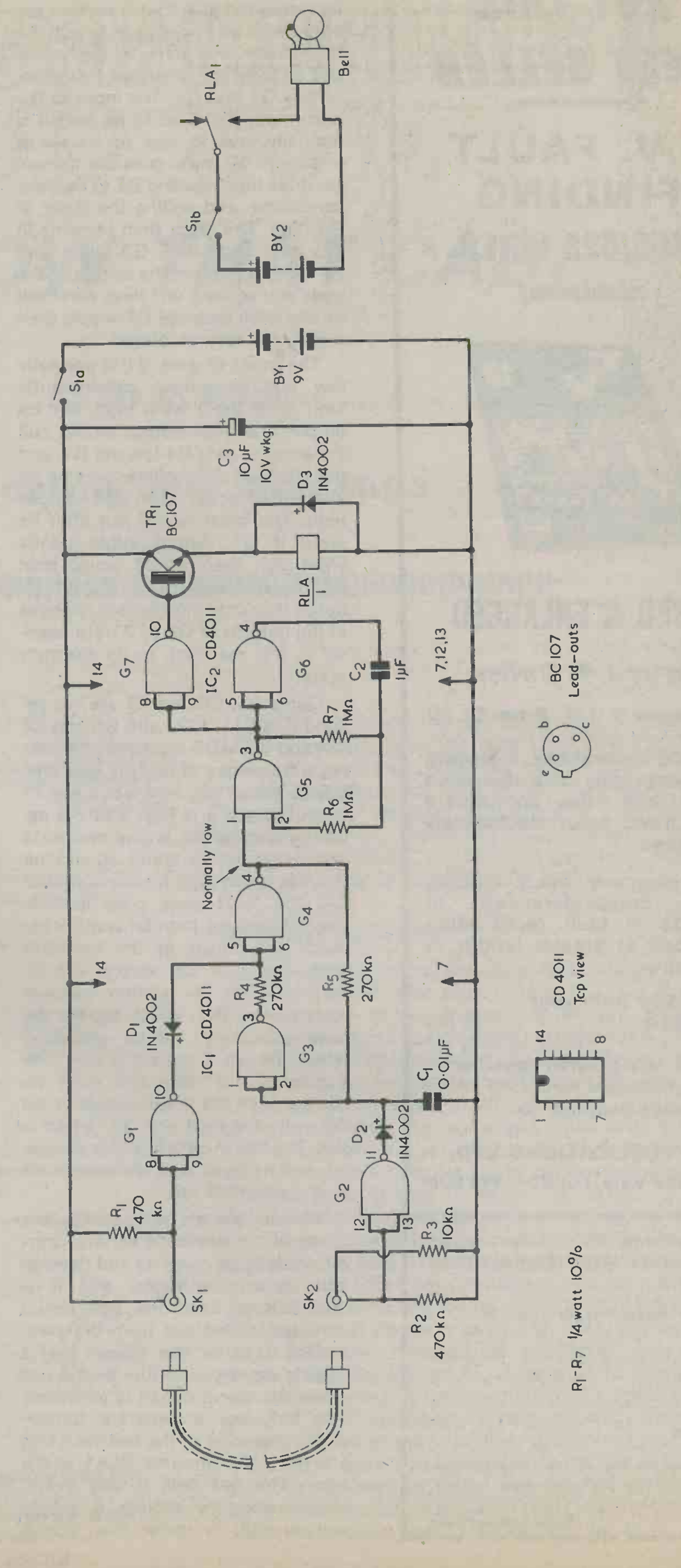


Fig. 2. The full circuit of the alarm. Momentary triggering is all that is required to trip the latch given by gates G3 and G4, after which the bell sounds at 1-second intervals until the alarm is switched off at S1(a) (b)

and the output of gate G4 low, thus maintaining the latch state.

The point A and B inputs from the screened guard wire section are at too high an impedance to pull the latch from one state to the other, and so they are amplified by the inverters G1 and G2. The input to G2 is normally high and so its output is normally low. If, due to an alarm condition, G2 input goes low its output goes high, causing D2 to become conductive and pulling the input of G3 high. The latch then remains in this new state with G3 input, and G4 output, high. If the output of G2 goes low again it will have no effect on the latch because D2 would then merely be reverse biased.

The input of gate G1 is normally low and its output consequently high. If its input went high, and its output low, that output would pull the input to gate G4 low via D1, and the latch would similarly take up its alternative state with G4 output high. The latch would not alter its state if G1 output subsequently went high again as D1 would then be reverse biased. It should be noted that only momentary changes in the outputs of G2 or G1 are needed to trip the latch to its alternate state.

Gates G5, G6 and G7 are in a second CD4011, IC2, with G5 and G6 forming a CMOS multivibrator having a frequency of slightly less than 0.5Hz. When pin 1 of G5 is low its output at pin 3 is high and the oscillator is inhibited. It commences to run when, under alarm conditions, pin 1 is taken high by the output of G4. Pin 3 at once goes low for about 1 second, high for another second, and so on, as the oscillator runs. Pin 3 of G5 couples via inverter G7 to the emitter follower relay driver, TR1, which causes the relay coil RLA/1 to be energised when the pin 3 output is low. The transistor and relay coil draw no current from the 9 volt supply when G5 output is high and G7 output is low. The fourth gate in IC2 is not used, and its input pins are connected to the negative rail.

Modern electric bells, particularly those of the domestic variety, draw relatively large currents and develop high reverse voltages, and it is desirable to keep the bell circuit completely divorced from the electronics. It is for this reason that a relay is employed to turn on the bell when the alarm circuit is activated. The bell has a separate battery which connects to the bell via S1(b) and the make contacts, RLA1, of the relay. The bell will, in any event, almost certainly require a supply voltage that is lower than the 9 volts used for the CMOS circuitry. The voltage of BY2 should be that which is most suitable for the particular bell employed. It should be noted, in passing, that a bell creates a much louder noise than does any simple electronic audio warning device consuming the same battery power.

On-off switching is provided by the 2-pole switch S1(a) (b). S1(b) is not entirely necessary, since the relay contacts are normally open, and could be omitted if desired. Bypass capacitor C3 prevents bell noise and pulses from the relay coil appearing on the 9 volt CMOS supply rails.

FURTHER POINTS

The alarm assembly may be housed in a plastic case, bearing in mind that the outer conductors of SK1 and SK2 should be insulated from each other. The coaxial sockets and plugs may be TV aerial or phono types. The relay recommended for RLA is the "Open Relay" with 410Ω coil which is retailed by Maplin Electronic Supplies. This has a quick lightweight switching action and requires a comparatively low energising current.

The measured quiescent current drawn from the 9 volt supply by the prototype circuit was approximately 40μA, this rising to some 19mA when the alarm was triggered and the relay was energised. Average alarm current is therefore about half of 19mA. A PP9 battery would be suitable and should offer a long life.

The only feature which cannot be designed into the circuit with complete certainty is the switch-on bias imparted to the G3-G4 latch by C1. The author has checked the circuit with a number of CD4011 i.c.'s, and in all cases C1 caused the latch, after switch-on, to take up the state where G4 output is low. There is, nevertheless, a very slight possibility that C1 will not exert sufficient control with all CD4011 i.c.'s, and it is therefore advisable for the wiring to IC1 to be taken to an i.c. holder. No difficulties then arise if it is found necessary to use an alternative CD4011 in the IC1 position. A quad NOR gate type CD4001 may also be employed for IC1 (but not for IC2).

A final point is that the alarm system is intended for use only in dry indoor conditions. It should not be employed in excessively damp environments or out of doors.

'NOTES FOR NEWCOMERS'

FOLLOW THAT CAB!

By D. Snaith

Sorting out jack tags

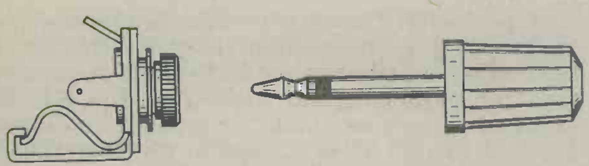


Fig. 1. A 3.5mm. jack socket and plug. The socket is of "open" construction and has a "break" contact

Fig. 2(a). Circuit symbol for the jack socket (b). The contacts may be identified by the letters A, B and C

Fig. 3(a). The jack socket, as viewed from the rear
(b). The tag letters, read in clockwise order, spell out the word "CAB"

Nearly all of us are familiar with 3.5mm. jack sockets and plugs of the type shown in Fig. 1. The socket interests us most for the moment. It is of "open" construction (i.e. is not insulated) and it has a "break" contact which opens when the jack plug is inserted. Normally this contact is used to mute the speaker in a radio receiver when an earphone plug is fitted in the socket.

CIRCUIT SYMBOL

The circuit symbol for the socket is shown in Fig. 2(a). When the jack plug is inserted its "tip" section connects to the uppermost contact, causing it to be raised and breaking the connection it has with the "break" contact below it. The "sleeve" section of the plug makes contact with the right-hand part of the socket symbol which, with the "open" type, is common with the mounting bush and nut.

The socket symbol is easy to picture mentally, and we can identify its three connection points by the letters A, B and C, as in Fig. 2(b).

When we examine the jack socket physically we find that it doesn't quite match up with the circuit symbol and, also, that visually tracing the contacts to which its three tags connnect can be a little difficult. If we hold the socket with its rear towards us, the tag layout appears as in Fig. 3(a). We can overcome all tag recognition problems by simply appending the letters C, A and B to the tags in clockwise order. These fortuitously spell out the word "CAB" and they correspond with the similar letters of the symbol of Fig. 2(b).

So, next time you have to wire up one of these little sockets, bear in mind the symbol of Fig. 2(b), look at the socket tags, then just "follow the CAB" when you make your connections to it. ■

NEWS . . . AND

"OCEAN STAR 240" VHF MARINE RADIOTELEPHONE

For the yachtsman who wishes to telephone his home or office or to other ships and coast stations throughout the UK and Continental waters, a new compact radiotelephone is being marketed by Frank Cody Electronics Limited, utilising up-to-date technology. This set can operate on any 24 switch selected channels in the International Maritime VHF service. It is delivered factory adjusted to operate on 24 of the most commonly used VHF channels, including Public Correspondence, Coast Guard and Marina Channels. Should it be necessary to alter this selection, it is a simple matter of readjustment in this synthesised radio. No replacement of expensive crystals is neccesary.

The "Ocean Star 240" transmits at the full legal limit of 25 watts, and its circuitry enables it to maintain this power when the supply battery has run down to 10 volts (important in sailing craft). It has a built-in loud hailer and intercom facility, and at £225.00 is supplied complete with power lead, press-to-talk fist microphone and universal mounting bracket.

The standard model is small, 70 x 203 x 260 mm, and weighs only 3kgs. The materials and components used are of the highest quality for the marine environment, gaskets and seals resist the entry of moisture.

Further technical data is available from Frank Cody Electronics Limited, Star House, 44 Gresham Road, Staines, Middlesex TW18 2AN.

WARC 79

The World Administrative Radio Conference — **WARC 79** — is being held in Geneva from September 24th to November 30th.

As this year's President of the Radio Society of Great Britain, Mr. John Bazley, G3HCT, said in his installation speech in January:– "This year, in the latter part of September, we shall see the opening of the World Administrative Conference in Geneva — WARC 79 — where, to quote Mr. Butler, the Deputy Secretary General of the ITU, **'WARC 79 will come forward with a new treaty which will govern the planning and operation of radio communication services well beyond the year 2000'.** Negotiations have been taking place for several years between our Society and the Home Office in preparation for this conference, and I would like to record our appreciation of the sympathetic attitude taken by officials of the Home Office during these discussions."

A Special Preparatory Meeting was held between 23rd October and the 17th November, 1978, in Geneva, in response to a resolution of the ITU Administrative Council which invited the International Radio Consultative Committee (CCIR) to carry out the necessary studies to ensure timely provision of the technical information likely to be needed as a basis for the work of the WARC. During the two years prior to this Special Preparatory Meeting, a great deal of earlier work had been carried out by CCIR Study Groups. Some 350 documents were sent to the 720 delegates who were to participate in the meeting. These documents covered such diverse subjects as Classification of Radio Emissions, Terrestrial services up to 40 GHz, Space services, Monitoring of the Radio Spectrum, Services above 40 GHz, Propagation and so on.

Of particular interest to radio amateurs is, of course, the question of what effect **WARC 79** will have on future allocations within the radio spectrum for radio amateur activities. The UK has proposed three new bands for amateur radio use, viz., 10.1 to 10.2 MHz; 18.568 to 18.768 MHz and 24.0 to 24.3 MHz and four new microwave bands, viz. 40.5 to 41.0 GHz; 49.5 to 50.0 GHz; 71.0 to 76.0 GHz and 160 to 165 GHz.

It should be mentioned of course, that many other of the proposals being put forward at **WARC 79**, whilst primarily of interest to the professional administrators and radio engineers, will also have their repercussions on the radio amateur scene, particularly the SWL's. Numerous proposals are being put up for instance, for the reallocation of SW broadcast stations.

There is a great deal of technical rearrangement proposed, to take account of the recent advances in radio, Space, TV and VHF and UHF broadcasting techniques, and to try and make provision for future technical developments. At the same time there is a need to preserve frequencies which are currently being used by millions of users of radio receivers throughout the world.

From a recent radio-teletype broadcast, the RTTY News Bulletin (put out by the British Amateur Radio Teleprinter Group on Sunday mornings at 1200 hours local time, on 3590 KHz), we learn that the cost will be approximately £3,000,000, exclusive of delegates' expenses for hotels and food.

With the ever increasing demand for space in the radio spectrum, we shall have to wait and see just what finally comes out of the deliberations.

We wish Noel Eaton, VE3CJ and his IARU team every success in their negotiations.

. . . COMMENT

NEW SCOPEX OSCILLOSCOPE

UK oscilloscope manufacturers Scopex Instruments Limited announce the introduction of their latest instrument the 4D10B Dual Trace Oscilloscope featuring full XY operation and Z modulation.

The 4D10B, succeeding the earlier 4D10A range, retains the high accuracy (±3%) and the DC-10MHz bandwidth of its predecessor but now also features enhanced specifications made possible by the incorporation of the latest CMOS Integrated Circuit technology into its design.

In the XY mode Channel 'A' is switched into the horizontal deflection system giving fully matched sensitivities for both X and Y axes over the entire 10mV to 50V/cm range. When used in the conventional YT mode, the vertical amplifiers are complemented by a fully triggered 16 range timebase of 1μs to 100ms/cm.

The easy to use single trigger control, pioneered by Scopex in the low cost market, is retained together with all the other "easy to use" facilities for which the Company's oscilloscopes are noted. The XY mode for example is easily selected on just one position of the timebase switch.

Priced at around £188 (excluding VAT) the 4D10B is less than 5% up on the March 1978 price of the superseded instrument, a fact made possible by virtue of the high volume of production now being carried on at Scopex.

GROUP ONE

A number of our readers are professionally connected with electronics usually either in industry, the teaching profession or in the retailing of components.

Some years ago we gave news of the formation of the organisation, Group One, which by giving a service to retailers of electronics components enabled them, in turn, to aid the hobbyist — we are glad to report that the group has flourished.

Its services are divided into three areas: exchange of information; disposal of surplus stocks; sharing in the benefit of bulk buying at special prices.

Any component retailer readers of this journal who wish to learn more about the organisation should write to its founder, Mr. Alan Sproxton of Home Radio Ltd., 234-240 London Road, Mitcham, Surrey CR4 3HD. There is an entrance fee of £3 and the annual subscription is £5 all of which seems to add up to a very good "buy".

ICS 75th ANNIVERSARY

In the coming winter months many thousands of people will settle down to studying. Their motivations and goals will be very varied — many will be studying for a specific examination to further their career, others to improve their job capability, some just to increase their general knowledge.

Many will study with ICS (International Correspondence Schools) including those wanting to make a career in radio and electronics for whom ICS provide a number of courses.

To mark their 75th Anniversary in the UK, ICS are initiating a new 'Student of the Year' award.

Thousands have benefitted from the various courses that ICS have provided over all these years and we congratulate them on deservedly reaching this milestone and we look forward to congratulating them on their centenary in 25 years time.

AMATEUR RADIO NOVICE LICENCE

Responding to the considerable interest shown in the suggested amateur radio CW only novice licence the Telecommunications Liaison Committee of the Radio Society of Great Britain have set up a sub committee to investigate the matter and then make an approach to the Home Office. Owing to the great pressure on the Committee caused by preparation for the forthcoming WARC 1979 meetings, mentioned on previous page, action is unlikely before early in 1980.

"Pity about that — he's designed an electronic mouse trap and now we can't find anyone plagued by electronic mice!"

PEAK MILLIVOLT ASSESSOR

By A. P. Roberts

A. F. signal tracer with built-in amplitude assessment.

This unit is basically a signal tracer but, unlike the normal type of tracer, it incorporates circuitry which enables the operator to assess the amplitude of the input signal. The circuit uses a technique which is illustrated in simplified form in Fig. 1. The input signal is coupled to an amplifier which has eight switched voltage gains, these being selected by switching in eight close tolerance negative feedback resistors. An amplified output is then available for an earphone or headphones

The amplifier output is also applied to a precision voltage detector i.c. which causes an l.e.d. to light up when it is fed with a positive input voltage in excess of 1.15 volts. If the amplifier is switched to have a voltage gain of 11.5 times then an input signal having a peak amplitude of 100mV or more will light up the l.e.d. The feedback resistors have values which enable the circuit to indicate peak millivolt values of 1, 2, 5, 10, 20, 50, 100 and 200. By finding the lowest gain setting which gives a positive indication from the l.e.d. it is thus possible to obtain an approximate indication of the input signal amplitude.

VOLTAGE DETECTOR

The voltage detector section takes advantage of the 8211 i.c., which is primarily intended for use as a low supply voltage indicator. In this application it appears in a circuit of the basic type shown in Fig. 2, in which it causes a warning to be given, or equipment to be switched off, when the supply voltage falls below a certain critical threshold level.

The 8211 input is fed from the slider of a pre-set potentiometer connected across the supply rails, the potentiometer being set up to apply 1.15 volts with respect to the negative rail when the supply voltage is at its minimum acceptable level. When the supply voltage is above the critical level the 8211 output at pin 4 is virtually floating. Should the supply fall below the critical voltage a constant current generator is turned on inside the i.c. which allows a sink current limited to 7mA to be drawn from the positive supply rail. This output current could light up a warning l.e.d. connected between the output pin and the positive rail or it could operate a switching circuit which cuts the power to the circuits being supplied.

The operation of the 8211 may be improved by taking advantage of the output at its hysteresis pin.

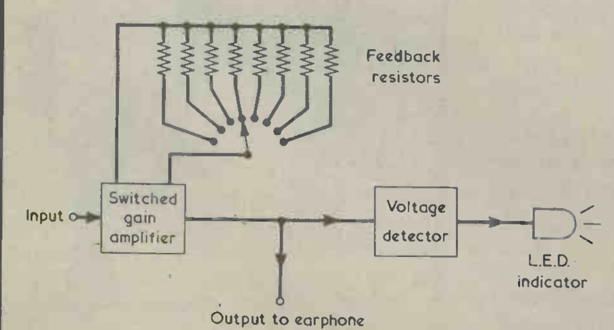


Fig. 1. Basic line-up of the peak millivolt assessor. The gain of the amplifier is successively decreased until a switch position is found at which the l.e.d. extinguishes

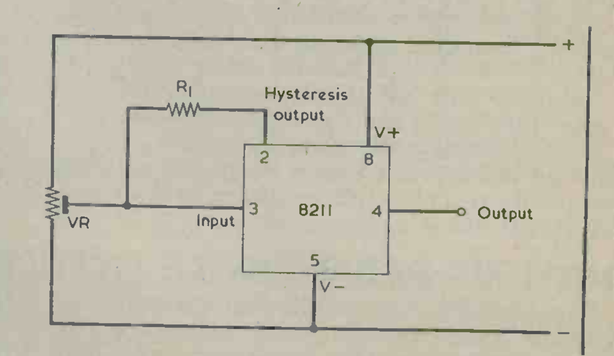
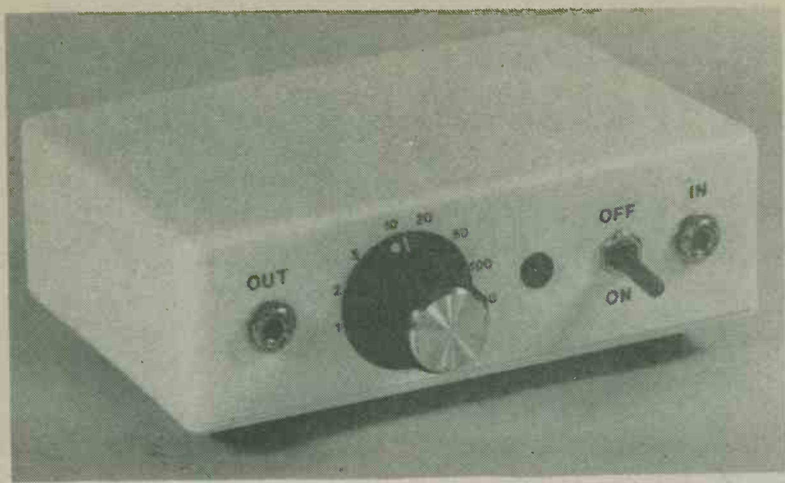


Fig. 2. The 8211 voltage detector is primarily intended for giving warning of low supply voltages, in which application it is connected as shown here



The completed millivolt assessor is housed in a small plastic case fitted with four rubber feet

When the 8211 input is above the 1.15 volt reference level the voltage on the hysteresis pin is close to that on the positive rail whilst, when the 8211 input is below 1.15 volts the hysteresis output is low and approaches the negative rail voltage. With R1 in circuit VR is adjusted, at the critical supply voltage, so that the input to the 8211 is at 1.15 volts with the hysteresis output high. As soon as the input voltage falls even fractionally below 1.15 volts the hysteresis output starts to go negative, causing the input voltage to go further negative. There is a regenerative action which rapidly results in the input to the 8211 falling well below 1.15 volts, with the hysteresis output fully in the low state. The supply voltage will then have to rise significantly above its minimum acceptable level if the 8211 is to be returned to its previous state, in which its output is floating and the hysteresis output is high. The supply voltage range over which the hysteresis effect takes place is governed by the values chosen for R1 and the potentiometer.

The advantage of the hysteresis circuit is that it causes the 8211 output to be triggered rapidly to the current sink mode at the threshold voltage level, and it also prevents unstable operation if the supply is just hovering around the minimum voltage level.

