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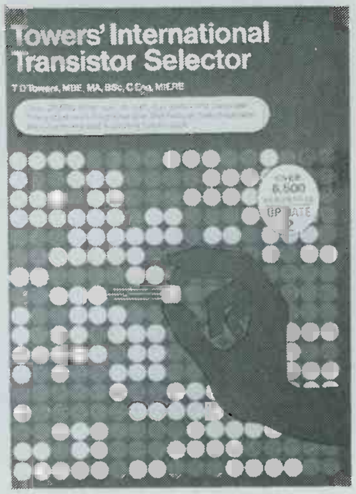

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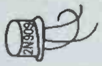
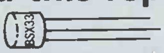


Would this replace it?



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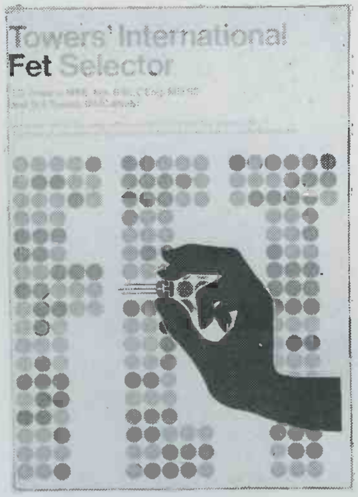

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BA128	2½p	OA75	11p
BA145	2½p	OA79	11p
BA148	12p	OA81	3½p
BA182 Varicap	6p	OA95	8p
BAX14	2½p	OA200	2½p
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BY236	900	1½	7½p
BY238	1200	1½	9p
BY264	300	3	9p
BY265	600	3	11½p
BY266	900	3	15p
BY274	300	5	14½p
BY275	600	5	17½p
BY277	1200	5	27p
BY299	800	2	4p
BY1202	2kV	10mA	6p
BYX20-200	200	25	72p
BYX22-200	300	1½	25p
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5	400	Texas	85p
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3½	100	B40C 3200	58p
½	60V	BC30 C350	23p
2½	350V	9F2	70p
2½	500V	9E4	85p
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1	200V	WO2 Ex Equip	15p
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7425	18p
7426	16p
5430	12p
7430	11p
74L30	11½p
7432	13p
54/7437	13p
7438	14p
74H40	26p
7442	26p
74LS42	40p
7445	42p
7450	11p
74H50	26p
7451	7½p
7454	11p
74L54	11½p
54/7472	20p
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930399-500 Bit Shift Register	4p
930399-512 Bit Shift Register	4p
AJ371-002	4p
AY38500 TV Game	£2
AY58300 Ch/Time Display	36p
BRCM300 Volt Reg.	£1.40
BTT822	£1.73
C500 Calculator	37p
CA139AG Quad Volt Comp.	54p
(T)CA270AE	£1
(T)CA270CW/AW	35½p
CA3001 RF Amp	86p
CA3028A	75p
CA3044	£1.20
CA3046	40p
CA3054	69p
CA3060	72p
CA3065	36p
CA3083	65p
CA3086	29p
CA3089	54p
CA3093	36p
CA3123	73p
CA3132EM	£2.22
CA3146E	90p
CA3183	80p
CA3189	73p
CA3401 (LM3900)	36p
CD4001	14p
CD4002	12p
CD4009	19p
CD4011	14p
CD4012	13p
CD4013	23p
CD4014	36p
CD4018	43p
CD4019	25p
CD4022	36p
CD4023	19p
CD4028/MC14028	42p
CD4029	54p
CD4033	72p
CD4035	54p
CD4040	54p
CD4046	36p
CD4050	25p
CD4066	27p
CD4069	13p
CD4078	19p
CD4094	72p
CD40194	72p
CD4502	44p
CDP1802 Cosmac	£3.60
CDP1833 Cosmac	£3.60
D3624	36p
DM8214 C.P.U.	36p
FCH111	8p
FCH201	18p
FCJ101	50p
FPQ/MPQ3725 4 Tr. Array	45p
FZH151	18p
FZH191	18p
FZH201	18p
IM5623 C.P.U.	36p
LM300 Volt Reg.	86p
LM309 (Ex Equip.) 5v Reg.	60p
LM326 Volt Reg.	20p
LM340T6 6v Reg.	36p
LM343 Amp	4p
LM1303N	65p
LM/MC1458N	19p
LM3900 Quad Op. Amp	36p
MC830P	4p
MC833P	4p
MC837P	4p
MC846P	4p

MC862P	4p
MC863P	4p
MC1306P	40p
MC1307P	35½p
MC/CA/BRC 1310P St. Dec.	35½p
MC1312P Stereo Decoder	40p
MC1314P	35½p
MC1315P	35½p
MC/BRC1330	85p
MC1350P	35½p
MC1351P	35½p
MC1357P	35½p
MC1358PQ	35½p
MC1596L	35½p
MC3302L	75p
MC4044P	£1
MC4344P	£3.50
MIC7C	25p
MK2686	36p
MK4012 Memory	38p
ML237B	£1
MM5233 C.P.U.	36p
MM5335D C.P.U.	36p
MM5387N	£3
MM8008 C.P.U.	36p
MPC900 10A—4 to 30v Reg.	75p
MT300 Volt Reg.	8p
MT305 Volt Reg.	8p
SAA661	36p
SAA1010	34½p
SAA1025	£4
SAS580	18p
SAS590	18p
SGS308 Op. Amp	4p
SL403A 3Wt. Amp	38p
SL442	36p
SN7528	11½p
SN15836	25p
SN15844P	4p
SN15845	50p
SN15846	37p
SN15851	50p
SN15858N	55p
SN15862	6p
SN75107	£1.15
SN75108	36p
SN75110	46p
SN75150	18p
SN75235N	11p
SN75451	36p
SN76001	36p
SN76003 5Wt. Amp	36p
SN76003N 5Wt. Amp	£1.10
SN76013 5Wt. Amp	36p
SN76013ND 5Wt. Amp	£1.18
SN76023 5Wt. Amp	36p
SN76110P	35½p
SN76115N	35½p
SN76131	58p
SN76226	58p
SN76227	59p
SN76228N	£1.60
SN76396 (TBA396)	35½p
SN76630	18p
SN76650N	50p
SN76660N	35½p
SN76666N	35½p
SN158093	50p
SN158097	4p
SN158099	50p
TAA263 Amp	75p
TAA300 1Wt. Amp	£1
TAA320	35p
TAA550 Volt Reg.	23p
TAA700	£2.30
TAD100 AM Radio	£1.22
TBA120S/CQ/SB/B TV Amp	25p
TBA240	£3.90
TBA395Q	£1.50
TBA396	36p
TBA550	£1.61
TBA560C	52p
TBA800 Amp	52p
TBA810 Amp	70p
TBA920	70p
TCA270Q/SA/AE/OS	£1
TCA270SQ	55p
TCA440	£1.25
TCA830S Ex. Equip.	18p
TCA830S	37p
TCA4401	£1.25
TCEP100	£1
TDA/MC1327	18p
TDA2610	71p
TDA2680	71p
TDA2690	71p
TL720	28p
TMS4034 Memory	£1.08
TYA0171	4p
XR215	£2

ZN414 AM Radio	79p
ZST131A	8p

ROTARY WAFER SWITCHES

Pole	Way	
1	3	23p
1	4	40p
1	8	40p
1	11	23p
1	12	23p
1	20	23p
2	2	40p
2	3 plus Mains D.P.	25p
2	4	23p
2	5	48p
2	6	40p
3	7	23p
3	11	23p
4	2	23p
4	3	45p
4	5	47p
6	3	23p
7	4 plus Mains D.P.	23p
12	3 plus Off	23p
24	2	60p

Makaswitch 1" diam. small centre, 1 pole, 10 way wafer 5p

7 MILLION CARBON FILM RESISTORS PURCHASED

¼ — ⅓ — ½ — ¾ — 1 — 1½Wt.
Iskra and Piher, mainly 5%, few 2%. Lucky Dip as the packs come (will not duplicate under 20 packs) due to cartons packed tight and on top of each other to ceiling of warehouse.

PACK OF 100 FOR 20p

Gents 3" 4-6 Vac Dome Bell
£1.50

I.C. SOCKETS

Low Profile
8 Dil 9p. 14 Dil 11p. 16 Dil 11p.
28 Dil 22p. 14 Dil to Q 8p
Standard
14 Dil to Q 8p. 16 Dil to Q 11p

SLIDE POTENTIOMETERS

60mm Track

LOG		LIN	
250 Ω	30p	500 Ω	30p
1K	30p	1K	30p
5K	29p	2K2	27p
47K	23p	5K	30p
50K Neg.	30p	10K	30p
100K	23p	22K	25p
250K	36p	47K	24p
470K	24p	50K	17p
1M	25p	100K	30p
2M	30p	250K	18p
		500K	19p

40mm TRACK

LOG		LIN	
10K	30p		
22K	30p	470K	30p
50K	7p		
100	30p		

30mm TRACK

LOG		LIN	
5K	30p	1K	30p
22K	30p	5K	30p
50K	20p		
100K	30p		

ELECTROVALUE

SUPPLIERS OF COMPONENTS THAT COUNT

SIEMENS SEMI-CONDUCTOR CAPACITORS FERRITES	NASCOM MICRO COMPUTERS AND ANCILLARIES	VERO BOARDS CASES & KITS	
ISKRA RESISTORS	RADIOHM POTENTIOMETERS	BREADBOARDS	
		SOLDER TOOLS	
	OPTO-ELECTRONICS	SWITCHES	CATALOGUE 10

OUR MINI-SELECTION POINTS THE WAY!

EXAMPLE ONE – SOLDERING IRONS

Aryx 50	£12.08 net	Antex x 25	£4.83 net
Isotip	£25.90 net	Desolder tool SR3A	£7.48 net
Antex C	£4.83 net	500 gm reel solder	£6.61 net

EXAMPLE TWO – PRINTED CIRCUIT MATERIALS

PCB's 300 x 150 mm		Etch Resist Pen	£1.14
SRBP S/S £1.38	D/S £1.73	Breadboards	
F/Glass S/S £1.96	D/S £2.13	Bimboard	£9.23
Positive resist 75cc	£1.67	Eurobreadboard	£6.56 net
Ferric Chloride 500 g	£3.45	T-DeC	£5.18

EXAMPLE THREE – SWITCHES

Chrome toggle		13A time switch adaptors	
Std. SPDT 65p	DPDT 89p	Smiths TS100	£14.43 net
Min. SPDT 66p	DPDT 92p	Wavechange, Lorlin, 1P12W, 2P6W, 3P4W, 4P3W	46p each

EXAMPLE FOUR – CAPACITORS BY SIEMENS

Polyester 7.5mm PCM
1, 1.5, 2.2, 3.3, 4.7μF, 10, 15, 22, 33, 42μF 8p each, .1μ 12p, .15μ 15p, .22μ 18p, .33μ 21p, .47μ 27p, .68μ 34p, 10mm PCM 1μ 37p.
Electrolytic, axial, (μF/V)
1/40 24p, 1/100 15p, 2.2/25 24p, 2.2/63 15p, 4.7/16 24p, 4.7/40 15p, 10/25 15p, 10/40 18p, 22/25 18p, 22/40 18p, 22/63 19p, 47/10 18p, 47/25 18p, 47/40 16p, 47/63 20p, up to 1000/16V 36p, then 1000/25V 49p to 47/16 65p.
Also full supporting ranges of other ceramic, plastic and electrolytic caps.

EXAMPLE FIVE – POTENTIOMETERS BY RADIOHM

Single gang lin or log	34p	*(Twin types stereo matched)*	
Twin gang lin or log	93p	Slider knobs	10p each.
Mono slider lin or log	83p	Presets lin, horiz, or vert at	10p
Twin slider lin or log	136p		

EXAMPLE SIX – RESISTORS

1/3, 1/2, 3/4W 2.3p 1W 6p
Wirewound from 21p

AND AS FOR SEMI CONDUCTORS . . .

1N914	6p	40673	99p	MU481	£1.70	T1P41A	69p
1N4007	9p	AC128	36p	MJ491	£1.88	T1P41C	74p
1N4148	5p	AC176	67p	MJ2955	97p	T1P42A	69p
1N5402	19p	AD136	£4.25	MJE2955	£1.13	T1P42C	74p
2N1599	£1.01	AD149	£1.01	MJE3055	£1.00	T1P2955	69p
2N2369A	24p	AD161	40p	MPSA12	42p	T1P3055	69p
2N3055	81p	AD162	52p	MPSA63	44p	T1S43	40p
2N3702-11	11p	AF127	43p	OA47	14p	W02	35p
2N4443	£1.78	AL102	£1.84	OA90	8p	2T x 107, 9	14p
2N4444	£2.28	BA379	29p	OA91	8p	2T x 300	14p
2N4991	98p	BB103	43p	OA202	16p	62T x 500	16p
2N5457-9	45p	BB104	70p	OC29	£1.23		
40HF40	£2.25	BB105	37p	OC36	£1.18		
40361	49p	C106D1	52p	T2800D	£1.20		
40362	49p	E1110	92p	T1P31A	52p		
40636	£1.69	E1210	97p	T1P32A	52p		

This list is but a fraction of what we carry.

INFORMATION – To show everything we supply would take about seven pages of closely packed type in this journal — the range is enormous including not only opto devices and very advanced sophisticated items, but all the everyday things you need as well down to nuts and washers! IT'S ALL IN CATALOGUE 10 — OUR 120 PAGE CATALOGUE FREE FOR THE ASKING.

PRICES AND V.A.T – All prices quoted here include V.A.T. for U.K. orders. Overseas buyers deduct 13% when ordering.

POSTAGE – For orders up to £5.57 value (U.K.) please add 40p for p/p. If over, orders sent post free in U.K. Overseas orders sent at cost (Min. 40p).

DISCOUNTS – 5% allowed on non-net items if order value exceeds £11.50, 10% if order value exceeds £29. Quantity discount prices on most components.

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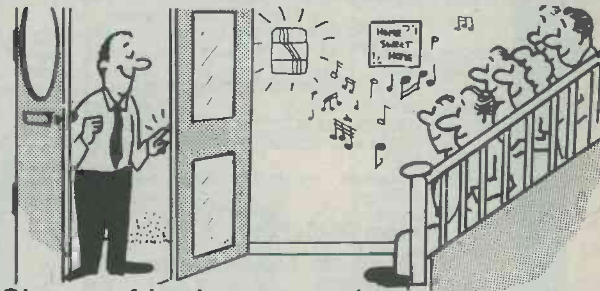
Northern Branch (Personal Shoppers only) 680 Burnage Lane, Burnage, Manchester M19 1NA. Phone (061) 432 4945.

TUNE IN!

Build the World Famous

CHROMA~CHIME



Give your friends a warm welcome

This kit has been carefully prepared so that practically anyone capable of neat soldering will have complete success in building it. The kit manual contains step by step constructional details together with a fault finding guide, circuit description, installation details and operational instructions all well illustrated with numerous figures and diagrams.

- Handsome purpose built cabinet
- Easy to build and install
- Uses Texas Instruments TMS1000 microcomputer
- Absolutely all parts supplied including I.C. socket
- Ready drilled and legended PCB included
- Comprehensive kit manual with full circuit details
- No previous microcomputer experience necessary
- All programming permanently retained is on chip ROM
- Can be built in about 3 hours!
- Runs off 2 PP3 type batteries.
- Fully Guaranteed

ONLY £11.95 + 75p p&p UK ONLY

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TMS 1000N

–MP0027A Micro-computer chip available separately if required. Full 24 tune spec device fully guaranteed.

This unique chip can be used not only for electronic door chimes but for other projects requiring musical output:

Car Horns
Musical Boxes
Amusement Machines
Alarms
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New low price only **£4.95** inc. p & p.
Free applications manual and data supplied with device! (Or 30p separately.)

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Signature ____________ R.E.C. 780

CHROMATRONICS

MOTORS

1.5-6VDC Model Motors **22p.** Sub. Min. 'Big Inch' 115VAC 3rpm Motors **32p.** 6 volt standard cassette motors new **£1.20.** 8 track 12V Replacement Motors **55p.** Cassette Motors 5-8VDC ex. equip. **70p.** Geared Mains Motors (240V) 2.5 rpm **75p.** 115VAC 4rpm Geared Motors **95p.**

SEMICONDUCTORS

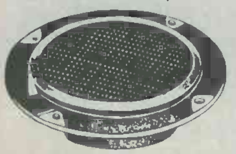
LM340 **80p.** BY103 **10p.** 2N5062 100V 800mA SCR **18p.** BX504 Opto Isolator **25p.** CA3130 **95p.** TBA800 **50p.** 741 **22p.** 741S **35p.** 723 **35p.** NE555 **24p.** 2N3773 **£1.70.** AD161/2 **70p.** ZN414 **75p.** BD238 **28p.** BD438 **28p.** IN4005 **10 for 35p.** TIL305 alpha numeric displays **£2.50.** TIL209 Red Leds 10 for **75p.** Man3A 3mm Led Displays **40p.**

PROJECT BOXES

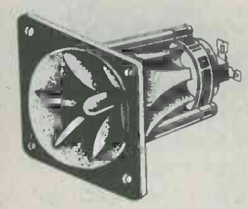
Sturdy ABS black plastic boxes with brass inserts and lid. 75 x 56 x 35mm **65p.** 95 x 71 x 35mm **75p.** 115 x 95 x 37mm **85p.**

MOTOROLA PIEZO CERAMIC TWEETERS

No crossover required



2.5" Direct Radiating Tweeter, maximum rating 25 volts R.M.S. 100 watts across 8 ohms. Freq. range 3.8kHz-28kHz, **£3.65**



3.5" Super Horn (flush mounting), maximum rating 25 volts R.M.S. 100 watts across 8 ohms. Freq. range 3.8-2.8kHz, **£4.50**

MORSE KEYS

Beginners practice key **£1.05.** All metal full 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.**

JVC NIVICO STEREO CASSETTE MECHANISM. Music centre type. Rev. counter, remote operation **£13.50** and **£1.00** p&p.

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). 0-6, 0-6V, 280mA **£1.20** (20p). 6V 500mA **£1.20** (15p). 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 **£7.92.** DYNAMIC stick microphone dual imp., 600 ohms or 20K, 70-kHz., attractive black metal body **£7.75.** EM506 dual impedance condenser microphone 600 ohms or 50K, heavy chromed copper body, **£12.95** CASSETTE replacement microphone with 2.5/3.5 plugs **£1.35.** INSERT Crystal replacement 35 x 10mm **40p.** GRUNDIG electric inserts with FET preamp, 3-6VDC operation **£1.00.**

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

RIBBON CABLE

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

SPECIAL OFFER TAPE HEAD DEMAGNETIZER

240VAC with curved probe suitable for reel to reel or cassette machines, **£1.95.**

STEREO FM/GRAM TUNER AMPLIFIER CHASSIS, VHF and AM. Bass, treble and volume controls, Gram. 8-track inputs, headphone output jack, 3 watts per channel with power supply. **£14.95** and **£1.20** p&p (CCT supplied).

MULTIMETER BARGAINS

Pocket Multimeter, 1,000 opv sensitivity. Ranges 1KV AC/DC Volts, 150ma DC current, resistance 0-2.5K, 0-100K, **£4.50**

20,000 opv., 1,000 volts AC/DC, DC current to 500ma, 5 ranges, resistance 4 ranges to 6 meg. Mirror scale, carrying handle, **£975.**

MURATA MA401

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

TELEPHONE PICK UP COIL

Sucker type with lead and 3.5mm plug **62p.**

RELAYS

Plastic Encap. Reed Relay, 0.1 matrix. 1k Ω 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.** Min. sealed relay, P.C. mounting, 6-9vdc operation changeover 3 amp contacts, new **85p.** Metal Cased Reed Relay, 50 x 45 x 17mm, has 4 heavy duty make reed inserts, operates on 12VDC **35p** each. Magnets 1/2" long 1/8" 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 illustrated lists

TMK500 MULTIMETER

TMK500 30,000 ohms per volt. IKV AC/DC., D.C. Current to 12 amps. Resistance to 60 meg in 4 ranges, mirror scale, with built in buzzer for continuity testing **£20.95**

YN360TR MULTIMETER

YN360 M/Meter. 20,000 ohms per volt. IKV AC/DC volts, 250ma dc current, 4 resistance ranges to 20meg, also has built in transistor tester with leakage and gain ranges. **£12.50**

CRIMPING TOOL

Combination type for crimping red blue and yellow terminations also incorporates a wire stripper (6 gauges) and wire cutter, with insultated handles only **£2.30.**

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 STABLISED 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, voltage operating 4-15VDC, **75p** each. LOUD 12VDC BUZZER, Cream plastic case, 50mm diam. x 30mm high **63p.** Carters 12 volt Minimite Alarm sirens **£7.65p.** 12VDC siren, all metal rotary type, high pitched wail, **£6.25.**

TOOLS

SOLDER SUCKER, plunger type, high suction, teflon nozzle, **£4.99** (spare nozzles **69p each**).
All Antex irons still at pre increase prices, order now as new stock will be going up next month.
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 **59p each.**
Miyarna IC test clips 16 pin **£1.95**

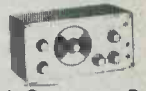
SWITCHES

Sub. miniature toggles: SPST (8 x 5 x 7mm) **42p.** DPDT (8 x 7 x 7mm) **55p.** DPDT centre off 12 x 11 x 9mm **77p.** PUSH SWITCHES, 16mm x 6mm, red top, push to make **14p each,** push to break version (black top) **16p each.**

G.P.O. Telephone handsets **£1.95.** Electrolytic Caps, can type, 2,200mfd and 2,200mfd 50VDC **35p each.**

RES. SUB BOX

Resistance Substitution Box. Swivelling disc provides close tolerance resistors of 36 values from 5 ohms to 1 meg. **£3.95.**



Signal Generator. Ranges 250Hz-100MHz in 6 Bands, 100MHz-300MHz (harmonics) internal modulator at 100Hz. R.F., output Max. 0.1vRMS. All transistorised unit with calibrating device. 220-240VAC operation, **£48.95.**

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

SUGGESTED CIRCUIT

OSCILLOSCOPE VOLTAGE CALIBRATOR

By G. A. French

A number of requests from readers have been received recently asking for the publication of a voltage calibrator design for oscilloscopes. In consequence, this article in the "Suggested Circuits" series will be devoted to a practical calibrator circuit which employs basic principles and should offer few difficulties in assembly and setting up. The process of setting up, it may be added, requires no test equipment other than a multimeter having a low d.c. volts range capable of giving a clear indication of 1 volt.

