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

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

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production— Web Offset.

15 METRE DELTA BEAM — "A DX Grabbing Antenna" — by F. C. Smith 270

NEWS AND COMMENT 272

USING CMOS 555's — Suggested Circuit — by G. A. French 274

ULTRASONIC REMOTE CONTROL — Sequential on-off switching; Exceptionally low receiver consumption; Portable hand-held transmitter — by R. A. Penfold 277

LOGIC TESTER — by Peter Roberts 284

SHORT WAVE NEWS — For DX listeners — by Frank A. Baldwin 286

"RING OF LED's" PRINT TIMER — Accurate Timing for the Development of Photographic Prints — by P. R. Arthur 288

THE ACCUMULATOR — Databus Series No. 6 — by Ian Sinclair 293

IN NEXT MONTH'S ISSUE 297

WIRE GAUGE MEASUREMENT — Finding Wire Diameter without a Micrometer — by C. P. Finn 298

CAN ANYONE HELP? 299

VMOS POWER DEVICES — Part 2 — by John Baker 300

BOOK REVIEW 303

RADIO TOPICS — by Recorder 304

SURFACE ACOUSTIC WAVE FILTERS — In Your Workshop 306

RECENT PUBLICATIONS 311

TOUCH CONTROL SWITCH — by R. Otterwell 312

TRADE NEWS 314

CONTROLLED VOLTAGE GAIN — Electronics Data No. 53 iii

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OUR FEBRUARY 1980 ISSUE WILL BE PUBLISHED EARLY IN JANUARY

STEVENSON
Electronic Components

CMOS

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

FULL DETAILS IN CATALOGUE!

TTL

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

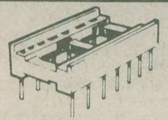
OPTO

LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

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

SKTS



Low profile by Texas

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

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

PCBS

VEROBOARD

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

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

RESISTORS

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

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

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

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

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

WE WISH ALL
OUR CUSTOMERS
A MERRY CHRISTMAS
AND A
HAPPY NEW YEAR

LINEAR

THIS IS ONLY A SELECTION!

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

TRANSISTORS

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

DIODES

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

ITT Full spec. product.
1N4148 £1.40 100

CAPACITORS

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

MYLAR FILM
0.001, 0.01, 0.022, 0.033, 0.047 . . . 3p
0.068, 0.1 . . . . 4p

POLYESTER
Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 5p
0.15, 0.22 . . . . 7p
0.33, 0.47 . . . . 10p
0.68 . . . . 14p
1.0uF 17p

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

RADIAL LEAD ELECTROLYTIC

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

CONNECTORS

JACK PLUGS AND SOCKETS

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

DIN PLUGS AND SOCKETS

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

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

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

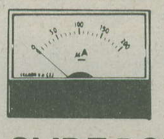
PHONO PLUGS AND SOCKETS
Insulated plug in red or black 9p
Screened plug 13p
Single socket . . 7p Double socket . . 10p

CHRISTMAS SPECIALS

A range of special offer items valid during December. All orders placed for these items must be received during December.

Murata Ultrasonic Transducers, per pair	~~350p~~	280p
PCB etch kit. Contents: 5 assorted sheets Alfac. Pound of Ferric Chloride. Dalo pen. Fibre glass PCB.	~~375p~~	325p
Resistor Development Pack. 10 off, each ¼W value from 4.7Ω to 1M	~~570p~~	470p
Polyester Development Pack. 5 off, each value from 0.01uF to 2u2.	~~620p~~	480p
Texas sockets. Must be in multiples of 100.		
8 pin, per 100		750p
14 pin, per 100		900p
16 pin, per 100		1000p
Pack of 10 x NE555	~~230p~~	200p
Pack of 10 x PP3 clips	~~60p~~	45p
Pack of 10 crocodile leads (20 clips)	~~115p~~	90p
Pack of 6 x C106D thyristors	~~270p~~	220p
Pack of 70 x 1N4148	~~140p~~	100p
Expo Reliant drill	~~665p~~	550p
Expo Titan drill	~~1030p~~	890p
LEDs, Pack of 10 x 0.2 Red, 10 x 0.2 Green, 10 x 0.2 Yellow	~~350p~~	290p
AY51013P UART	~~360p~~	325p
2114 Low Power 300nS	~~535p~~	450p
2708 EPROM	~~750p~~	590p
SS-2 Breadboards	~~1085p~~	990p

PANEL METERS



High quality 2" wide view meters. Zero adjustment. Back illumination wiring.
Available in 50 uA, 100 uA, 500 uA, 1 mA, 100 mA, 500 mA, 1 A. £4.75 ea.
VU meter similar style. £1.40 ea.