CIRCUIT DIAGRAM

The full circuit of the peak millivolt assessor is given in Fig. 3. The amplifier employs the two transistors, TR1 and TR2, in a conventional direct

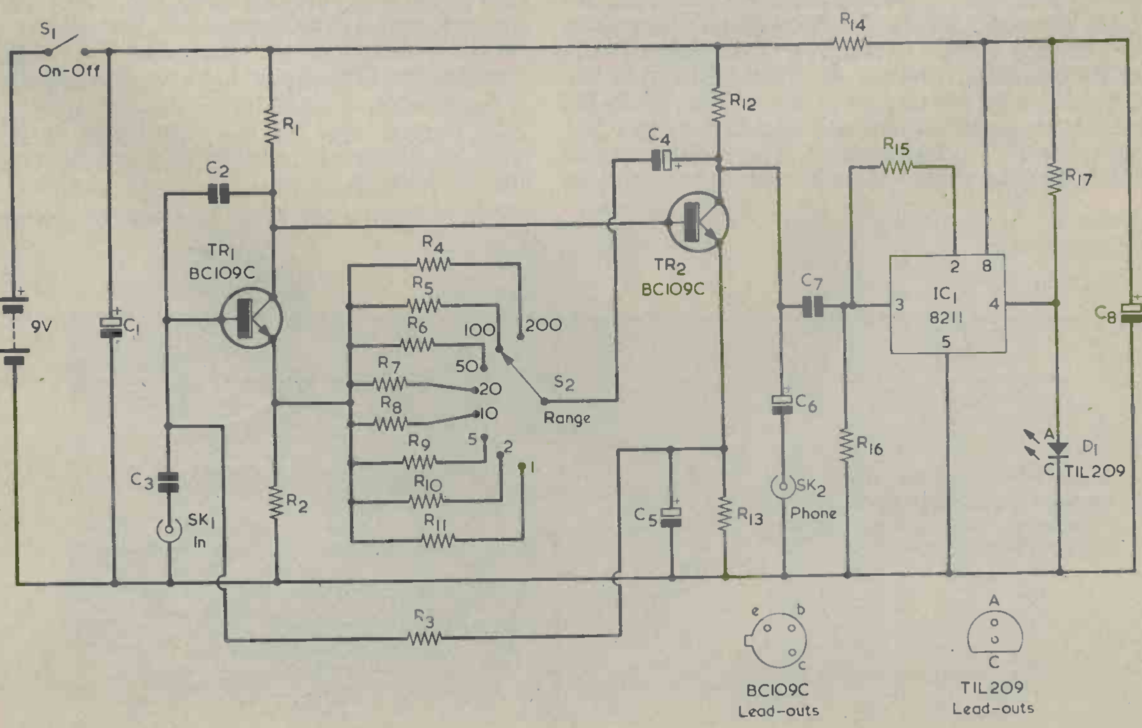


Fig. 3. The full circuit of the peak millivolt assessor. The switched feedback resistors are R4 to R11 inclusive. The numbers at the positions of S2 indicate the corresponding threshold levels in millivolts

COMPONENTS

Resistors
(All ¼ watt)
R1 4.7k Ω 5%
R2 100 Ω 2%
R3 1.5M Ω 10%
R4 470 Ω 2%
R5 1.1k Ω 2%
R6 2.2k Ω 2%
R7 5.6k Ω 2%
R8 12k Ω 2%
R9 22k Ω 2%
R10 56k Ω 2%
R11 120k Ω 2%
R12 1k Ω 5%
R13 1k Ω 5%
R14 390 Ω 5%
R15 680 Ω 5%
R16 100k Ω 5%
R17 1.2k Ω 5%

Semiconductors
IC1 8211
TR1 BC109C
TR2 BC109C
D1 TIL209, with panel-mounting bush

Sockets
SK1 3.5mm. jack socket
SK2 3.5mm jack socket

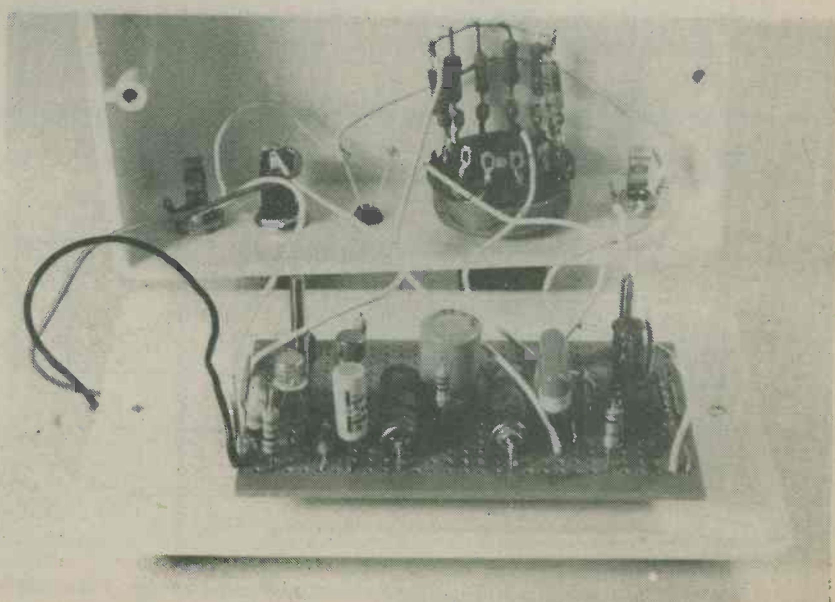
Capacitors
C1 100μF electrolytic, 10 V. Wkg.
C2 39pF ceramic plate
C3 0.047μF type C280
C4 100μF electrolytic, 10 V. Wkg.
C5 10μF electrolytic, 10 V. Wkg.
C6 2.2μF electrolytic, 10 V. Wkg.
C7 0.22μF type C280
C8 100μF electrolytic, 10 V. Wkg.

Switches
S1 s.p.s.t. subminiature toggle
S2 1-pole 8-way rotary (see text)

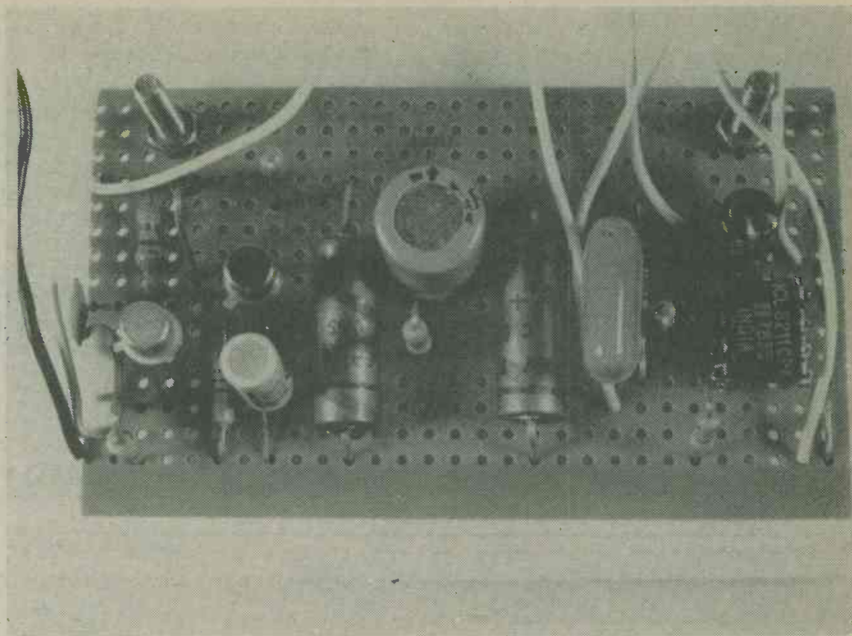
Miscellaneous
Plastic case (see text)
Control knob
Veroboard, 0.1in. matrix
9-volt battery type PP3
Battery connector
4 rubber cabinet feet
3.5mm. jack plug
Screened wire
Test prod
Crocodile clip
Nuts, bolts, wire, etc.

coupled arrangement, the overall voltage gain of which is controlled by the amount of negative feedback applied between TR2 collector and TR1 emitter. The eight switched feedback resistors, R4 to R11, give eight levels of voltage gain. This gain is equal to (RA + RB) divided by RA, where RA is the 100 Ω emitter resistor for TR1 and RB is the resistor selected by the range switch, S2. With R4 selected, the gain is 5.7 times and it rises to 1,201 times when R11 is switched in. The resistor values are in the E24 series of preferred values and in most cases they do not cause the input voltages indicated at the switch positions to be amplified to precisely 1.15 volts. However, the voltage gains provided are very close to the exact values required, and it is recommended that all the resistors in the feedback circuit, including the 100 Ω emitter resistor for TR1 should have a tolerance on value of 2% or better. Capacitor C4 provides d.c. blocking and ensures that the d.c. conditions in the circuit are not altered by the selection of different feedback resistors.

Most of the small components are assembled on a Veroboard panel which is bolted to the base of the case



A close-up view of the Veroboard component panel

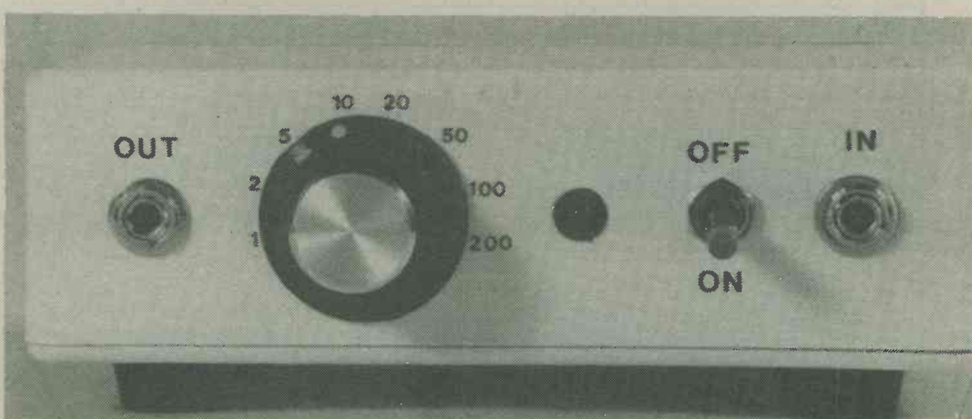


It is desirable for a test instrument of this nature to have a high input impedance so that it places minimal loading on the circuits being checked. The input impedance is acutally quite high, varying from about 100k Ω on the 1mV range to about 1M Ω on the 200mV range. The output of the amplifier is coupled via C6 to the phone socket SK2, allowing the a.f. signal which is being handled to be monitored. The output at SK2 is suitable for a crystal earphone, a high impedance (5k Ω) magnetic earphone or high impedance (2k Ω + 2k Ω) magnetic headphones. A low impedance earphone or headphones must not be used as it would load the amplifier output too heavily and would prevent the required voltage gain being achieved.

The output signal is also applied, by way of C7, to the 8211 input at pin 3. This input is biased to the negative supply rail by R16. For input signals below 1.15 volts the 8211 output at pin 4 is low and causes the l.e.d., D1, to be extinguished. When the input signal exceeds 1.15 volts the output becomes floating and allows D1 to be lit by the current flowing through R17. Without the hysteresis introduced by R16 the l.e.d. would be alight only during the period when the input voltage exceeds the threshold level; with R16 in circuit the l.e.d. is alight for a slightly longer period. This is of advantage, since it increases the brightness of the l.e.d. indication.

Supply decoupling is provided by C1, R14 and C8, with S1 being the on-off switch. The current consumption from the 9 volt battery is approximately 10mA.

Capacitor C6 is specified as having a working voltage of 10 volts, but it will be perfectly satisfactory to employ a component having a much higher working voltage, such as 63 volts. Capacitor C5 may similarly have a higher working voltage than 10 volts if difficulty is experienced in obtaining this component in 10 volts working. Switch S2 is a miniature 1-pole 12-way rotary switch with adjustable end stop set for 8-way working.



The front panel controls, with letter and number legends taken from "Panel- Signs" Set No. 4

CONSTRUCTION

The project is housed in a white plastic box having nominal dimensions of 114 by 76 by 38mm. This is a case type PB1, obtainable from Maplin Electronics Supplies. The case is also available in black if the constructor prefers this colour. What would normally be the removable back or lid of the case becomes the base panel, and it is fitted with four small rubber cabinet feet. One of the 114 by 38mm. sides of the case is used as the front panel and the front panel components are mounted on this, employing the general layout illustrated in the photographs. Looking at the panel from the front, SK2 is to the left, with S2 next to it. The l.e.d. is next, followed by S1, with SK1 at the right. SK1 and SK2 are both 3.5mm. jack sockets.

Most of the other components are assembled on a Veroboard panel of 0.1in. matrix having 29 holes by 15 copper strips. This panel has to be cut out from a larger panel by means of a small hacksaw. The two mounting holes, which are clearance size for 6BA or M3, are next drilled out after which the seven breaks in the copper strips are made using a Vero spot face cutter or a small twist drill held in the hand. The components and the two link wires are then soldered in place. The connections required are shown in Fig. 4, which so gives details

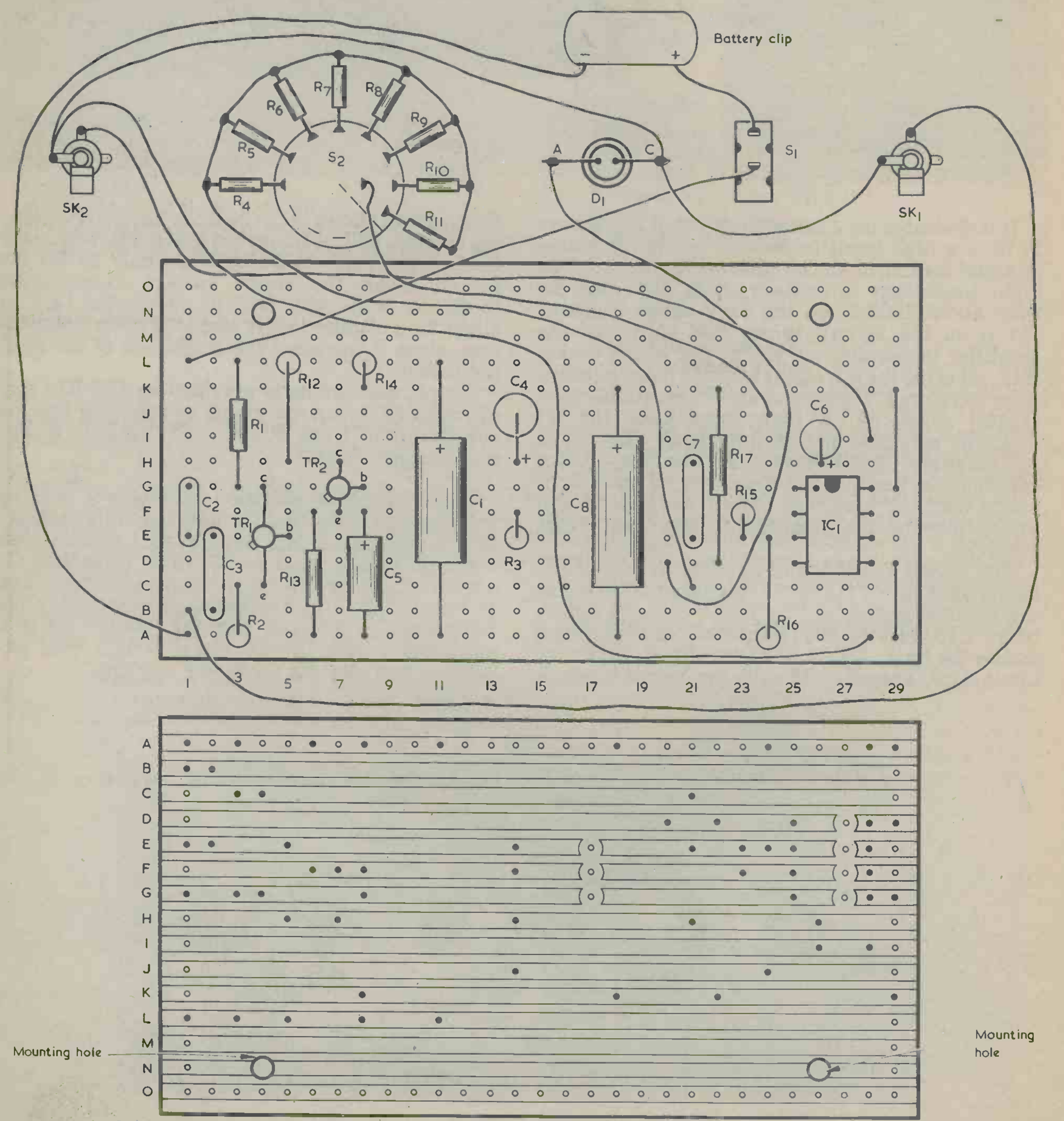


Fig. 4. Component and copper sides of the Veroboard panel. Also shown are the connections to the front panel components

of the wiring to the front panel components. Flexible insulated wires about 4in. long are used between the board and the components on the front panel, and these wires, as well as those to the battery connector, must all be soldered in place before the board is finally mounted.

R4 to R11 are soldered directly to the appropriate tags of S2, and the switch should be mounted so that these tags are near the upper part of the case. This provides greater clearance from the component board. For the same reason, the resistor leads should be kept short. The soldering of the resistors should be carried out quickly, as there is a possibility that excessive heat could cause shifts in resistance values. The board is fitted to the base of the case with the mounting holes towards the front and, again for clearance, should be positioned as near to the rear as possible. The board is secured by two short 6BA or M3 bolts with nuts, spacing washers being passed over the bolts between the underside of the board and the inside surface of the base of the case. Without these washers the board would be strained and could crack when the bolts are tightened up.

There is sufficient space to accommodate the battery to the rear of SK1 and SK2. It will be held quite firmly in place when the base is fitted, and it is not necessary to make a mounting bracket.

USING THE CIRCUIT

The millivolt assessor requires no adjustment or calibration of any kind, and is ready for use as soon as it has been completed. A screened test lead is necessary to reduce stray pick-up. One end is connected to a jack plug which fits into SK1, and the other end is terminated in a test prod with the braiding connected to a short flexible lead ending in a crocodile clip. Normally, the clip is connected to the chassis of the equipment being checked, the test prod being applied to the a.f. check points in the equipment. The equipment must, of course, be given an input signal of some sort so that it may be traced through.

When an a.f. signal is present at any point it will be reproduced in the earphone or headphones plugged into SK2. The amplitude of the signal may be estimated by rotating the spindle of S2 clockwise and noting the highest setting at which the l.e.d. remains alight. The control knob for S2 should be either a pointer type or a round type having a dot or radial line to indicate its position, and the front panel should be marked with numbers to indicate the millivolt levels corresponding to each switch setting. The author employed numbers cut out from "Panel-Signs" Set No. 4, and these offer a neat and pleasing appearance. The legends at SK2, S1 and SK1 were taken from the same "Panel-Signs" set. ("Panel-Signs" can be obtained from the publishers of this journal.)

The usual signal tracing technique is to start checking at the input of the equipment under test and then proceed through its subsequent stages. If the signal is absent, or has a low amplitude at any point, this indicates a fault in the stage being checked or in the circuitry immediately preceding it. The assessor may also be used to check the functioning of bypass and decoupling capacitors. The test prod is applied to the non-earthy terminal of the capacitor, and no significant signal should be obtained if the capacitor is functional.

R. F. PROBE

A very useful item of ancillary equipment when checking a.m. superhet radio receivers is an r.f. probe, which in many cases will enable the signal to be detected in the i.f. stages and, if there is an adequate signal strength, even in the r.f. and mixer stages as well. The circuit diagram of the r.f. probe used with the prototype is shown in Fig. 5, and is quite conventional in design.

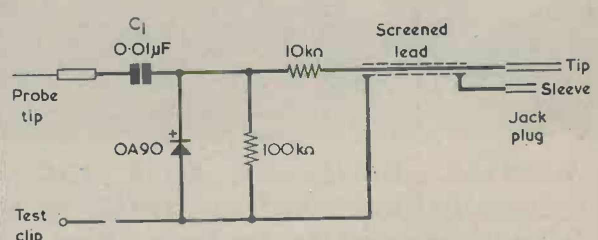


Fig. 5. Circuit of an optional r.f. probe. The two resistors are ¼ watt 5% and the capacitor is plastic foil. A flexible lead terminated in a crocodile clip connects to the "test clip" point

The peak millivolt assessor with the optional r.f. probe plugged into the input jack socket

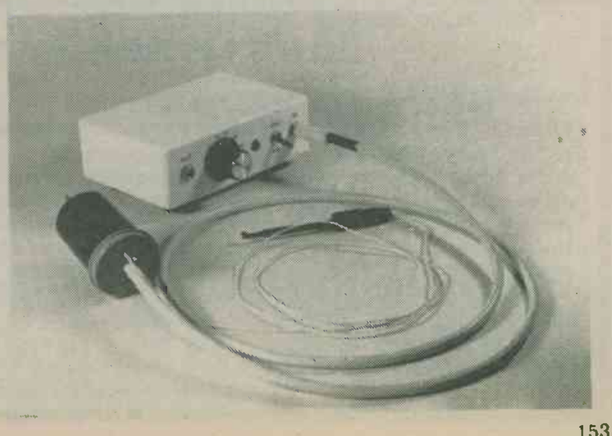
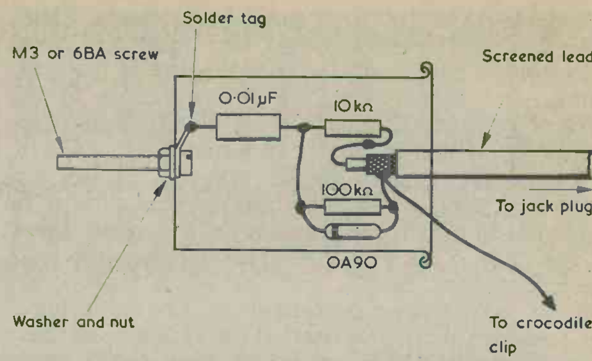
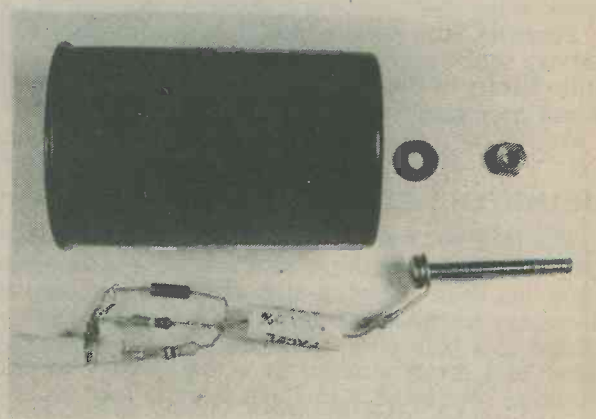


Fig. 6. How the components are wired up in the r.f. probe



The author's r.f. probe was assembled in a 35mm. plastic film can, as illustrated in Fig. 6. The probe is simply a 6BA or M3 bolt about 1¼in. or more long. A flexible lead from the screened lead braiding is terminated in a crocodile clip which is connected to the chassis of the equipment under test.