Normally, oscilloscope voltage calibrators are not used frequently by amateurs and shoult not, in consequence, incorporate expensive components. However, high accuracy is needed, and this requirement can be satisfied by the use of a few readily available close tolerance resistors. The calibrator to be described produces square waves of known voltage amplitude and at very low impedance, and it meets the convention that the pulses be positive-going with reference to a common earthy output terminal.

SQUARE WAVE GENERATOR

A suitable square wave generator for use in the calibrator is the CMOS timer type ICM7555. However, this i.c. has rather a poor output source current performance (i.e. the current it can pass to the negative voltage rail with a high output is limited) and the possibility of using this output to produce square waves directly is not attractive. It is, nevertheless, a simple matter to use the ICM7555 low output to drive a constant current transistor, with the transistor producing positive-going pulses. When this combination is fed from a regulated voltage supply,, output pulse amplitude becomes virtually constant over a wide range of unregulated supply voltages.

The circuit of the oscilloscope voltage calibrator is given in Fig.1. Here, the ICM7555 functions as an astable multivibrator running at around 450Hz with timing components R1, R2, R3 and C1. When the normal timing resistors R2 and R3 have the same

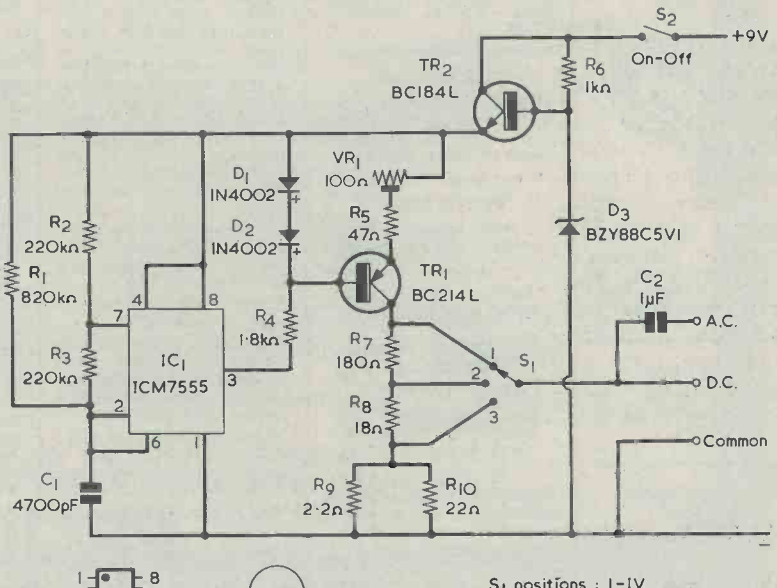


Fig.1. Circuit of the oscilloscope voltage calibrator. Switch S1 selects square waves having the voltage amplitudes shown, and these are applied to the input of the oscilloscope being calibrated

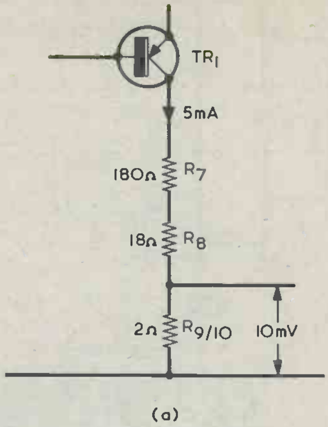
value, and the added resistor R1 has about 4 times that value, the timer produces a square wave with a (calculated) mark-space ratio of 50:50. This neat circuit trick was described by J.R. Davies in the article "50:50 Output From The 555" which appeared in the April 1978 issue of this journal.

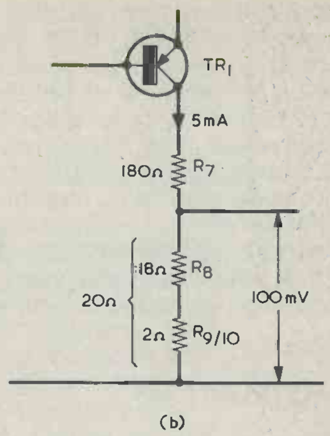
The 50:50 square wave output at pin 3 of the ICM7555 is applied via R4 to the two diodes D1 and D2, and to the base of the p.n.p. transistor TR1. When the pin 3 output is high TR1 is cut off and no current flows in its collector circuit through R7 to R10 inclusive. As a result, no voltage appears across these resistors. When the pin 3 output of the i.c. goes low, diodes D1 and D2 conduct and a relatively stable reference voltage of around 1.1 volts is applied to the base of TR1. Pre-set potentiometer VR1 in the emitter circuit of TR1 is set up so that the collector current of the transistor is precisely 5mA. As we shall see shortly, this current enables S1 to tap off positive-going square wave pulses having a high degree of accuracy in terms of voltage amplitude.

TR1 is a constant current generator with an output current which, in practice, remains stable for fairly large changes in supply voltage. Since it is intended that the calibrator be battery driven, whereupon high changes in battery voltage are possible, the circuit as so far described is supplied by the voltage regulator consisting of zener diode D3, R6 and pass transistor TR2. With the prototype circuit this combination of voltage regulator and constant current transistor produces a performance in which there is no noticeable change in output pulse amplitude even when the battery voltage of 9 volts nominal falls well below 7 volts.

POTENTIAL DIVIDER

The 5mA collector current from TR1 which is produced when the pin 3 output of IC1 is low flows through the potential divider consisting of R7, R8, R9 and R10. These are all close tolerance 1% resistors. The parallel combination of R9 and R10 produces a resistance of 2Ω. The four values shown can be obtained in 1% tolerance from several component suppliers (e.g. Maplin Electronic Supplies) and may be available with ratings of ½ or ¼ watt. Either rating is suitable. If a 2Ω 1% resistor can be obtained this may be used instead of the parallel combination of 2.2Ω and 22Ω which is shown in the diagram.





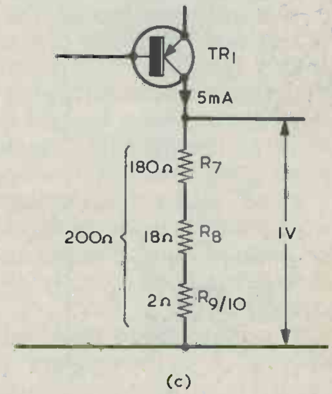


Fig.2(a). With S1 in position 3, the output pulses are produced by the 5mA collector current of TR1 flowing through a resistance of 2Ω

(b). Setting S2 to position 2 produces pulses built up across a 20Ω resistance

(c). 1 volt pulses are given across the total potential divider resistance of 200Ω

When S1 is set to position 3, the output pulse is obtained from the combination of R9 and R10, as shown in Fig.2(a). The 5mA from TR1 collector which flows in the 2Ω combination produces a voltage of 10 millivolts. Fig.2(b) shows the situation with S1 in position 2. The 5mA current now flows through a total resistance of 20Ω, producing a voltage amplitude of 100 millivolts. In position 1, S1 selects the voltage dropped across all the potential divider resistors. As is illustrated in Fig.2(c) the resistance now totals 200Ω, giving an output voltage of 1 volt.

Thus, S1 selects square wave pulses having the amplitudes indicated in Fig.1. These pulses may be directly coupled to the oscilloscope to be calibrated if this is connected to the "Common" and "D.C." output terminals. An a.c. output, given via C2, is provided when the oscilloscope input is connected to the "Common" and "A.C." terminals. All the output impedances are very low, the highest impedance being 200Ω when S1 is at position 1.

Since the 5mA collector current provided by TR1 is only present for half the time, as also is the current flowing through R4 to D1 and D2, this part of the circuit only draws an average current of about 3 to 3.5mA. The total current consumption of the calibrator at 9 volt battery voltage is 7mA, a high proportion of which flows through R6.

The components are all standard parts, and the close tolerance potential divider resistors have already been dealt with. The remaining fixed resistors are all ¼ watt 5%. VR1 may be a 0.1 watt skeleton potentiometer, but it will probably be found that greater resolution in setting up, and improved long term stability, is given if a larger 0.25 watt potentiometer is employed. C1 can be polystyrene or polycarbonate, and C2 polycarbonate or polyester. The frequency of the square waves produced by IC1 can be altered by changing the value of C1. The frequency is inversely proportional to C1, so that if its value is halved the frequency is doubled, and so on.

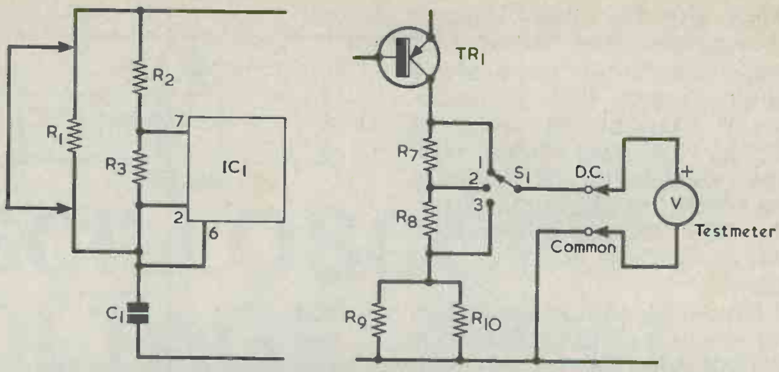


Fig.3. Setting up the calibrator. R1 is temporarily short-circuited, whereupon the pin 3 output of the ICM7555 goes low, turning on the constant current transistor TR1. VR1 in the emitter circuit of TR1 is then adjusted to produce a measured voltage across the potential divider of 1 volt.

CONSTRUCTION

The circuit may be assembled in any conventional manner. Layout is not critical provided that interconnecting wiring is kept reasonably short. A suitable housing would be given by an inexpensive plastic case with the two switches and the three output terminals mounted on the front panel. If a metal case is used this should be made common with the negative rail.

After construction has been completed it is necessary to adjust VR1. Initially this potentiometer should be set to insert maximum resistance into circuit. Selector switch S1 should be in position 1 and a testmeter switched to a low volts range connected across the "Common" and "D.C." output terminals, as shown in Fig.3. A temporary short-circuit is connected across R1 so that, when the calibrator is switched on at S2, pins 2 and 6 of the ICM7555 are taken high and its output forced low.

After switch-on, a voltage of less than 1 volt will be indicated by the meter. VR1 is then adjusted until the meter reads exactly 1 volt. The temporary short-circuit across R1 is next removed, after which the calibrator is fully set up and ready for use. ■

Keeping Currents Low

By R. J. Caborn

Flea-power oscillator for CMOS.

Many CMOS circuits incorporate an oscillator for clock or timing purposes. Since CMOS devices draw exceptionally low supply currents, a minor challenge to the experimenter is given in the designing of low current oscillators for CMOS circuitry.

OSCILLATOR CIRCUITS

The well-known CMOS relaxation oscillator illustrated in Fig. 1 is often employed. When running at audio frequencies, this type of oscillator can draw a surprisingly high current of several hundred microamps at 9 volts. It has to be remembered that a CMOS gate only draws a significant current when its input passes through the voltage range at which linear amplification takes place, and that the quicker the input passes through this range the lower is the overall average current. With the oscillator of Fig. 1 at least one of the gate inputs goes through its transition at a relatively slow rate; hence the high overall current. The ICM7555 (the "CMOS 555") is more attractive. This draws a current of about 70μA at 9 volts and has the further advantage that its output changes extremely rapidly from the high to the low state and vice versa. This very fast output transition results in very low current-demands in CMOS gates whose inputs are connected to the ICM7555 output.

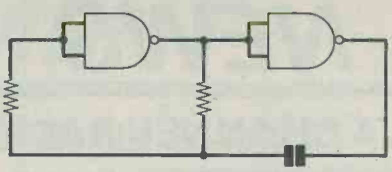


Fig. 1. A common CMOS relaxation oscillator using two NAND gates acting as inverters. Two NOR gates, similarly connected, would give the same performance

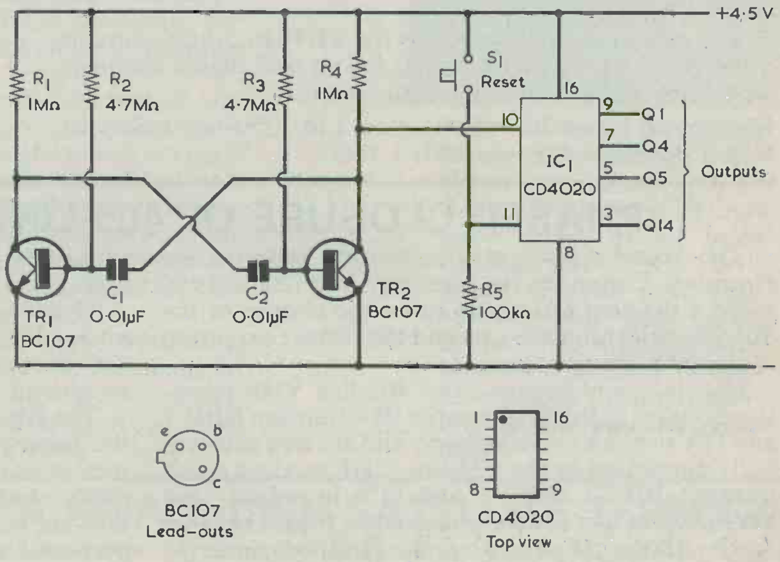


Fig. 2. The multivibrator consisting of the circuitry around TR1 and TR2 draws an extremely low supply current. However, supply voltage is restricted to 4.5 volts.

An alternative oscillator circuit which the author has used offers even lower consumption than the ICM7555, provided certain requirements peculiar to the circuit are satisfied. It consists of the multivibrator shown in Fig.2, in which an output is fed to the pulse input of a CD4020. The latter is a 14-stage binary divider, and its Q14 output at pin 3 offers division by 2 to the power of 14, or 16,384 times. However, the device following the multivibrator is incidental to the present discussion as we are interested in the multivibrator itself. The device it drives can be any CMOS gate or divider.

The multivibrator is made to draw a low current by the simple expedient of using high value collector and base resistors. The current flowing in either R1 or R4 from the 4.5 volt supply cannot exceed 4.5μA and, since only one transistor is turned on at a time, total collector current has to be around this level. Immediately after the multivibrator changeover the current in R2 or R3 is about 2μA, falling to about 1μA as the appropriate cross-coupling capacitor discharges. The multivibrator runs at about 16Hz and, without the CD4020 in circuit, the measured current consumption is 7μA. When the CD4020 is connected into circuit the total current consumption rises to 10μA. It follows from this that the output transistions at TR2 collector are a little slow, and not as fast as those from an ICM7555. Nevertheless, overall performance in terms of current consumption is better than would be given with an ICM7555.

Although the two transistors are operating at very low current levels the multivibrator works well with all transistors checked in it and has been found to be reliably self-starting.

Note that the supply voltage is 4.5 volts only. This low voltage is necessary because the maximum reverse base-emitter voltage rating for the BC107 is 5 volts. If the base-emitter junction is taken to breakdown level it zeners and upsets multivibrator operation. In consequence the multivibrator, using the circuit as shown, should only be run at supply voltages below the base-emitter voltage rating of the transistors.

As proof of this fact the circuit of Fig. 2 was run at 9 volts. With the CD4020 out of circuit, current consumption was 14μA, but it rose to as much as 100μA when the CD4020 was added. This high increase was due to a distorted output from TR2 collector causing slow switching in the input gate of the CD4020. ■

NEWS . . . AND

4 CHANNEL RADIO CONTROL IN ONLY TWO ICs.

The increasing interest in electronic toys has led to a considerable upsurge in remote control in applications previously considered to be the province of the 'toy' manufacturer. The majority of the current toys are crude non-proportional control systems, using AM transmissions with superregenerative receivers in the 27MHz radio control band.

TOKO have announced a new approach to the production of low cost digital proportional radio control system for the 27MHz to 50MHz radio control bands.

The KB4445 is a complete 4 channel encoder, with crystal oscillator and FM modulator system, giving approx. 30mW RF output, which is readily boosted to a watt or more with a single transistor stage.

The companion receiver IC is the KB4446, which contains a complete RF Decoder system for up to 5 digital channels with a total of less than 25 components.

Distributed by Ambit International Ltd., 200 North Service Road, Brentwood, Essex CM14 4SG.

PHASED CLOSURE OF 405-LINE TV NETWORK

The Home Secretary in a written reply in the House of Commons on Tuesday, May 20th, 1980 made a detailed statement about the closure of the 405-line television services and the further extension of the 625-line services.

His statement began: "The 405-line VHF television services of the BBC and the IBA transmit BBC-1 and ITV in black and white only and are now substantially duplicated by the 625-line UHF services which transmit BBC-1, BBC-2 and ITV in colour, and which will in due course transmit the fourth channel service. Phase II of the current UHF engineering programme for extending the 625-line services to communities with populations of 500 or more (over 99% of the population) should be completed by about 1984.

"I have, therefore, agreed with the broadcasting authorities on a timetable for the closure of the 405-line services. Closure will begin in 1982 and will be phased over a period of about 4 years."

The BBC and the IBA are co-operating closely in the implementation of these engineering programmes in order to minimise any inconvenience to the public. As far as possible they plan to close down their 405-line services in Bands I and III at the same time in particular areas, although this will not be possible everywhere since the BBC have 110 transmitters on 405-lines while the IBA have 47.

NEW BRITISH MADE MONOCHROME TV's

The new 12 inch monochrome portable television designed and produced by Fidelity Radio Limited of London, NW10.

Fidelity Radio Limited, London, NW10 have become, it is claimed, the first British manufacturer to enter the monochrome television market for many years with a totally new 12 inch portable, designed and produced exclusively by themselves.

The latest TV technology and the company's long experience of value-for-money volume production in the radio and audio field, where they are Britain's leading manufacturer, will enable their new television to be one of the lowest priced quality models available.

Features of the new 12 inch monochrome television, designed to claim a substantial share of the market currently running at about 1.2 million units per annum are an essentially simple design, hence good reliability, easy operation and servicing and the provision of a two year guarantee.

Powered by 12v battery mains the white moulded cabinet houses circuitry employing the latest techniques. Programme selection is by rotary tuning and a single control combines on/off and volume. A brightness control and earphone socket are included together with a loop aerial and battery leads.

The new Fidelity television is expected to reach shops by the autumn.

. . . COMMENT

TEXAS HOME COMPUTERS FOR UK MARKET

Low cost multi purpose domestic computers have hit the UK at last. Sussex based Scan Computers has launched on to the market a home computer costing about £1,000 all-in; a price made even more incredible by the fact that the VDU monitor doubles as a second household colour TV, receiving all normal TV channels.

The new incredibly compact computer is the Texas Instruments TI-99/4, manufactured in the USA and marketed by Scan Computers under an agreement newly signed with Texas Instruments in the UK . It consists of a compact keyboard and processor unit plus a colour TV monitor. Unique solid-state command modules plug into the processor to program the machine for personal finance, home records, educational purposes and entertainment. Readily available solid-state pre programmed modules can be purchased for all these functions from as little as £16.95.

Alternatively, easy to follow instruction booklets teach you to program the machines yourself. The home computer is capable of keeping the accounts for a small business, of charting sales results – you name it, the TI-99/4 can probably do it.

The home computer can even speak – synthesising a human voice with a Solid State Speech synthesiser. You type in the word – the computer speaks it or tells you that you have spelt it wrongly. This capability is an invaluable teaching aid for children, particularly those with learning difficulties.

Scan Computers' Managing Director Steve Russell is delighted with the agreement that enables his company to market the TI Domestic Computer. He said "We're marketing this amazing machine direct to the public or to any retail outlet that expresses interest. People are going to love it."

The T1-99/4 Domestic Computer being marketed for under £1,000 by Scan Computers. It can keep track of all your house accounts, will teach you to spell correctly, and can even speak! The monitor doubles as a second household colour TV set, receiving all normal TV channels.

DIGITAL-VIDEO ON IBA'S SMALL-DISH SATELLITE TERMINAL

The first reception on a small-dish satellite terminal of digital-video television transmissions through a European space satellite has been successfully achieved at the IBA Engineering Centre at Crawley Court, Winchester.

This was in the course of experimental work being carried out with the assistance and co-operation of the British Post Office and the European EUTELSAT organisation, using the OTS experimental geostationary satellite launched in May 1978.

The first digitized pictures – of excellent quality – were received by IBA engineers on April 25, 1980 and were transmitted to the satellite from the Post Office's 14 GHz satellite terminal at Goonhilly Downs, Cornwall, where an experimental IBA digital encoder had been installed for the purpose. The downcoming signals were received and decoded on the IBA's 11GHz space terminal which was built in 1977 and which has a dish-aerial only three metres in diameter.

For these experiments, a conventional 625-line analogue television picture was encoded and transmitted through the 120MHz-bandwidth OTS transponder using a bandwidth of some 40MHz and modulated by means of quadrature phase-shift keying. The pictures were initially sampled at four times the frequency of the colour sub-carrier (142Mbit/s) and then digitally converted to the equivalent of twice sub-carrier frequency sampling (71 Mbit/s). This data rate is then further reduced by means of bit-reduction techniques including the use of differential pulse code modulation and, when error-protection and 'housekeeping' bits are added the system has a bit rate of 60Mbit/s.

The purpose of the experiments is to establish the relative merits of digital (QPSK) and analogue (FM) modulation techniques for international distribution of television pictures and to determine the minimum size of dish aerial for a given satellite power needed for the reliable reception of good quality pictures when using digital techniques.

The digital sampling rate and techniques used in these trials are for experimental purposes only and are not being proposed as an international standard.

LATE PUBLICATION

We apologise to our readers for the late publication of this issue, and the preceding one, due to the recent dispute in the printing industry. Such disruption, unfortunately, adversely affects print schedules for some time ahead.

The next issue should be available by mid July and future issues will be published a little earlier each month until the normal publication date is achieved.