SLIDE POTENTIOMETERS

Good quality 60mm travel slider with 80mm fixing centres. Available from 5k – 500K in log and linear. 55p each.
Suitable black knobs 6p ea. Coloured knobs 10p ea.

We now offer one of the widest ranges of components at the most competitive prices in the U.K. See catalogue for full details. We welcome callers at our shop in College Rd, Bromley, from Mon–Sat, 9am–6pm (8pm on Weds and Fridays). Special offers always available.
We also provide an express telephone order service. Orders received before 5pm are shipped same day. Contact our sales office now with your requirements.
TELEPHONE: 01-464 2951/5770.

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

ORDERS DESPATCHED BY RETURN POST

BARCLAYCARD & ACCESS WELCOME.

Mail orders to: STEVENSON (Dept RE)

76 College Road, Bromley, Kent BR1 1DE.

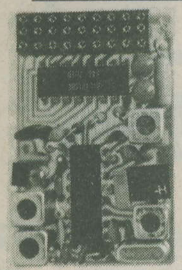
ambit
INTERNATIONAL

IT'S HAPPENNED* AGAIN !

THE PART THREE CATALOGUE IS PUBLISHED & WE HAVE MOVED TO BIGGER PREMISES.

Yes, it's here at last - the all new Part Three Catalogue. Fun for all the family, and the usual update on all that is new, worthwhile and exciting in the world of Radio and Communications. A big section on frequency synthesis techniques covering broadcast tuners, to communication quality transmitter systems. More new products than ever - RADIO CONTROL parts, crystal filters, ceramic filters for 455kHz and the new range of TOKO CFSH low temperature coefficient types for 10.7MHz. Details on new radio ICs, including the new HA11225, the CA3189E lookalike with 84dB signal to noise, and adjustable muting threshold. Radio control ICs - and an updated version of the RCM&E 8 channel FM receiver - now with an Ambit designed screened front end, with 27MHz ceramic bandpass filter. LCD panel clock/timer modules - the neatest and best LCD panel DVM yet (only £19.45 each + VAT), the new 5 decade resolution DFM3 for LW/HF/VHF with LCD readout. The DFM6 with fluorescent display to 10kHz resolution on VHF, 1kHz on SW. A 1kHz HF synthesiser with five ICs - the list is endless. Get your copy of the catalogue now. Post publication price is 60p (inc PP etc). The previous two sections are also required for a complete picture: Parts 1 & 2 £1 the pair. All 3 £1.50. And don't miss our spot the gibbon contest, together with a quiz to see if you can spot the differences between a neolithic cave drawing and a circuit diagram of one of our competitor's tuners. (* Yes, we still haven't learnt how to spell.)

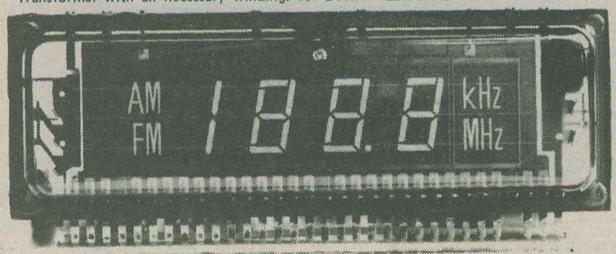
Updated RCME FM radio control RX kit



8 Channel RC receiver (FM)
- Single IC RF/IF/Detector
- Single IC decoder
- 27MHz ceramic filter input
- FET RF stage with double tuned bandpass filter
- Dual ceramic filter IF
- Based on RCM&E FM system
- Best quality SLM servo connector block
- ONLY £16.10 inc VAT (kit) (includes new SLM case)

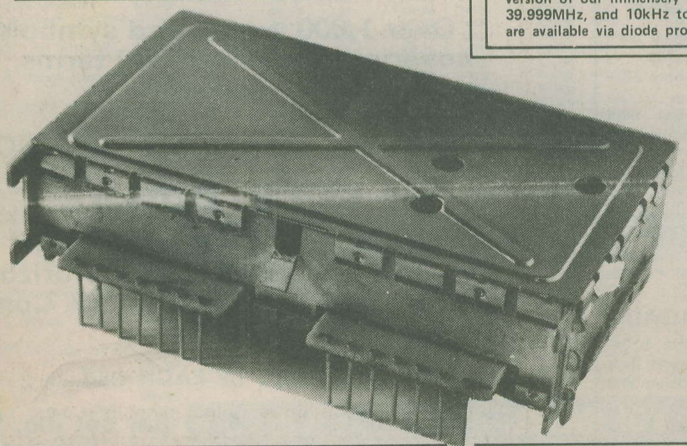
DOES YOUR ONE GLOW GREEN IN THE DARK ??