The r.f. probe requires two resistors, a germanium diode and a capacitor. They are fitted in a 35mm. plastic film case



It should be noted that the probe detects the modulated r.f. signal to which it connects, allowing the detected a.f. signal to be heard in the monitoring earphone or headphones, with S2 and the l.e.d. giving indications of the amplitude of the *detected* signal. If a high amplitude locally generated r.f. signal is present, as could occur at points to which the superhet oscillator connects, it is possible that some of the r.f. could break through to the assessor and result in misleadingly high millivolt readings. The detected signal, if available at sufficient strength, will still, nevertheless, be audible in the earphone or headphones.

Signal tracing in a t.r.f. receiver using the r.f. probe follows similar lines, and there is not then the complication of high amplitude r.f. signals from a local oscillator. High amplitude r.f. signals would, however, be present if the receiver has a regenerative detector which was adjusted beyond the oscillation point or if it was unstable. ■

RADIO & ELECTRONICS CONSTRUCTOR

DIGITAL TANTALISER

Match your timing skill against this ingenious electronic game

S.W. AERIAL TUNING UNIT

An aerial tuning unit (or a.t.u.) is one of the simplest accessories for a short wave receiver and yet it can provide quite significant and worth-while improvements in performance.

It has two beneficial effects, these being an increase in signal strength and an attenuation of spurious responses.

CMOS OSCILLATORS

CMOS logic circuits frequently require low frequency oscillators or pulse generators, these being used for such purposes as producing clock pulses or causing light-emitting diodes to attract attention by flashing on and off. It then becomes desirable to use CMOS logic gates themselves in the oscillator circuit.

Amplifier Clipping Monitor
Suggested Circuit

Readers' Hints
In Your Workshop

IN OUR NEXT ISSUE

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

CURRENT SCHEDULES

● **WEST GERMANY**

"Deutsche Welle — the Voice of Germany", Cologne, does not present programmes in English to Europe but they may be logged with English programmes to Central and East Africa from 1715 to 1745 on **9735** and **11965** from the relay station at Kigali, Rwana and on **15135** and **21600** from Cologne. From 1745 to 1805 to the same area on **15135** and **17730** from Cologne. A broadcast to West Africa in English is made from 1930 to 2000 on **11905**, **15150** and on **17795**. English programmes to Asia may be heard from 1720 to 1750 on **9590**, **11785** and **21620** from Cologne and on **15405** and **17825** from the relay station at Cyclops, Malta.

● **EAST GERMANY**

"Radio Berlin International — the Voice of the German Democratic Republic", Berlin, radiates programmes in English to Europe as follows:- from 1800 to 1845 on **7260**; from 1915 to 2000 on **6080**, **6115** and on **7185**; from 2045 to 2130 on **7185**, **7300** and on **9730**.

● **TURKEY**

"The Voice of Turkey", Ankara, offers a programme in English to South West Asia from 1200 to 1300 on **17775**.

● **CHINA**

The P.L.A. Fujian Front Station operates an External Service, mostly in Standard Chinese directed to Taiwan and other offshore islands. For 'China Chasers', some of the Dx frequencies are listed here — from 1530 to 2230 on **2490**; from 1700 to 2144 on **3535**; from 1400 to 2314 on **4330**; from 1000 to 1659 and from 2145 to 0500 on **5240** and from 1000 to 0500 on **5265**.

"Radio Peking" has an External Service in English to Europe from 2030 to 2130 and from 2130 to 2230 on **6860**, **7470**, **11500** and on **12450**.

English programmes during the late afternoon and early evening are transmitted as follows — from 1600 to 1800 to East and South Africa on **6810**, **8300**, **9860** and on **15315** consisting of a one hour programme repeated; to South Asia from 1800 to 1900 on **12450** and to North and West Africa from 1930 to 2130 on **7620**, **9880**, **11455**, **11695** and on **15095**.

● **IRAQ**

"Radio Baghdad" has an External Service in which a programme in English is broadcast to Europe from 2130 to 2230 on **9745**.

The Domestic Service in Arabic operates on several frequencies during the period 0228 to 2315. Try from 1900 to 2315 on **7170**, **7245** and on **11925**.

● **JORDAN**

An English Service from Amman is on the air from 1500 through to 1730 sign-off on **9560**. The Domestic Service in Arabic is scheduled from 0330 through to 2330 on several short wave channels. Try from 0930 to 1230 on **9530** or **11920** or from 1900 to 2330 on **7155** or **9530**.

AROUND THE DIAL

In which are presented some of the loggings made recently which some readers may find of interest.

● **QATAR**

Doha on **9570** at 2047, OM in Arabic followed by Koran reading. Identification in Arabic, National Anthem and close at 2105.

● **SEYCHELLES**

FEBA Mahe on **15325** at 1550, OM with a religious programme in English, identification at 1600.

● **GRENADA**

Radio Free Grenada (announced) on **15045** at 2155, record requests, announcements in English, identification at 2200.

● **ISRAEL**

Jerusalem on **11655** at 2004, YL with a newscast in the English programme to Europe, the Middle East, North America and South and West Africa, scheduled on this channel from 2000 to 2030.

● **BULGARIA**

Sofia on **11720** at 1946, YL with the English programme directed to the UK, scheduled from 1930 to 2000.

● **ROMANIA**

Bucharest on **11940** at 1950, OM with the English programme for Europe, scheduled from 1930 to 2030.

● **ALBANIA**

Tirana on **7075** at 1942, YL with a newscast in the English programme for Africa, scheduled from 1930 to 2000. Also logged in parallel on **9500**.

● **WEST GERMANY**
Cologne on **11905** at 1935, OM with a newscast. in the English programme for West Africa, scheduled from 1930 to 2000.

● **SOUTH KOREA**
Seoul on **7550** at 2000, OM with identification and a newscast in the English programme for Europe and Africa, scheduled here from 2000 to 2030.

● **GREECE**
Athens on **9530** at 1935, OM with the European Service (in Greek, English, French and German respectively) scheduled from 1900 to 1950.

● **CUBA**
Radio Havana (Moscow Relay) on **17710** at 1813, OM with the Spanish programme to the Middle East and Europe, scheduled from 1800 to 2000.

● **CHINA**
Radio Peking on **11575** at 1805, YL with the Standard Chinese programme for Europe, North Africa and West Asia, scheduled from 1730 to 1830.
Radio Peking on **11515** at 1815, OM with the Persian programme for Iran and Afghanistan, scheduled from 1800 to 1830.
CPBS Peking on a measured **6493** at 2020, Chinese classical music in the Domestic Service 1st Programme, scheduled on this channel from 2000 to 2300.
CPBS Peking on **11610** at 2008, OM with the Domestic Service 1st Programme, scheduled here from 2000 to 0200.

● **U.S.S.R.**
Radio Moscow on **11715** at 1850, YL with the Turkish programme for Turkey (where else!), scheduled from 1830 to 1900.
Radio Moscow on **11780** at 1846, OM with announcements in Russian in the 5th Programme — a relay of the Moscow 2nd Programme 'Mayak', scheduled here from 1830 to 1900. Also logged in parallel in **11790**.
Radio Moscow on **11850** at 1856, musical items in the French programme for Europe, scheduled from 1830 to 1900, also logged in parallel on **11880, 11890** and on **12020**.
Radio Moscow on **11745** at 1850, OM with the Hausa programme to Africa, scheduled from 1830 to 1900.

● **COLOMBIA**
La Voz del Norte, Cucuta, on **4875** at 0431, OM with pop love song after identification and announcements. The schedule is from 1000 to 0500 and the power is 5kW.

● **ECUADOR**
Radio Zaracay, Santo Domingo, on **3390** at 0230, OM with station identification, announcements, local-style dance music. The schedule is from 1000 to 0500 (closing time is variable) and the power is 10kW.
Radio Iris, Esmeraldas, on a measured **3381.5** at 0225, OM with frequent announcements in Spanish, some news items of local interest with mentioned place-names, short musical interludes — a real mixed bag! The schedule is from 1100 to 0300 (closing time is variable) and the power is 10kW.
Radio Quito on **4920** at 0236, OM with a sports commentary in Spanish, local place-names being quoted. The schedule is from 1030 to 0500 and the power is 10kW.

● **BRAZIL**
Radio Nacional, Boa Vista, on **4835** at 0234, YL with a love song in Portuguese. The schedule is from 0900 to 0400 and the power is 10kW.
Radio Borborema, Campina Grande, on **5025** at 0245, OM with identification followed by a discussion nin Portuguese. The schedule is from 0830 to 0500 (variable closing) and the power is 1kW. The frequency of this one can vary to **5023** and it sometimes identifies as "A Princesa do Sul".
Radio Rural de Santarem on **4765** at 2248, OM with a very excitable commentary on a 'futebol' match. The schedule is from 0800 to 0400 and the power is 10kW.
Radio Sociedad, Fiera de Santana, on **4865** at 2250, local-style dance music, OM announcer in Portuguese, identification at 2300.
Radio Aparecida on **5035** at 2325, OM and YL with pop songs, announcements, commercials, identification at 2330.

● **VENEZUELA**
Radio Barquisimeto, on **4990** at 0243, OM with a talk about economics in Spanish. The schedule is from 1000 to 0400 and the power is 15kW.
Radio Bolivar, Ciudad Bolivar, on **4770** at 0256, OM announcer, local pops on records, identification at 0300. The schedule is from 1000 to 0300 and the power is 1kW. This one identifies frequently during programmes.
Radio Universo, Barquisimeto, on **4880** at 2320, OM announcer, light music — palm court style! The schedule is from 1000 to 0400 and the power is 10kW.
Radio Juventud, Barquisimeto, on **4900** at 2350, OM announcer, local-style pops on records. The schedule is from 1000 to 0400 and the power is 10kW. One of the easiest of the Venezuelans.

● **SWAZILAND**
TWR Mpangela on **5055** at 0250, light orchestral music, identification in English at 0252. The published schedule is from 0430 to 0615 and from 1900 to 2030. The power is 30kW. Either an extended schedule or, more likely, testing.

"Call yourself a Radio Amateur. We've been here three months and you still haven't built one!"

SINGLE-CHIP M.W. RADIO

By R. A. Penfold

LM389 i.c. gives r.f. gain, a.f. gain and power output. Ultra-simple medium wave t.r.f. design.

This radio is easy to construct and uses readily available components. It covers the medium wave band and provides an output power of some 100 to 200mW to its internal loudspeaker. For the sake of simplicity a t.r.f. (tuned radio frequency) circuit has been used instead of the more complicated superhet design, with the result that the set is very inexpensive. The results cannot be as good as are given with a superhet, but the receiver still has quite good sensitivity and selectivity. Radios 1, 2 and 3, as well as Radio Luxembourg and a few other stations, are all received quite well at the author's home in South-East England. A further advantage of employing a t.r.f. circuit, and one which will particularly commend itself to the newcomer, is that no complicated alignment procedure is required. All that are needed after construction has been completed are one or two very simple adjustments.

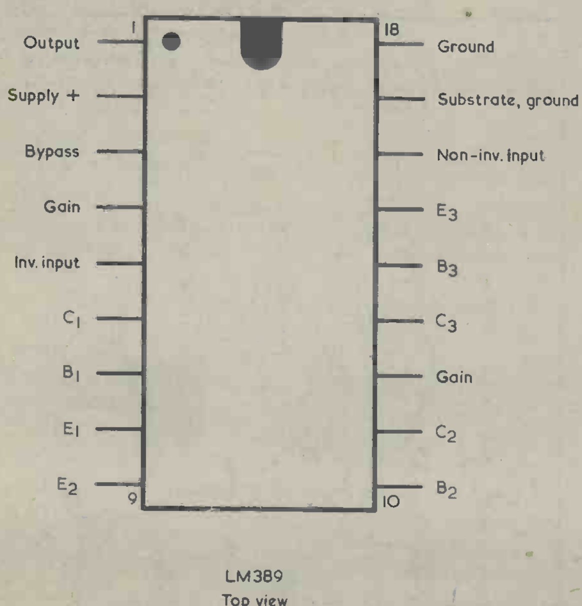


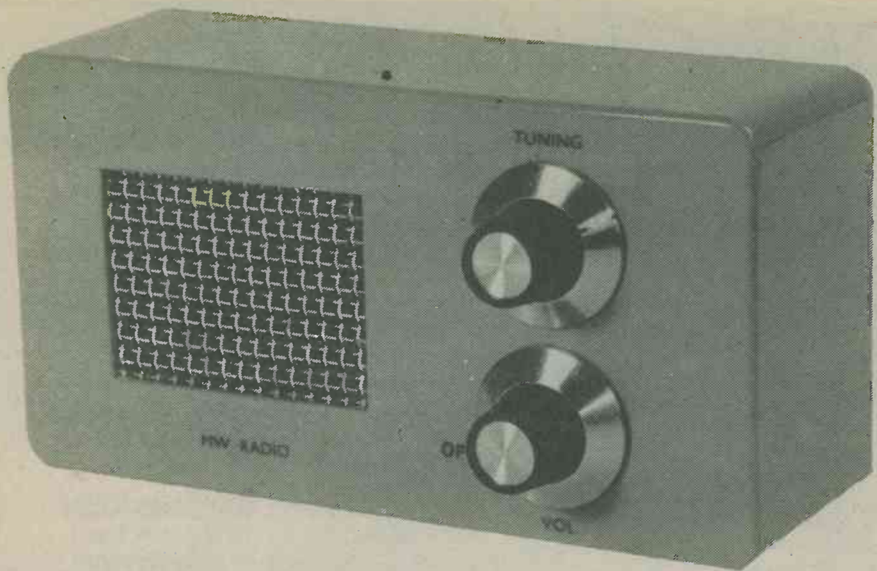
Fig. 1. Pin connections for the LM389. The "ground" pins connect to the negative supply tail. In addition to a power amplifier the i.c. has three separate n.p.n. transistors

THE LM389 I.C.

The main design feature which gives the receiver its special attributes is the use of a simple integrated circuit to provide both r.f. and a.f. amplification as well as the output power to drive the loudspeaker. There are several i.c.'s available these days which could be used for the receiver application, and the author has chosen the LM389 since it offers a good performance at low costs. What is of particular interest in this i.c. is that it not only incorporates a power amplifier but also has three separate high performance n.p.n. transistors which are brought out to their own individual base, emitter and collector pins. The LM389 has the pinout arrangement shown in Fig. 1, and it will be seen that the provision of pins for the three separate transistors results in its having the rather large number of 18 pins.

The main part of the i.c. is a Class B audio amplifier with an output power capability of up to 325mW r.m.s. into an 8Ω speaker, or progressively less into higher speaker impedances. The total harmonic distortion is typically only about 0.1% at most output power levels. The amplifier has an inverting input at pin 5 and a non-inverting input at pin 16, and these can either be ground referenced or left floating. An internal negative feedback loop causes the gain of the amplifier to be pre-set at approximately 26dB, although an external capacitor and resistor can be added between pin 4 and the negative supply rail to increase the voltage gain if this is desired. Pin 3 may be coupled to the negative rail via a bypass capacitor if it is required that hum and ripple on the supply to the early stages of the amplifier be reduced. Such a capacitor is not required if the i.c. is supplied by a battery instead of a mains power supply.

The three separate transistors in the i.c. are brought out to pins 6 to 11 inclusive and to pins 13, 14 and 15, as indicated in Fig. 1. These are n.p.n. devices with typical current gains of 275 at collector currents of 1mA, and they can be employed in r.f. circuits as well as in a.f. circuits since they provide useful gain at frequencies extending into the v.h.f. spectrum. In the receiver described here, one of the transistors is employed as a regenerative r.f. amplifier and another as a high gain audio preamplifier. The third transistor is not needed, and no connections are made to its pins.



The single-chip receiver employs only one integrated circuit but it offers loudspeaker reproduction of stations in the medium wave band

RECEIVER CIRCUIT

The full circuit of the single-chip receiver is shown in Fig. 2. In this diagram, TR1 and TR2 are shown as separate transistors but they are, in fact, part of IC1. The numbers alongside their symbols are those of the corresponding i.c. pins.

TR1 is in the r.f. amplifier section and is connected in the common emitter mode with R1 providing base bias and R2 functioning as its collector load. L1 is the tuned winding of the ferrite aerial and has the tuning capacitor VC1 connected across it. The low impedance winding, L2, couples the received signals into the base of TR1 via d.c. blocking capacitor C1.

Positive feedback, or regeneration, is provided between the collector and base of TR1 by way of capacitor CX. The result, when CX has the requisite value, is an increase in gain and selectivity. CX needs to have an extremely low value and is not, in practice, an actual capacitor. It consists, instead, of two insulated wires positioned near each other, and its value is altered by the simple process of moving one or both of the wires. For positive feedback it is necessary for the collector of TR1 to be in phase with the upper end of L1, to which CX connects. Since TR1 collector is out of phase with its base, a second phase inversion is provided by connecting L2 in the manner shown in the diagram.

The collector of TR1 couples via C2 to the diode D1. Despite the apparent lack of a d.c. return to its anode this diode functions in practice as an a.m. detector, with R3 as its load and C4 as an r.f. bypass capacitor. The detected audio signal is fed via C5 to the base of TR2, which has R4 as its base bias current feed resistor and R6 as its collector load. TR2 raises the a.f. signal level to a few hundred millivolts r.m.s., which is more than adequate to feed the main amplifier and output section of the LM389.

The signal at TR2 collector is passed via C6 to volume control VR1, the slider of which couples to the main amplifier inverting input by way of R7. This resistor and C7 form a low pass filter, and they prevent any remanent r.f. breaking through into the main amplifier of the i.c. where it could cause a high level of overall instability. The non-inverting input of the main amplifier is connected directly to the negative supply rail to ensure that it does not receive any stray pick-up of signal.

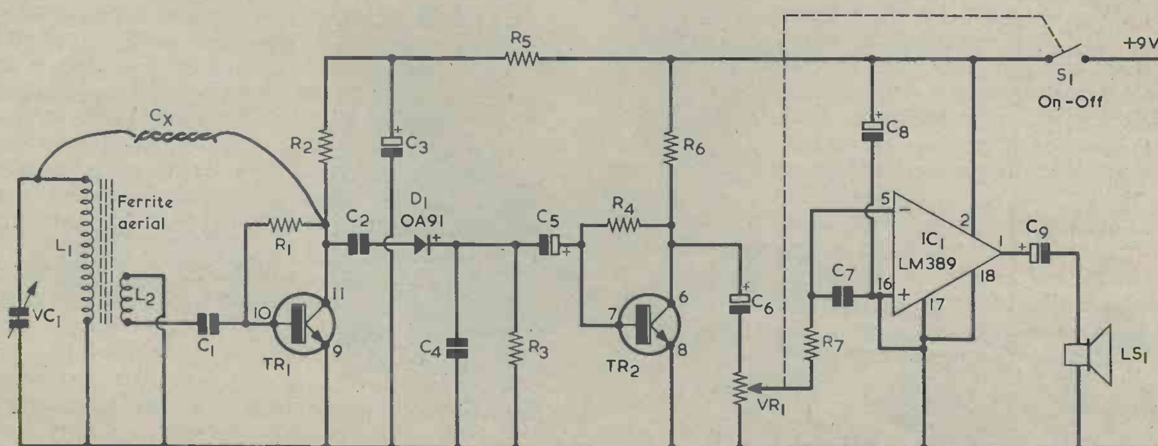
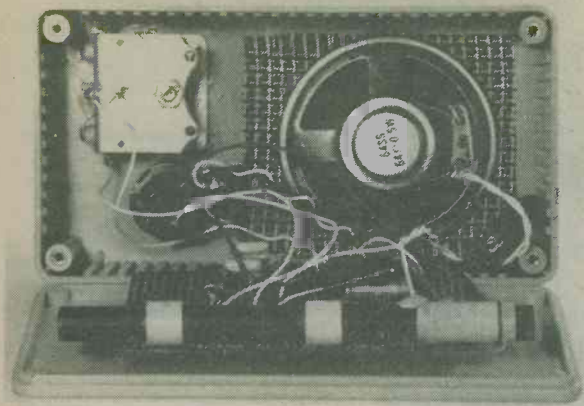


Fig. 2. The circuit of the single-chip medium wave receiver. The two transistors are part of IC1, but are shown separately to enable the circuit to be followed more easily. The "capacitor" CX consists of two insulated leads positioned close to each other



The component board and ferrite aerial are secured to the plastic case lid, which now effectively becomes the rear panel

The output of the LM389 main amplifier drives the speaker by way of d.c. blocking capacitor C9. The speaker is a miniature type and can have any impedance between 40Ω and 80Ω. The output power with a 40Ω speaker is a little less than 200mW r.m.s., and is just under 100mW with an 80Ω speaker. The use of speakers having an impedance lower than 40Ω is not recommended with this circuit. The author employed a 64Ω miniature speaker.

On-off switching is provided by S1, which is ganged with volume control VR1. Although the circuit has very high gain, more than adequate supply decoupling is provided by C3, R5 and C8. The quiescent current consumption from the PP3 9 volt battery is only about 8mA, but this increases to some 30mA at high volume levels.