We regret the inconvenience caused to readers which is through no fault of ours or that of the distributive trade.

CAPACITANCE MEASURING ADAPTOR

by
R.A. Penfold

Neat add-on unit allows your testmeter to measure capacitance. Five switched ranges from 0-2,500pF to 0-5μF.

When used in conjunction with an analogue multimeter set to a 0-50μA range, this simple device provides the following five ranges of capacitance measurement: 0-2, 500pF, 0-5,000pF, 0-0.05μF, 0-0.5μF and 0-5μF. Most multimeters do not have provision for measuring capacitance and their usefulness will be considerably enhanced by the use of this add-on instrument.

Many multimeters have a 0-50μA range, but the unit can also be used with multimeters not having such a range, as is explained at the end of the article. All that is required is a modification to two of the resistor values in the unit.

The output of the add-on adaptor does not consist of a straightforward direct current, but is instead a series of pulses. These pulses are averaged in an analogue meter to give a single steady reading. Because of the nature of the output, the unit cannot be employed with a digital multimeter.

If preferred, the adaptor could be built as a completely self-contained capacitance measuring instrument having its own 0-50μ panel-mounted meter. However, the cost of good quality panel meters is relatively high these days, and an obvious saving is given by employing the unit with a multimeter which will already be on hand.

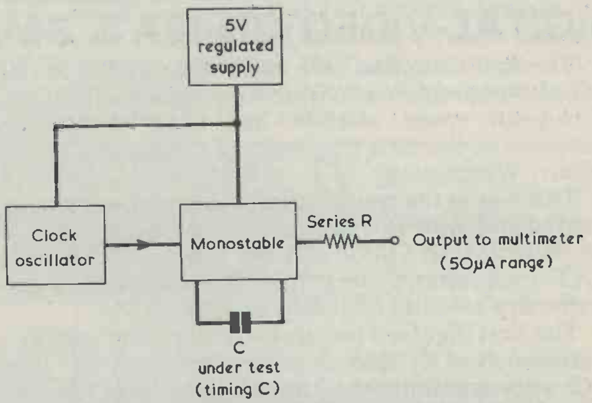
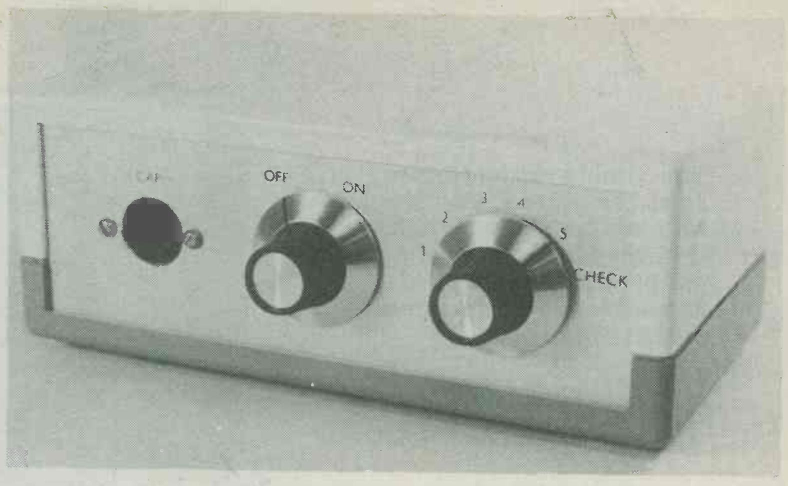


Fig.1. Block diagram illustrating the operating principle of the adaptor. This is employed in conjunction with an existing multimeter switched to a low current range

OPERATING PRINCIPLE

The method of operation is quite conventional and is shown in block diagram form in Fig.1. A clock oscillator running at a fixed frequency triggers a monostable, which produces a positive output pulse at each cycle from the oscillator. These pulses are applied to the multimeter, switched to a 0-50μA range, via the series resistor shown. The duration of each monostable pulse is controlled by a timing resistor and a timing capacitor, and is proportional to the values of both. The timing capacitor is the capacitor being measured whilst the timing resistor is, in practice, one of five different resistances which is switched in to provide the required capacitance range.



Housed in an attractive Verobox, the add-on adaptor presents a tidy and neat appearance

The circuit values are arranged such that the multimeter gives full-scale deflection for the maximum capacitance in each range. In, for example, the last of the ranges just referred to, a 5μF test capacitor will give a reading in the multimeter of 50μA. If the 5μF test capacitor is replaced by a 2.5μF capacitor the same number of output pulses will be produced in a given time but each will have half the duration of the previous ones. The multimeter, measuring the average current, will then give an indication of 25μA. Similarly, a 1μF capacitor will give a reading of 10μA and so on.

Since the output current indicated by the multimeter is directly proportional to test capacitance, the overall effect is that of a linear scale capacitance meter. The existing meter calibration does not require any alteration. The use of a 0-50μA scale on a multimeter is particularly useful here as this scale corresponds directly to four of the five capacitance ranges provided. It would, of course, be nearly as easy to interpolate readings from a multimeter having, say, a linear scale calibrated from 0 to 100.

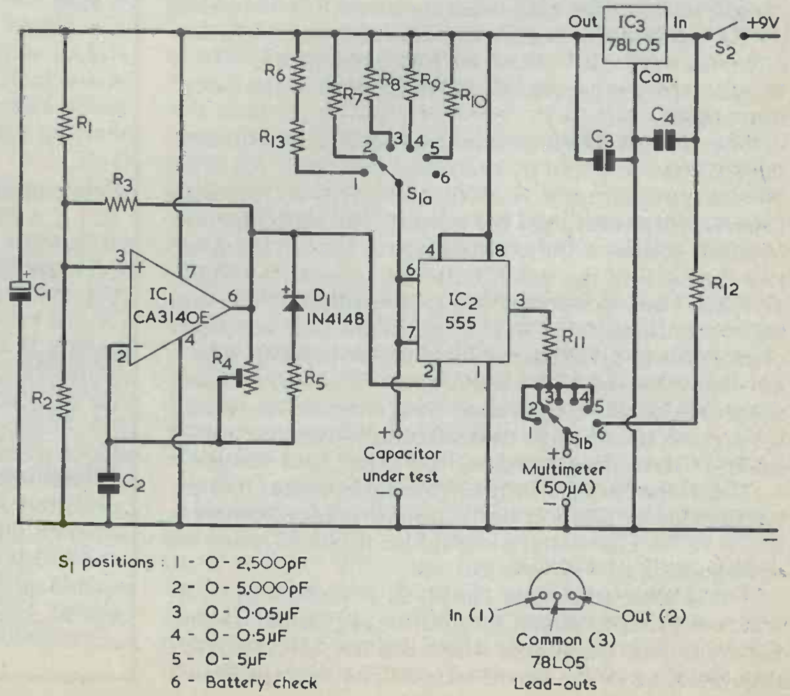
The unit is powered by its own 9 volt battery which couples into a 5 volt monolithic regulator i.c. to give a very stable supply voltage to both the clock oscillator and the monostable. In consequence, the oscillator frequency is not altered due to changes in battery voltage, nor is the voltage amplitude of the pulses from the monostable. Readings are not therefore affected by falling battery voltage. The unit also has a position of the range switch which allows the battery voltage to be checked by the multimeter.

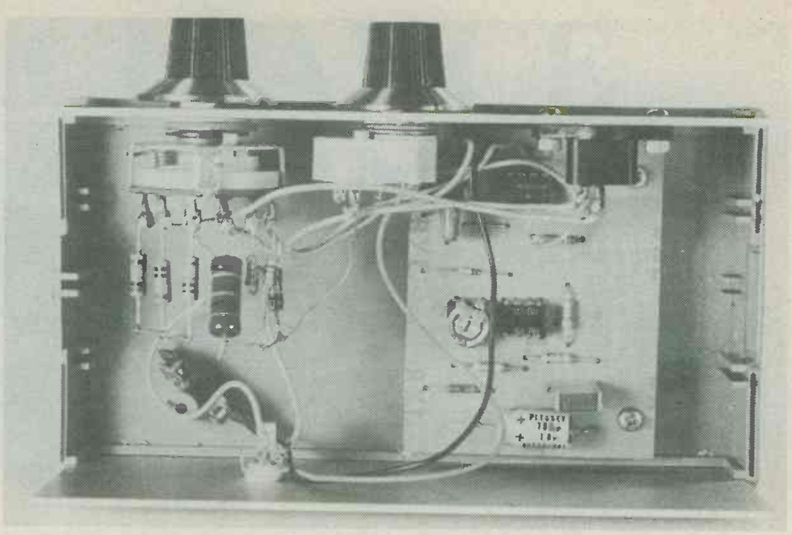
FULL CIRCUIT

The full circuit is shown in Fig.2. In this a CA3140E operational amplifier is employed as the clock oscillator, and a 555 timer as the monostable.

Dealing first with the oscillator, the non-inverting input of the CA3140E has a potential which is controlled by R1, R2 and R3. All of these resistors have the same value of 47kΩ with the result that, if the output of the op-amp is high the voltage at the non-inverting input is two-thirds of the supply voltage and, if the output is low, the non-inverting input voltage is one-third of supply voltage. Capacitor C2 is connected between the inverting input and the negative

Fig.2. The circuit of the adaptor. The full type number of IC3 is given in the Components List and it is shown inset here with the lead-outs pointing towards the reader





The timing resistors are soldered direct to the tags of the range switch, whilst the remaining small components are assembled on a printed circuit board

rail. Immediately after switch-on it will be discharged, whereupon the op-amp output will be high. The capacitor charges via R4 until the voltage across it reaches and marginally passes two-thirds of the supply voltage. The op-amp output will then swing low, whereupon the capacitor discharges via R4, R5 and the now forward biased D1 until the voltage across it falls to very slightly less than one-third of the supply voltage. The op-amp output then swings high again, the capacitor starts to charge to two-thirds of the supply voltage once more and the clock oscillator cycles then continue. The hysteresis effect in the circuit is the same as that given with a Schmitt trigger, and is essential for the operation of this type of oscillator.

Because R5 has a very much lower value than R4 (after the latter has been set up) the length of the negative-going pulse from the clock oscillator is extremely short, and is very much shorter than the positive pulse. It is this negative pulse which triggers the 555 monostable and it has to have almost negligible duration because the monostable cannot produce an output pulse shorter than the negative pulse which triggers it. Since R5 has a value which should be less than one-three hundredth of the value of R4 after adjustment, the unit offers resolution down to very low values of test capacitance which would hardly cause significant deflection of the meter movement.

The monostable is a standard 555 circuit with timing resistors selected by the range switch S1 (a). The 555 output connects via R11 and S1(b) to the multimeter which monitors the output. The sixth position of S1(b) connects the multimeter via R12 to the positive terminal of the 9 volt battery to check its voltage on load. The clock frequency is controlled by R4, and this potentiometer is set up after the unit has been completed to give the required meter reading with a known value of test capacitance. If all the timing resistors are close tolerance components the setting up process needs to be carried out on only one range and will then hold good for the other four ranges.

The value chosen for R12 causes the meter to have a full-scale deflection corresponding approximately to 10 volts. The battery should be replaced when its voltage falls to 7.5 volts or less.

The 5 volt stabilized supply is provided by IC3, which is a small 100mA monolithic regulator. C3 and C4 are bypass capacitors which ensure stability in the regulator. S2 is the on-off switch. The current drawn

COMPONENTS

Resistors
(All fixed values ¼ watt unless otherwise stated. See text for values indicated as close tolerance)

R1 47kΩ
R2 47kΩ
R3 47kΩ
R4 220kΩ pre-set potentiometer, 0.1 watt, horizontal
R5 330Ω
R6 10MΩ close tolerance
R7 10MΩ close tolerance
R8 1MΩ close tolerance
R9 100kΩ close tolerance
R10 10kΩ close tolerance
R11 82kΩ
R12 200kΩ
R13 10MΩ close tolerance

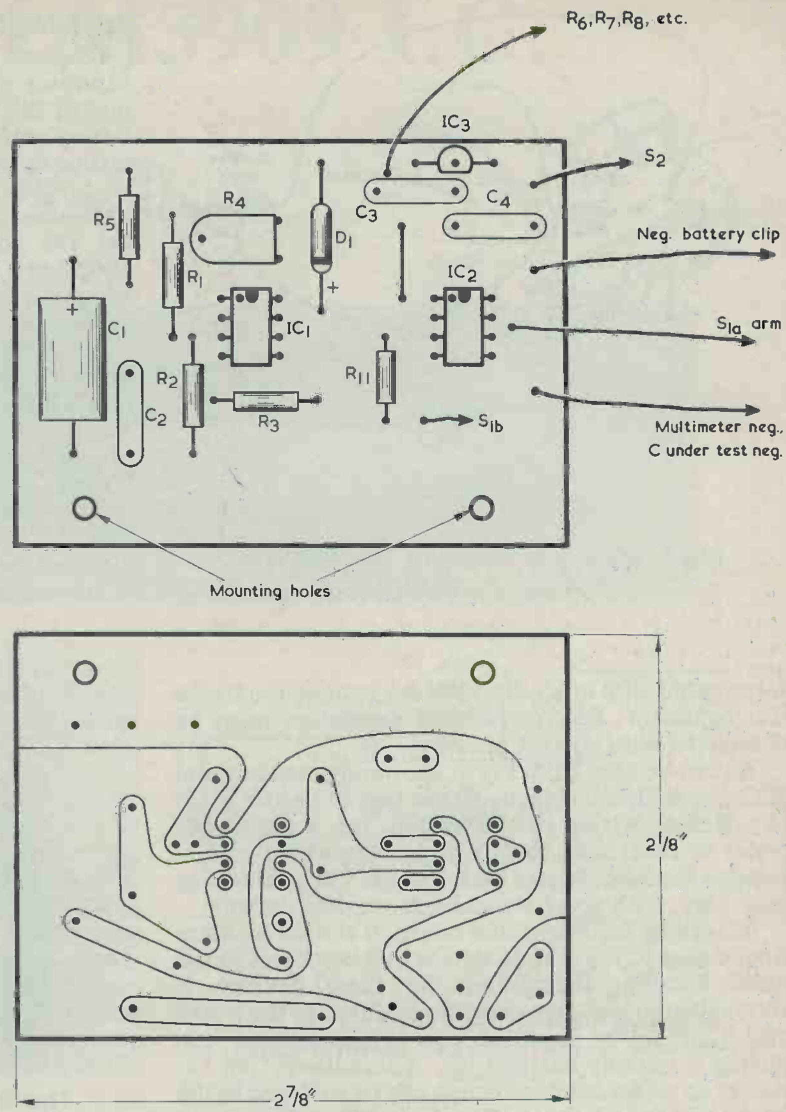
Capacitors
C1 100μF electrolytic, 10V Wkg.
C2 0.1μF type C280
C3 0.1μF type C280
C4 0.1μF type C280
Setting up capacitor (see text)

Semiconductors
IC1 CA3140E
IC2 555
IC3 μA78L05AWC (+5V 100mA regulator)
D1 1N4148

Switches
S1(a)(b) 2-pole 6-way rotary
S2 s.p.s.t. toggle rotary

Miscellaneous
Verobox type 75-1238-D (see text)
3.5mm jack socket
3.5mm jack plug
2-way DIN socket
2-way DIN plug
2 crocodile clips
9-volt battery type PP3
Battery connector
2 control knobs
Printed circuit board
Wire, solder, etc.

Fig.3. Component and copper sides of the printed circuit board



from the 9 volt battery is about 9mA, and this gives a reasonably long life from a PP3 battery, as is used in the author's unit. If it is intended that the add-on adaptor be employed extensively rather than occasionally, as would normally be the case in an experimenter's workshop, a larger battery would represent a more economic choice, and it might then be necessary to employ a larger case than that used for the prototype. This case is a Verobox type 75-1238-D with nominal outside dimensions of 153 by 84 by 59mm.

The timing resistors, R6 to R10 and R13 should be close tolerance types, and values up to and including 1MΩ are readily available in 2% or, better, in 1%. The closest tolerance in which the 10MΩ resistors R6, R7 and R13 are generally offered is 5% and, if a slight lack of accuracy on Ranges 1 and 2 can be accepted, these three resistors may have that tolerance. In this case, setting up should be carried out on Range 3, 4 or 5. Readers who are fortunate enough to have access to accurate resistance measuring equipment may be able to select resistors for the three 10MΩ positions. It is, of course, perfectly in order to use timing resistors having a higher wattage rating than the ¼ watt figure given in the Components List. The maximum permissible timing resistance for the 555 is 20MΩ, and this limits the minimum capacitances which can be measured to those given with Range 1.

CONSTRUCTION

Many of the components are assembled on a small printed circuit board which is shown full size in Fig.3. This board is prepared in the usual manner. The specified Verobox has two mounting pillars and the board is secured to these by means of two of the self-tapping screws supplied with the case. For optimum accuracy, the positions of the two mounting holes in the board should be checked physically against the mounting pillars in the Verobox before drilling them. The board is not finally mounted until it has been wired up to the remainder of the components.

The wiring external to the board is illustrated in Fig.4. A 2-way DIN socket is used for the connections to the test capacitor and this socket, together with S1(a) (b) and S2, is mounted on the front panel. A 3.5mm. jack socket mounted on the rear panel is used for the connection to the multimeter. The jack plug which fits into this has the negative connection at its "sleeve" and the positive connection at its "tip".

Most small capacitors can have their lead-outs passed into the contacts of the DIN socket on the front panel without difficulty. For other capacitors, a test lead assembly must be made up. This simply consists of a DIN plug with a short red flexible lead connected to the positive contact and a short black flexible lead connected to the negative contact. The two leads are

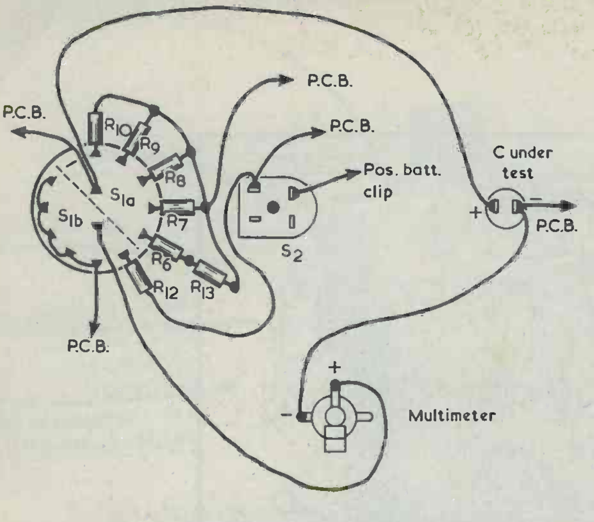


Fig.4. Wiring external to the board is carried out as shown here

SETTING UP

The unit is set up with the aid of a close toleranc capacitor whose value is near the maximum value o one of the ranges. If, as was mentioned earlier, 5% timing resistors are used for Ranges 1 and 2, the setting up process should be carried out on Range 3, 4 or 5. Close tolerance capacitors are fairly easy to obtain and, for instance, Maplin Electronic Supplies list 1% polystyrene capacitors with values from 100pF to 0.022μF. Two 0.022μF capacitors in parallel would give a test capacitance of 0.044μF, which could be used on Range 3.

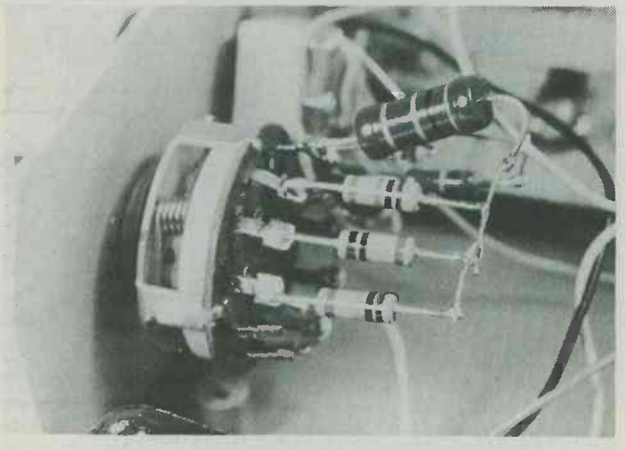
R4 is initially set fully anti-clockwise and the multimeter and the test capacitor are connected to the unit. This is switched on at S2 and R4 is next carefully adjusted for the appropriate meter reading. Setting up is then complete and the add-on adaptor is ready for use.

The completed adaptor should be found to have excellent linearity and accuracy. Despite the simplicity of its design it should give results that are more than accurate for normal amateur requirements.

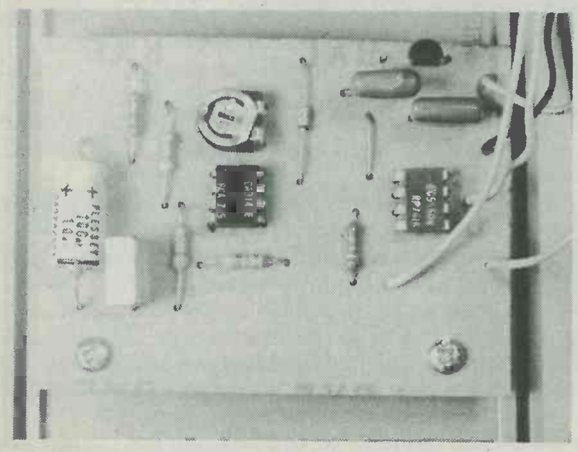
terminated with crocodile clips for connection to the test capacitor. Electrolytic test capacitors must be connected with correct polarity.

As can be seen from Fig.4, the timing resistors and R12 are soldered directly to the tags of switch S1(a) (b). Before wiring to this switch, use a continuity tester to determine the six outer tags which correspond to the inner tags of each section. Tag positioning may vary, with some switches, from that shown.

Returning to the printed board, it should be mentioned that IC1 is a MOS device and is subject to the usual handling precautions for these devices. It should be the last component to be fitted to the board and it should be soldered into circuit with an iron having a reliably earthed bit. Alternatively, an i.c. holder or soldercon connectors can be soldered to the board and the i.c. fitted afterwards. (The photograph of the board does not, incidentally, show the lead which takes the stabilized 5 volt supply to the timing resistors. The photograph was taken before the design was finally developed.)