Our DFM4 does, since it uses a vacuum fluorescent display for direct readout of MW/LW/FM. Basically the same as the DFM2, (LCD Version). £24.45 kit (inc VAT) Transformer with all necessary windings for DFM4 - £2.50 inc VAT.



Not illustrated here - but also now available is the DFM6. This is a vacuum fluorescent display version of our immensely popular DFM3 (LCD). Resolution is 100Hz to 3.9999MHz, 1kHz to 39.999MHz, and 10kHz to 200.00MHz+; all standard IF offsets (inc. 10.7MHz on shortwave) are available via diode programming.

New series of radio modules in fully screened cans:



UM1181 VHF band 2 VARICAP TUNERHEAD
5 tuned circuit, with image/spurii better than −80dB, buffered LO output, MOSFET RF stage, FET IF preamp, tunes with only 1½ to 8v, −9dBm 3rd order intercept. 1off price £12.00 inc VAT. (100off/ OA)

911225 FM IF strip with all mod cons for the HiFi tuner:
All types use 80+dB S/N Hitachi IC, with muting, AFC, AGC, meter outputs for signal level and centre zero. IF preamp stage.
'A' Dual linear phase ceramic filters, with MOSFET (AGC'd) IF preamp and a 3rd narrow filter with DC filter selection. Dual tuned FM detector stage. £23.95 inc VAT (built)
'B' Dual ceramic filters, single tuned detector stage £14.95 inc VAT
(All 'A' series units are set up with a spectrum analyzer for best THD)

91072 AM RADIO TUNER MODULES - DC TUNED and DC SWITCHED Available February '80
All include buffered LO output, mechanical IF filter (TOKO CFMQ)
1-10v tuning bias, switching by a single pole to earth
A MW/LW (150 to 350kHz LW range) with ferrite rod antenna
B As 'A' but also including SW1 or SW2 (specify.)
SW1 = 1.8 to 4MHz SW2 = 5 to 10MHz
C With both SW ranges
Prices -one off INC VAT
'A' £14.43 'B' £15.90 'C' £17.50 (Custom types OA)

There is a danger - when advertizing in some magazines - that because we do not find space to list everything we sell in every ad., that some readers forget about half the ranges we stock. So to summarize the general ranges:

TOKO	Chokes coils for AM/FM/SW/MPX, Audio filters etc Filters: Ceramic for AM/FM, LC for FM, MPX etc. Polyvaricons ICs for radio, clock LSI, radio control, MPX decoders etc
Micrometals	Dust iron cores for toroids for resonant and EMI filters Toroid mounts
Hitachi	Radio/audio/mpx linear ICs 100W MOSFETs, small signal FETs, MOSFETs and bipolar

And the following groups of products from a broad range of sources:
Semiconductors —specializing in radio devices, Plessey SL1600, EUROPE's best selection of AM/FM and communications devices. Power MOSFETs, WORLD's LOWEST NOISE AUDIO small signal transistors, BAR graph LED drivers for linear and log.
CD4000 series CMOS, TTL/LPSNTTL, standard linears (741, 301, 3080 etc). MPUs, memories. Small signal transistors from AEG BC237/8/9 families etc. (1000 off BC239C : 5.2p ea)
LEDs: AEG 3mm/5mm round, 2.5x5mm flat, red, greem, orange, yellow. The best prices you will find for quality products.
MOSFETs for RF signal processing, including the BF960 UHF device, and 3SK51 for VHF. Varicap diodes for 17:1 capacity ratio tuning

FREQUENCY READOUT LSI from OKI, with a one-chip answer to most digital frequency display needs (and various modules).
Crystal and ceramic ladder filters from leading manufacturers, ferrite rods, various ferrite beads and a range of crystals for 'standard' frequencies and both AM and FM radio control at 27MHz. Trimmer capacitors.
METERS - a new range of linear movement types, plus many 'indicator' types for VU, all types of tuning indicators etc.
SOCKETS - a new range that are better quality than Texas low profile, yet better priced.
Modules for AM/FM/STEREO, complete kits for tuners, audio amplifiers from Larsholt.
SWITCHES - complete low cost DIY systems for push button arrays, keyboard switches.
DOUBLE BALANCED MIXERS - MCL SBL1, replacement for MD108 etc. And cheaper.