COMPONENTS

Resistors
(All fixed values ¼watt 5% unless otherwise stated)
- R1 1.2MΩ10%
- R2 3.9kΩ
- R3 100kΩ
- R4 1.8MΩ10%
- R5 390Ω
- R6 4.7kΩ
- R7 6.8kΩ
- VR1 5kΩ potentiometer, log, with switch S1

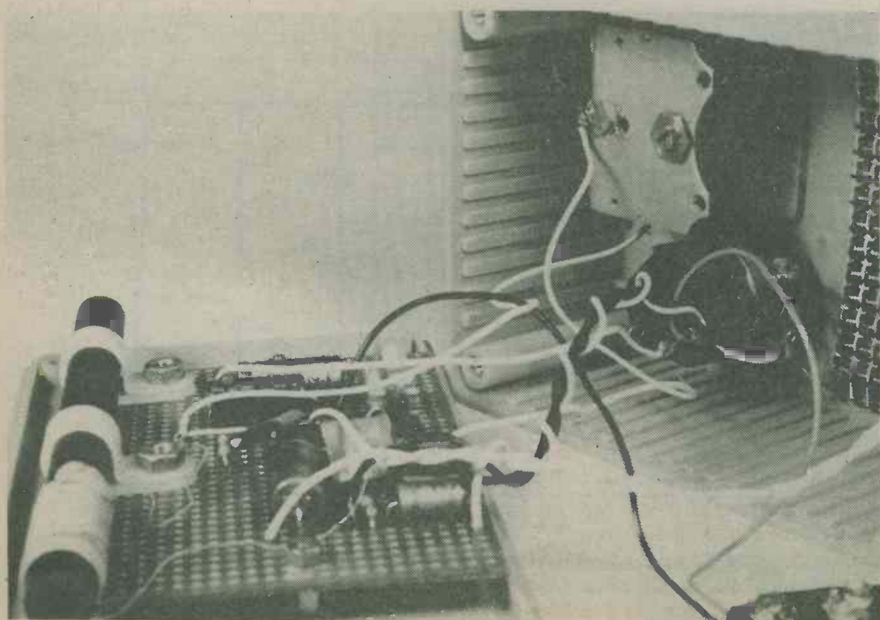
Capacitors
- C1 0.047μF type C280
- C2 0.047μF type C280
- C3 100μF electrolytic, 10V. Wkg.
- C4 0.01μF type C280
- C5 1μF electrolytic, 10 V. Wkg. (see Text)
- C6 1μF electrolytic, 10 V. Wkg. (see text)
- C7 6,800pF ceramic plate or polystyrene
- C8 220μF electrolytic, 10 V. Wkg.
- C9 220μF electrlytic, 10 V. Wkg.
- VC1 208pF variable, Jackson type "O" (see text)

Inductors
- L1/L2 medium wave ferrite aerial type MW5FR (Denco)

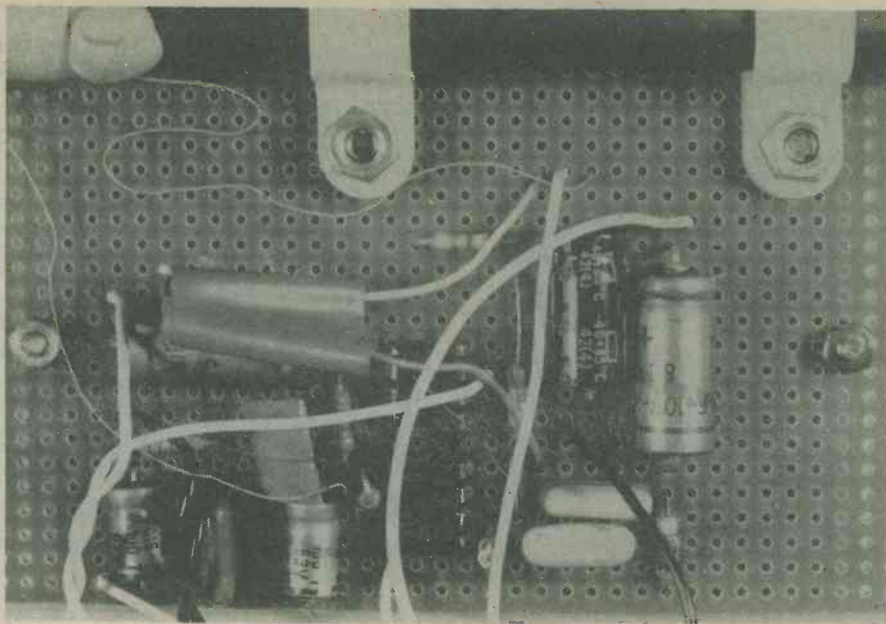
Semiconductors
- D1 OA91
- IC1 LM389

Speaker
- LS1 miniature speaker, 40Ω to 80Ω

Miscellaneous
- Plastic case (see text)
- Plain s.r.b.p. perforated board, 0.1in. matrix, 3.75 x 2.5in.
- 9-volt battery PP3
- Battery connector
- 2 control knobs
- 2 cable clips (see text)
- Speaker fabric
- Wire, nuts, bolts, etc.



Short flexible leads connect the board to the front panel components



Close-up showing how the "capacitor" CX appears in the prototype receiver. The two insulated wires are maintained at the required spacing by the insulating tape which covers their ends

COMPONENTS

Capacitors C5 and C6 are specified in the Components List as being 1µF electrolytic with a working voltage of 10 volts. It will almost certainly be found that 1µF electrolytic capacitors with a working voltage as low as this are difficult to obtain, and it is perfectly in order to use capacitors having a much higher working voltage, such as 63 volts.

VC1 is listed as a Jackson Type "O" single gang 208pF component and this can be obtained from a few suppliers. However, a much more readily available component is a Jackson Type "OO" 2-gang capacitor having a 208pF front section and a 176pF rear section, and this may be employed with connection made to the fixed vanes of the front section only. Such a capacitor is employed in the author's receiver. The 2-gang component is normally supplied with integral trimmers. Should this be the case the trimmer for the 208pF front section may simply be fully unscrewed to provide minimum capacitance, and then ignored.

The ferrite rod aerial is a Denco type MW5FR, and this can be obtained direct from the manufacturer, Denco (Clacton) Ltd., 357 Old Road, Clacton-on-Sea, Essex, CO15 3RH. The ferrite aerial is secured to the component board by two plastic clips. These are ⅜in. "P" type cable clips (9.5 to 12mm.) and are available from Maplin Electronic Supplies.

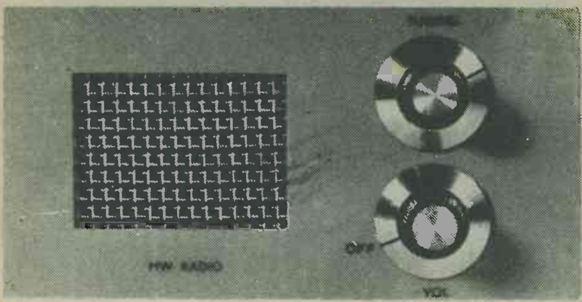
The case for the receiver should be a plastic type, without metal front or rear panels, which is large enough to take the component board and the other parts. A case having approximate dimensions of 150 by 80 by 50mm with a lid secured by screws at the corners is ideal, but any other plastic case of around this size or slightly larger may also be used.

CONSTRUCTION

Radio receivers, and particularly t.r.f. types, can be rather critical with regard to component layout, and it is strongly recommended that the receiver be built in the same general manner and with the same layout as the prototype. The accompanying photographs of the receiver clearly show the manner in which the author's receiver is assembled.

What would otherwise be considered the base of the case forms the front panel of the receiver, and the speaker is mounted to the left of this panel as seen from the front. It quires a rectangular cut-out which can be made with a fretsaw or a miniature round file. A piece of speaker "fret" or cloth is glued in place behind the panel, and the speaker is then, in turn, glued to this. A good quality adhesive such as Bostik 1 or an epoxy type, should be used. Care must be taken to ensure that none of the adhesive gets on to the moving diaphragm of the speaker.

The tuning capacitor is situated towards the top of the front panel on the right hand side, with sufficient space below it to allow VR1/S1 to be mounted. The capacitor has three 4BA tapped holes in its front plate through which 4BA bolts may be passed for mounting purposes. The positions of these holes relative to the central hole for the spindle can be marked out on the front panel in the following manner. Cut out a ¼in. diameter hole in a piece of paper and then pass the paper over the spindle of the capacitor. Mark out the positions of the three tapped holes on the paper with a pencil, and then use the piece of paper as a form of template to mark out the corresponding 4BA clear



Front panel layout is very simple. To the left is the speaker aperture. On the right, the tuning capacitor is above the combined volume control and on-off switch

holes on the receiver front panel. Drill out these holes and also, of course, a central hole slightly larger than $\frac{1}{4}$in. for the capacitor spindle. The 4BA mounting bolts must be short in length because their ends must not pass more than fractionally inside the front plate of the capacitor as they would then damage the capacitor fixed or moving vanes. Also, spacing washers, which could in practice be 2BA nuts, should be passed over the mounting bolts between the rear of the case front panel and the front plate of the capacitor. The mounting procedure in the plastic case is somewhat fiddling and a much easier approach, which is admittedly not so mechanically "respectable", is to simply make a hole slightly in excess of $\frac{1}{4}$in. in diameter through which the spindle and bush surround can pass. The front plate of the capacitor can then be glued to the inside surface of the front panel using a good quality adhesive.

VR1/S1 is mounted below VC1, and merely requires a standard hole of $\frac{3}{8}$in. diameter.

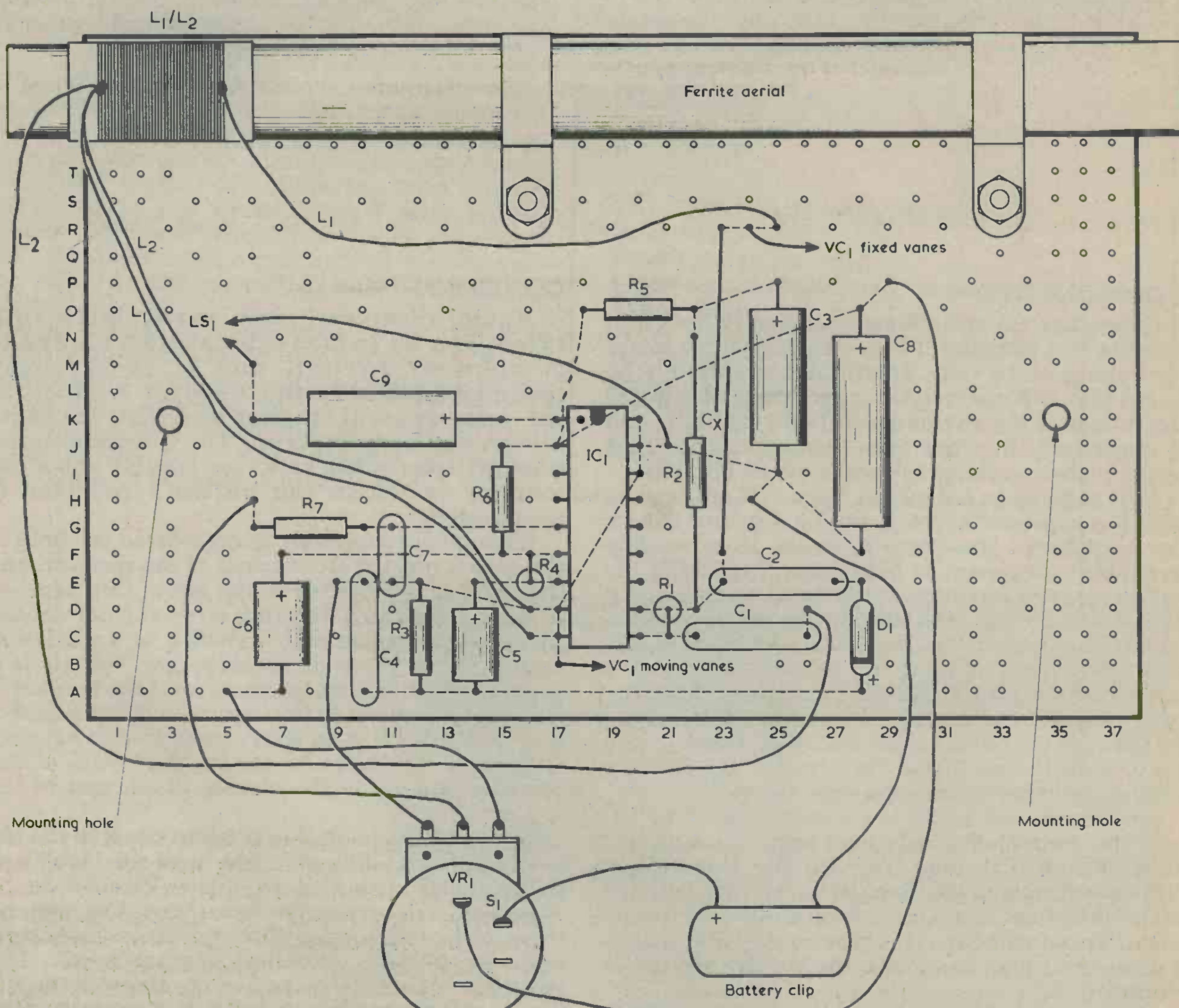


Fig. 3. Apart from the battery and the components on the front panel of the case, all the parts are assembled on a perforated s.r.b.p. board of 0.1in. matrix. Interconnections below the board are shown in broken line.

CIRCUIT BOARD

The remaining small components are assembled on a plain (i.e. without copper strips) perforated board of 0.1in. matrix which measures 3.75 by 2.5in. This is a standard size in which the board is readily available, and there is no need to cut it down from a larger size. Details of the component layout and wiring are given in Fig. 3.

The two mounting holes are first drilled out, and these can be clearance size for 6BA or M3 screws. The two holes for the ferrite aerial mounting clips are drilled next. These are drilled to take 2BA or M4 screws, which should be about ½in. long.

The integrated circuit, IC1, is next fitted to the board, its pins being bent out flat against the underside of the board so that it is held in place. The other components are then mounted one by one, their lead-outs being bent at right angles under the board, cut to length and soldered together as shown in Fig. 3, in which the wiring under the board is depicted in broken line. Where lead-out wires are too short, as may occur for instance with the connection between capacitor C5 and diode D1, tinned copper wire of around 22s.w.g. can be employed as extension wire. It is important to ensure that L2 is connected with the correct phasing, and Fig. 4 shows in detail the connections required here.

CX later, the lead from L1 to hole R25 in the board should be kept clear of the wiring around TR1 collector (pin 11 of IC1), as also should the lead from hole R24 to the fixed vanes tag of VC1. CX consists of two single core p.v.c. insulated wires fitted at holes R23 and F23. These should have a length which enables them to overlap each other for about ¾in.

The battery fits into the space beneath the speaker and should be held in place when the rear panel of the case if fitted.

ADJUSTMENT

The set will probably give reasonable results without the two wires which form CX being included. However, the regeneration provided by CX gives substantial improvements in selectivity and sensitivity. As the two wires are brought closer to each other the regeneration is increased until a point is reached at which the r.f. stage breaks into oscillation, causing heterodyne whistles to be given with some or all of the stations which are tuned in. The final setting for CX is that at which regeneration is just below the oscillating condition. This can occur with the wires spaced by quite some distance, and they can be held at that spacing by passing a piece of insulating tape around them.

The frequency coverage of the receiver is affected by the positioning of the coil on the ferrite rod, and full coverage of the medium wave band may not be given if the coil is well away from its correct position. A lack of coverage at the high frequency end of the band (VC1 vanes unmeshed) can be rectified by moving the coil closer to the end of the rod. Similarly, a lack of coverage at the low frequency end of the board may be corrected by moving the coil further to the centre of the rod. When the coil, has been positioned correctly it may be held in place with a piece of insulating tape. Final adjustments in CX should not be carried out until the correct frequency coverage has been obtained. ■

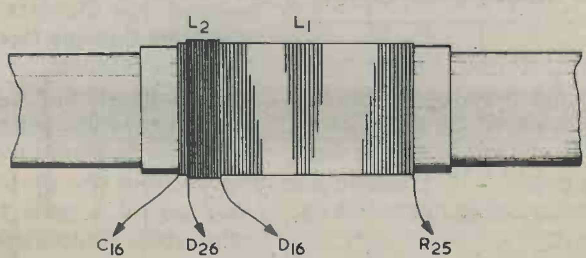


Fig. 4. To obtain correct phasing, L1 and L2 should be connected to the board in the manner shown here. The letter and number references apply to the corespondingly identified holes in the board

The completed component panel is secured to the rear panel of the case by means of two 6BA or M3 screws about ½in. long, with appropriate nuts. The ferrite aerial should be towards the top when the rear panel is fitted to the case. Spacing washers about ¼in. long should be fitted over the screws between the component board and the rear panel to prevent physical strain on the board when the bolts and nuts are tightened up. Before it is finally mounted in position, the component board must be wired up to VR1/S1, VC1 and the loudspeaker, using flexible p.v.c. insulated wires about 4in. long. The battery clip should also be wired to the board at this stage. To avoid difficulties when setting up

DATABUS really explains microprocessors

series No. 4

By Ian Sinclair

The CPU Registers

This fourth article in our 12-part series explains the registers which are built into the CPU of the microprocessor

Remember what a shift register is? Just in case you've forgotten, it's a row of flip-flops connected so that each flip-flop hands on its stored bit to the next flip-flop when a clock pulse is applied to all the flip-flops. If the flip-flops are not clocked, they act simply as a store, a temporary memory of as many bits as there are flip-flops.

There are several particularly important registers built into the microprocessor CPU, the accumulator (A) register, the data counter, the instruction register, and the program counter (PC) register. The accumulator register stores 8-bit information, one byte, and has, naturally enough, eight flip-flops. The program counter register has 16 flip-flops and stores two bytes of binary bits. The accumulator register is used for data bytes, the program counter and data counter for storing addresses.

PROGRAM COUNTER REGISTER

Let's look at the program counter register first. As the name suggests, this is a register which stores, in binary form, the results of a count. What makes this register (and the data counter register) so important is that its outputs (sixteen of them) can be gated to form the address outputs of the CPU so that the number to which the PC register has counted is the address to which the address lines from the CPU are set. The counter part ensures that the program moves from one part to another, because the count goes up by 1 each time a program instruction is completed. The phrase that the textbooks use is that the PC increments on completion of each instruction.

The data counter can also be gated so that its outputs are connected to the address lines, but not, of course, at the same time as the program counter is connected. The data counter register is not usually incremented, because it's used to store an address number which is not part of a program sequence — data rather than program. As far as the CPU is concerned, all signals are binary signals,

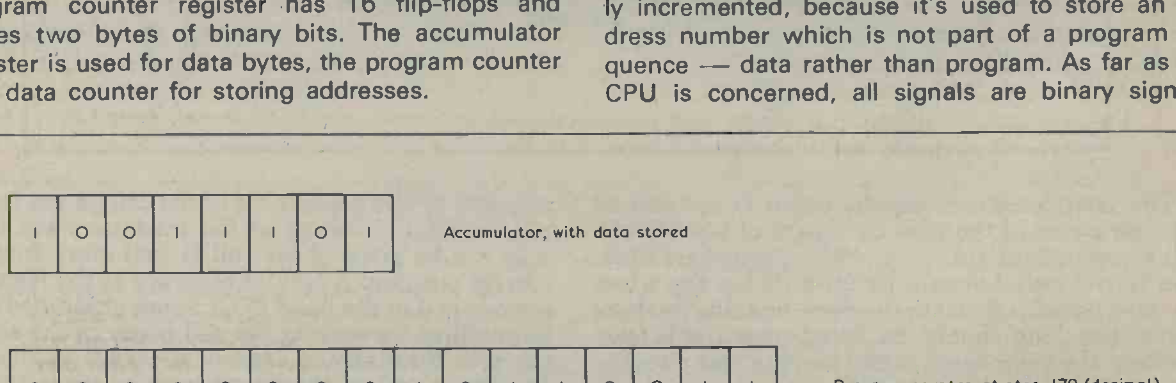


Fig. 1. Representing registers by boxes. The accumulator holds 8 bits, the program counter (PC) holds 16 bits

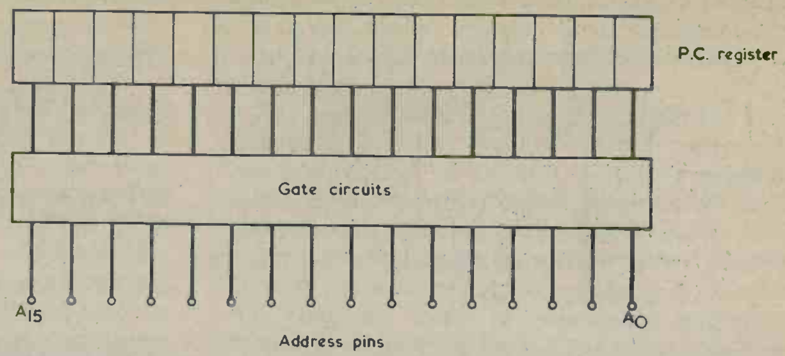


Fig. 2. The bits held in the program counter can be gated to the address pins so that they form an address number

whether they represent program instructions, numbers to be added, or symbols. The separation is achieved by using the program counter to address program bytes, with some exceptions (see later) and the data counter to access data bytes.

You can begin to see a bit more clearly now how a program which is stored in a ROM starts to carry out its work. Imagine the CPU which has been reset so that the PC register like all the other registers, stores zeros in all sixteen bits. Now RESET is an instruction like any other instruction, so at the end of the reset instruction the program counter, which has been reset to zero, counts up (increments) so that 1 is stored. That means that address number 1 (decimal) has been selected, and address line Ao has logic 1 on it, with the rest set to zero. See Fig. 4. In a very short time, a matter of nanoseconds later, eight bits of data will connect (from memory) to the data pins of the CPU, carrying the first byte of instructions into the CPU. If there's nothing stored at this address, of course, everything grinds to a halt.

The next few clock pulses will then cause things to happen to this byte, and they won't be used to clock the PC counter — a gate sees to that. When does the gate open? The answer is that each instruction byte which comes in will take a definite number of clock pulses to carry out, and the form of the instruction byte itself contains a code which allows the CPU to count out the correct number of clock pulses.

The instruction (program) byte is passed from the data pins to an instruction register, which stores the byte until the next instruction comes in. Gates connected to the outputs of this register can detect what instructions have been selected, and arrange for the correct number of clock pulses to be delivered to the right places.

At the end of the instruction, the next clock pulse increments the program counter again, and we get to program step 2 (decimal), a byte ending in 0010 (binary). Once again, this sets address number 2 on the address lines, so that the new data byte coming in from the ROM is the next step of the program.