The timing resistors. These are close tolerance types and it may be necessary to obtain some or all of them with wattage ratings greater than ¼ watt



The three i.c.'s and their immediate components are wired up on the printed board

OTHER METER CURRENTS

The unit can be used with meters having current ranges other than 0-50μA by changing the value of R11. This value, in kilohms, is equal to 4 divided by the f.s.d. current of the meter in milliamps. A 0-100μA meter would require R11 to have a value of 4 divided by 0.1, or 40kΩ. Similarly, a 1mA meter would need a value of 4kΩ in R11. In practice the nearest preferred value in 5% (39kΩ and 3.9kΩ in the two examples just given) would be employed, since slight differences here are taken up in the setting up procedure.

The value of R12 would also need to be altered. This, in kilohms, is equal to 10 divided by the meter current in milliamps, and for a 0-100μA meter would require a 100kΩ resistor for R12, and a 0-1mA meter would require a 10kΩ resistor. The battery voltage measurements are intended to be approximate only, but purists who require high accuracy here can first find empirically a value for R12 which takes in the voltage dropped across the multimeter and then fit this value to the printed board. ■

THE LM3909 I.C.

By
A. P. Roberts

8-pin i.c. with both useful and novelty applications

Although it is one of the simplest i.c.'s currently available, the LM3909 has many useful home-constructor applications. Contained in a standard 8-pin d.i.l. encapsulation, it is primarily designed to act as a low frequency low power oscillator.

INTERNAL CIRCUITRY

Fig. 1 shows the internal arrangements of the device and the method of using it in a simple l.e.d. flasher circuit. When power is initially connected to the circuit the discrete capacitor C1 will obviously be in a discharged state. Due to the relatively low value of R4 in the potential divider consisting of R4, R2 and R3, nearly the full positive supply voltage is then applied to the voltage detector. The detector passes a signal to the electronic switch which keeps it in the open condition.

C1 commences to charge whereupon the voltages across R4, R2 and R3 fall accordingly. When the voltage across R2 and R3 in series drops to a pre-determined low level the voltage detector triggers the electronic switch on. This takes the positive terminal of C1 down to the negative rail whereupon the charge voltage in C1 is effectively connected in series with the supply voltage. A voltage which is higher than the supply voltage is therefore applied across the l.e.d. and current limiting resistor R1.

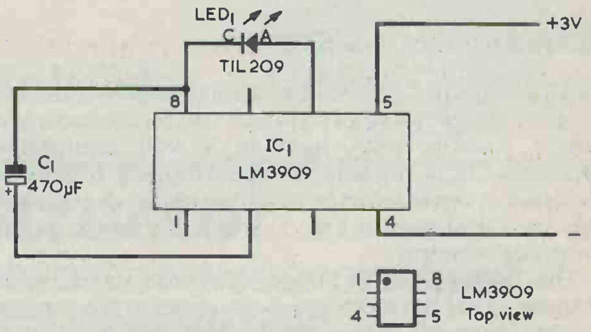


Fig.2. Practical 3 volt circuit giving an approximate flashing rate of one per second.

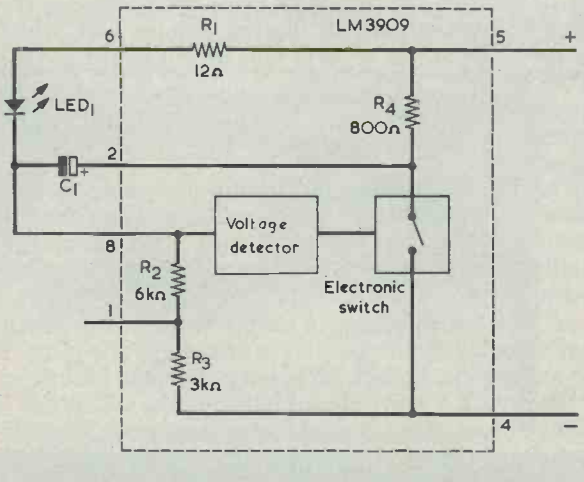


Fig.1. The internal functions of the LM3909 (shown inside the broken line) and its use as an l.e.d. flasher.

The l.e.d. flashes and C1 discharges rapidly. The altered voltage conditions cause the voltage detector to open the electronic switch and C1 charges once more via R4, R2 and R3. When C1 is sufficiently charged the electronic switch closes again to give another flash in the l.e.d. The cycles then proceed in the same manner, giving a series of l.e.d. flashes. As will be gathered, the circuit is really a form of relaxation oscillator.

TORCH FINDER

A typical application for the LM3909 is as a torch finder or as a flasher to show the location of important items at night time. A suitable circuit is given in Fig. 2, where C1 is given a value which provides a flash rate of roughly one per second, although the actual rate can vary from one circuit to another due to the wide tolerance on value of electrolytic capacitors and other factors such as supply voltage. The flashing light enables the torch or other item to be easily found in the dark, and the circuit can be left on continuously with only a low current drain from the battery.

The average current consumption of the Fig. 2 circuit is 500μA. This is an average figure as the actual consumption varies considerably during the oscillation cycle. The circuit will also function from a 1.5 volt supply, even though 1.5 volts is not sufficient in itself to turn on a light-emitting diode. As was just explained, an extra voltage is obtained from the charged C1. The operating frequency becomes lowered as the supply voltage decreases to this level and, with a 1.5 volt supply, the value of C1 should be changed to 220μF to maintain the flashing rate at about one per second. The average current drawn from the 1.5 volt supply is only of the order of 300μA.

The circuit of Fig. 2 can be employed, without modification, with a 4.5 volt supply. The average current demand is then approximately 800μA.

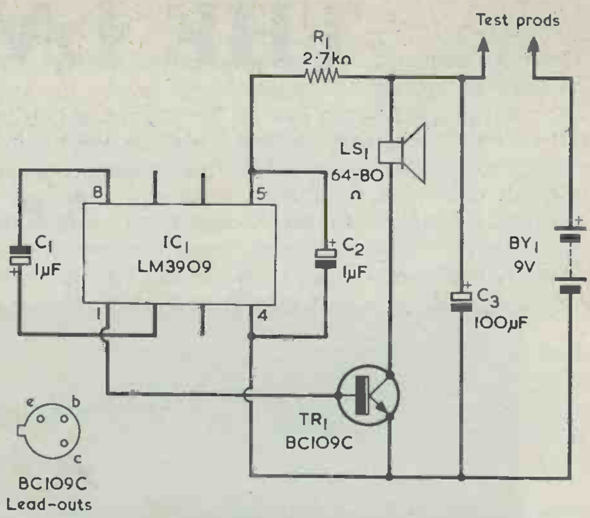


Fig.4. The LM3909 may also be employed as an audio frequency oscillator. In this circuit it functions as an a.f. continuity tester.

FLASHING PILOT LIGHT

Although the LM3909 has a maximum permissible supply voltage rating of 6 volts, it can be used as a low power flashing pilot light in 9 volt equipment provided that a suitable voltage dropping resistor is included in series with the positive supply. A circuit of this type is shown in Fig. 3, where R1 is the series dropping resistor.

The flashing circuit proper functions in the same manner as has been described. Because of the varying current demands during the flashing cycle it is essential to include the bypass capacitor C2, which smooths out voltage variations and ensures that the voltage applied to the i.c. always stays within acceptable levels. C2 must on no account be omitted as device operation would then be upset, and the supply voltage applied to the i.c. could exceed the maximum permissible level.

The Fig. 3 circuit gives a flashing rate of around one per second, and the average current consumption from the 9 volt supply is only about 300μA. The circuit will also work from a 12 volt supply, with a slightly higher current consumption of approximately 500μA.

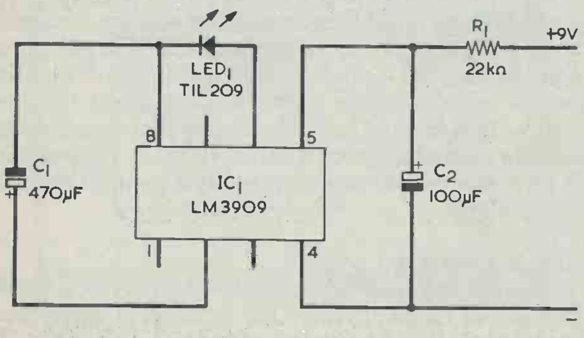


Fig.3. The circuit arranged to operate from a 9 volt supply.

CONTINUITY TESTER

A device as versatile as the LM3909 is not, of course, confined to l.e.d. flasher applications. It can be employed for other low frequency oscillator applications including sound generator circuits. An example is the continuity tester shown in Fig. 4.

The oscillator circuit is much the same as in the previous examples but as the l.e.d. is not now required this component is omitted. The discharge path for the timing capacitor, C1, is through two internal resistors in the i.c. (R2 and R3 of Fig. 1). C1 is given a much lower value than before, so that the operating frequency is raised to a few hundred Hertz. R1 is a voltage dropper resistor and is necessary because the circuit is powered by a 9 volt battery. C2 ensures that the voltage across the i.c. supply pins is maintained at a satisfactorily low level during the oscillatory cycle.

TR1 is a high gain common emitter amplifier with a high impedance speaker as its collector load. Its base couples to pin 1 of the LM3909 which, as was shown in Fig. 1, connects to the junction of R2 and R3 inside the i.c. During the oscillator cycle the voltage at this junction rises sufficiently high to turn on TR1, which causes a current of several tens of milliamps to flow in the speaker. These pulses of current in the speaker produce a loud audio tone. Between the pulses TR1 is turned off. Capacitor C3 is merely a supply bypass capacitor.

The circuit functions as a continuity tester because power is only applied to the oscillator when there is continuity between the test prods. The circuit still oscillates when there is a resistance between the two test prods but, because operating frequency varies a great deal with changes in supply voltage, this condition causes a readily apparent change in the pitch of the audio tone. In fact, there is a noticeable difference in the note if a short-circuit between the test prods is changed to a resistance of just a few ohms. The current drawn by the continuity tester from the 9 volt supply is 20mA.

In all the circuits, the electrolytic capacitors should have a working voltage higher than the supply voltage employed. ■

IN OUR NEXT ISSUE

PORTABLE SHORT WAVE RADIO

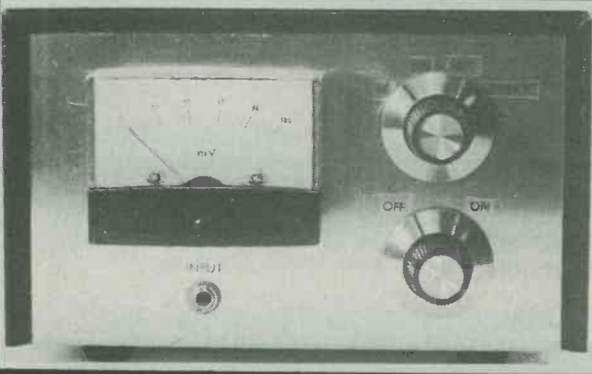
- Suitable for newcomers
- Employs only one i.c. and one transistor
- Covers 25, 31, 41 and 49 metre bands

The INStructor

A FULLY CONSTRUCTIONAL PROJECT INCORPORATING AN INS8060 MICROPROCESSOR CHIP

- *A Practical introduction to microprocessor functioning*
- *Relatively small number of components required*
- *An instructional project*

Featured in our new 8-part series, the INStructor is a fully constructional project incorporating an INS8060 microprocessor chip which provides a practical introduction to microprocessor functioning. Where previously you read about microprocessors you will now be able to handle a working microprocessor i.c. with power applied. Clock frequency is considerably reduced to enable inputs to be applied by push-buttons and by a 10-way digital slide switch. Readout is given by light-emitting diodes. The relatively small number of components required are wired up in breadboard form and most can be used in other projects later. The INStructor is not a mini-computer – it is an instructional project which illustrates in slow-motion form exactly how a microprocessor deals with its input data and program commands.



A. F. MILLIVOLT METER

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SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

Just recently a brief survey was made of that most difficult of bands – the 90 metre part of the dial (3200 to 3400 kHz) – simply to assess the current situation. The brief period amounted to a couple of hours on three evenings of the month; the following being most of the results obtained.

●SOUTH AFRICA
"Radio Five", Johannesburg on **3250** at 1805, pops on records, OM announcer in English. Radio Five closes at 2200, at which time the All Night Service begins.

●BURUNDI
Bjumbura on **3300** at 1810, OM with a newcast in French. This is a good time to log this one – later in the evening the channel is covered by commercial QRM.

●CHINA
CPBS Peking on **3220** at 2046, YL with a song in Chinese in the Domestic Service 1 programme which closes at 2200 on this channel.

●GHANA

Ejura on **3350** at 2053, OM and YL with a discussion in vernacular.

Accra on a measured **3367** at 2056, OM with announcements in English followed by a programme of local pops.

●NIGERIA
Lagos on a measured **3326** at 1925, OM with a talk in English about national defences.

●RWANDA
Kigali on **3330** at 1813, OM with a newcast in French.

●MALAWI
Blantyre on **3380** at 1818, OM with the local news in English.

AROUND THE DIAL
In which are listed some of the interesting loggings recently made on the various bands covered – use these as a general guide for those countries you wish to hear and/or QSL.

●FINLAND
Helsinki on **15400** at 1325, OM and YL with a discussion on Finnish internal affairs in the English programme announced here from 1300 to 1330. Also logged in parallel on **15265,** this latter channel providing the best reception here in the U.K.

●SWITZERLAND
Berne on **21570** at 1345, recorded dance music 1950 style in the English programme scheduled here from 1315 to 1345.

●PORTUGAL
Lisbon on **21495** at 1348, OM with a talk in Portuguese to the Cape Verde Islands.

● CZECHOSLOVAKIA
Prague on **17840** at 1730, YL with station identification and programme details at the commencement of the English transmission to Africa, followed by OM with a newcast. The English programme ended at 1825.

●HOLLAND
Hilversum on **17605** at 1740, OM with news of internal affairs in the Dutch programme for Africa and Europe.

●ROMANIA
Bucharest on **17720** at 1750, OM with station identification and "Radio Review" in the English programme announced for Africa, scheduled from 1730 to 1800.

●BULGARIA
Sofia on **11720** at 1731, OM with station identification and announcements at the commencement of the German programme for Europe, on the air from 1730 to 1800. A newcast of world events followed.

Sofia on **11765** at 1724, OM with a talk in Arabic for the Middle East.

●POLAND
Warsaw on **11840** at 1735, YL with news of Poland in the Italian programme which ended at 1800.

●YUGOSLAVIA
Belgrade on **11735** at 1738, OM with a newscast in Arabic, presumably for Arabian consumption.

●CUBA

Havana on **15385** at 1937, OM with identification and a talk in Spanish.

●MALTA

Cologne Relay on **17825** at 1735, YL with a talk about German internal affairs in an English programme which ended at 1750.

●NETHERLANDS ANTILLES

Bonaire on **17810** at 1730, OM with station identification and a talk in Arabic obviously for the Arabian areas.

●AUSTRALIA

Melbourne on **21630** at 1858, OM with station identification, announcements, time-check for 1900 GMT then some local news followed by news of events in the Pacific area.

Melbourne on **21680** at 0801, OM with a newscast in English which was also logged soon after on **21570** in parallel. The latter channel provided the best reception conditions here in the U.K.

Melbourne on **21890** at 0405, OM with a newscast of world events, followed by the local news read by a YL announcer – all in English.

●TURKEY

Ankara on **9515** at 1646, OM with the local news – many place-names mentioned – then YL with songs, all in the Turkish Service for those overseas.

●AFGHANISTAN

Kabul on **15075** at 1709, YL and OM in Arabic until several station identifications were made at the commencement of the German programme at 1830.

●ECUADOR

HCJB Quito on **15250** at 0430, OM with the station identification in English in a programme obviously directed to North America – judging from the announcements.

●EAST GERMANY

Radio Berlin International on **6040** at 0500, OM with the station identification and announcements with programme details at the commencement of a Spanish programme.

●VATICAN

Vatican City on **11700** at 2050, YL with the English programme all about the Greek and Roman gods of classical times, followed by details of other programmes for Africa.

●BRAZIL

Radio Nacional Brasil, Brasilia, on **15445**, at 1904, OM and YL announcers in Portuguese in a programme for internal consumption.

Radio Nacional Brasil, Boa Vista, on **4835** at 0208, OM with pops in Portuguese, OM announcer. The schedule is from 0900 to 0400 and the power is 10kW.

Radio Cultura do Para, Belem, on **5045** at 0243, OM announcer in Portuguese, followed by a programme of light orchestral music – quite a change from the eternal pops or LA (Latin American) music! The schedule here is from 0900 to 0600 but it has been reported by some listeners closing as early as 0300 or so. The power is 10kW.

●COLOMBIA

Radio Colosal, Neiva, on **4945** at 0237, OM announcer with some of the local pops on records. This one has a 24-hour schedule and it is one of the easiest Colombian stations to receive here in the U.K. The power is 2.5kW.

●VENEZUELA

Radio Mundial Bolivar, Bolivar, on **4770** at 0159, OM songs in Spanish, full identification at 0200. The schedule is from 1000 to 0400 and the power is 1kW.

Radio Lara, Barquisimeto, on **4800** at 0203, YL's in chorus with local ballads, piano solo. The schedule here is from 1000 to 0400 and the power is 10kW.

Radio Universo, Barquisimeto, on **4880** at 0220, YL with local pop song, OM with a programme of pops on records. The schedule of R. Universo is from 1000 to 0400 and the power is 10kW.

Radio Juventud, Barquisimeto, on **4900** at 0227, OM announcer with the inevitable local pops. The schedule is from 1000 to 0400 and the power is 10kW.

●PERU

Radio Loreto, Iquitos, on **5050** at 0248, OM with a sports commentary in Spanish – all very excitable stuff, complete with many trilled R's. The schedule is from 1100 to 0650 and the power is 2kW.

Radio Atlantida, Iquitos, on **4790** at 0430, OM identification in Spanish, local-style songs and music. Quite a change from pops. The schedule is from 0900 to 0600 but sometimes transmits around the clock. The power is 1kW.

Radio Chinchaycocha, Junin, on **4860** at 0425, local songs and music, identification in Spanish at 0430. The schedule is from 1100 to 0700 but has been reported closing around 0500. Just to confuse us all, it sometimes operates a 24-hour schedule. The power is 0.5kW.

●MAURITANIA

Nouakchott on **4845** at 1950, OM with a newscast in French. The schedule is from 0600 to 0900 and from 1830 to 2400 (on Sundays the second session opens at 1700). The power is 100kW.

●CAMEROON

Radio Yaounde on **4850** at 1908, OM with a newscast in French. The schedule is from 0430 to 0800 and from 1700 to 2300. The power is 30kW.

●EQUATORIAL GUINEA

Radio Ecuatorial, Bata, on **5005** at 2200, station identification in Spanish, the National Anthem and off. This station now seems to be permanently on this channel – formerly on **4926.** The schedule is from 0430 to 0630, 1000 to 1600 and from 1700 to 2200. The power is 5kW and it is a much easier station to log now it is on the present channel; I hope that it is still on **5005** when this is published!

●TOGO

Togblekope on **5047** at 2320, local songs and music in typical style, OM announcer. The schedule is from 0530 to 0800 and from 1700 to 2400. The power is 100kW.

80 METRE AMA BAND RECEIVE

By M. V. Hastings

Expressly designed for s.s.b. and c.w. amateur signals.

Minimal alignme

This easily built and fairly inexpensive receiver has been specifically designed for beginners who want to get started on amateur band reception. Unfortunately, most broadcast receivers having one or more short wave bands are not suitable for reception on any amateur bands which fall within their frequency coverage. This is because the two modes of transmission most commonly employed on the amateur bands are single sideband (s.s.b.) and morse (c.w.), neither of which can be resolved with an ordinary a.m. receiver. Communications receivers are obviously ideal for amateur bands reception but these are relatively expensive even when home-built. Quite good results can be obtained employing a much simpler receiver using the "homodyne" or "direct conversion" principle. Such a receiver is described here and it will provide reception of British and other European amateur stations, as well as reception of stations from further afield when conditions are suitable. A considerable simplification in design is given by having the receiver operate on a single band only, this being the popular 80 metre band.

In most countries, including the U.K., the 80 metre band extends from 3.5 to 3.8MHz. In the U.S.A. and a few other countries it extends from 3.5 to 4.0MHz. This set covers slightly more than the second of these two ranges whereupon little difficulty will be experienced in aligning it for the required frequency coverage. Alignment, in any case, merely consists of adjusting the cores of two coils, one to give the correct frequency coverage and the other to give maximum sensitivity over this range. No test equipment of any type is needed for the alignment. The receiver is not intended for the reception of ordinary a.m. signals.

Power is obtained from an internal 9 volt battery type PP6, and the output is suitable for high impedance magnetic headphones (2kΩ or 4kΩ) or a crystal earphone. An external aerial is required. However, a short indoor aerial will give reasonably good results, and an outdoor aerial is by no means essential.

DIRECT CONVERSION

An s.s.b. transmitter is basically an a.m. transmitter with the carrier and one sideband removed. If the s.s.b. signal is to be resolved the missing carrier must be re-inserted at the receiver and this and the signal passed through a suitable detector. Normally, a product detector will be used. In a superhet receiver the locally generated carrier can be inserted into the i.f. amplifier. With a receiver of the type described here, the locally generated carrier has the same frequency as would the carrier of the received signal.

The transmitted signal can be upper sideband (u.s.b.) or lower sideband (l.s.b.). If a 1kHz audio modulating tone were fed to a u.s.b. transmitter tuned to 3.6MHz, the corresponding upper sideband of 3.601MHz would be transmitted, whilst with an l.s.b. transmitter it would be the lower sideband of 3.599MHz which would be radiated. In either case the modulating tone of 1kHz can be resolved at the receiver by injecting a locally generated carrier frequency of 3.6MHz. When the 3.6MHz s.s.b. transmitter is modulated by a speech signal, the speech can similarly be resolved by injecting the local carrier of 3.6MHz. It is important, however, that the local oscillator be tuned as precisely as possible to 3.6MHz or

TEUR
ER

Simple homodyne design for the beginner.

nt requirements.

all the components of the speech signal will be raised or lowered in frequency. Only slight detuning can make the received speech signal difficult to comprehend.