OUR LATEST MOVING EXPERIENCE :: At last, we have moved to the address below. There is car parking for customers approaching via North Service Road (an extension of North Road Avenue, entrance opposite the Brentwood Fire Station.) Pedestrian access from the High Street (alongside 117 High Street). The new building is six times bigger than our Gresham Road offices, and we will be installing a much expanded sales counter in the fullness of time. NEW TELEPHONE NUMBER (0277) 230909, TELEX NUMBER (as before) 995194 AMBIT G. See you there !

200 North Service Road, Brentwood, Essex.

BI-PAK SEMICONDUCTORS

Send your orders

DEPT. RC1, PO Box 6, WARE, HERTS.

Visit our Shop at: 3 Baldock Street, Ware, Herts.

TEL: 0920 3182
TELEX: 817861

CERAMIC PAK

16160 - 24 - 3 of each value - 22pf 27pf 33pf 39pf 47pf 68pf 82pf £0.69
16161 - 24 - 3 of each value - 100pf 120pf 150pf 180pf 220pf 270pf 330pf 390pf £0.69
16162 - 24 - 3 of each value - 470pf 560pf 680pf 820pf 1000pf 1500pf 2200pf 3300pf £0.69
16163 - 24 - 3 of each value - 4700pf 6800pf 01uf 015uf 022uf 033uf 047uf £0.69

ELECTROLYTIC PAKS

A range of paks each containing 18 first quality, mixed value miniature electrolytics.
16201 — .47mFD-10mFD £0.69
16202 — 10mFD-100mFD £0.69

CARBON RESISTOR PAKS

16213 - 60 mixed ¼w 100 ohms - 820 ohms £0.69
16214 - 60 mixed ¼w 1K ohms - 82k ohms £0.69
16215 - 60 mixed ¼w 10K ohms - 83K ohms £0.69
16216 - 60 mixed ¼w 100K ohms - 820K ohms £0.69
16217 - 40 mixed ½w 100 ohms - 820 ohms £0.69
16218 - 40 mixed ½w 1K ohms - 82K ohms £0.69
16219 - 40 mixed ½w 10K ohms - 82K ohms £0.69
16220 - 40 mixed ½w 100K ohms - 820K ohms £0.69
16230—60 mixed ¼w 1 Meg 10 Meg ohms £0.69
16231 - 40 mixed ½w 1 Meg - 10 Meg ohms £0.69

COMPONENT PAKS

16164 - 200 Resistor mixed value approx (Count by weight) £0.69
16165 - 150 Capacitors mixed value approx (Count by weight) £0.69
16166 - 50 Precision resistors. Mixed values £0.69
16167 - 80 ¼w resistors. Mixed values £0.69
16168 — 5 pieces assorted ferrite rods £0.69
16169 - 2 Tuning gangs MW LW VHF £0.69
16170 - 1 Pack wire 50 metres assorted volours single strand £0.69
16171 - 10 Reed switches £0.69
16172 - 3 Micro switches £0.69
16173 - 15 Assorted pots £0.69
16174 - 5 metal jack sockets 3 x 3.5mm 2 x standard switch types £0.69
16175 - 30 Paper condensers - mixed values £0.69
16176 - 20 Electrolytics trans types £0.69
16177 - 1 Pack assorted hardware - Nuts, bolts, gromets etc £0.69
16178 - 5 Mains slide switches, assorted £0.69
16179 — 20 Assorted tag strips and panels £0.69
16180 — 15 Assorted control knobs £0.69
16181 - 3 Rotary wave change switches £0.69
16182 - 2 Relays 6-24v operating £0.69
16183 - 1 Pak copper laminate approx 200 sq inches £0.69
16184 - 15 Assorted Fuses 100mA 5 amp £0.69
16185 - 50 metres PVC sleeving assorted size and colours £0.69

METAL FOIL CAPACITORPAK

16204 - Containing 50 metal foil capacitor like Mullard C280 series - Mixed values ranging from 01uf-2.2uf. Complete with identification sheet £1.38

SLIDER PAKS

16190 — 6 slider mixed £0.69
16191 - 6 slider 470 ohms £0.69
16192 — 6 slider 10K ohms 1in £0.69
16193 - 6 slider 22K ohms 1in £0.69
16194 - 6 slider 47K ohms 1in £0.69
16195 - 6 slider 47K log £0.69