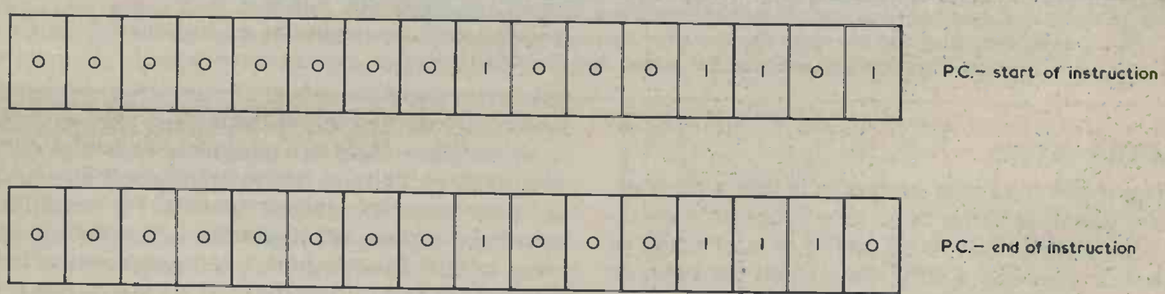


Fig. 3. The program counter increments at the end of an instruction

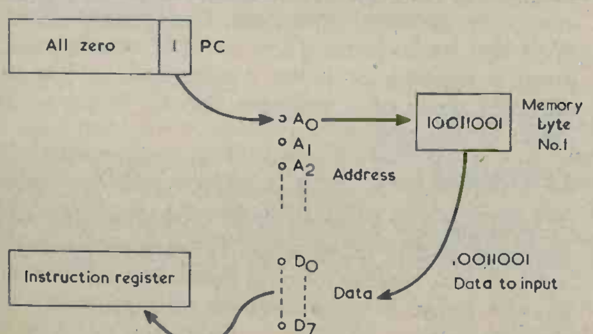


Fig. 4. An instruction sequence. The number in the PC addresses the memory section and the 8 bits of data from the memory at that address number are delivered to the data input pins. They then go to the instruction register, because the first byte delivered must be an instruction

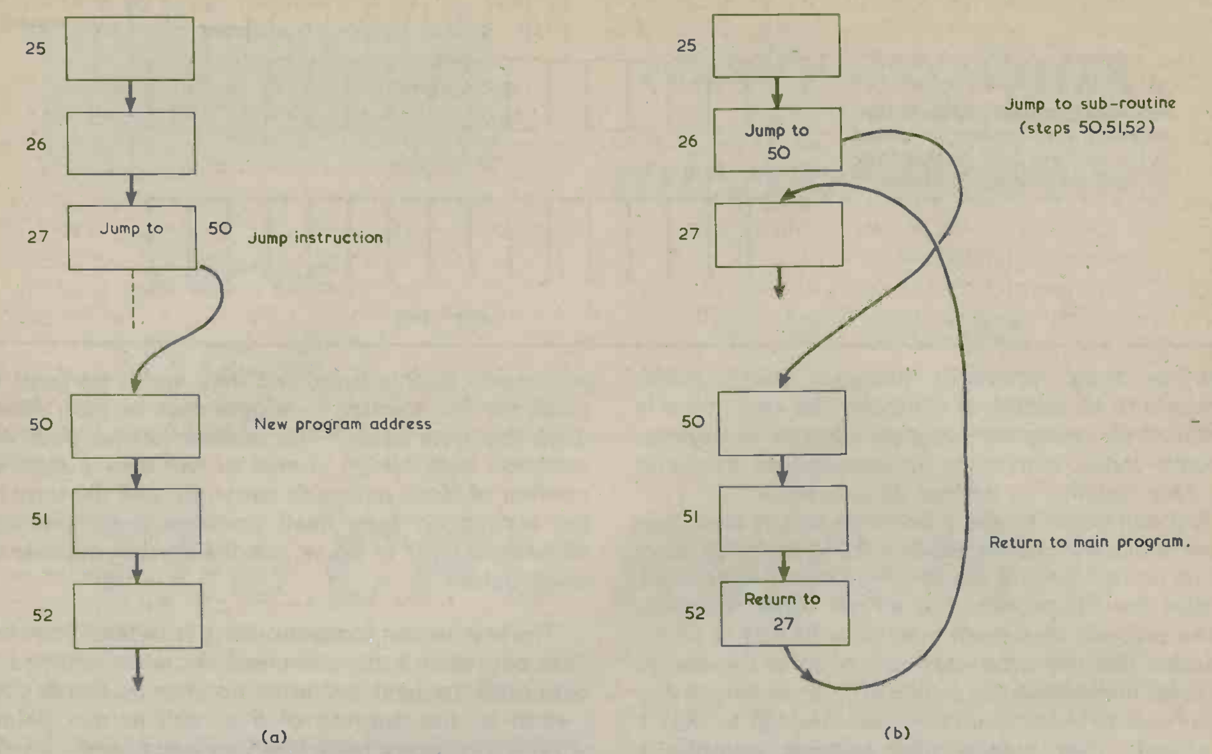


Fig. 5. Jumps and subroutines. In the jump of (a) the sequence of program suddenly jumps to a new address number and continues from there. A subroutine, as in (b), contains a jump at the start but returns to the main routine after completing the subroutine steps. Decimal numbers have been used to indicate the steps, but the CPU would, of course, use binary

NUMBER BYTE

What if the byte that comes in is just a number, not one which is to be used as a program instruction, but one that has to be added or subtracted or whatever? How can a CPU distinguish between an instruction and a number, when they are all 8-bit bytes anyway? The answer is that pure numbers never come into the data inputs unprepared. When a pure number which is to be operated on arrives, the previous byte has been one which sets up a reception committee — one type of such instruction is called "immediate". The "immediate" instruction sets up gates in the CPU which will ensure that the next byte in is treated as a number which will be sent to the accumulator register (see Part 5) to be added, subtracted, multiplied, divided, AND-ed, OR-ed, or whatever the instruction happens to specify.

For example, the "add immediate" instruction sets up the CPU so that the next byte in is added to whatever number is already there in the accumulator register of the CPU.

Now all of this works splendidly when we go step-by-step through a program, but what happens if we want to take something out of sequence? This may happen, for example, if there are data bytes which aren't loaded into the program, or if we want to jump. Readers who have followed the "Tune-in to Programs" series in this journal will be familiar with jumps and loops, but a brief word of explanation is due to anyone who has not read the "Tune-in" articles.

A program need not progress from one step to the next in line — sometimes another piece of program has to be carried out first. For example, we may have a piece of program in which two numbers have to be added together, but one number has to be obtained by multiplying two other numbers; in algebra this is written as a+bc. The normal run of program gets as far as the ADD instruction, then the multiplication can be done in a quite different section of program. In such a simple example, of course, the multiplication could be done as part of the same program, but this is not always convenient when a lot of steps are needed. After the multiplication has been carried out and the result obtained, the main program takes over again — this is an example of a jump-to-subroutine. Another time when a jump out of the normal program routine is needed is when a test is made. A test means comparing the number that is obtained (in the accumulator register) with zero. The program instructions can be to jump if the number equals zero, or jump if positive or jump if negative. In this way, different parts of a program can be followed as a result of the test.

LOOPING

Looping is a jump back to an earlier part of the program and is done when operations have to be repeated. A typical looping operation occurs when several bytes of data have to be transferred from one memory to another — each has to be read in from one memory into the accumulator register and then read out to the other memory. The instructions are the same for each byte, so that the program consists of a loop of read-then-write, with an increment of the address numbers each time.

Actions like this are carried out by making use of the other registers in the CPU. The total number of registers which can be connected to pins varies considerably from one CPU design to another. The popular SC/MP, for example, has a total of two 8-bit registers and four 16-bit registers; the Z80 has four 16 bit special registers, used for program counting and other program activity, another special-purpose register which is split as two independant 8-bit registers, and eight 16-bit general purpose registers which can also be used as 8-bit units, one of which is the accumulator. There are, in fact, so many registers in a Z80 that no one ever seems to use all of them!

Let's stick for the moment to the program counter and data counter registers. The problem of finding a byte of data which is not part of a program is solved by the use of the data counter. The address number for this place in the memory is loaded into the data counter — we'll see later how this may be done. When the instruction for reading this piece of memory comes in, the instruction byte is transferred from the data input pins to the instruction register. The gates connected to this register then stop incrementing the program counter and switch the address pins to the data counter. The address number which is stored in the data counter now goes out on the address lines, activates the memory, and so causes the byte that is in the memory to be connected to the data lines. By this time, the instructions will have connected the data pins to the accumulator, so that the stored byte is copied into the accumulator. The next step is to disconnect the data pins, and then switch back control of the address lines to the program counter. That's the end of the "memory fetch" instruction, so that the program counter can now increment, setting a new program address, and the data pins can once more be connected to the instruction register for the next instruction byte.

How does the address number get into the data counter register? We'll have to leave details until later, but this isn't an automatic operation like the incrementing of the program counter — the address has to be read into the accumulator, either from memory of from outside the processor (from a keyboard, for example) and then transferred to the data counter. All of this has to be programmed, and this is one of the jobs which must be done by an operating program kept in ROM.

16-BIT ADDRESS

You may have spotted one odd feature in that brief description. An address consists of 16 bits, two bytes, but data comes in single 8-bit bytes — how can we get an address of 16 bits using 8-bit data? The answer is, in two stages, with one byte of data loaded in and then transferred to the lower half of the data counter register. At the next instruction, another byte of data is loaded in, and this time transferred to the higher half of the data counter register. This procedure isn't as awkward as it sounds, but doesn't always have to be done because the higher 8-bits of an address often don't need to be changed.

This sort of data fetch is comparatively simple, because it involves switching over address lines from one register to another. A jump instruction is quite a different sort of beast, because the address lines stay connected to the program counter but the program counter shifts from one number to another which is not a simple increment (+1) or decrement (-1). That, by itself, is reasonable enough, the problem is of jumping back if the jump has been for a sub-routine. The exact methods of doing this vary a bit from one CPU to another, but the principle is always the same. When the jump instruction occurs, the number which is stored in the program register is copied, either into another register in the CPU or into a piece of memory called the stack. The stack memory can be inside the CPU, in which case it will be only a small memory, probably 6 to 10 bytes; or it can be a piece of RAM which is addressed by the CPU. Whatever method is used, the copying of the program register preserves the address number which was in the program register, so that the program register can now be changed to the new address number specified by the jump. The new piece of program is carried out, and when the time comes to jump back an instruction at the end of the new piece of program causes the original program

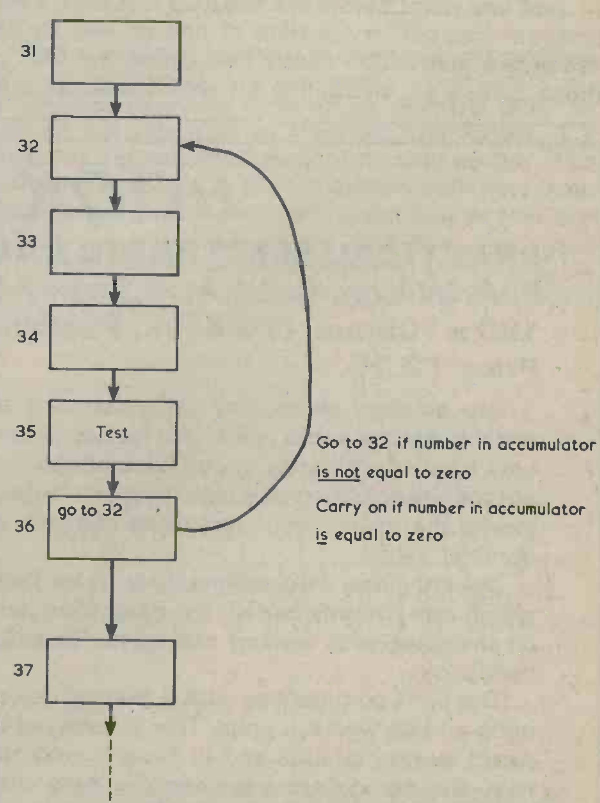


Fig. 6. Looping. The program loops from step 36 back to step 32 (decimal numbers) each time until the number which is in the accumulator at step 35 is equal to zero. The program then continues to step 37

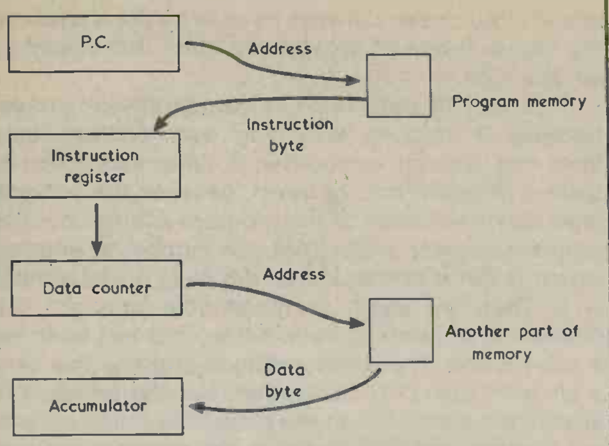


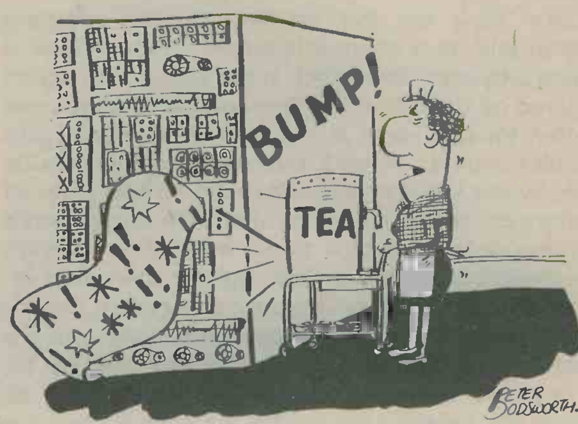
Fig. 7. Finding a data byte in another part of memory. The PC address fetches the instruction byte(s) from program memory. The instruction register then switches the address pins to the data counter, so addressing another part of memory with the number stored in the data counter. The data byte from this part of memory is then guided into the accumulator to be used. Part 5 will deal with this and other ways of reading memory

register address to be returned from wherever it has been stored. This puts the old address back, and at the end of the return instruction the program counter is incremented in the usual way.

Just one point before we wrap up this part. Each program instruction consists of one or two bytes. When the instruction needs two bytes, the first of these carries an instruction bit which ensures that the second byte is shifted to the correct part of the instruction register. When an instruction byte is followed by a data byte, the instruction byte will contain a bit which ensures that the next byte in is transferred to the accumulator register. The byte following a data byte is assumed to be another instruction byte. In this way, each byte that comes in at the data pins prepares the connections for the next one, and it is up to the programmer to see that each byte is correctly placed — that's why a program must be 100% correct.

Next month — how we specify an address for the data register or program counter!

(To be continued)



"Hey, watch your language!"

BOOK REVIEW

PRACTICAL ELECTRONIC CALCULATIONS AND FORMULAE. By F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., M.B.I.M. 248 pages, 180 x 105mm. (7 x 4¼in.) Published by Bernard Babani (Publishing) Ltd. Price £2.25.

Any amateur electronics enthusiast who sets out to design his own equipment will almost inevitably find, at some point, that he has to carry out some calculation, even if this is only at Ohm's Law level. Fortunately, most calculations in electronics are of a relatively simple nature and do not require solutions at a high level of accuracy. Indeed, electronics must be unique in engineering insofar that many circuit quantities can have exceptionally wide tolerances of the order of 10% on nominal value.

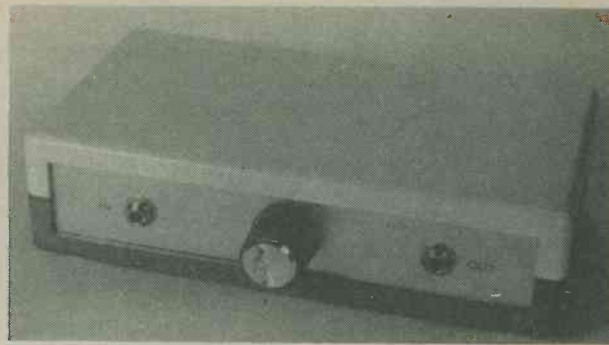
Nevertheless, calculations have to be faced and it is of great help if a handbook is available which can not only furnish the basic formulae and equations required but can also give guidance on their use with worked examples. "Practical Electronic Calculations and Formulae" is such a handbook.

The book commences with a chapter on units and constants, part of which deals with basic S.I. units and derived S.I. units. This is followed by chapters dealing with the calculations involved in direct current circuits and in circuits incorporating resistance, capacitance and inductance. The next chapter covers alternating current circuits, and takes in reactance, impedance and the behaviour of resonant circuits. The book then carries on to a chapter on networks and theorems, this including network analysis, waveform analysis, attenuating networks, matching networks and filters. The final chapter in the book discusses measurements.

The book is concisely written and contains a mass of information. In many instances, tables are given to assist in determining quantities for specific circuit requirements.

ENVELOPE SHAPER

By M. V. Hastings



The envelope shaper is housed in a two-tone plastic case with an anodised aluminium front panel

Add further character to the output of last month's "Stylus Organ"

This circuit has been designed as an add-on unit for the "Stylus Organ" which was described in last month's issue. It connects between the tone generator output and the amplifier input in the organ, and it shapes the envelope of the signal produced to give an output amplitude which quickly decays from normal to a lower pre-determined level. Thus, the ordinary constant output level from the tone generator, as in Fig. 1(a), emerges from the envelope shaper with a varying amplitude characteristic, as in Fig. 1(b). The effect is given with every new note selected on the organ.

The result is in the nature of a percussive effect, similar to that of a piano and certain other instruments. However, it must be stressed that the unit is not intended to simulate the sound of a piano, or any other instrument for that matter. The intention is simply to give an interesting effect from the organ and thus increase its usefulness and versatility. To actually simulate the sound of a piano with reasonable accuracy requires quite complex and expensive circuitry, even when using modern devices and techniques.

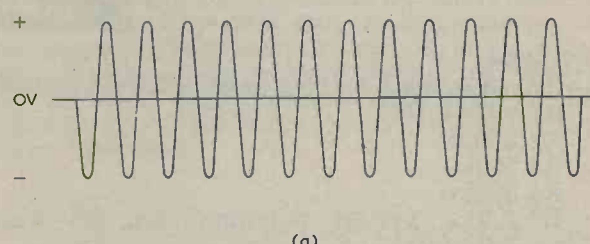


Fig. 1(a). The output of the stylus organ tone generator is a signal of constant amplitude

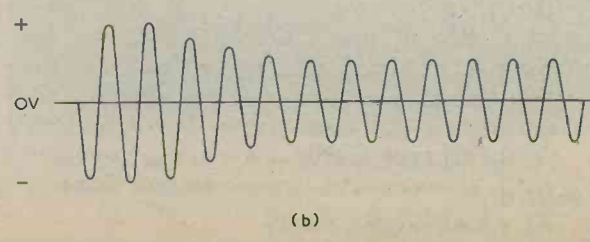


Fig. 1(b). When passed through the envelope shaper the signal is initially at its full amplitude, after which it falls rapidly to a pre-determined lower level.

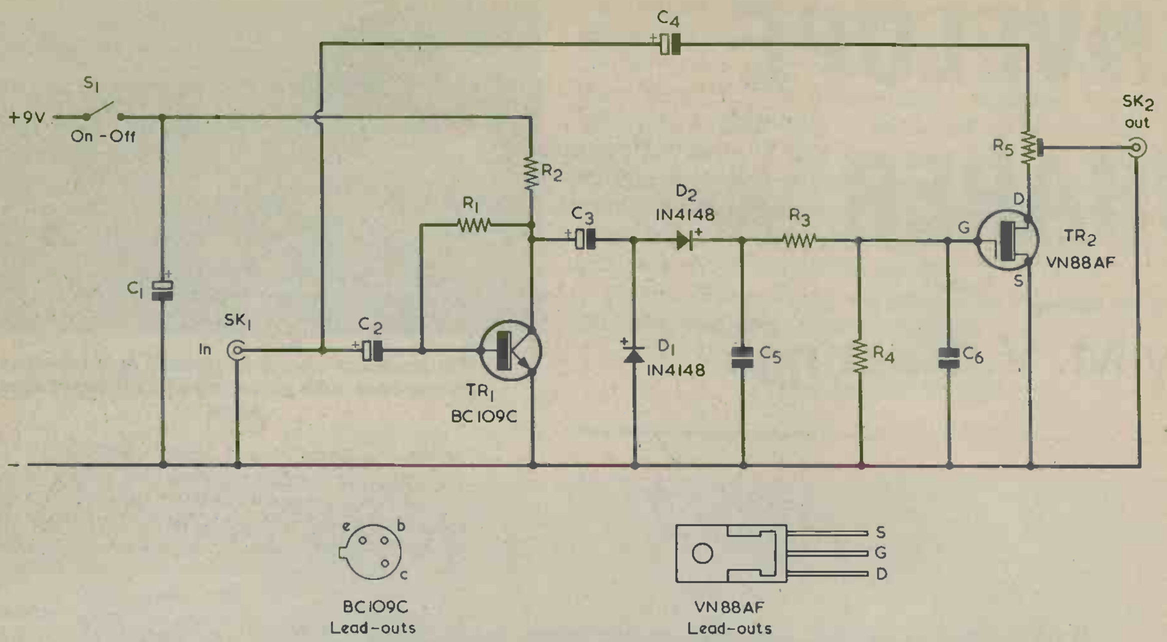


Fig. 2. The circuit of the shaper unit. An incoming signal turns on TR2 after a short delay, thereby producing a reduction in signal amplitude at the output

THE CIRCUIT

The envelope shaper has an extremely simple circuit, as will be apparent from Fig. 2. The input signal is coupled by C4 to the pre-set potentiometer R5 and the drain of a VMOS power f.e.t., TR2. Together, R5 and TR2 form a potential divider, the lower section of which is given by the drain-to-source resistance of the transistor. The latter acts rather as a voltage controlled resistor. The output signal is extracted from the slider of R5 and this is adjusted to provide the desired level of attenuation, as evident in the later part of the waveform of Fig. 1(b). Under quiescent conditions, with no output from the organ tone generator, the gate of TR2 is held at the potential of the negative supply rail by R4, and TR2 then exhibits a drain-to-scource resistance of typically many megohms.

The input signal is also applied by way of C2 to the base of TR1. This is a high gain common emitter amplifier with R2 as its collector load and base biasing provided by R1. The amplified signal at TR2 collector is passed via C3 to the rectifier and smoothing circuit consisting of D1, D2 and C5. In the presence of signal from the organ this circuit produces a high positive bias which is applied to the gate of TR2 through the potential divider given by R3 and R4.