A c.w. signal merely consists of a radio frequency signal which is keyed on and off. A local oscillator at the receiver can then be adjusted to beat with the signal and produce an audible heterodyne note. The locally generated signal used for s.s.b. reception can also be employed here, its frequency simply being adjusted to produce a comfortable tone.

The basic line-up of the receiver is shown in Fig.1. The aerial is connected to an r.f. amplifier with a tuned output filter, the latter being set to the centre of the 80 metre amateur band. This filter stops breakthrough from signals outside the band. The r.f. amplifier output is fed to a product detector, as also is an output from a variable frequency oscillator. The v.f.o. provides the missing carrier with s.s.b. signals or gives a heterodyne with c.w. signals. A second function of the r.f. amplifier and filter stage is to prevent signals from the v.f.o. being passed to the aerial, where they would be radiated and cause intèrference with other receivers.

The product detector couples into an r.f. filter which passes the detected audio signal to the a.f. amplifier whilst removing the r.f. signals present at the detector output. These r.f. signals, consisting of the received signal and the v.f.o. signal, are at a much higher frequency than the audio signal and can easily be filtered out by a single RC circuit.

The audio output from the product detector is very weak, and a considerable amount of audio amplification is required to bring it up to headphone level. The majority of the gain in the receiver is provided by the high gain a.f. amplifier which follows the r.f. filter.

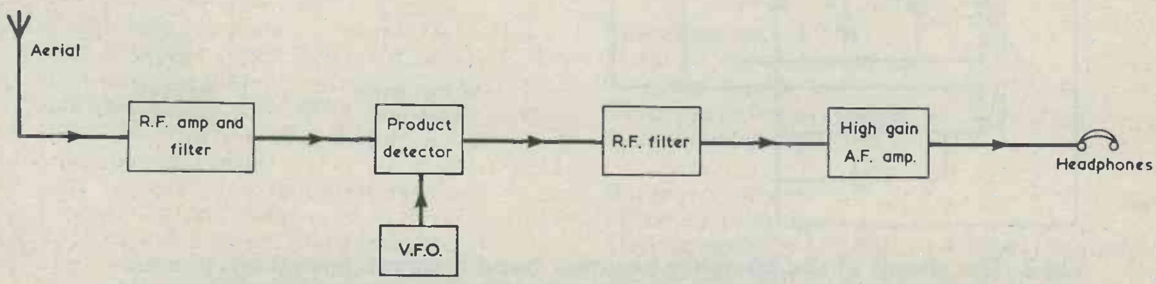


Fig.1. Block diagram representing the stage line-up of the receiver

The receiver is tuned by adjusting the v.f.o. frequency. This selects the s.s.b. signal to be received by inserting the missing carrier. The tuning here is much more critical than is given with ordinary a.m. reception because, as was just explained, a slight inaccuracy in v.f.o. frequency can make the detected signal incomprehensible. With c.w. signals tuning is similar to a.m. reception, however, as it is merely necessary to set the v.f.o. to a frequency which produces an acceptable heterodyne note.

THE CIRCUIT

The full circuit of the receiver is shown in Fig.2. TR1 is the r.f. amplifier and is used in the common emitter mode with an untuned base input circuit. Two aerial sockets, SK1 and SK2 are provided. SK2 couples direct to TR1 base and is used with short indoor aerials. SK1 couples to the base via trimmer TC1 and is employed with longer and more efficient aerials, which could cause the r.f. amplifier to be overloaded by strong signals if the aerial were connected direct to the transistor base. TC1 is adjusted to suit the particular aerial used.

The collector of TR1 connects to a coupling winding of coil L1. The winding between pins 1 and 6 is tuned by C2, and the core of the coil is adjusted so that this tuned circuit is resonant at the centre of the 80 metre amateur band. A second coupling winding on the coil connects to the product detector, consisting of D1, D2 and R2. The v.f.o. signal is introduced, via capacitor C3, at the junction of the two diodes. R2 is adjusted to minimise breakthrough of out-of-band signals.

The variable frequency oscillator is provided by the circuitry around TR4. This is a Jfet device used in the source follower mode. The gain from gate to source is somewhat less than unity, but there is a voltage step-up from the source coupling winding to the tuned winding of L2., which ensures that there is sufficient positive feedback to produce strong and reliable oscillation. Tuning is controlled by VC1 and VC2. VC1 is the bandset capacitor and VC2 the bandspread capacitor. Because of its low value and the fact that C11 is in series with it, VC2 can tune over only a small part of the band, but fine tuning is much easier to carry out with this capacitor. The oscillator signal is taken from TR4 source and passes to the product detector through C3.

R4 and C4 constitute the low pass r.f. filter which follows the product detector, and the remaining audio signal is coupled via C5 to the high gain low noise a.f. amplifier given by TR2 and TR3. These are both employed in the conventional common emitter configuration. C6 and C8 provide negative feedback of the higher audio frequencies, and thus roll off the high frequency response of the receiver. This is beneficial as it gives an improved signal-to-noise ratio and decreases adjacent channel interference. A good audio frequency response is of no benefit at all in a receiver of this nature since s.s.b. amateur transmitters normally incorporate filtering which limits the audio frequencies to a range suitable for good communications quality speech, with frequencies above 3kHz being virtually eliminated. C9 couples the output of the amplifier to SK4, the phones socket.

On-off switching is provided by S1, and C1, R3 and C10 are the only supply decoupling components

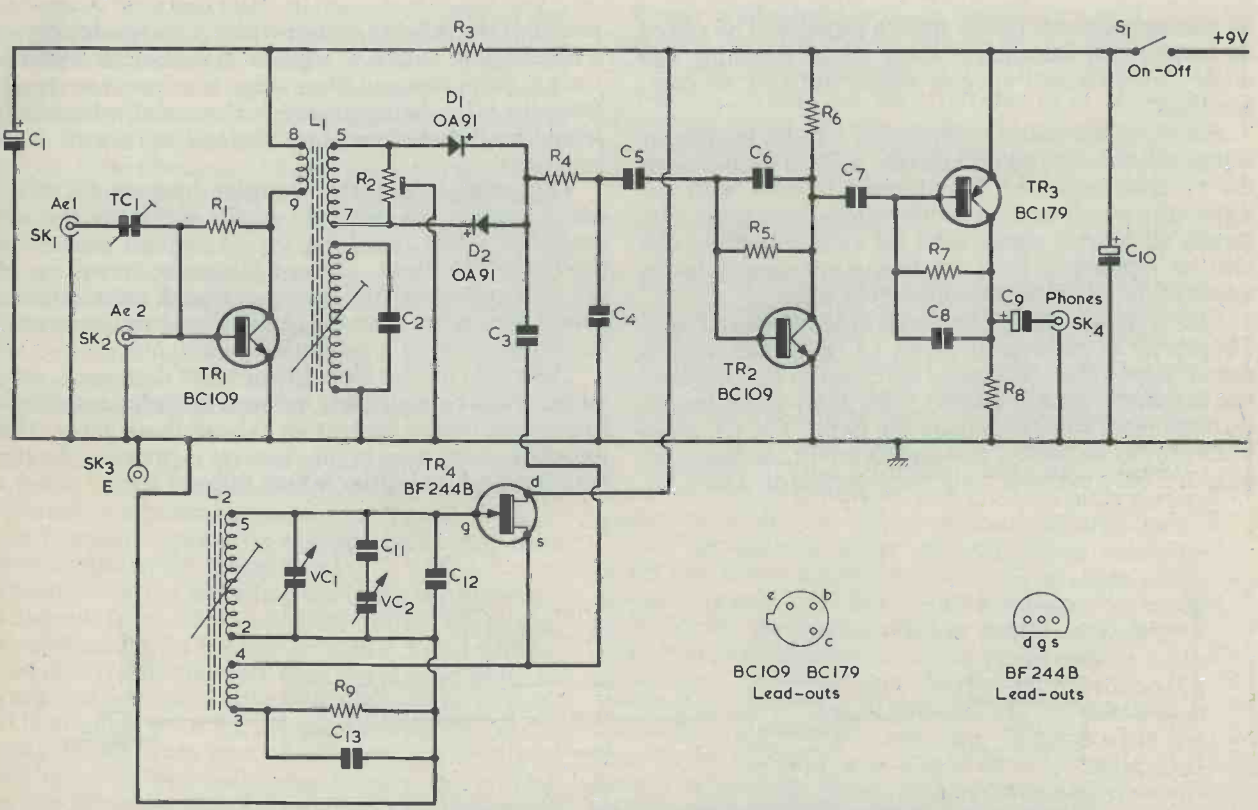
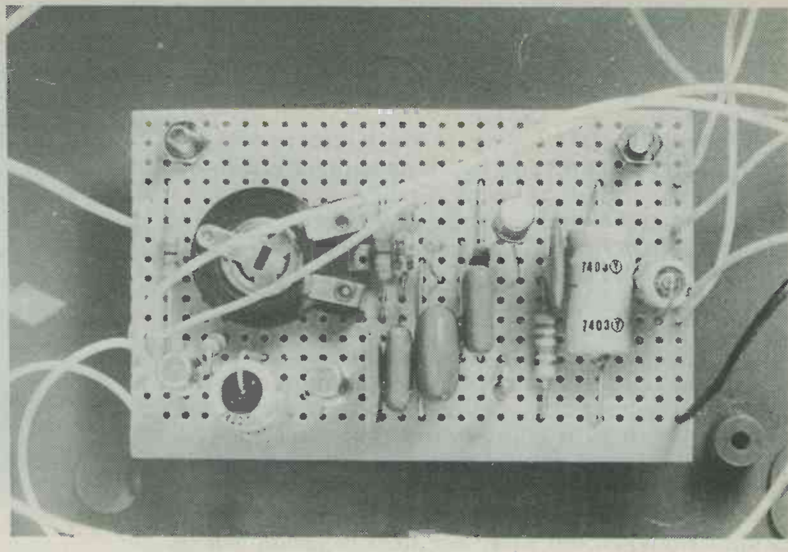


Fig.2. The circuit of the 80 metre amateur band receiver. Reception of s.s.b. signals is achieved by "direct conversion" with the output of oscillator TR4 inserting the missing carrier at the product detector stage

The components on the veroboard panel. This takes transistors TR1, TR2 and TR3 and their immediate components



which are required. Current consumption from the 9 volt battery is approximately 7mA only.

A few notes need to be made concerning components. SK4 should be a 3.5mm. jack socket of open construction, i.e. it should not have an insulated body. This is because a chassis connection to the front panel of the receiver is made by way of its mounting bush and nut. If difficulty is experienced in finding a source for the coil specified for L2, this may be obtained (as may also L1) direct from the manufacturer at Denco (Clacton) Limited, 355-7-9 Old Road, Clacton-on-Sea, Essex, CO15 3RH. The coil has a third winding, incidentally, which connects between pins 8 and 9. This winding has no effect on circuit operation and is not shown in Fig.2.

Trimmer TC1 can be any small trimming capacitor having a maximum value of about 20pF. The BF244B specified for TR4 is available from a number of suppliers, including Greenweld, 443 Millbrook Road, Southampton, S01 OHX.

COMPONENTS

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

R1 1MΩ
R2 470Ω pre-set potentiometer, 0.25 watt, horizontal
R3 470Ω
R4 3.9kΩ
R5 1.8MΩ 10%
R6 4.7kΩ
R7 1.2MΩ 10%
R8 2.2kΩ
R9 3.3kΩ

Capacitors
C1 100μF electrolytic 10V Wkg.
C2 56pF ceramic plate or polystyrene
C3 27pF ceramic plate
C4 0.01μF polyester type C280
C5 0.1μF polyester type C280
C6 1,000pF ceramic plate
C7 0.1μF polyester type C280
C8 390pF ceramic plate
C9 10μF electrolytic, 10V Wkg.
C10 100μF electrolytic, 10V Wkg.
C11 3.9pF ceramic plate
C12 22pF ceramic plate or polystyrene
C13 4,700pF ceramic plate
VC1 25pF variable type C804 (Jackson)
VC2 10pF variable type C804 (Jackson)
TC1 20pF trimmer (see text)

Coils
L1 Dual purpose, coil, transistor usage, Blue, Range 3T (Denco)
L2 Dual purpose coil, valve usage, Green, Range 3 (Denco)

Semiconductors

TR1 BC109
TR2 BC109
TR3 BC179
TR4 BF244B
D1 OA91
D2 OA91

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

Sockets
SK1 insulated socket, red
SK2 insulated socket, red
SK3 insulated socket, black
SK4 3.5mm. jack socket

Miscellaneous
Verocase type 75-1411-D
3 control knobs
Veroboard, 0.1 in. matrix
9-volt battery type PP6

Battery connector
2B9A valveholders
High impedance (2,000Ω or 4,000Ω) headphones or crystal earphone with 3.5mm. jack plug
Wire, solder, etc.

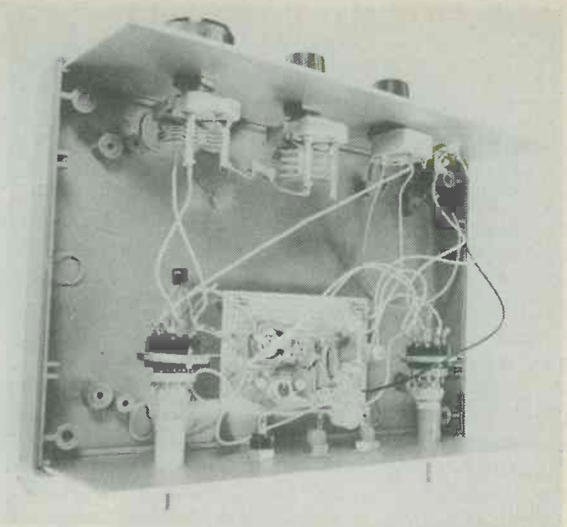
CONSTRUCTION

A Verocase type 75-1411-D with dimensions of 205 by 140 by 75mm. makes an excellent housing for the receiver.

This has a metal front panel which screens some of the circuitry and prevents hand capacitance effects on the tuning.

The general layout of the set can be seen from the photographs. On the front panel, from left to right, are SK4, S1 VC2 and VC1. On the rear panel are mounted L1, L2, the two aerial sockets and the earth socket. Looking at the receiver from the front, L1 is to the left, with SK2 next to it, followed by SK1, SK3 and, at the right, L2. Each of these coils requires a ¼in. mounting hole and is held in place by a plastic nut provided with it. It is important that these nuts be tightened by hand only as excessive force here could easily strip the plastic thread on the nut or the former. Soldered connections can be made directly to the pins of the two coils, but these are held in plastic which melts readily when heated. In consequence, a B9A valveholder is passed onto the pins of each coil and connections are made to the valveholder tags.

A Veroboard panel of 0.1in. matrix having 28 holes by 16 copper strips takes most of the components, and this is cut down from a larger panel. The Veroboard layout is shown in Fig.3. The two mount-



Looking into the receiver from the L2 end. Each of the coils has a B9A valveholder fitted over its pins, and connections are made to the valveholder tags

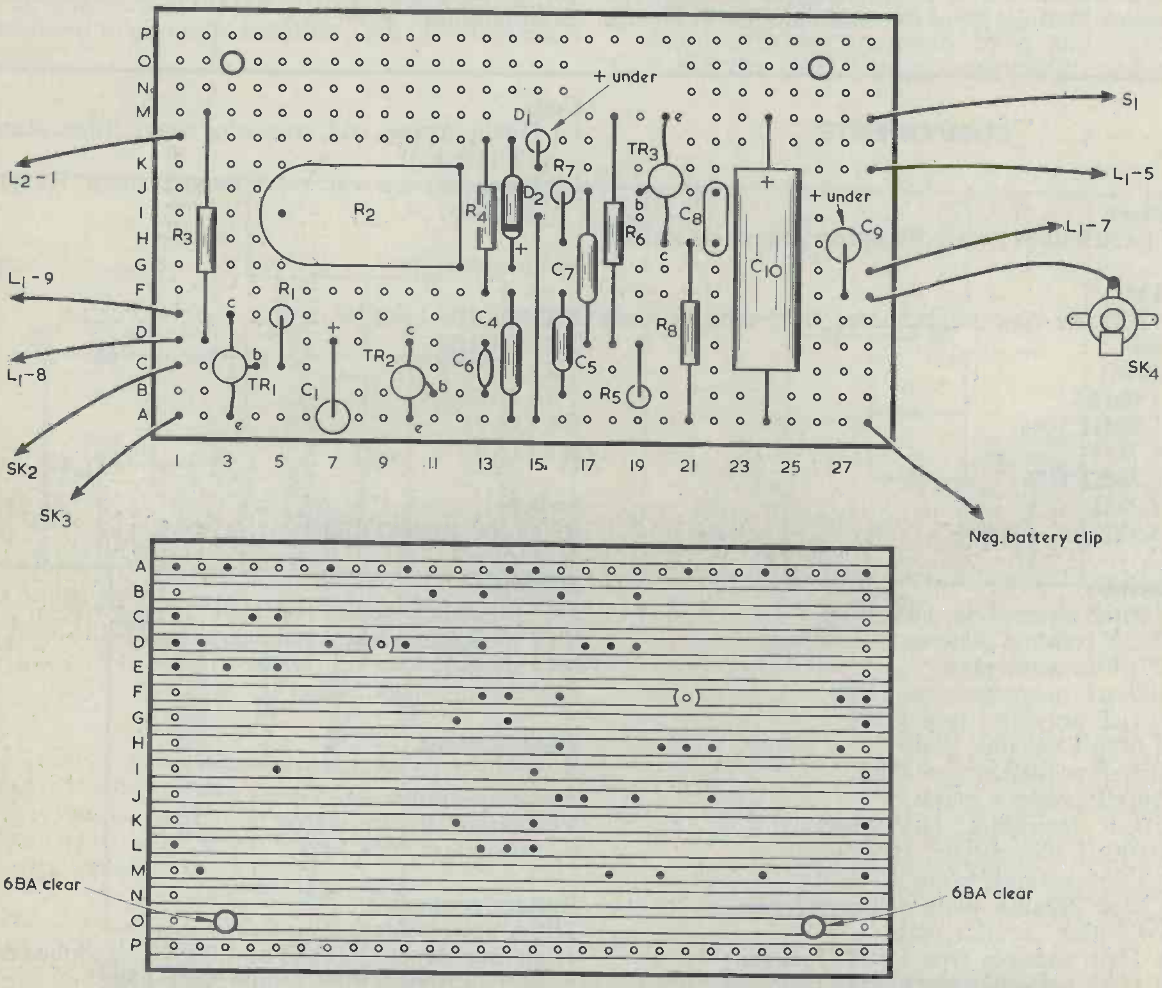


Fig.3. The component and copper sides of the Veroboard assembly. Wiring to components on the rear and front panels is also shown in Fig.4

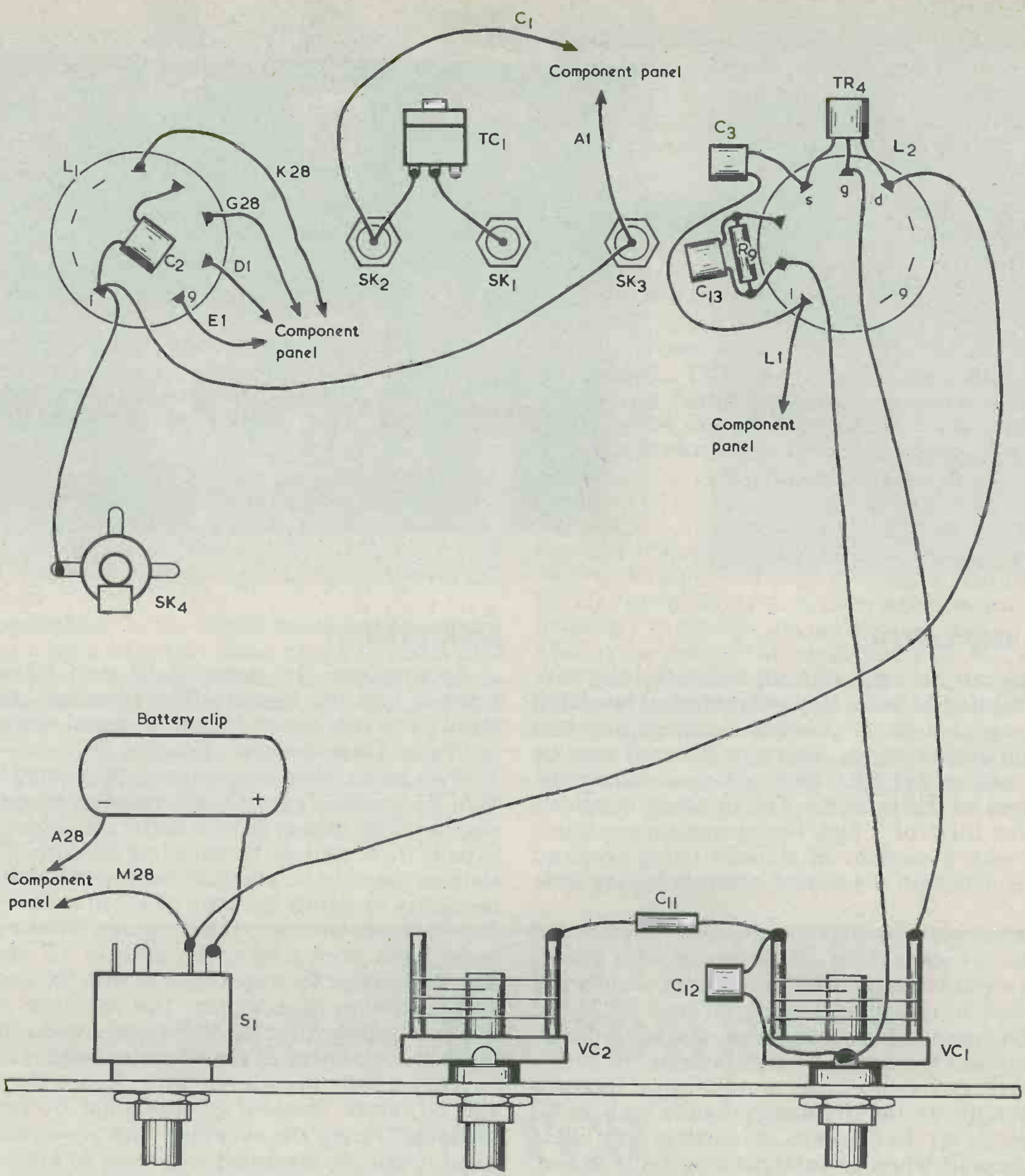


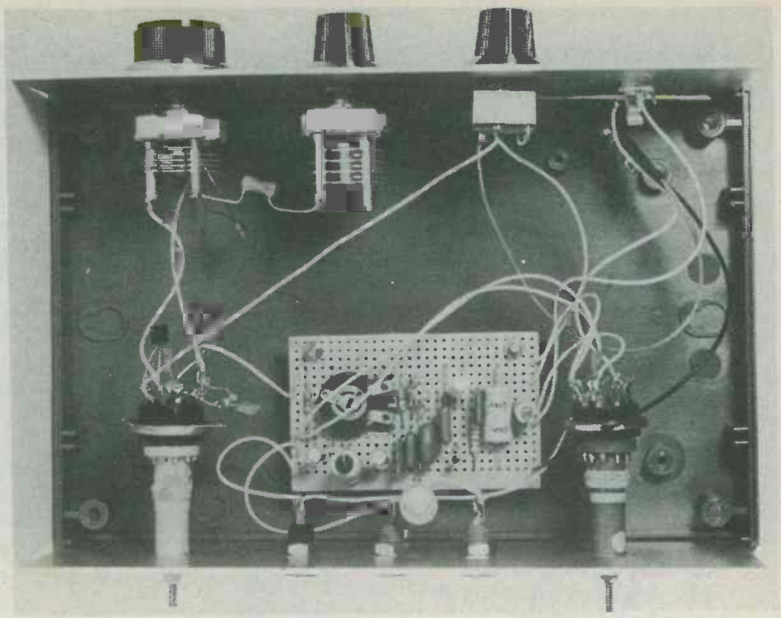
Fig.4. Point-to-point wiring. The letter and number references apply to the corresponding Veroboard holes. This diagram shows the remaining connection to SK4, shown removed from the front panel for clarity

ing holes have to be drilled out, and the two breaks made in the copper strips before soldering components to the board. Note that there is a link wire near the centre of the board. The two diodes should be the last components to be soldered to the board. The soldering of these diodes should be carried out fairly quickly as they are germanium types which can be damaged by excessive heat.

The panel is mounted on the base of the case just in front of the aerial and earth sockets. The two mounting holes are to the front. Two 6BA bolts and nuts are employed here, with spacing washers to keep the panel underside clear of the case bottom.

Before it is finally mounted in place, the Veroboard panel must be wired up to the components on the front and rear panels. The point-to-point wiring is shown in Fig.3. and 4. All the wiring should be kept reasonably short and direct. TC1 is connected directly between SK2 and SK1, being supported here by two stout pieces of tinned copper wire soldered to the socket tags. Some of the oscillator circuitry is connected to the valveholder fitted over the pins of L2. Pins 1 and 6 of this valveholder are used as anchor tags and do not connect to any coil windings. The letter and number references in Fig.4 apply to the corresponding Veroboard holes in Fig.3.

Another view into the receiver interior. Transistor TR4 is mounted on the valveholder tags at L2. The battery is positioned behind S1 and SK4



AERIAL AND EARTH

The set can be used with an ordinary long wire aerial consisting of some 10 to 40 metres of insulated wire strung as high as possible between any two convenient anchor points. This type of aerial must be plugged into socket SK1 to avoid overloading the input stages of the receiver. Overloading manifests itself in the form of a high background noise level, together with a number of stations being received simultaneously with the tuning controls having little effect.

An indoor aerial will give quite good results and can consist of some 3 to 10 metres of wire strung around a room or in an attic. Satisfactory results will be obtained by plugging this aerial into SK2, but overloading may still occur at times, making it necessary to connect the aerial to SK1 instead.

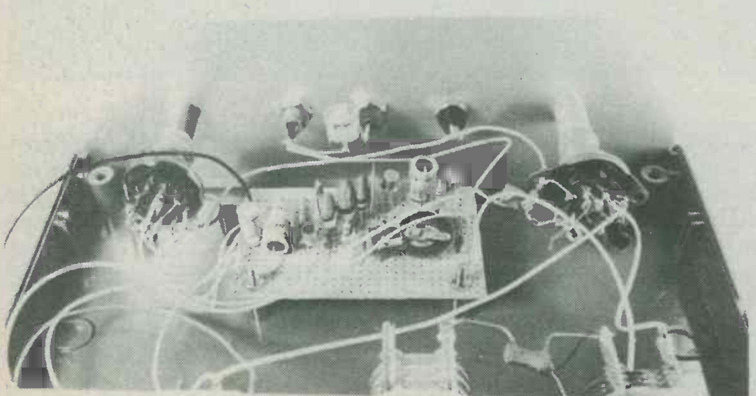
An earth connection can considerably increase signal strength on low frequency bands such as 80 metres. However, in this case, an earth is only likely to be of benefit when an inefficient aerial is in use. The set does not require a very strong input signal and can be overloaded by such a signal. The best type of earth connection is provided by a metal pipe buried or pushed into moist earth, with a lead which is as short as possible connecting it to the receiver.

ADJUSTMENT

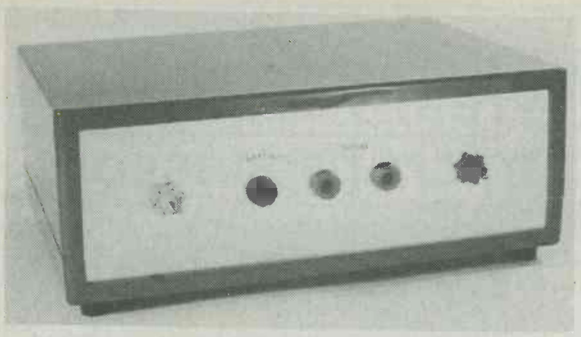
As supplied, the cores of L1 and L2 are fully screwed into the formers. The cores should be unscrewed so that about 10mm. of metal screw thread protrudes from the end of each coil.

With an aerial and headphones connected it should then be possible to tune in a number of stations of some kind by means of VC1 and it should be possible to peak these stations by adjusting the core of L1. The stations may not be amateur ones, and it will then be necessary to adjust the core of L2 in order to locate the 80 metre amateur band signals. When some of these have been found, the core of L2 should be adjusted so that they are tuned in with VC1 at around half maximum capacitance. The coverage provided by VC1 should then be sufficiently wide to ensure that all or nearly all of the 80 metre band is covered.

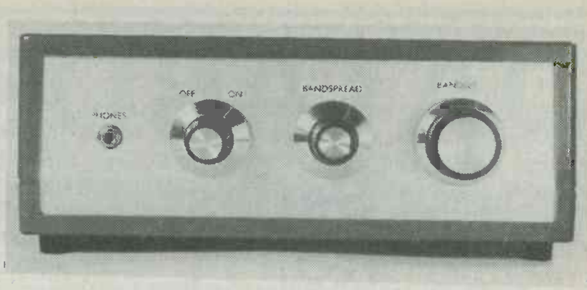
After a little experience with the set the limits of the 80 metre amateur band should become fairly obvious. During the evenings, and at weekends, the band is usually crammed from end to end with stations, and the band limits can then be located quite easily. If necessary, the core of L2 can be given a final slight adjustment to centralise the band in the range covered by VC1. VC1 is then adjusted to the centre of the band and the core of L1 finally adjusted for max-



The rear panel wiring. Trimmer TC1 is wired between sockets SK1 and SK2



The coils and aerial and earth sockets are assembled on the rear panel. The coils are held in position by plastic nuts which are supplied with them, and care must be taken not to over-tighten these nuts



On the front panel socket SK4 is to the left with the on-off switch next to it, followed by VC2. VC1 is to the extreme right. The panel legends are taken from Panel-Signs Set No. 4. It will be found convenient to fit VC1 with a larger knob than is employed with the other two controls

imum sensitivity. The bandwidth of the L1 tuned circuit is wide enough to give good sensitivity over the entire band.

During daylight hours the 80 metre band provides reception over a relatively short range of about 200 miles, but after darkness has fallen the range becomes very much greater and quite distant stations can often be received.

Two remaining adjustments concern R2 and TC1. The set will work perfectly well with R2 at any setting. It may occasionally be found that strong broadcast signals or possibly other transmissions are breaking through whereupon R2 should be adjusted in an attempt to null the interferring signal. Adjustment of R2 may not always remove the signal, whereupon it is necessary to change the aerial input to SK1 if it is at SK2, or to reduce the capacitance of TC1.

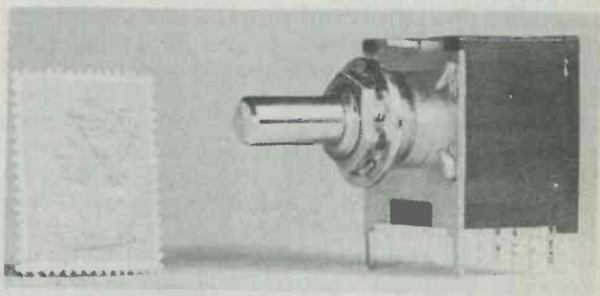
When only a modest outside aerial is being used, TC1 will probably give best results when set for maximum capacitance. However, with longer aerials the set may be overloaded unless the capacitance of TC1 is reduced somewhat. This is really a matter of finding a setting which gives good sensitivity without overloading problems. ■

BCD ENCODER SWITCH

A miniature 10-position rotary switch, introduced by Impectron Limited, has five connection pins and produces a binary-coded decimal output (i.e. a four digit binary group representing decimal 0 to 9) at each position. One signal pin is for voltage supply whilst the others represent decimal 1, 2, 4 and 8. No contacts are made on position "O" but as the switch is taken through the remaining 9 positions the four output pins present the number of the position selected in BCD form.

Known as the type BCM23, and measuring only 23 by 23 by 19mm. overall (excluding mounting pins and spindle), the switch will enable designers of mechanical-electrical interfaces to fit a low cost encoder into tight corners. The device will prove particularly useful where manual controls or mechanical assemblies have to be interfaced to electronic logic such as microprocessor circuits.

There are two fixing tabs for mounting to printed circuit boards and also a threaded spindle and nut for front panel mounting. Power rating is 3 watts maximum, with maximum voltage and current ratings of 200 volts and 500mA. The manufacturers are Impectron Limited, Foundry Lane, Horsham, W. Sussex, RH13 5PX.



The Impectron type BCM23 10-position rotary switch. This offers BCD outputs for switch positions corresponding to decimal numbers from 0 to 9. The spindle may be continuously rotated whereupon the switch functions as a shaft encorder with 36 degree resolution

DATABUS Series No. 11

(Part 10 appeared in our May issue)

really explains microprocessors

By Ian Sinclair

COMPUTING LANGUAGES

This concluding article examines current computing languages and ends with a glimpse into the exciting future world of microprocessors.

Whatever a microprocessor system is used for, the CPU action is always that of a number-cruncher, loading bytes of binary digits from memory and processing them. In some applications, all that the CPU ever does is to shift data bytes from one place to another; in other applications, quite extensive operations may be carried out on each byte.

MONITOR PROGRAM

Whatever the action, though, programming in binary code is never easy nor straightforward, so that the first essential for any programming that goes beyond the stage of finding out what a microprocessor can do is a monitor program in ROM. A suitable monitor program (and it must be one which suits the CPU exactly – you can't use a 6502 monitor to run a Z80) will enable addresses and data bytes to be entered in hex or octal form rather than in binary, and will allow the data byte in each memory location to be displayed when the memory address is keyed. All of this *can* be carried out by hardware, but if you have ROM in your microprocessor system it makes sense to program it so as to do this work, thus making the hardware simpler. Many monitor programs (or BUGS) do considerably more than these simple requirements, of course, but these are essentials.

Development systems, such as the MK14, the KIM 1, and others consist of the CPU with monitor ROM, RAM for your own programs, and I/O ports coupled to a keyboard and a hexadecimal display. Such development systems allow programs to be written in hexadecimal code so that machine control, or any other programs, can be tried out in RAM, and modified until they do what is required. The program can then be transferred to a PROM (using a PROM programmer circuit), written out in hex form, stored on tape or otherwise recorded for later use.

These development systems are excellent educational tools. Even if they taught nothing else they would certainly teach you how much programming is needed for even the simplest operations. For professional use, however, the time that is needed makes it necessary to use other methods of programming if a system is to be designed quickly. This involves the use of assembler language or of higher level languages.

An assembler is a device which "translates" letters, symbols and numbers typed on a keyboard into binary code which can be used to program the microprocessor. The important point here is "program" – lots of development units include full alphabetical keyboards, but that doesn't mean that they can be used to write programs. An assembler allows the operator to type out the mnemonics in place of the binary codes. If this were its only task it would still be useful, because a program written out as a series of mnemonics is easier to follow and less liable to error than one written in hex or binary codes. A good assembler allows much more than this to be done, however, because several steps of machine code can be generated by one assembler statement, and much of the tedious work of hex or binary coding can be carried out more easily.

HIGHER LANGUAGES

This is one step towards the use of higher computing languages. The ideal computing language would be "normal" English, so that a description of what the program is to do could be typed on a keyboard, and thus automatically translated into a program. The nearer the programming "language" gets to this ideal the higher its level is said to be. The use of an assembler makes it possible to substitute groups of letters and words for the binary or hex numbers which have to be used for machine-code programs, so that assembler language is a step in the right direction. The assembler may be in hardware, meaning that logic circuits exist to perform the conversion, or in software, a program which makes the microprocessor carry out its own conversions. A hardware assembler is expensive and cannot easily be modified. A software assembler which might be a magnetic tape of a program written out to be placed in RAM by the user, is more adaptable, but is going to use up valuable memory space. An assembler program could very well use up so much of the precious RAM of a small microprocessor system that there would be no memory left for the user to write programs. A third option is the "firmware" one, which uses the assembler program on a ROM or PROM chip; this is the most usual form of assembler.
usual form of assembler.

A variation of assembler that few of us are likely to encounter is the "cross-assembler". A cross-assembler allows a program written for an existing (large) computer to be translated into machine language for a micro. This is a very attractive proposition for the professional engineer who has access to a main-frame or mini computer. The programs can be written and tested on the large computer, then translated by the cross-assembler, loaded into the microprocessor and tested again. There is an impressive saving of time by using this method, but you need a few tens of thousands of pounds invested in a computer and again in a cross-assembler.

The next step to a genuine high level language is a compiler, which allows the use of one of the genuine higher level computing languages, such as FORTRAN, ALGOL or COBOL. These languages are as close to English as any computing language gets at the moment, are internationally understood, and are standard on large main-frame computers. When we use one of these languages with a compiler, we can say goodbye to all the tedious business of calculating relative displacements for memory addresses, because the compiler does this automatically; some assemblers will also do this. Readers who have followed the "Tune-In To Programs" series in this journal will appreciate that the TI-57 programmable calculator uses a simple form of compiling, since no displacements have to be calculated to label a memory point – if we could just marry a TI-57 or a CBM P50 to a microprocessor, we would have a computer worth writing home about.

The use of a compiler allows any programmer to use a computer; whereas the use of machine code is possible only if the workings of the CPU, and also its circuit arrangement (the hardware) are well understood by the programmer. Once again, though, a compiler takes up a lot of memory space, so much that a FORTRAN compiler is of little use in a computer with less than 2^{14} bytes of memory – this is 16,384 bytes, often referred to as 16K bytes.

BASIC AND PASCAL

High level languages such as FORTRAN, ALGOL, and COBOL are seldom used for computer systems which are built around microprocessors. A compromise between assembler language and a genuine higher-level language is probably the best bet for small computer systems, and two such languages are BASIC and PASCAL. BASIC is the language which has been used in most of the first generation of home computers; the letters stand for Beginners' All-purpose Symbolic Instruction Code, but it exists in a wide variety of shapes and sizes, so that the BASIC which is used on one computer may not completely suit another; we also have size variations such as Tiny BASIC, Extended BASIC, and so on. PASCAL is a language which has not yet appeared on any machine offered in this country, but which may appear in the future when the competition hots up a bit. At the time of writing, the announcement that the first home computers

The Tandy TRS-80 Model I Microcomputer System. Shown in the photograph are a 12in. video monitor, keyboard, battery/a.c. cassette recorder and the User's Manual for Level I. The Manual is intended for the novice, and its 232 pages explain the capabilities of the computer

The Model II TRS-80 System. Particular attention has been paid to making the keyboard as simple as possible, with as few "special" keys as are necessary. As with the Model I the Model II is fully expandable. Further details can be obtained from Tandy Corporation (Branch UK), Bilston Road, Holyhead Road, Wednesbury, Staffordshire

from Hong Kong are coming out of the factories has led to some sudden price-cuts, and those who bought the larger kits are seeing a hundred pounds or so being clipped off the prices they have just paid. At first sight, it all looks like the sort of thing which happened with pocket calculators – if you want a calculator keyboard, it's now cheaper to buy a £3.99 calculator from Woolies than it is to try to buy the bits.

Remember, though, that items such as QUERTY (typewriter style) keyboards, printers, video displays and cassette mechanisms can never reach the same low prices as i.c.'s so that there must be a lower level to the prices which can be reached, and it doesn't pay to wait too long if you genuinely have a need for a computer.

At the moment, BASIC is the main language for these machines, and is well worth learning before your sons and daughters start to teach it to you. Like all computing languages, though, BASIC is best learned on an actual computer, so that you can find out at once if you've made a mistake. Readers who have followed the "Tune-In" series will know what I mean. If you're tempted to take evening classes in BASIC, make sure that the college or school which offers the course has a computer, and not just a terminal or a card punch. One of the quickest ways of being turned off programming is to fill in a program on punched cards this week and to find next week that there was a fault in it, and that is can't be run again for yet another week. The ideal arrangement is to have one micro-computer (PET or similar) for each two or three learners, so that you can program and run, then retire to find out what went wrong.

THE FUTURE

What of the future? Well, the sixteen-bit microprocessor is already with us, and every major CPU manufacturer has announced his own version of this particular beast. At the moment prices are high, waiting times are long, and few of us have had a chance to see one, let alone play with one. In fact, at the time of writing, there is a scarcity of all the chips associated with microprocessors, caused by the rush of everyone eager to update to this comparatively new technology. We needn't wait for the sixteen-bit machines – the difference is in speed of operation, which is the least important of factors for the amateur user. In any case, anyone who has mastered 8-bit machines will have no trouble adapting to a sixteen-bitter from the same manufacturer, so that 8-bit micros are not going to vanish overnight; though some of the prices being asked for the more advanced 8-bit chips (like the Z-80) might drop.

The most interesting hint to the future, though, in my view is the announcement of analogue microprocessors by INTEL, followed by several other manufacturers. This isn't quite so revolutionary as it sounds – it's basically a digital microprocessor fitted with a built-in analogue-to digital and digital-to-analogue converter system, but it could make a lot of microprocessor applications a lot easier. For example, many car manufacturers would welcome microprocessor control of carburettor and ignition to ensure that an engine always worked at maximum efficiency. The snag has always been the interface circuits – how to generate the right input signals for the microprocessor, and to make use of the digital output signals from the microprocessor. For example, inputs might include signals of engine temperature, r.p.m., load torque, air temperature, air humidity, throttle opening, and so on. To make a digital transducer for each of these quantities, so that each quantity would be converted into digital signals, would be prohibitively expensive. Even in the USA, where manufacturers are highly efficient and trim costs to the bone, the average price for each transducer would have to be around 25p to make the whole proposition worthwhile. The chances of producing digital transducers at this sort of price, even in the 20-million batches which would be needed, looks a bit remote.

Continued on Page 681

GENERAL PURPOSE 8 WATT AMPLIFIER

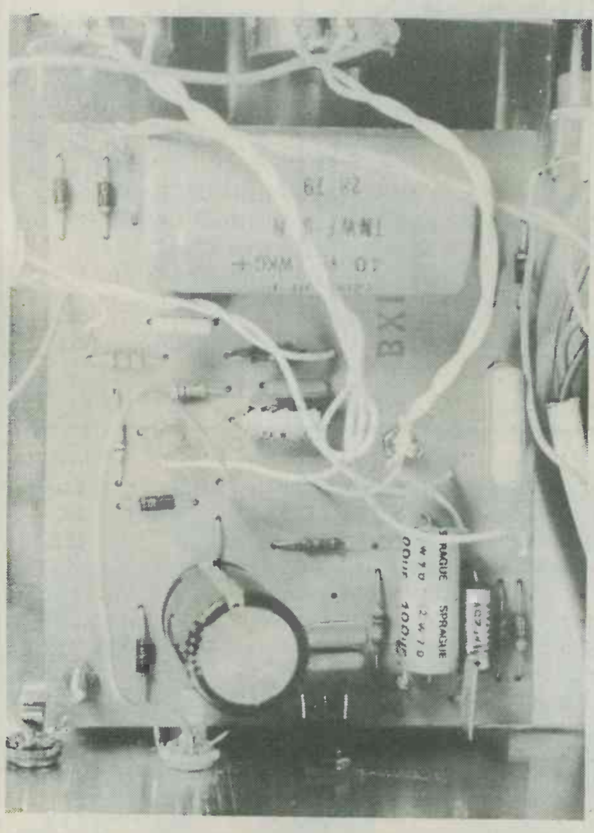
Part 2

by A.P. ROBERTS

Final steps in constructing this versatile design.

MAIN P.C.B.

A single circuit board is used to accommodate the components associated with the power amplifier section and the power supply rectifying circuit, and this is reproduced actual size in Fig.4. The board is etched, drilled and completed in the conventional manner.