Before a signal is applied to the input of the envelope shaper TR2 exhibits its high drain-to-scource resistance. When a signal is applied, a rectified positive voltage is fed to R3 and R4. The junction of these two resistors does not go positive immediately, however, because of the pressure of C6. There is a very short delay which, although only a fraction of a second, is still significant and perceptible. After this delay, the positive voltage at

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 1.5MΩ 10%
R2 4.7kΩ
R3 560kΩ
R4 560kΩ
R5 2.2kΩ pre-set potentiometer, 0.1 watt horizontal

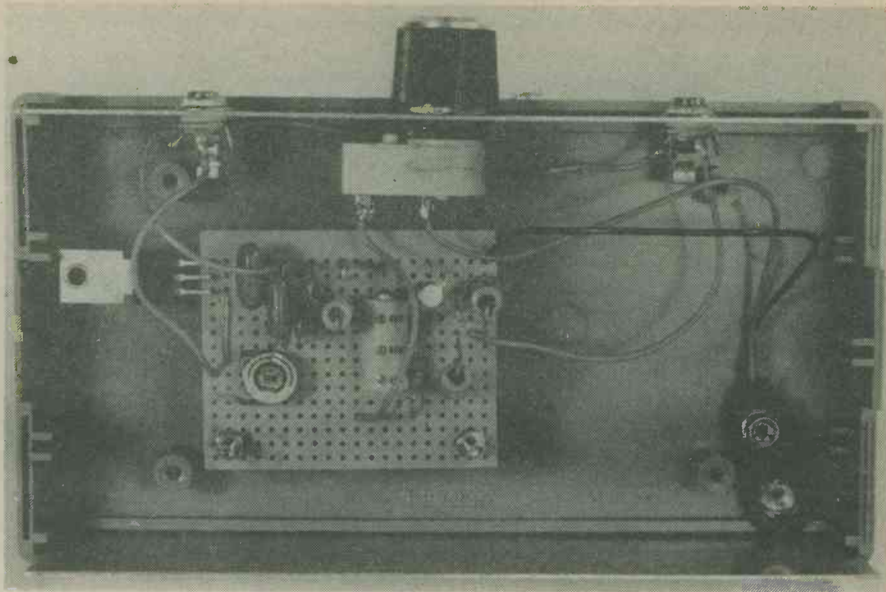
Capacitors
C1 100μF electrolytic, 10V, Wkg
C2 1μF electrolytic, 10V. Wkg.
C3 0.47μF electrolytic, 10V. Wkg.
C4 1μF electrolytic, 10V. Wkg.
C5 0.1μF type C280
C6 0.1μF type C280

Switch
S1 s.p.s.t. toggle, rotary

Semiconductors
TR1 BC109C
TR2 VN88AF
D1 1N4148
D2 1N4148

Sockets
SK1 3.5mm. jack socket
SK2 3.5mm. jack socket

Miscellaneous
Verobox type 75-1237-J
Veroboard, 0.1 in. matrix
9-volt battery type PP3
Battery connector
Control knob
4-off 3.5mm. jack plugs
Connecting cables, wire, solder, etc.



There is ample space inside the case for the Veroboard module and the 9-volt battery

TR2 gate causes this transistor to exhibit a very low drain-to-scource resistance of a few ohms only.

If the slider of R5 is set to the bottom of its track the attenuated signal given when TR2 turns on has virtually zero amplitude. This does not give a very musical effect, but it is, of course, possible to adjust R5 so that the amount by which the signal is attenuated can be varied. With R5 slider at the top of its track there is hardly any fading, and it is merely necessary to adjust this potentiometer so that the level of attenuation after TR2 turns on has the most pleasing subjective effect. This will normally be in the region of —20dB.

It is necessary for TR2 to turn off quickly at the end of each note so that the envelope shaper can repeat the fade-out process at the start of the next note from the organ. The requisite gap in organ output is automatically given with a stylus organ since there is inevitably a gap between one note and that following as the stylus is lifted from one key and placed on the next. Although this gap is only very short it is sufficient, in practice, to allow C6 to discharge into R4 to a level that turns off TR2.

The circuit is powered, via on-off switch S1, by a 9 volt battery type PP3. This has an extremely long life as current consumption is only about 1 mA.

The choice of a power f.e.t. as the gain control element may seem unusual, but the fact that it is an enhancement mode device (which is normally in the off state and requires a forward gate bias to turn it on) makes it easier to use than the more common depletion devices. These are normally conductive and are turned off by applying a reverse bias. The VN88AF is available from Maplin Electronic Supplies.

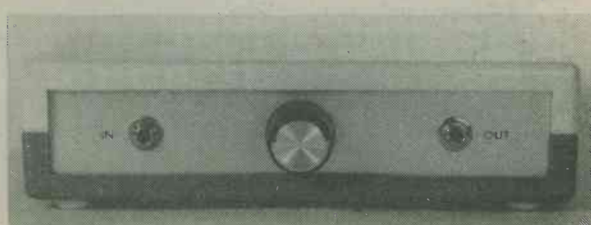
It may be considered at first sight that C2 is connected into circuit with incorrect polarity. The polarity is correct, however, as the output from the stylus organ is obtained from a positive point via an electrolytic capacitor. It follows that C4 similarly has correct polarity, C2, C3 and C4 are very low value electrolytic capacitors and are specified in the Components List as having working voltages of 10 volts. It will almost certainly be found that electrolytic capacitors available in the values listed have working voltages considerably higher than 10 volts, and it is perfectly in order to employ such capacitors in the present circuit.

CONSTRUCTION

With the obvious exceptions of SK1, SK2, S1 and the battery, all the components are assembled on a panel of 0.1 in Veroboard having 15 copper strips by 20 holes. Details are given in Fig. 3.

After cutting out a panel of the correct size the two mounting holes are drilled 6BA or M3 clear. There is just a single break in the strips, which should be made next. The components and the one link wire are then all soldered into position. The unit is housed in a Verobox type 75-1237-J, which has dimensions of 153 by 84 by 39.5 mm. The leadouts of TR2 need to be bent through 90 degrees before they are passed through the appropriate holes in the Veroboard for soldering. This enables the transistor to lie flat. If it were positioned vertically its height would be too great for the box. TR2 does not, of course, require a heat sink.

The simple and straightforward layout inside the case can be seen from the photograph of the case interior. On the front panel, the rotary on-off switch is mounted in the centre with the input jack socket SK1 to its left and the output jack socket SK2 to its right. The Veroboard module is bolted to the bottom of the case with spacing washers over the mounting bolts to ensure that the board underside is clear of the inside surface of the case. It should not be finally mounted until all the connections to the components external to the board have been completed.



On the left of the front panel is the input socket, with the rotary on-off switch in the centre. The output socket is to the right

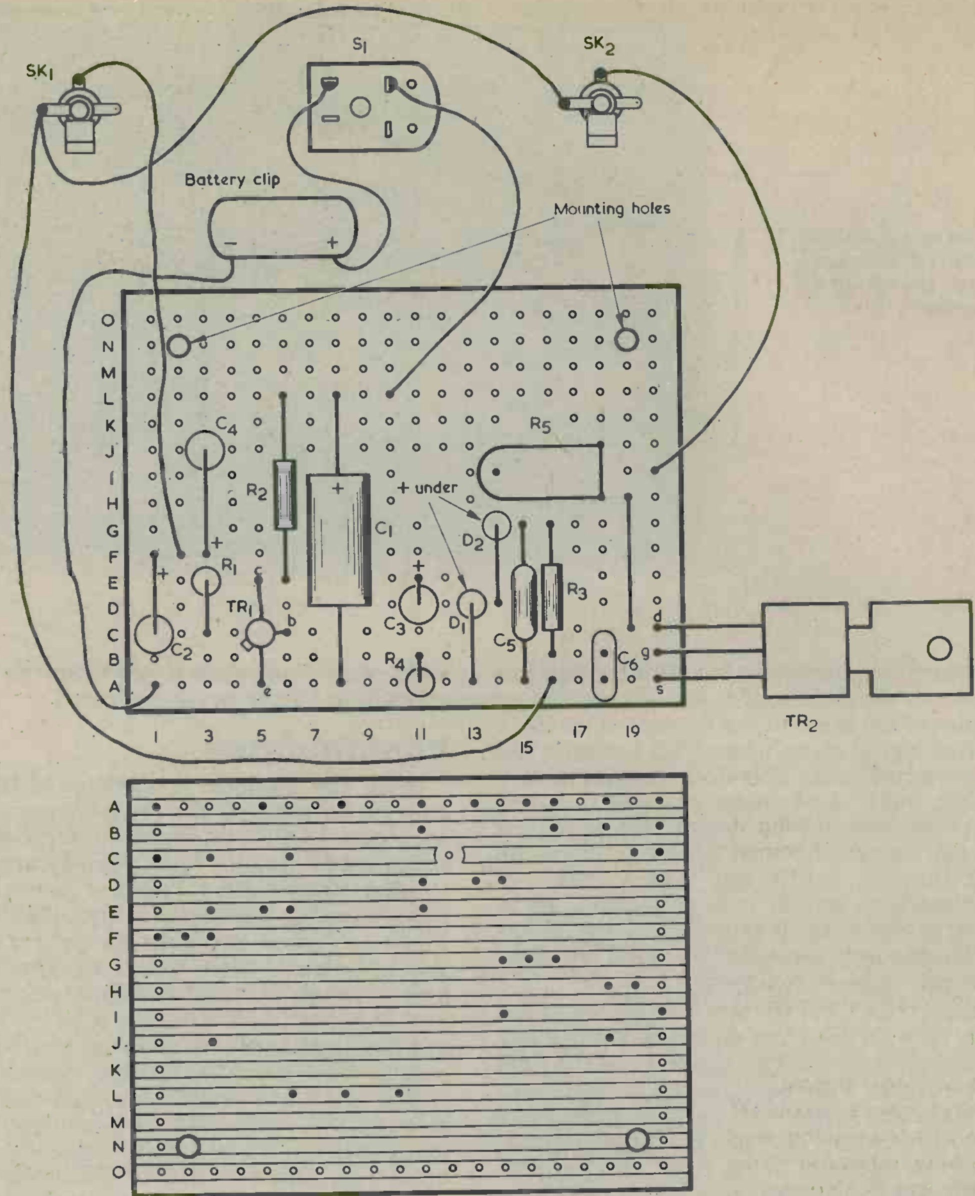
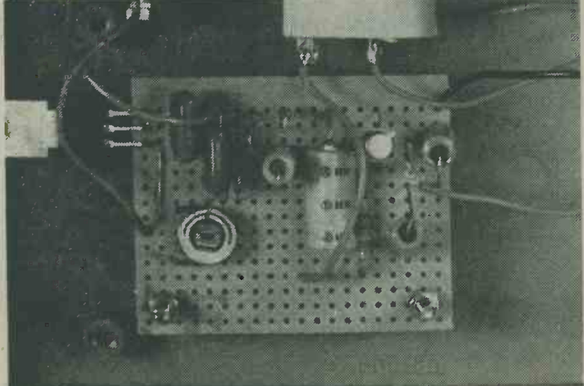


Fig. 3. Wiring up the components in the envelope shaper, including those on the Veroboard panel

ADJUSTMENT AND USE

Two twin leads fitted with 3.5 mm jack plugs at each end are needed to couple the output section of the organ to the input socket of the envelope shaper, and to couple the output of the shaper back to the a.f. amplifier input of the organ. Since low impedence signals at fairly high level are involved, it is not essential to use screened leads. However, it is necessary to ensure that the sleeve and tip connections to the plugs are not accidentally crossed over through the twin leads.

R5 is the only component which needs adjustment, and this is merely given the setting which gives the most pleasing effect. Although unlikely, it is just possible that some devices used in the TR2 position may have a low gate threshold voltage; this will result in an excessively fast decay time, with the circuit also not recovering quickly enough between notes from the organ. Should this effect be encountered it may be cleared up by reducing the value of R4, say to about 270 kΩ or 220 kΩ. ■



Close-up of the Veroboard panel

In your work-shop

Smithy's

REACTION TIMER

Just a question of timing . . .

"With prices going up the way they are these days," said Dick gloomily, "we'll soon be finding it impossible to live any sort of normal life at all."

Smithy grunted in assent.

"Still," went on Dick more cheerfully as a thought suddenly occurred to him, "at least the price increases will phase out some of the more illegal people who flourish in our midst."

"What sort of illegal people?"

"Why, drunken drivers, of course! With the cost of booze going sky-high, and that of petrol even higher, nobody will be able to indulge in both of them together. So we'll either have sober drivers or drunken pedestrians!"

"Don't you believe it," responded Smithy. "The drunken driver problem is just the same as it always was. If I'm out walking just after chucking-out time at night I take jolly good care to keep well out of the way of any vehicles that come near me. As a matter of fact, we're having a little campaign at my club to bring home to members that they shouldn't drink too much before they drive off home in the evenings. Or, better, that they should leave their cars at home before coming round to the club."

"Are you having any success?"

"A little. In fact I've devised a gadget which is intended to convince the more hard-nosed types that their responses are actually slowed down by indulgence in the sauce, rather than speeded up as they fondly imagine."

REACTION TIMER

Dick's interest was aroused.

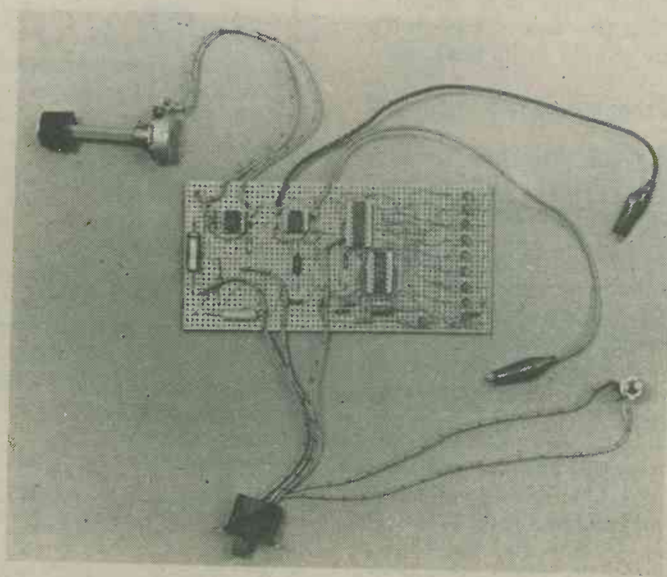
"A gadget?"

"Yes," said Smithy. "Actually, it's a reaction timer, with which you press a button when a light comes on. The gadget then tells you what time has elapsed between the lighting of the lamp and the pressing of the button."

"Reaction timer, eh? Aren't people likely to get a bit bored with that sort of thing?"

"There is that risk," conceded Smithy, "and so I've tried to make the timer operate in as attractive a manner as possible. The idea is to make people use the timer just for the fun of it. I've also gone to some pains to make it good and accurate."

"How does it work?"



Smithy's prototype reaction timer. This was assembled on a Vero V-Q board, which is extremely useful for the quick construction of experimental circuits. The wiring layout employed for the timer is not critical, and it can be assembled in any normally acceptable manner

"There's a vertical column of l.e.d.'s," explained Smithy, "and at a random moment they start to light up in turn, starting with the l.e.d. at the top. As soon as the first l.e.d. lights up, the chap using the timer presses the button, and the l.e.d. which is alight at the instant of pressing the button stays alight. Each l.e.d. is alight for 0.05 second, and so it is possible to use the timer to measure reaction time with an accuracy of one-twentieth of a second."

"That sounds pretty good to me. What happens if someone is dead slow and presses the button really late?"

"At the bottom of the column of l.e.d.'s are two l.e.d.'s which flash on and off alternately until the timer is reset or switched off. Anyone who is sufficiently slow to let the timer advance to this state has got to be really squiffy!"

"You certainly seem to be in the gadget making business these days, Smithy. The last time we had a gen session you were demonstrating your electronic dice to me."

"These things tend to come in bursts," said Smithy. "And, at any event, they do make a change from servicing. Things are quiet for the moment, so would you like to see the circuit of this timer of mine?"

Dick nodded eagerly in agreement and walked over to Smithy's bench as the Serviceman opened a drawer and pulled out a sheet of paper on which he'd drawn out a circuit diagram. (Fig. 1.)

"Here we are," said Smithy. "As you can see, it's rather more complicated than that dice circuit I showed you last time, although it's still pretty simple in its basic concept."

"I see that it uses four integrated circuits."

"That's right. The first i.c. is a 555 and it provides a random delay before the top l.e.d. in the column lights up. The second i.c. is another 555 and, as soon as it is allowed to so so by the first 555, it produces positive-going pulse edges spaced at intervals of 0.05 second. These positive-going pulses go into the clock input of the third i.c., which is a CD 4017."

"What does that do?"

"It's a decade counter. It has ten output pins, each corresponding to a number from zero to 9. When it's reset the 'O' output at pin 3 goes high and all the other outputs go low. If a positive-going pulse is fed to its clock input the 'O' output goes low and the '1' output goes high. The next pulse at the clock input causes the '1' output to go low and

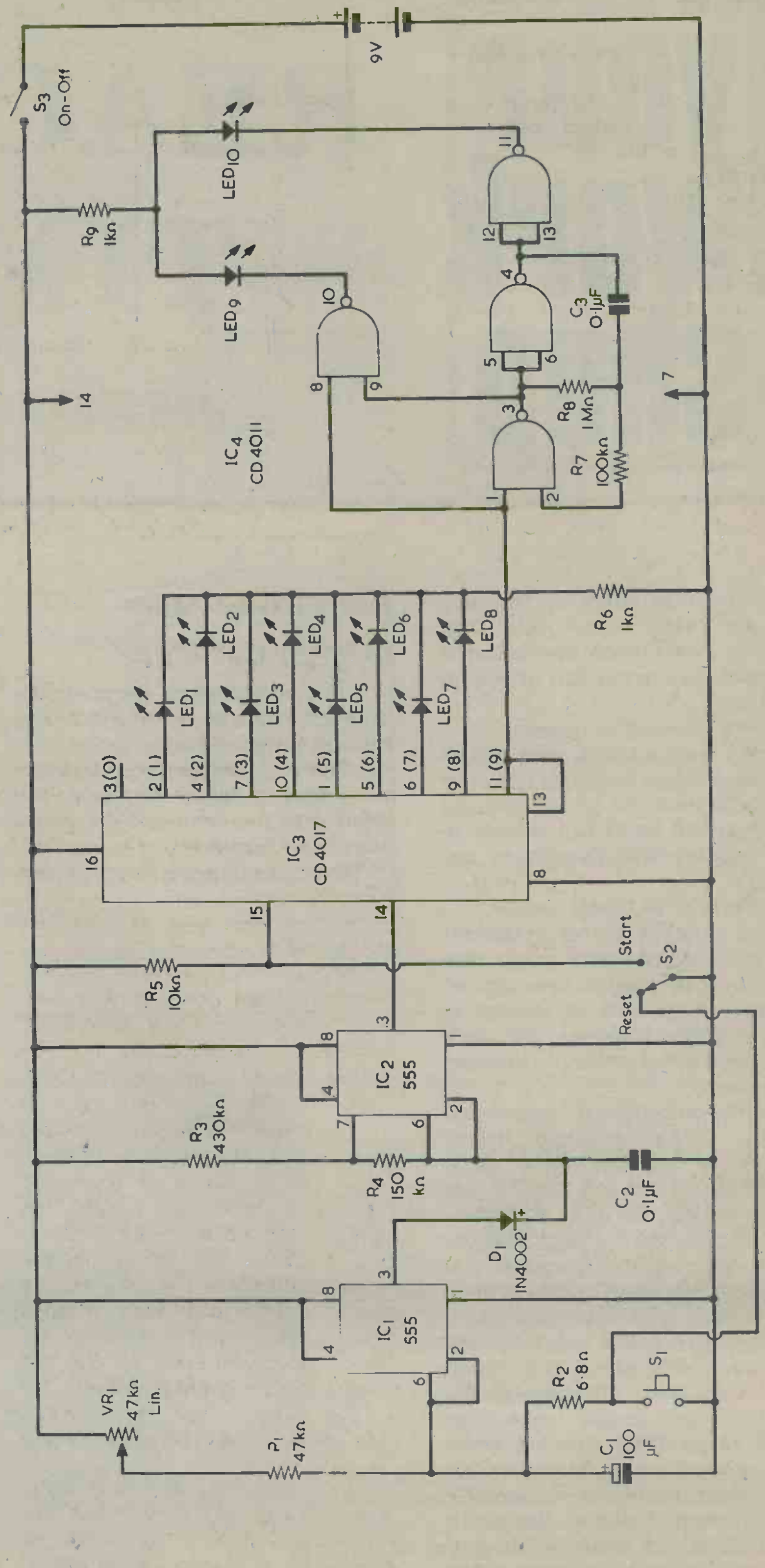


Fig. 1. The complete circuit of the reaction timer. After a delay which can be varied by adjusting VR1, the l.e.d.'s light up successively, starting with LED1 and ending with LED10 flashing alternately

the '2' output to go high. And so the process repeats, with each number output going high in turn for each clock pulse input. The outputs couple into a series of eight l.e.d.'s, so these each light up in turn. They are, of course, the l.e.d.'s in the vertical column."

"What happens when the figure 9 output goes high?"

"The CD4017 counting then stops and the CMOS oscillator given by two of the NAND gates in the fourth i.c., which is a CD4011, turns on. This oscillator causes LED9 and LED10 to continually flash on and off alternately."

Smithy drew another sheet of paper towards him and indicated it to his assistant. (Fig. 2.)

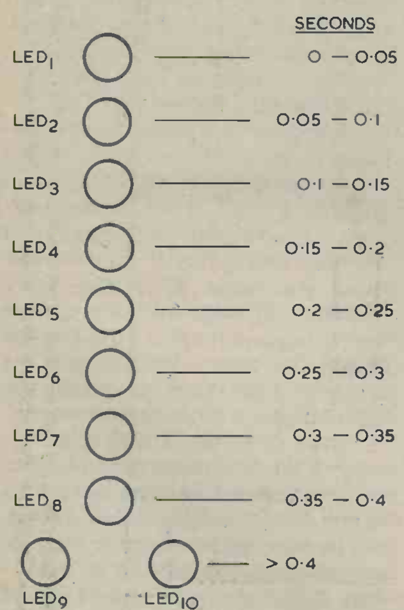
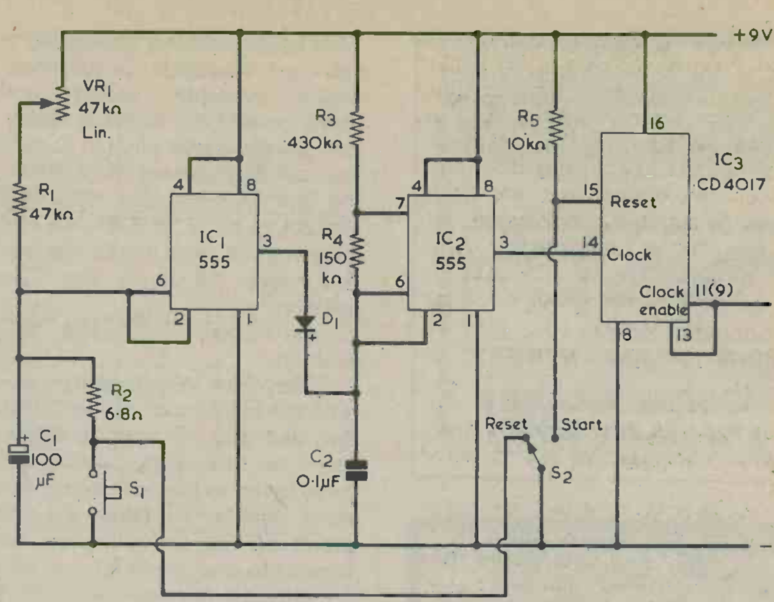


Fig. 2. The l.e.d.'s are arranged in a vertical column, as here. Also shown are the timing periods to which the l.e.d.'s correspond

"When I make up the timer finally and put it in a box," he went on, "I'll have the l.e.d.'s laid out like this on the front panel. Alongside each l.e.d. is the time to which it corresponds. If, for instance, LED5 stays alight when you press the button after the first l.e.d. has lit up, your reaction time is 0.2 to 0.25 second. Got it?"



$T = 0{\cdot}685\,(R_3 + 2R_4)\,C_2$

Fig. 3. The circuitry in which IC1 and IC2 appear. The timing display is caused to stop by pressing S1

CIRCUIT DETAILS

"In general, yes," stated Dick. "But I wish you'd go into the circuit in a bit more detail."

"All right," said Smithy obligingly, "we'll work our way along it from left to right. Let's start off by looking at what happens with the two 555 i.c.'s and the clock input to the CD4017."

Dick concentrated on the first section of the circuit. (Fig. 3.)

"Now," continued Smithy, "before we get down to the nitty-gritty, there are three things we need to bear in mind. The first two are concerned with the CD4017. When the CD4017 reset input at pin 15 is high its output is cleared to zero, and when the reset input is taken low it starts to count on successive clock input pulses. The CD4017 has a clock enable input at pin 13. When this pin is low the count proceeds in the manner I've just described, but when it goes high the clock input is inhibited and the count stays fixed at the last number which was high. Okay."

"Yes," said Dick thoughtfully, "that seems clear enough. What's the third thing?"

"That concerns the 555 i.c.'s. When pins 2 and 6 of a 555 are high its output at pin 3 is low, as also is its discharge pin at pin 7. And when pins 2 and 6 are low the output is high and the discharge pin is floating."

"Fair enough," said Dick. "I've absorbed all that, so let's get down to the explanation."

"Right," responded Smithy briskly. "When we switch on the 9 volt supply, switch S2 should be in the 'Reset' position. This causes the reset pin of the CD4017 to go high via R5 and its '0' output to go high also."

"Hey, hang on a moment! Won't that '0' output cause the first l.e.d. to light up?"

"It won't cause any l.e.d. to light up. If you look at the main circuit diagram you'll see that the '0' output isn't connected to anything. The first l.e.d. is connected to the '1' output."

"Ah yes, so it is. Go on, Smithy!"

"Another thing that S2 does when it's in the 'Reset' position is to short-circuit C1. Forget R2 for the moment, since it has a very low value. Now, if C1 is short-circuited there is zero voltage across its plates and so the input to pins 2 and 6 of the first 555 is low. So what does that mean?"

"It's output at pin 3," replied Dick promptly, "will be high."

"Good. That high output is applied via diode D1 to capacitor C2, causing the upper plate of this capacitor to be close to the potential of the positive rail."

"Let me think now," said Dick. "This means that pins 2 and 6 of the second 555 will be high and its pin 3 output will be low."

"Excellent," approved Smithy.

"The second 555 is connected in a standard oscillator circuit but it cannot possibly oscillate under these conditions. Another factor is that the discharge pin, pin 7, will be low, so that current from pin 3 of the first 555 will flow through D1 and R4 to pin 7, and thence to the negative rail. And that's the situation when S2 is in the 'Reset' position."

"Let's take it to the 'Start' position."

"Okeydoke. When we do that we take the reset input of the CD4017 low, and this will start to count as soon as the first positive-going pulse is fed to its clock input. At the same time we've taken the short-circuit off C1 and this now commences to charge via R1 and VR1."

"Why do you have a pot in the charging circuit, Smithy?"

"To introduce a random factor in the timing provided by the first 555. VR1 can be a panel mounting potentiometer having a round knob without markings so that it is difficult to guess its setting just by looking at it. Either the person using the timer or somebody else can adjust it in random fashion. Well, C1 continues to charge and, after a period, causes pins 2 and 6 of the first 555 to reach two-thirds of the supply voltage, whereupon its output at once goes low. C1 continues to charge after this, but this fact is of no importance so far as circuit operation is concerned."

MULTIVIBRATOR

"If pin 3 of the first 555 goes low," said Dick ruminatively, "D1 will become reverse biased, won't it?"

"That's right. C2 can now discharge via R4 and pin 7 of the second 555. When the voltage across the capacitor reaches one-third of the supply voltage the second 555 triggers and its output goes high, passing the first positive-going pulse to the clock input of the CD4017, and causing its output count to be advanced to 1. LED1 lights up. The second 555 now commences to function as a standard 555 multivibrator having a cycle length of 0.05 second."

"I suppose that cycle length is 0.05 second approximately?"

"The *calculated* cycle length," said Smithy, "is virtually 0.05 second *precisely*. Working to Signetics data, the length of the timing period is given by finding the sum of R3 and twice R4, and then multiplying this sum by 0.685 and the value of C2. This works out as 0.05 second to three significant figures. So we've now got the second 555 pumping out positive-going pulses at 0.05 second intervals. Each pulse causes the next l.e.d. in the vertical column to light up and the previous one to be extinguished."

"How do you stop the l.e.d.'s?"

"By pressing push-button S1," said Smithy. "This at once discharges C1 and causes pins 2 and 6 of the first 555 to go low and its pin 3 output to go high. The second 555 is immediately inhibited. If, at the instant of pressing the button, its output is high, that output is taken low. And if the output of the second 555 is low when the button is pressed, it stays low. The overall effect is that pressing the button stops the count and the last l.e.d. which was lit up stays alight."

"Do you have to keep the push-button continually pressed?"

"A momentary closure of its contacts is all that's needed, as it's merely necessary to discharge C1. If you then put S2 to the 'Reset' position, C1 will stay discharged until the next timing run. If, on the other hand, you leave S2 in the 'start' position, C1 will gradually charge until it triggers the first 555, and the l.e.d.'s will then continue from the last count until they end up with the last two l.e.d.'s flashing alternately."

"How long would that take?"

"For C1 to charge up again and trigger the first 555? The same time as the initial random delay. This is, incidentally, about 6 to 12 seconds according to the setting of VR1. I said earlier that you should ignore R2 for the moment. All it's in the circuit for is to limit the current which flows when S1 is pressed to short-circuit C1. Without R2 you could have a tiny spark at S1 contacts which could, conceivably, eventually reduce its efficiency. The same applies to the 'Reset' contacts of S2 if these happen to short-circuit C1 when it is charged. Whatever the state of the circuit, putting S2 to 'Reset' always returns it to the state where it is ready to start another timing run with all l.e.d.'s extinguished."

"Gee, all this is pretty neat."

"I'm glad you like it."

"Well, I can see how the first eight l.e.d.'s are lit in turn. But what happens when the count gets to 9?"

"That takes place when pin 11 of the CD4017 goes high," said Smithy. "And we can see more clearly what happens then if we concentrate on the CD4011 part of the circuit."

Smithy indicated the right hand

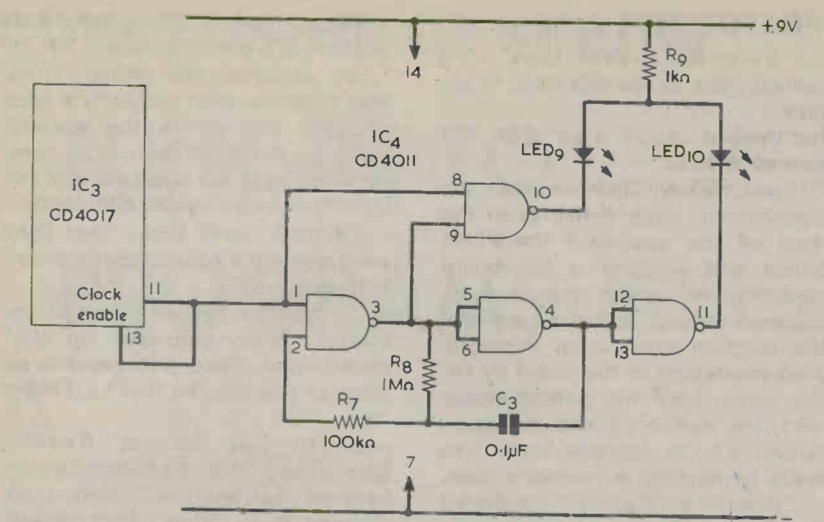


Fig. 4. The four NAND gates in a CD4011 are used to cause LED9 and LED10 to flash alternately

section of the reaction timer circuit. (Fig. 4.)

"At the ninth count," he resumed, "pin 11 goes high. It's connected to the clock enable input at pin 13, so the CD4017 does not respond to further clock input pulses and stays with pin 11 high until the whole circuit is reset by S2. Pin 11 also connects to pin 1 of the CD4011, which has four 2-input NAND gates. The two NAND gates associated with pins 1 to 6 form a CMOS oscillator with a frequency of about 5 Hz. When pin 1 of the oscillator is low, before the count gets to 9, the oscillator is inhibited and pin 3 of the first gate is high. Pin 4 of the second gate is low, causing pin 11 of the gate which follows it to be high. As a result LED10 is not lit up. The high output at pin 3 of the first gate goes to pin 9 of the last NAND gate in the CD4011. But, since pin 8 of that gate is low, because it connects to pin 11 of the CD4017, the output at pin 10 is also high. As a result, LED9 does not light up, either."

"Let's see if I can work out what happens in the CD4011 when pin 11 of the CD4017 does go high at the ninth count."

"Go ahead."

"Well," said Dick slowly, "When this pin 11 goes high it takes pin 1 of the first NAND gate high, and so the oscillator starts to run."

"Good."

"Pin 8 of the last NAND gate goes high, too. That means that when pin 3 in the oscillator section goes high, pin 10 goes low and causes LED9 to light up. LED10 lights up when pin 4 in the oscillator section goes high, because pin 11 of the CD4011 then goes low. Since pins 3 and 4 go high alternately, the two l.e.d.'s flash alternately, too."

"And that's it," said Smithy cheerfully. "That's got the whole operation of the reaction timer buttoned up. Quite simple when you get round to it, isn't it?"

"What current does it draw from the 9 volt battery?"

"Oh, about 8mA if none of the l.e.d.'s are alight, rising to some 14mA when any of them are alight."

"I see. You said earlier on that S2 should be in the 'Reset' position when you switch on the 9 volt supply. What would happen if it was at 'Start' when the 9 volt supply was applied?"

"There'd be no damage done," replied Smithy, "but you'd find that the CD4017 would be giving a few funny outputs. With my prototype I find that applying the 9 volt supply with S2 at 'Start' causes LED2 and LED5 to be lit, as well as the alternately flashing LED9 and LED10. The circuit reverts to normal as soon as S2 is put to 'Reset'."

PROTOTYPE

"Stap me," said Dick. "I'd certainly like to see this timer in action."

"Would you? I've got my prototype here."

Speechlessly, Dick watched the Serviceman reach down, open the door of the cupboard under his bench and produce a Veroboard assembly on which the four integrated circuits and the l.e.d.'s of the reaction timer were mounted. Also connected to the board by flying leads were the potentiometer VR1, the switch S2 and the push-button S1. In addition were two leads terminated in crocodile clips.

"Dash it all, Smithy," spluttered Dick, "has this been here while we've been talking about it?"

"Why yes," replied Smithy, surprised. "Why shouldn't it be?"

"All this time," complained Dick, "I've been bending my brain trying to visualise how the darned thing works when you could have actually demonstrated it to me!"

"Well," said Smithy soothingly, "here it is now for you to look at. I knocked it up on a Vero V-Q board having 28 copper strips by 58 holes. The strips are divided into 4-hole segments, which makes the board an excellent choice for building up quick circuits, because you don't have to cut any strips. I slightly misjudged the layout of the l.e.d.'s, and LED10 is at the bottom of the vertical column, below LED8, and not to the right of it as it will be in my finalised version. Also, i didn't bother to include the on-off switch, S3."

"All the components on that Veroboard," said Dick, looking at the board critically, "appear to be quite standard types."

"In general they are," confirmed Smithy. "Apart from R3 and R4 all the fixed resistors can be $\frac{1}{4}$ watt 10% or 5%. If a high level of timing accuracy is being aimed at, R3 and R4 could be 2% or even 1% types."

"What about C2?"

"Ideally, that should be a close tolerance component, too. You can get 0.1μF capacitors in 5% tolerance quite easily, these being available both in polystyrene and polycarbonate. It is possible to get a 0.1μF capacitor in a closer tolerance than 5%, but you will have to hunt round a little for it, and it may tend to be rather expensive. Anyway, let's try out the prototype."

Smithy picked up a PP9 battery and connected the crocodile clips to its terminals.

"Nothing's happening," said Dick.

"I know it isn't," replied Smithy. "I've got switch S2 in the 'Rest' position. I'll put it to 'start'."

He actuated the switch. There was a pause, then suddenly a spot of light ran down the vertical column l.e.d.'s as each lit in turn, terminating in the two l.e.d.'s at the bottom quickly flashing alternately.

"Blimey," said Dick, "that light went down the column pretty smartish, didn't it?"

"It took 0.4 second to get to the bottom. Now, you pick up that push-button, Dick, and press it as soon as you see the first l.e.d. light up."

Smith put S2 to 'Reset', whereupon the flashing l.e.d.'s became extinguished, and then returned it to 'Start'. Dick picked up the push-button and waited. Almost unexpectedly the top l.e.d. lit up and Dick pressed the push-button quickly. The display was arrested at LED6, which glowed steadily.

"Humph," grunted Smithy, "that's pretty slow."

Smithy actuated the switch once again, and this time Dick was able to halt the display at LED5. At succeeding attempts and with much concentration, he was able to stop the l.e.d.'s at LED4 on several occasions but was unable to improve on this. Smithy took up the push-button and let Dick actuate the switch. Dick also altered the setting of the potentiometer in order to provide a new time delay before the light travelled down the column of l.e.d.'s.

To Dick's fury, Smithy was able to stop the display at LED4 without any apparent effort at all, and on several occasions was even able to do so at LED3.

"How," fumed Dick, "do you manage to beat me at this? Here am I, a heathy youth with all my faculties, yet all I can do is just manage a reaction time of 0.15 to 0.2 seconds. Dash it all, you're able to press that darned button in less than 0.15 second."

"Ah," chuckled Smithy. "I've got a built-in regenerative loop in my nervous system."

Dick stared at him unbelievingly.

"Come off it, Smithy."

"It's true."

"Then tell me what that regeneration does?"

"It improves my reaction!"

■

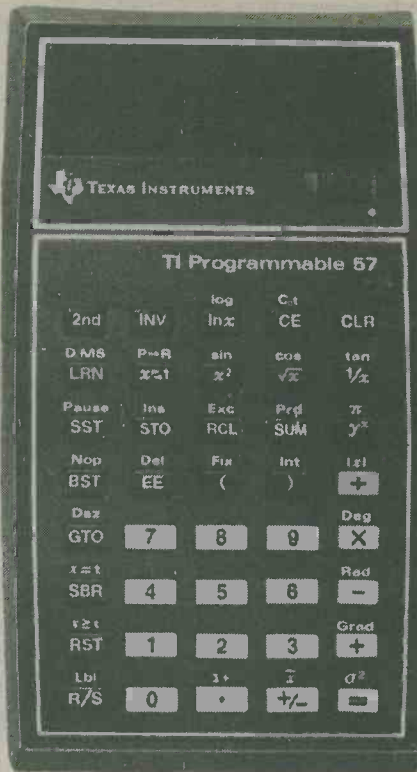
CONCLUSION OF SERIES

TUNE-IN TO PROGRAMS

Part 9

By
Ian Sinclair

Some tunes to play



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

This part consists simply of programs, with some notes and explanations of how they work, so that you can see what processes of thought, plain or twisted, went into producing the program. No two approach a problem in the same way, and I don't claim that these are the most obvious, the easiest, shortest or simplest programs for these particular problems. They are, however, programs which I wrote from scratch for this series, so that they do at least have some degree of originality about them.

DECIMAL TO BINARY

The first program converts a decimal number (less than 256) into a binary number. The program follows the old-established method of dividing successively by two, and storing the remainder as a number. The decimal number is divided by 2, producing either a whole number or a number with the remainder 0.5; for example, 155 ÷ 2 = 77.5. This result is temporarily stored. The fractional part of the number is now taken, making use of the [INV] [Int] procedure, so that the result is either 0.0 or 0.5 according to whether the number was even or odd respectively. This in turn is multiplied by 2 to give 0 or 1, and is again multiplied by 10°, giving 0 or 1 again, since 10° is just 1. By using [Dsz], a countdown which has started with 9 stored in memory 0 reduces by one, and the instruction [GTO] [4] starts the loop again. The reason for using the figure 9 in store 0 is that only eight digits can be displayed — the [Dsz] instruction is arranged so that if a ninth digit is needed (because the original number exceeded the limit) the program switches to an impossible instruction ([GTO] [5] with no label 5) so causing a flashing display.

On the next loop, the integral part of the number is taken, using [Int], and the division by 2 is carried out again. Once more the remainder is extracted,

DECIMAL TO BINARY CONVERSION

Program

LRN 9 STO 0 1 STO 2 0 STO 3 0 STO 7 Lbl 4 RCL 1 x=t GTO 1 ÷ 2 = STO 4 INV Int X 2 X RCL 2 = SUM 3 RCL 4 Int STO 1 10 Prd 2 Dsz GTO 4 GTO 5 Lbl 1 RCL 3 R/S LRN

Procedure

Load the decimal number (up to 255) into store 1. Press CLR RST R/S. Display shows binary number. If the decimal number is greater than 255, the display will show a flashing 10.

Test Data: Load 255 STO 1. CLR RST R/S. Answer 11111111.
Load 256 STO 1. CLR RST R/S. Answer 10 flashing.

Fig. 1.

BINARY TO DECIMAL CONVERSION

Program

LRN 8 STO 0 0 STO 3 Lbl 0 RCL 1 ÷ SBR 1 = STO 2 Int X (2 y^x(RCL 0-1)) = SUM 3 RCL 2 INV Int X SBR 1 = STO 1 Dsz GTO 0 RCL 3 R/S Lbl 1 (10y^x (RCL 0-1)) INV SBR LRN

Procedure

Load the binary number into store 1. Press CLR RST R/S. Display shows decimal number.

Test Data: Load 10101010 STO 1. CLR RST R/S. Answer 170.

Fig. 2.

multiplied by 2 to convert 0.5 to 1 and multiplied, this time by 10^1 (which is 10) to place the digit 1 or 0 in the correct place in the display. On the next loop, the multiplier 10^2 (which is 100) will be used, on the loop after that 10^3 (which is 1000) and so on. This tenfold multiplication is carried out on each loop by using the instruction [10] [Prd] [2]. The action stops when there is no number left to divide by 2, and this is detected by the [x=t] step early in the program loop. The number which is set into memory 7 is 0, so that when there is nothing left of the original number after several divisions by 2, there is no skip, and the [GTO] instruction fetches the final result from memory 3 to display.

Note that each complete run of the program starts with the storing of essential quantities. The step [0] [STO] [3] ensures that this store is cleared before a new number is processed. It is good practice to use such clearing steps in the program itself, because if the stores were not cleared old results could be mixed in with the new ones. Store 4 does not have to be cleared in this way, because the first use of this store is the instruction [STO] [4], which automatically wipes out any previous information. Store 3 is used in the form [SUM] [3], however, and would not be cleared in the normal course of the program.

BINARY TO DECIMAL

The binary to decimal conversion in the second program uses a quite different method. The number is keyed into the display as a set of 1's and 0's, like any binary number. The calculator will treat this as a ***decimal*** number, so that we must carry out some sort of conversion in the program. The way in which we write decimal numbers, however, is the same as the way in which we write binary numbers, except that each place to the left of the point represents a power of 10 (10^1, 10^2, 10^3 and so on) rather than a power of two. The program works by taking each power of ten digit and converting it into the corresponding power of two number, and summing these numbers for each digit.

The number written into the display is divided by 10 to the power of n-1, where n is the number stored in memory 0, starting with 8. This detects the highest placed digit of the number, and the [Int] step then takes the 1 or 0 in the 8th place of the display. This number, 1 or 0, is now multiplied by 2 to the power of n-1, using the same value of n, so as to give the correct power of two, and the result is collected in store 3 by using [SUM] [3]. The divided number, which was stored in memory 2, is recalled, its fractional part taken, using [INV] [Int], and multiplied by 10 to the power of n-1 again to restore the number to its correct value so that it can be replaced in memory 1. The [Dsz] step then decrements memory 0, and the loop is started by the [GTO] [0] instruction.

On the next loop, the next lower power of ten is used, because n=7, and the corresponding power of 2. The result is again gathered in store 3, and the loop continues until the contents of memory 0 are decremented to zero, whereupon the program steps

IMPEDANCES IN PARALLEL

The impedances are in the form: A + jB, C + jD. At the end of the calculation, the figure in the display is the phase angle (degrees). Pressing [x ⇌ t] gives amplitude.

Program

LRN 0 STO 2 0 STO 3 Lbl 1 RCL 0 X SBR 0 = SUM 2 RCL 1 X SBR 0 = +/- SUM 3 CLR INV SBR SBR 1 RCL 2 STO 0 RCL 3 STO 1 0 STO 2 0 STO 3 SBR 1 RCL 2 x ⇌ t RCL 3 INV P–R Fix R/S Lbl 0 (RCL 0 x^2 + RCL 1 x^2) 1/x INV SBR LRN

Procedure

Load value of A into store 0, value of B into store 1. CLR RST R/S. When the display clears to 0.00, load value of C into store 0, value of D into store 1. CLR R/S. Final display is phase angle in degrees. Press [x ⇌ t] to get amplitude of total impedance (same units as A, B, C, D).

Test Data: 2 STO 0 3 STO 1 CLR RST R/S.
At 0.00 4 STO 0 5 STO 1 CLR R/S.
Answer 54.52°, 2.309 amplitude.