A closer look at the power amplifier section board

The lead-outs of IC1 are bent at right angles so that its heat tab surface is just very slightly outside the board edge at which it is mounted. This enables the heat tab to be bolted to the rear panel of the case whilst the board is mounted horizontally to the bottom of the case. After the board has been completed and the components fitted, it is used to mark out the hole for IC1 heat tab and the two mounting holes in the case bottom. The board should be just to the right of T1. It will be mounted with short metal spacing washers on the two 6BA bolts so that the board underside is well clear of the metal bottom of the case. The board takes up its chassis connection by way of one of the spacing washers as well as via the heat tab of IC1. Socket SK3 obtains its chassis connection by way of its own mounting bush and nut.

Before finally mounting the board in position, the connections to the external components must be made. These are illustrated in Fig.5. The lead from the board taking the positive supply to the pre-amplifier board can, at this stage be about 6in. long. It will be connected, shortened as necessary, to the pre-amplifier board after the latter has been completed and made ready for mounting. The pre-amplifier board, incidentally, measures 1½ by 2 5/8in. The lead from VR1 to the pre-amplifier board will also be fitted later. Note that all the signal-carrying leads in the amplifier can be unscreened, as the metal case provides all the screening required. It is desirable, however, to keep the output lead to SK3 reasonably well spaced from the input leads to SK1 and SK2 when these leads are later fitted.

The mains lead should be clamped inside the case. The earth wire connects to the solder tag under the securing nut for T1, whilst the live and neutral wires connect to the on-off switch tags. If the mains transformer has tags at the top which could be fairly close to the inside surface of the lid when the latter is fitted, secure a piece of thin s.r.b.p. sheet to the lid on the area over which the transformer tags appear. The s.r.b.p. should be held in place with a strong adhesive such as an epoxy resin.

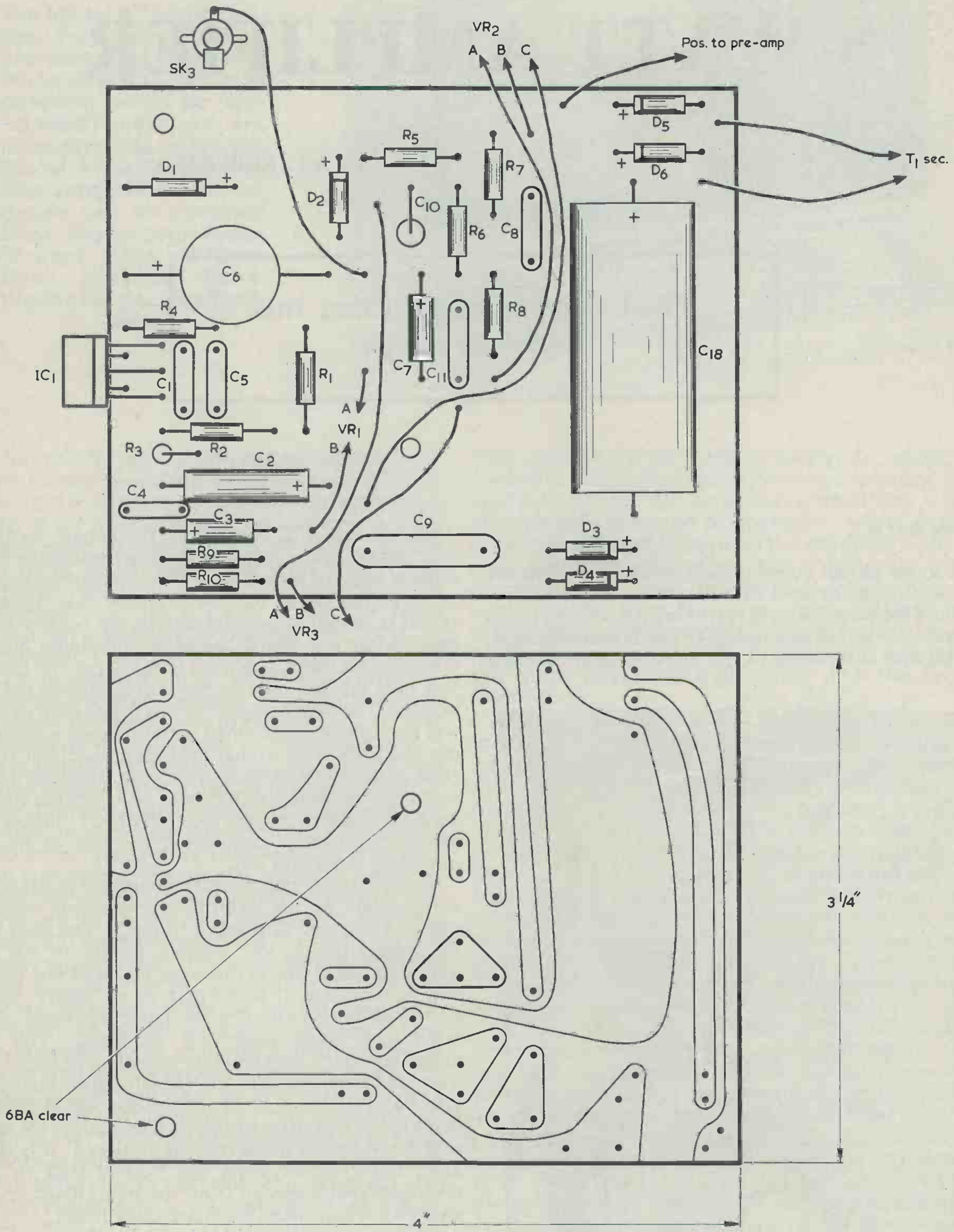
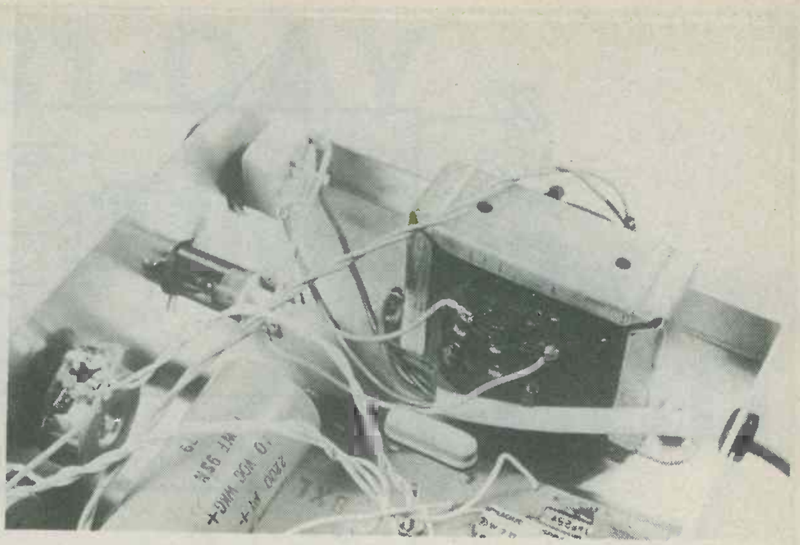


Fig.4. The power amplifier and supply rectifier circuitry is assembled on a printed board, reproduced here full size. See the text for details of the mounting of IC1

The wiring around the mains transformer and the on-off switch



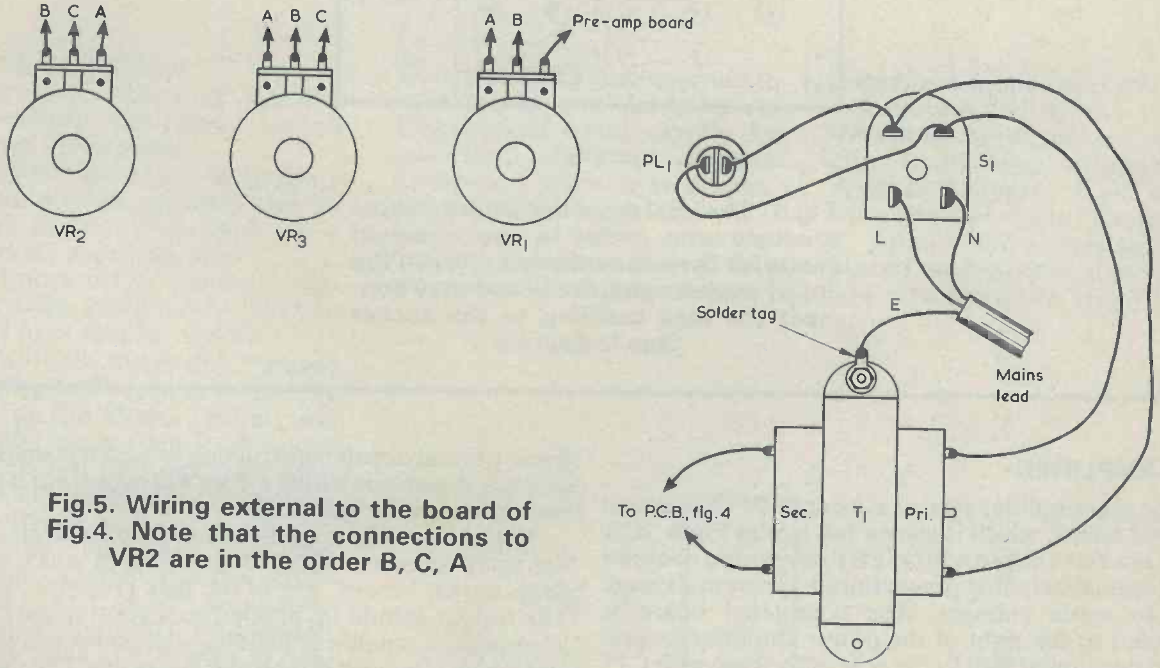


Fig.5. Wiring external to the board of Fig.4. Note that the connections to VR2 are in the order B, C, A

Looking at the front panel wiring from the rear

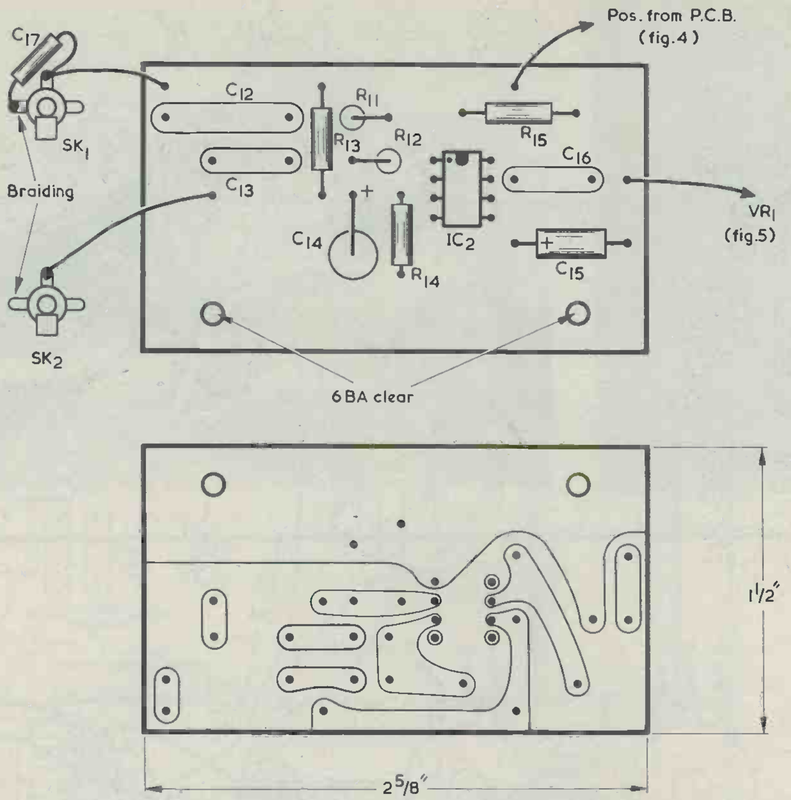


Fig.6. The pre-amplifier board. Constructors who prefer to use screened leads for the connections between the input sockets and the board may connect the lead braiding to the socket tags indicated

PRE-AMPLIFIER

The pre-amplifier section is assembled on a second printed board, which is shown full size in Fig.6. IC2, here, is a Jfet and not a MOSFET device and does not need special handling precautions to prevent damage due to static voltages. The completed board is mounted to the right of the power amplifier section and is positioned well to the rear of the case with C15 and C16 nearer the front, so that the input leads to SK1 and SK2 are kept short. As was stated last month, these two wires do not need to be screened. If, nevertheless, the constructor would prefer to use screened wires here, the braiding can be connected to the appropriate tags of SK1 and SK2 as indicated in Fig.6. The board is mounted by means of 6BA bolts with metal spacing washers, and picks up its chassis connection by way of these washers. It is not finally mounted until the connections to SK1, SK2, VR1 and the power amplifier section board have been completed. As will be noted, C17 is not mounted on the pre-amplifier board but is connected across the tags of SK1. This socket, in company with SK2, obtains its chassis connection from its own mounting bush and nut.

TESTING

Before switching on and testing the completed amplifier, give all wiring a thorough check for errors. Since printed circuit construction is used it is unlikely that any disastrous wiring errors will occur, but it is as well to be on the safe side.

The input to the amplifier should be connected by the usual screened cable, the braiding of which connects to the "sleeve" tag of the jack plug employed. The output should be applied to a good quality 8Ω loudspeaker capable of handling the power provided and which is housed in a proper enclosure. The use of speaker impedances below 8Ω is not recommended. Speakers with impedances higher than 8Ω may be used but with an inevitable loss in maximum output power.

It is quite in order to have a switched-off item of equipment connected to one input whilst a second item of equipment is connected to the other input. This will have no adverse effect on the performance of the amplifier.

The amplifier may seem to be lacking in sensitivity when used with some items of equipment having slightly low output levels. This problem can be resolved by simply increasing the value of R15 to 1MΩ. The resultant doubling of amplifier gain will increase the r.m.s. sensitivity of Input 1 to about 12mV, and that of Input 2 to about 250mV.

(Concluded)

In your work-shop

31-DAY TIMING CIRCUIT

Smithy's timer runs for just over a month

"Hi-ya, Smithy!"

Smithy, standing on the Workshop doorstep, turned round in surprise.

"Don't tell me," he gasped, "that you've actually got to work *before* time. And on a Monday morning, too!"

"Come off it, Smithy," replied Dick indignantly. "When am I ever late for work?"

"Virtually every day," stated Smithy positively as he put his key in the door. "What you usually do is rush in at about five to ten minutes past nine with any possible excuse you can dream up."

"Well," said Dick, following the Serviceman into the Workshop, "I'm good and early today at any rate." He glanced at the clock on the wall. "Look, it isn't even five to nine yet. Hey, just wait a minute!"

"What's up?"

"You must have left something switched on on your bench. There's a little light glowing away over there."

LONG DISTANCE TIMER

And, indeed, a small light was plainly visible on Smithy's bench. Intrigued, Dick walked towards it, to find that the light emanated from a small l.e.d. which, with its series resistor, was coupled to a relay and a twin-cell 3 volt cycle lamp battery. The relay coil connected to a neat Veroboard assembly which, at first sight, seemed to be bristling with Veropins. As Dick looked more closely he saw that, mounted on the Veroboard, were three diodes, two transistors, two 16 pin d.i.l. integrated circuits, an electrolytic capacitor and a few resistors. A flexible lead terminated in a small crocodile clip was connected to one of the Veropins, and the crocodile clip itself was clipped to another Veropin. Two wires from the Veroboard passed to a small mains transformer placed on the other side of the board to the relay. (Fig.1.)

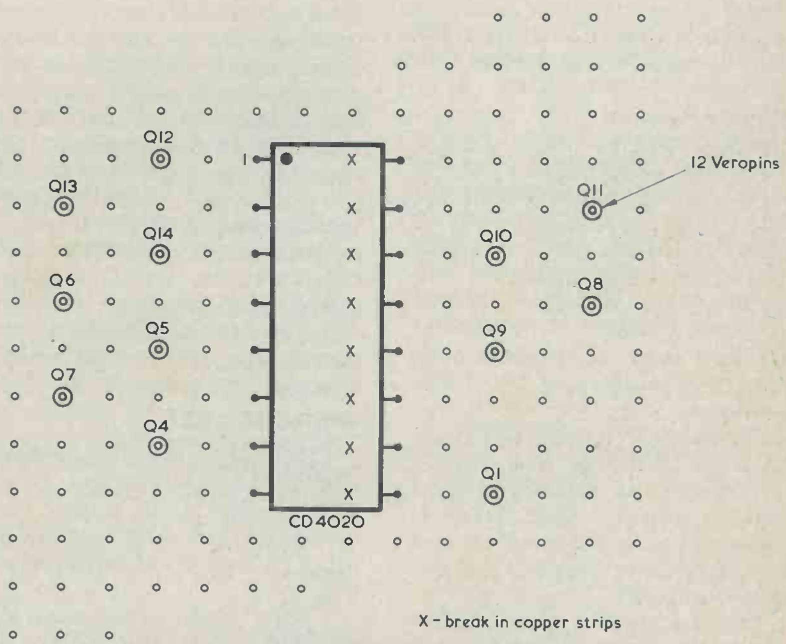


Fig.1.

The CD4020 i.c.'s employed by Smithy in his timing circuit have 12 output pins. Each i.c. is mounted on part of a Veroboard panel, as in this top view, with the outputs connected to Veropins in a staggered layout. A small crocodile clip can be clipped to any pin to select a particular output. The crosses indicate cuts in the copper strips below the board.

"Don't touch anything there," warned Smithy sharply, coming up behind Dick.

"What is it?"

"It's a little experiment in timing which I'm carrying out," stated Smithy proudly. "In a few minutes, if all goes well, that l.e.d. should extinguish. In fact, it should go out almost precisely at five minutes after nine o'clock this morning."

Dick looked incredulously at the Veroboard assembly.

"I don't believe it," he said flatly. "When did you set it up?"

"Yesterday morning," replied Smithy. "I popped in yesterday morning to start the timing run, and I did so at exactly 9.47."

"And the l.e.d. has been lit up all the time since?"

"It was lit up when I left yesterday and it was certainly still lit up when we came in just now."

Dick looked at the Workshop clock. It indicated two minutes past nine.

"Well," he stated in an unconvinced tone, "I've never heard of an electronic timer being as accurate as that over what is nearly a 24 hour period."

"We'll see," returned Smithy confidently, "what this particular timer does, anyway."

The minute hand of the Workshop clock crept past the fourth minute graduation on the clock face then moved imperceptibly until its tip started to merge with the five minute mark. The hand tip and the mark became convergent.

There was a sudden click from the relay, and the l.e.d. went out.

"Ye gods," exclaimed Dick, startled, "it did go out, too!"

"It went out exactly when I said it would," said Smithy. "*Now* do you believe that this timing circuit operated just as I said it would?"

The successful demonstration had changed Dick's scepticism to an attitude of intense interest.

"Yes, I'll go along with that," he replied keenly. "But how on earth do you manage to get an electronic timing circuit to be as accurate as that?"

"Simply by using a couple of CD4020 divide-by-two counters and driving them from the a.c. mains supply," explained Smithy. "My old colleague, G.A. French, has been playing around with CD4020's lately, and so I thought I'd get a few in for myself and see what they could do. If you've been following G. A. French's 'Suggested Circuits' you'll know that the CD4020 is a multi-stage divide-by-two device. It has one input and twelve outputs. The first output is called Q1, after which the remaining outputs are Q4 to Q14 inclusive. Each output corresponds to a division by 2 to the power of the Q number concerned. For example, the Q4 output corresponds to a division by 2 to the power of 4, or 16 times. It's when you get to the higher Q numbers that you hit the really big divisions. The Q14 output gives the biggest dividing number of the lot and it corresponds to a division by no less than 16,384 times."

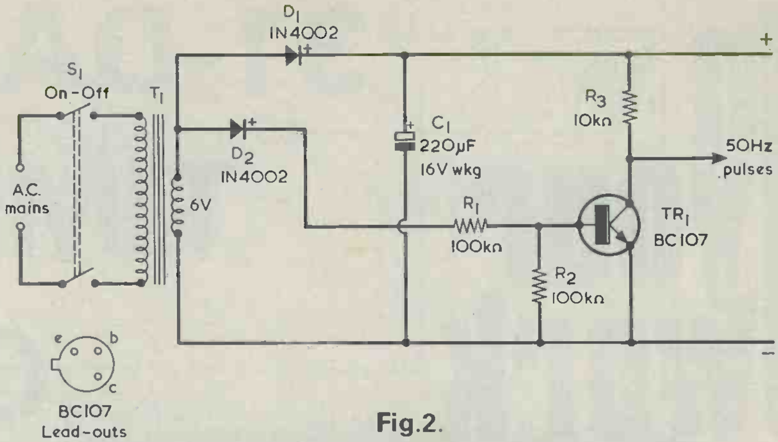


Fig.2.

A suitable circuit for obtaining pulses at a repetition frequency of 50Hz for driving a CD4020 divider. A half-wave rectified supply is also provided.

MAINS PULSES

"Blimey," said Dick, impressed. "I'm beginning to see how you can get such a very long timing period. And you get the input to the circuit from the a.c. mains?"

"The input pulses are derived from the 50Hz a.c. mains," confirmed Smithy. "Which means that you can get timing periods having the same accuracy as an a.c. mains analogue or digital synchronous clock. Here's a suitable circuit for obtaining the 50Hz pulses."

Smithy reached to the back of his bench and picked up a sheaf of papers. He selected one and passed it to his assistant. Dick looked down at the circuit which had been sketched out on it by Smithy. (Fig.2.)

"This seems pretty simple," he remarked. "For a start, you've got a mains transformer with a 6 volt secondary, and this couples to a standard half-wave rectifier circuit consisting of D1 and C1. Does that circuit power the timer?"

"It does," confirmed Smithy. "The rest of the circuit produces the pulses. When the transformer secondary voltage passed to D2 is negative of the negative rail, transistor TR1 is cut off and its collector voltage is the same as that of the positive rail. When, on the alternate half-cycle, the voltage passed to D2 starts to go positive of the negative rail, TR1 conducts as soon as that voltage overcomes the forward voltage delay in the diode and the base-emitter junction of the transistor. As the positive voltage applied to D2 increases, TR1 turns hard on and its collector voltage falls nearly to zero. The result is that there is very nearly a square wave at TR1 collector, with TR1 turned on for a slightly shorter time than it is turned off, and with a fairly rapid transition from one output voltage state to the other. This square wave is at 50Hz, and it's just the job for passing into the input pin of a CD4020."