Fig. 3.

out of the loop into [RCL] [3] [R/S], showing the decimal number. Note that we use a subroutine to calculate the power of ten because this result is used twice in the program.

The setting-up instructions are, as usual, included in the program. The [O] [STO] [3] step is important, as [SUM] [3] is used in the program. We could, of course, clear memory 3 outside the program, but the whole aim of a program is, after all, to reduce repetitive steps.

IMPEDANCES IN PARALLEL

Fig. 3 shows a program for adding two impedances connected in parallel. The impedances are written in "j-operator" form as A + jB and C + jD. The A and C figures are the in-phase components of impedance, and the B and D figures are the 90° phase components. This is a particularly useful program, as the calculation is normally very long and tedious. The final answer is expressed in the form of an amplitude (ohms) and phase angle (degrees).

The method is outlined in Fig. 4. The quantities

$$\frac{A}{A^2 + B^2} \quad \text{and} \quad \frac{B}{A^2 + B^2}$$

are added to the quantities

$$\frac{C}{C^2 + D^2} \quad \text{and} \quad \frac{D}{C^2 + D^2}$$

respectively in stores 2 and 3. This is done in steps, with the quantities C and D being keyed into stores 0 and 1 at an intermediate part of the program at which time the display clears. The contents of store 2 and store 3 are now treated in the same way, and stored in memories 2 and 3. The content of memory 2 is now transferred to memory 7 (the t register), by using [x⇄t], so that the cartesian to polar conversion can be carried out. This converts the A + jB form of impedance into the more useful amplitude and phase angle form. The results are read off the display with the phase angle in degrees displayed at the end of the program, and the amplitude displayed when the [x⇄t] key is pressed. It's not by any means a simple program, but a good illustration of the great power of the calculator.

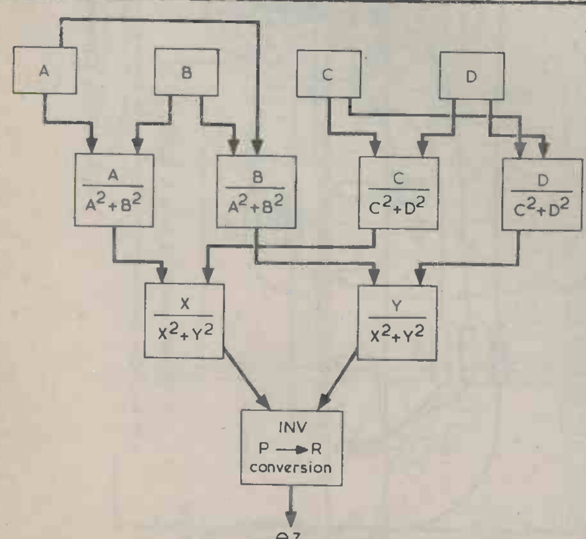


Fig. 4. The method employed for calculating complex impedances

HARMONIC CONTENT OF A SQUARE WAVE

Formula: V = A (cos Ø-1/3 cos 3Ø + 1/5 cos 5Ø- 1/7 cos 7Ø . . .)

Program

LRN 1 STO 1 5 SUM 2 SBR 0 SBR 1 STO 3 Lbl 2 1 SUM 1 SBR 0 SBR 1 X RCL 4 = SUM 3 RCL 4 +/- STO 4 RCL 1 x=t GTO 3 GTO 2 R/S RST Lbl 3 RCL 3 R/S RST

Lbl 0 RCL 1 STO 5 2 Prd 5 1 INV SUM 5 Lbl 1 RCL 2 X RCL 5) cos X RCL 0 ÷ RCL 5) INV SBR LRN

Procedure

Store wave amplitude voltage in STO 0.

Store number of runs required in STO 7 (1 for fundamental plus 1 for each harmonic) 1 STO 4 0 STO 2 Fix 2 CLR RST. R/S gives amplitude of wave plus harmonics for 5°. Each press of R/S subsequently gives the total amplitude for 5° intervals.

Test Data: 10 STO 0 2 STO 7 (only 3rd harmonic) 0 STO 2 1 STO 4 Fix 2 CLR RST.

Amplitude sequence is: 13.18, 6.96, 12.02, 7.73, 9.93, 8.66, 7.33 . . .

Note: SBR 0 and SBR 1 could be combined. They have been separated here to show the different steps involved. SBR 0 does not use INV SBR because it is always followed by SBR 1.

Fig. 5

SINE WAVE HARMONICS

Our last illustration is another highly useful one from the point of view of looking at the harmonics of a sine wave. This particular program calculates the total amplitude of a wave plus odd number harmonics up to as many harmonics as you want (if you have time to wait). The formula that is used is shown in Fig. 5, and it allows for the higher harmonics being of low amplitude. Students of electronic engineering will recognise this as a Fourier series. The required number of harmonics is stored in memory 7. A subroutine is used to calculate the odd numbers, using the formula 2n-1, this is subroutine 0. Subroutine 1 is then used for calculating the cosine of the angle which has been selected from store 2, multiplied by the odd number stored in memory 5. The cosine is then multiplied by the amplitude A (store 0) and divided by the odd harmonic number in memory 5. For each value of angle theta the loop goes round subroutines 0 and 1, adding up the harmonics into memory 4, and reversing the sign of amplitude on each run through. When the correct number of harmonics has been added, the [x=t] step switches out of the loop, so that the

(Continued on Page 185)

THE "DORIC" 9 WAVEBAND PORTABLE

The complete "Doric" receiver with all sections assembled together

Part 4 (Conclusion)

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

Completing the a.m.-f.m. tuner

In this concluding article we complete the construction of the v.h.f. medium and long wave tuner. This, positioned above the amplifier-speaker assembly, is the final unit in the composite "Doric" receiver. As readers who have followed the series will know, this employs a six-band short wave tuner which may be used on its own as a headphone receiver, and an amplifier-speaker unit which can similarly be employed as an amplifier in its own right. The present tuner can also be used, with stereo headphones, as a complete self-contained receiver.

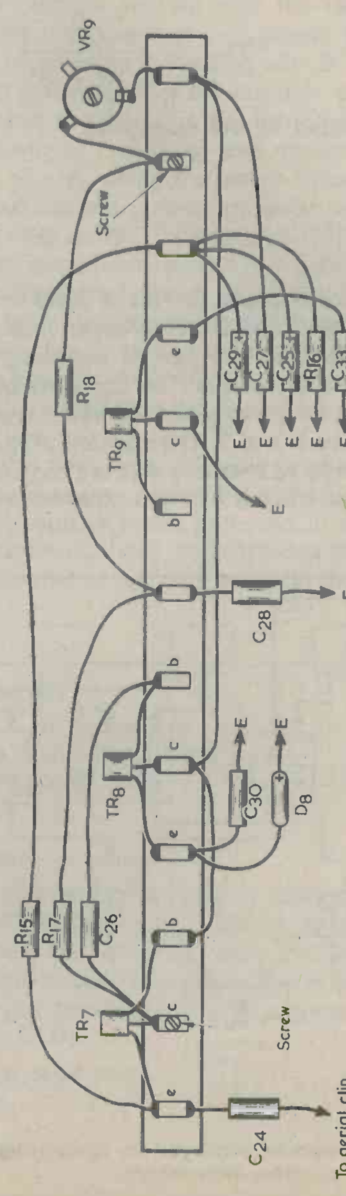
WIRING

A 13-way tagstrip and a 15-way tagstrip are cut from the 28-way tagstrip, and are secured inside the receiver with four small woodscrews. These pass through the tag centres indicated in Figs. 10a (a) and (c). A nut is placed over each screw between the tagstrip and the plywood to space the strip slightly away from the wood.

Wiring is then carried out as illustration in Fig. 10. For clarity, components are shown spread out but, in practice, all connections including in particular those in the v.h.f. section should be short and direct, and the components should all be within the outline of the item of Fig. 8(a).

The switch positions of S5, as its spindle is rotated clockwise, are: Off, Medium, V.H.F., Long. The switch is illustrated as mounted and also lying flat to show how the connections are made to it.

When wiring has been completed, connect a PP3 battery and insert the stereo plug from the amplifier-speaker unit or plug in a pair of stereo headphones. Turn S5 to medium waves and tune in a station at about 250 metres and then one at around 450 metres. Set up VR8 such that a minimum amount of adjustment is required in



All leads marked E go to E on VR_{10}

Fig. 10(a). Connections to the 13-way tagstrip

VR7 to keep the receiver in its most sensitive condition — on the edge of oscillation — for all settings between 250 and 450 metres. Next tune in a station at about 200 metres and adjust VC2 so that oscillation starts at about the same setting of VR7. These two adjustments are most easily carried out with the item of Fig. 9(a) temporarily removed.

Turn to the long wave band to check that all is well here. VR7 will have to be advanced further on this band to obtain oscillation.

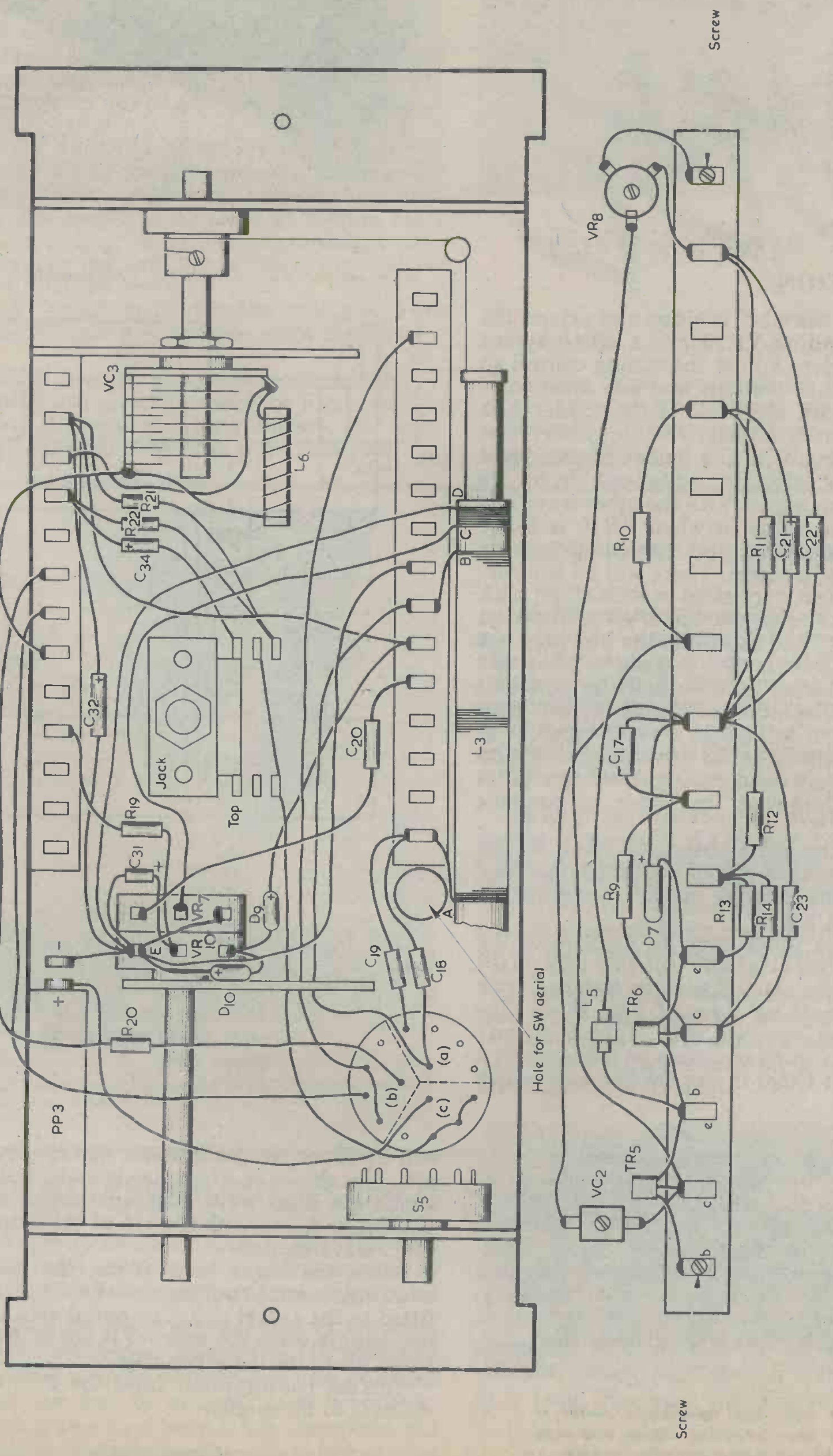
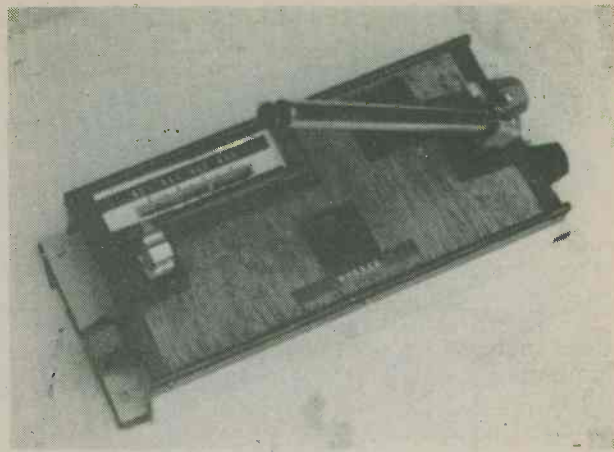


Fig. 10
(b). The layout on the baseplate of the a.m.-f.m. tuner. Note the hole for the short wave telescopic aerial
(c). The components which are wired to the 15-way tagstrip

The a.m.-f.m. tuner may be employed, with stereo headphones, as a receiver in its own right



V.H.F. RECEPTION

Next, set S5 to the v.h.f. position and extend the telescopic aerial. Adjust VR10 until a light inherent hiss becomes louder. Adjust the tuning control so that the local B.B.C. stations and any local commercial stations are received. If the louder hiss cannot be obtained, adjust VR9 to insert less resistance into circuit. If the louder hiss appears with VR10 only slightly advanced from its minimum position, adjust VR9 the other way. The louder hiss should come in when VR10 is fairly near its maximum setting, and it should disappear on the reception of a signal. There will be two correct tuning positions, very close to each other, with a tuning point in the centre which gives distorted results. In areas of bad reception the hiss may not disappear, and this is an indication that the receiver is not picking up a sufficiently powerful signal. Careful orientation of the aerial will help here, and it may also help to try the receiver in different parts of the room. In very strong reception areas the aerial may need closing down or even to be completely removed, in order to prevent overloading.

If, with use, the aerial becomes loose on the swivelling clip, another clip of the same type may be passed over the existing one to strengthen its grip on the aerial base.

A cover for the tuner may be made with the items shown in Figs. 11(a) and (b). Two Figs. 11(b) pieces are required, and these are fastened with woodscrews to the long sides of Fig. 11(a). The assembly is then covered with Fablon of any desired colour. A tuning scale can be made up on a piece of card and fitted in the cut out area which will lie above the pointer and slot as shown in Fig. 9(f). Not shown in Fig. 11(a) is a ½in. hole through which the short wave telescopic aerial passes. Its position is found with the aid of the amplifier and short wave section.

When the cover is in place, the base of the telescopic aerial for the a.m.-f.m. tuner may be fitted to the swivel clip. The aerial acts as a carrying handle when the receiver is not in use by being fitted also into the other clip.

Current consumption from the PP3 battery is about 2 to 3mA only.

(Concluded)

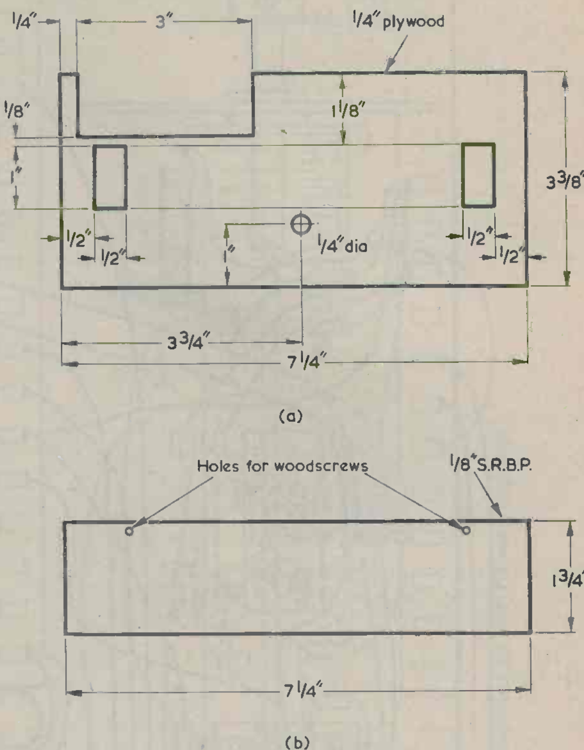


Fig. 11(a) The top section of the cover
(b). The cover has two sides attached to it. These have the dimensions shown here

When out of use, the telescopic aerial is stowed in the non-swivelling clamp and may then be employed as a carrying handle

Trade News . . .

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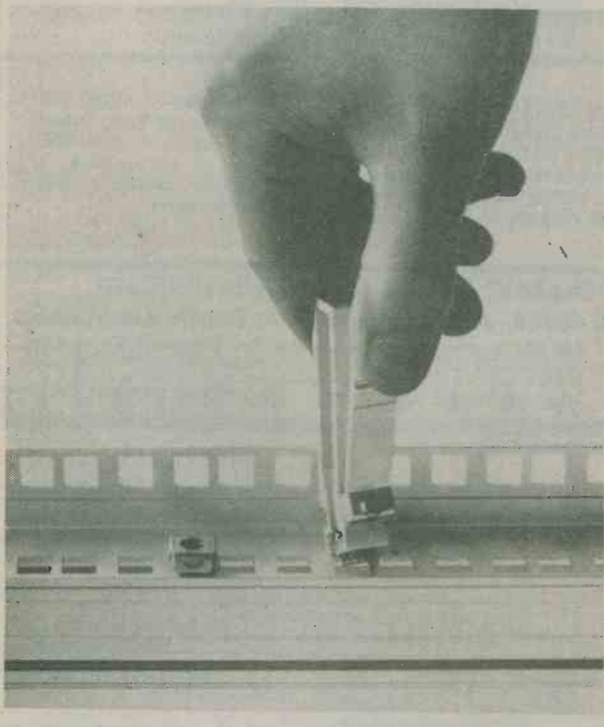

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TUNE-IN TO PROGRAMS — Part 9

continued from page 181

total amplitude is displayed ([GTO] [3]). The next press of the [R/S] key then increments the angle by 5° ([5] [SUM] [2]) and starts the calculation all over again. To draw the graph shape produced, we enter some convenient amplitude, such as 10, into store 0, and prepare a graph with 5° intervals of angle. Each result can then be entered up as it appears.

These programs have been briefly described, but there should be enough detail for you to follow what is going on if you are reasonably familiar with the formulae used in electronics. As for writing your own programs — only practice can help now. Reading other people's programs is interesting, but nothing beats the challenge of devising a program for yourself, debugging it, testing it, and making full use of it. Long may your subroutines loop smoothly!

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(Continued from page 189)

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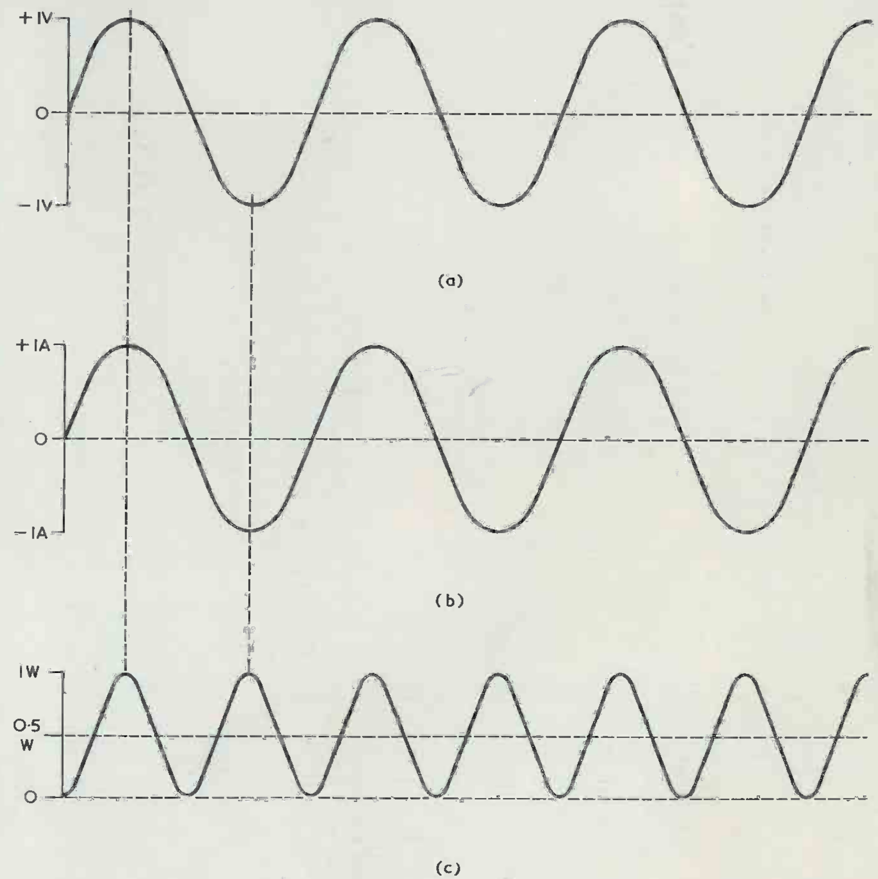
The power dissipated in the resistor is shown in (c) and it has a peak value of 1 watt when both the voltage and current are at their peak values of 1 volt and 1 amp respectively. The power is always positive because heat is dissipated in the resistor regardless of the applied voltage polarity or direction of current flow.

Now it can be shown mathematically, and it is evident from visual inspection, that the power curve of (c) is symmetrical about a line drawn through the 0.5 watt level. The average power dissipated in the resistor is therefore 0.5 watt.

Power is equal to voltage squared divided by resistance and, had a direct voltage been applied to the resistor the direct voltage squared divided by 1 (for 1 Ω) would have been 0.5 (for 0.5 watt). The direct voltage would then be equal to the square root of 0.5, or 0.707.

A similar line of reasoning will show that the r.m.s. value of the sine wave current is also equal to 0.707 times its peak value.



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