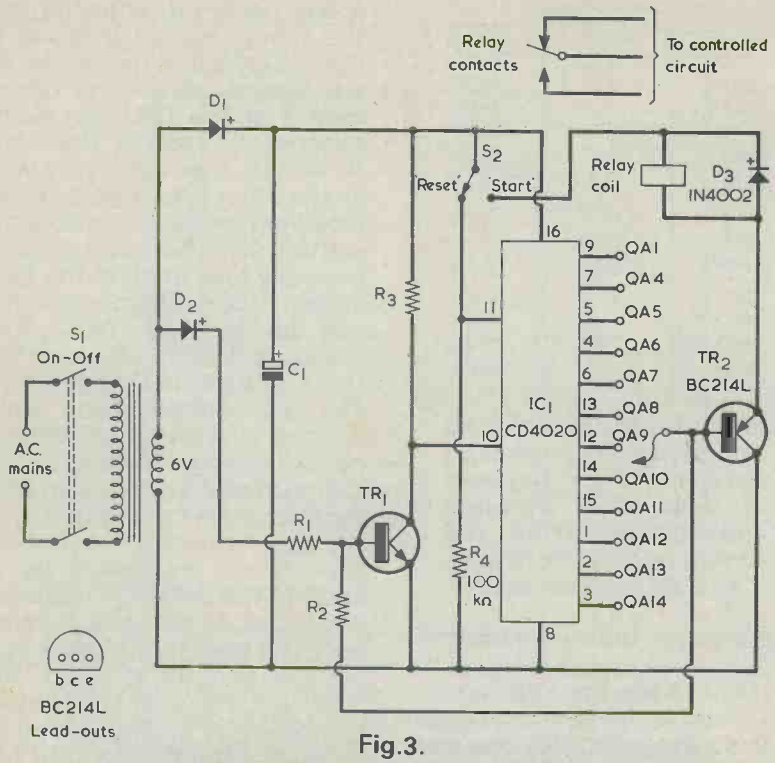


Fig.3.

The main part of the CD4020 timing circuit. The base of TR2 can be connected to any of the outputs of IC1 (although in practice the outputs below QA7 are not used). C1 and R1 to R3 have the same values as in Fig.2, but R2 is now returned to the base of TR2 instead of to the negative rail

Dick looked at the circuit a little dubiously.

"Is that diode really necessary?" he asked. "I mean the one you've marked as D2."

"It's not needed with the circuit as I've described it so far," replied Smithy. "But it serves a purpose in the complete circuit. Here's the main part of that circuit."

Smithy handed over another piece of paper to his assistant. This had a larger circuit drawn out on it, and Dick studied this with interest. (Fig.3.)

"As you can see," continued Smithy. "We've now introduced one of the two CD4020's which are used in the complete timing circuit. The 50Hz pulses are fed to pin 10, which is the input pin of the CD4020. On the right there are the twelve outputs, which I've labelled QA1, QA4, QA5 up to QA14."

"Why d'you put in the 'A'?"

"Because we'll be bumping into another lot of Q outputs in a few minutes, and I'll be calling these QB1, QB4, QB5 and so on. Now, pin 11 of the CD4020 is the reset pin, and when this is taken positive it causes all the outputs to go to zero and stay there, even if there is a pulse input at pin 10. When switch S2 in the diagram is at 'Reset' it connects pin 11 to the positive rail. And when S2 is put to 'Start' pin 11 is taken negative by R4 and the i.c. starts to divide."

"Giving," queried Dick, "divided pulses at the outputs?"

"That's right," said Smithy. "Just consider what happens at the QA1 output, which is simply a divide-by-2 output. The divider is advanced one count on each negative-going transition at the input, so let's assume for the moment that S2 is put to 'Start' at an instant immediately after the collector of TR1 goes negative. The QA1 output will then be low. Now, the length of the 50Hz cycle is 0.02 second, and so the next negative-going transition at pin 10 will be 0.02 second later. This will cause the QA1 output to go high. After another 0.02 second there will be another negative-going excursion at pin 10 and this will cause the QA1 output to go low again. So the length of the QA1 output cycle under these conditions is 0.04 second, or twice the length of the 50Hz cycle." (Fig.4.)

"Go on," said Dick cautiously.

"So," said Smithy, "at the QA1 output we have a voltage which is low for 0.02 second after which it goes high. For timing purposes we use the first 0.02 second part of the output cycle."

RELAY TRANSISTOR

Dick frowned.

"There's something fishy here," he remarked, "but I can't quite place my finger on it!"

"Don't worry about it," advised Smithy cheerfully. "Turn your attention next to the relay transistor, TR2. This is a p.n.p. transistor with its collector connected to the negative rail, its emitter connected to the relay coil and its base connected to a flying lead terminated in a small crocodile clip which connects to any QA output. Let's say, for the sake of explanation, that this clip is applied to the QA1 output. What happens now, when S2 is put to 'Start', is that the positive supply is applied to the relay coil. At the same time the QA1 output is low whereupon TR2, acting as an emitter follower, causes the relay to energise. This situation continues until, after 0.02 second, the QA1 output goes high. So also does the base of TR2, and the relay de-energises. But another important thing happens because, in this circuit, I haven't returned R2 to the

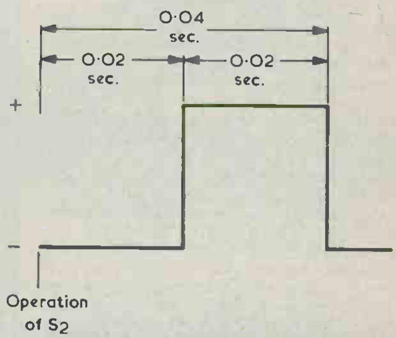


Fig.4. Theoretical consideration of the output at QA1, with the assumption that S2 is set to "Start" immediately after a negative transition at TR1 collector

QA TIMING PERIODS

Output	Minutes	Seconds
QA1		0·02
QA4		0·16
QA5		0·32
QA6		0·64
QA7		1·3
QA8		2·6
QA9		5·1
QA10		10·2
QA11		20·5
QA12		41·0
QA13	1	22·0
QA14	2	44·0

Fig.5. Table showing the timing periods for the QA outputs of Fig.4. Because of their short duration and starting errors, the timing periods from QA1 to QA6 are not used

negative rail but to the base of TR2."

"What does that do?"

"When the QA1 output goes high so also does the lower end of R2. This causes TR1 to stay turned on all the time, so that its collector voltage remains low and no further 50Hz pulses are fed to the CD4020 input. In consequence, dividing stops and the circuit remains fixed in this state until S2 is put back to 'Reset'."

Dick's furrowed brow cleared momentarily.

"That does at least explain," he said, "why you put diode D2 in the circuit from the transformer secondary to TR1 base."

"It does," agreed Smithy. "The diode ensures that TR1 still remains turned on during the mains half-cycles when the upper end of the transformer secondary is negative."

"Well, *that* seems okay," said Dick, clearly still unhappy. "But there's something else that's bothering me."

"Yes?"

Dick concentrated.

"Ah, now I know what it is," he exclaimed suddenly. "It's the assumption you made just now when you said that S2 is put to the 'Start' position immediately after a negative-going transition at TR1 collector. But, dash it all, S2 can be put to 'Start' at *any* time during the cycle at TR1 collector."

"Very good," commended Smithy approvingly. "And, of course, my assumption cannot hold true in practice, although it has helped in showing that the timing period is equal to half a CD4020 output cycle. So we cannot rely on the timing output at the QA1 pin being exactly 0.02 second. There will be similar starting errors with all the other QA outputs, but as these get higher in number the starting error becomes proportionately less until, at the QA7 output, it is negligibly low and can be ignored. Now, I've made up a table showing the QA outputs from QA1 to QA14. The QA1 output is the input divided by 2 and the QA4 output is the input divided by 16, and so the QA4 timing period is the QA1 period multiplied by 8. All the successive timing periods are multiplied by 2, ending with the QA14 output at 2 minutes 44 seconds. If I connect TR2 base to the QA14 output and put S2 to 'Start' the relay will energise and remain energised for 2 minutes and 44 seconds. After this period it will de-energise and the timing run will be over." (Fig.5.)

"That means, then," said Dick slowly, "that you can select any of the timing periods in your table simply by clipping the base of TR2 to the appropriate QA output."

"You've got it," confirmed Smithy. "In practice we wouldn't bother about the QA1 to QA6 outputs because of starting errors and also because the periods are too short for a relay operated circuit anyway."

SECOND DIVIDER

"That's definitely a neat circuit," said Dick approvingly. "But it only goes up to 2 minutes 44 seconds."

"I know," said Smithy. "And so I add another CD4020! All I do is connect its pin 10 input to the QA14 output and provide pins for all its outputs. These I have called QB1 to QB14."

Smithy selected another piece of paper and showed the circuit on it to his assistant. (Fig.6.)

"This is the final CD4020 set-up," he continued. "I've omitted the QA1 to QA6 outputs, but I've included all the QB outputs. You can now connect the base of TR2 to any QA or QB output that's available and you will get the corres-

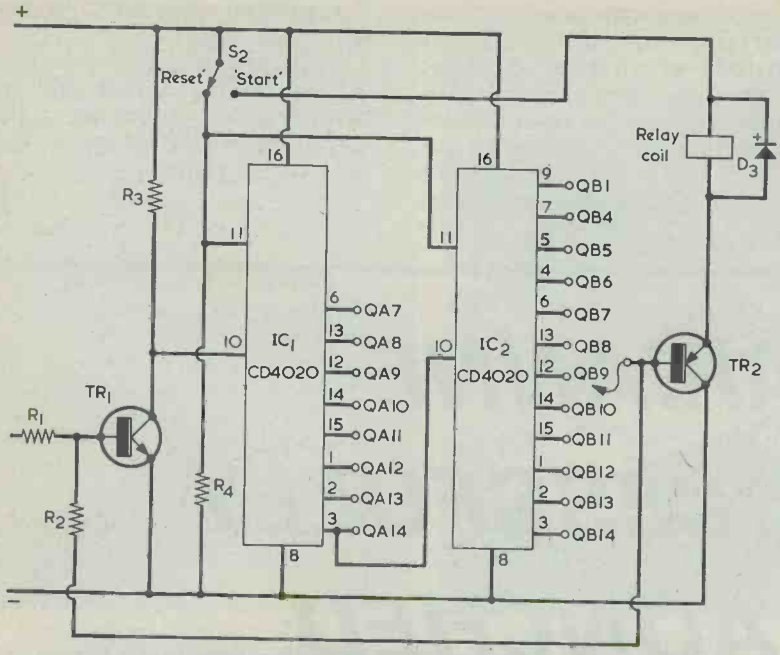


Fig.6. The final version of the circuit incorporates a second CD4020. This has its reset pin connected to the reset pin of the first CD4020. Timing periods can be selected by connecting the base of TR2 to any of the available QA or QB outputs

ponding timing period."

"With all this further division," observed Dick, "I can understand how you were able to get that timing period of nearly 24 hours we saw today. I mean the one which started yesterday morning and which ended this morning."

Smithy kept his face straight.

"And here," he said carelessly, "is a table showing the timing periods available at the QB outputs. The period I selected for today's little demonstration was the one given by the QB9 output." (Fig.7.)

QB TIMING PERIODS

Output	Days	Hours	Minutes	Seconds
QB1			5	28
QB4			43	41
QB5		1	27	23
QB6		2	54	46
QB7		5	49	32
QB8		11	39	3
QB9		23	18	6
QB10	1	22	36	
QB11	3	21	12	
QB12	7	18	25	
QB13	15	12	50	
QB14	31	1	40	

Fig.7. The timing periods available at the QB outputs. These are corrected to the least significant figure shown

Dick took the table from the Serviceman and glanced at it. As he scanned the figures near the bottom his jaw dropped.

"What's this?" he stuttered. "31 *days!* You've just got to be joking, Smithy!"

"No I'm not," chuckled Smithy. "If you select the QB14 output you'll get a timing period of 31 days, 1 hour and 40 minutes. What's more, the period should be accurate to within a minute or so and, as I said at the beginning, the accuracy will be the same as is given with a synchronous mains analogue or digital clock."

"Well, stap me," spluttered Dick, "you've certainly got a real long distance timing circuit here."

"It's partly a novelty circuit," admitted Smithy, "but at the same time it can have quite serious applications because of the accuracy of the timing periods. The only snag is that there is no continuously variable control of these periods, and you have to select one of the periods which appears in the tables. But, apart from that, it's a very simple little project and is not at all expensive."

"What about components?"

"Well, the transformer can be any mains transformer having a 6 volt secondary rated at

100mA or more. The relay can be one of those Maplin 'Open Relay' jobs with a 410Ω coil and changeover contacts. All the remaining parts are quite standard."

And with these words Smithy closed all further discussion and chivied Dick into starting on his normal trouble-shooting duties. However, before finally embarking on his own servicing work Smithy connected the base of TR2 in his timing circuit to the QB14 output and thoughtfully selected "Reset" and then "Start".

Which means that the relay in the timing circuit will be de-energising at just about the same time as we have our next little get-together. ■

ARIANNE SUCCESSFULLY LAUNCHED

Report by

Arthur C. Gee

The European Space Agency's rocket Arianne has been developed to gain independence from the U.S.A. for launching commercial satellites. Some estimates suggest that as many as two hundred satellites may need to be launched in the next ten years and the ESA hopes to get a share of this market with its Arianne launchers.

Arianne "propellant mock-up" erected on the launch site for testing of launch procedures in February 1979, Kourou French Guiana.

From its inception, the Arianne development programme has provided for a ground-testing phase, followed by a test-flight phase. The latter comprises four launches, to prove that the launchers can execute the missions foreseen and thus offer an operational launch facility to customers from the late 1980's onward. The first test flight was scheduled for July 1979 and the last for October 1980.

All went well until an incident affecting the rocket's 3rd Stage upset the programme. An explosion on a test stand, attributable to misfunctioning of a safety system, damaged the only 3rd Stage available at the time for final development testing.

However, it was possible to ship a completed rocket to the launch site at Kourou, French Guiana by the end of September 1979, and the launching programme sequences were started on 1st October. It was planned that this phase should last for 56 days, giving a launch date of 15th December.

On the 14th December, the countdown for a launch schedule for the next day was

Launch Centre E.L.A.

started. All went well, until the ignition of the First Stage engines, after which one of the pressure sensors in the First Stage propulsion system shut down the computer controlling the automatic launch sequences, indicating a malfunction somewhere in the system and the launch sequence was thus interrupted.

Evaluation of the telemetry data showed that the engines had been functioning correctly and that the shut down had been caused by malfunction of the pressure sensor itself.

The countdown was therefore resumed on the 22nd December for a launch on 23rd December. Once again during the automatic pre-launch sequence a minute or so before firing, a false signal at the instant of switching from ground to on-board electric power supply followed by the detection of insufficient pressure in the Third Stage helium bottle, led to the launch being postponed to the following day. Finally on the 24th December at 17 h. 14 min. 38 s. U.T. after a countdown interrupted by a number of comparatively minor incidents, the launcher lifted off for a totally successful flight.

No actual satellite was flown on this first test flight, but a simple "Technological Capsule" was put into orbit to make trajectory and environmental measurements. ■

Datubus series No. 11 Continued from Page 670

With a microprocessor which has analogue inputs and outputs all of these problems are eased. Temperature, for example, can be measured with thermistors, since a digital signal is no longer needed. Since all of the analogue-to-digital conversion takes place inside the microprocessor, the differences between different types of transducer become less important. At the other end, the analogue signal out of the microprocessor is better adapted to control quantities such as fuel and air supply than a digital signal, and again avoids conversion chips. Even before this announcement, General Motors had ordered 5 million 6802 micros from Motorola and Fairchild, so as to cope with the new US laws on fuel economy and pollution – and these new car designs could very well be the biggest threat we've ever seen to what's left of the British car industry.

I have a sneaking feeling, too, that the analogue micro may be of more than passing interest to audio designers, too! The analogue microprocessor, of course, still carries out all its operations in binary bytes, and has to be programmed in the same way as the digital version.

The important point about all this is that the microprocessor bandwaggon is moving very fast indeed, and the quicker we all hop on the better. It's like the valve-transitor switch – if you didn't get in early you had great difficulty in adjusting your thinking fast enough. We don't necessarily need to build or buy computers, or design machine-control systems to keep up to date, but we do need to be able to speak the language of microprocessing and to understand how they do what they do. That has been the aim of this series, and I hope that each reader has been able to derive benefit from it.

(Concluded)

(The series "Tune-In To Programs", by Ian Sinclair, appeared in *Radio & Electronics Constructor* for February to September 1979 inclusive and November 1979).

TRADE NEWS

VIDEO TAPE ERASER CUTS HEAD WEAR

Now being marketed by the Broadcast and Closed Circuit Television Equipment Division of S.G.I. is a video eraser which will erase video and audio cassettes and tapes in seconds.

Called the Videoraser, it is used instead of the recorders own internal mechanism and thereby leads to a reduction of video head wear and replacement frequency.

It also erases 100 times better than a recorder thus enabling higher re-recording standards to be achieved and prolongs the usable life of the tape.

Although used extensively by broadcasting organisations in North America, its price £49.50 plus V.A.T., makes it a worthwhile investment for the domestic video user.

With a magnetic flux of 1,400 gauss, it is the most powerful of its type and can erase a two inch cassette.

It measures 120mm x 114mm, weighs 2 kilos and is designed for 220-240 volts A.C. operation.

Further information can be obtained direct from: S.G.I. Limited, Broadcast & Closed Circuit Television Equipment Division, Fircroft Way, Edenbridge, Kent, TN8 6HA.

HOME RADIO ELIMINATOR KIT

With PP9 batteries hovering around the £1 mark use of battery eliminators becomes increasingly attractive. The newly introduced Home Radio Battery Eliminator Kit, at only £2 (plus 30p VAT and 50p postage) and with a running cost of approximately 500 hours for 1p, will in consequence be welcomed by owners of radios requiring a 9 volt supply. Included in the kit are a 6-0-6V 100 mA mains transformer, two high value electrolytic capacitors, smoothing and dropping resistors, 1N4002 rectifier, 9.1V zener diode and PP9 and PP3 style connectors. The kit can be assembled without soldering by the use of small terminal blocks which are also supplied. The output is suitable for all standard 9V portable radios.

The components can be assembled inside the radio or in a suitable case, such as the Home Radio BX53. The eliminator kit is available from Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey, CR4 3HD. Incidentally, Home Radio will be closed from 1st to 9th August for part of the Summer holidays.

NEW STEREO DESK FOR BBC LOCAL RADIO

BBC Local Radio's first 16-channel stereo studio desk is called the Mark 3(N). It came into operation in April in the Local Radio Training Unit's new studios just completed in The Langham, Portland Place.

First to use the equipment will be the production staff currently being trained as the broadcasting team for BBC Radio Norfolk, the station due to go on the air in stereo on 11 September. They will be followed by the staff of Radio Lincolnshire, who start broadcasting in November.

The Mark 3(N) is designed to the same operational principles as the present BBC Mark 3 but is as compact as the old Mark 1 with a number of new features added.

Said Robert McLeish, Head of BBC Local Radio Training: "This is an exciting development for the new BBC stations – a compact, self-op stereo desk with full production facilities.

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(Continued on page 685)

SMALL ADVERTISEMENTS

(Continued from page 683)

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(Continued on page 686)

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(Continued from page 629)

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(Continued on page 687)

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(Continued from page 686)

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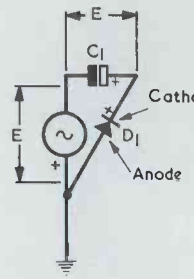
VOLTAGE MULTIPLIERS

In (a) the a.c. generator, with a peak voltage of E volts, is shown at an instant when its lower terminal is at peak positive. D1 conducts and C1 charges to E volts. D2 and C2 are added in (b), and the generator upper terminal is at peak positive. The anode of D2 is 2E volts positive with respect to earth and so D2 conducts, to charge C2 to 2E volts. D1 is reverse biased.

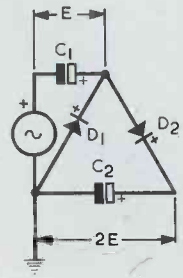
D3 and C3 are introduced in (c), with the generator lower terminal positive. The left hand side of C3 is at earth potential, because the left hand side of C1 is made E volts negative of earth by the generator, whilst the anode of D3 is 2E volts positive of earth because of C2. D3 conducts and C3 charges to 2E volts. D2 is reverse biased. In (d) a fourth diode and capacitor are added. With the generator upper terminal positive, 4E volts (generator voltage plus C1 voltage plus C3 voltage) is applied to the anode of D4, which conducts to charge C4 to 2E volts. Diodes D1 and D3 are reverse biased.

The circuit of (d) is a Cockroft-Walton voltage multiplying rectifier circuit and it produces 4 times the peak voltage of the a.c. generator. The series can be extended further and a Cockroft-Walton sextupler circuit is shown in (e).

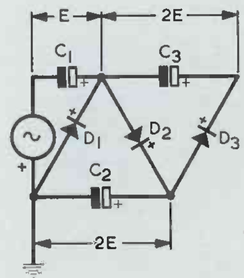
For purposes of illustration, the capacitors in (a) to (d) were shown as electrolytic. Non-electrolytic capacitors can, of course, also be used. As in any capacitor input rectifier circuit, the rectified output voltage falls from peak value when current is drawn. Multiplier circuits of this type are usually employed in high voltage low current applications, such as the provision of e.h.t. voltage for cathode ray tubes.



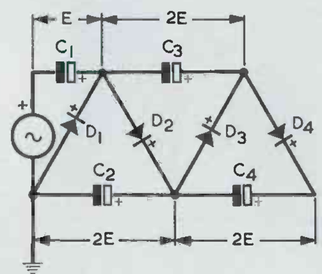
(a)



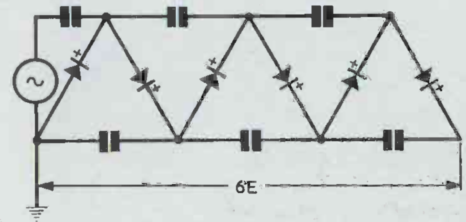
(b)



(c)



(d)



(e)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