TRANSISTORS

AC107	£0.25	AD162	£0.40	BC151	£0.25	BC441	£0.35	BF165	£0.55	2N1305	£0.21
AC113	£0.23	AD161/162	£0.81	BC152	£0.23	BC460	£0.44	BF167	£0.28	2N1306	£0.29
AC115	£0.23	ADT140	£0.63	BC153	£0.23	BC461	£0.44	BF173	£0.23	2N1307	£0.29
AC117	£0.35	AF124	£0.35	BC154	£0.22	BC477	£0.23	BF176	£0.44	2N1308	£0.35
AC117K	£0.39	AF125	£0.35	BC157	£0.12	BC478	£0.23	BF177	£0.30	2N1309	£0.35
AC121	£0.23	AF126	£0.35	BC158	£0.12	BC479	£0.23	BF178	£0.32	2N1711	£0.23
AC122	£0.18	AF127	£0.37	BC159	£0.12	BC547	£0.12	BF179	£0.35	2N2219	£0.23
AC125	£0.21	AF139	£0.40	BC160	£0.30	BC548	£0.12	BD239A/240AMP	£1.15	2N2221	£0.23
AC126	£0.21	AF178	£0.69	BC161	£0.44	BC549	£0.12	BF180	£0.35	2N2222	£0.23
AC127	£0.21	AF179	£0.69	BC167	£0.14	BC550	£0.16	BF181	£0.35	2N2369	£0.16
AC128	£0.18	AF180	£0.69	BC168	£0.14	BC556	£0.16	BF182	£0.35	2N2711	£0.25
AC128K	£0.30	AF181	£0.67	BC169	£0.12	BC557	£0.15	BF183	£0.35	2N2712	£0.25
AC132	£0.20	AF186	£0.8[illegible]	BC169C	£0.12	BC558	£0.14	BF184	£0.23	2N2714	£0.25
AC134	£0.23	AF239	£0.44	BC170	£0.10	BC559	£0.16	BF185	£0.23	2N2904	£0.21
AC137	£0.23	AL102	£1.38	BC171	£0.10	BCZ10	£0.69	BF186	£0.30	2N2905	£0.21
AC141	£0.24	AL103	£1.36	BC172	£0.10	BCZ11	£0.69	BF187	£0.30	2N2906	£0.18
AC141K	£0.35	AU104	£1.61	BC173	£0.10	BCZ12	£0.69	BF188	£0.46	2N2907	£0.23
AC142	£0.23	AU110	£1.61	BC174	£0.17	BD115	£0.58	BF194	£0.12	2N2923	£0.17
AC142K	£0.35	AU113	£1.61	BC175	£0.40	BD116	£0.92	BF195	£0.12	2N2924	£0.17
AC151	£0.23	BC107	£0.09	BC177	£0.18	BD121	£0.75	BF196	£0.12	2N2925	£0.17
AC153	£0.25	BC107A	£0.09	BC178	£0.18	BD123	£0.75	BF197	£0.14	2N2926G	£0.10
AC153K	£0.35	[illegible]	£0.10	BC179	£0.18	BD124	£0.81	BF198	£0.16	2N2926Y	£0.09
AC154	£0.23	BC107C	[illegible]	BC180	£0.29	BD131	£0.40	BF199	£0.16	2N2926O	£0.09
AC155	£0.23	BC108	£0.09	BC181	£0.10	BD132	£0.40	MJE340	£	2N2926R	£0.09
AC156	£0.23	BC108A	£0.09	BC182	£0.25	BD131/132MP	£0.92	MJE2955	£1.04	2N2926B	£0.09
AC157	£0.29	BC108B	£0.10	BC182L	£0.10	BD133	£0.46	MJE3055	£0.69	2N3053	£0.18
AC165	£0.23	BC108C	£0.12	BC183	£0.10	BD135	£0.44	TIP29A	£0.46	2N3054	£0.46
AC166	£0.23	BC109	£0.09	BC183L	£0.10	BD136	£0.40	TIP29B	£0.48	2N3055	£0.46
AC167	£0.23	BC109B	£0.10	BC184	£0.10	BD137	£0.40	TIP29C	£0.51	2N3402	£0.24
AC168	£0.29	BC109C	£0.12	BC184L	£0.10	BD138	£0.41	TIP30A	£0.46	2N3403	£0.24
AC169	£0.23	BC113	£0.18	BC186	£0.25	BD139	£0.41	TIP30B	£0.48	2N3404	£0.33
AC171	£0.29	BC114	£0.18	BC187	£0.25	BD140	£0.41	TIP30C	£0.51	2N3405	£0.38
AC176	£0.21	BC125	£0.20	BC207	£0.13	BD139/140MP	£0.92	TIP31A	£0.46	2N3702	£0.09
AC176K	£0.30	BC126	£0.25	BC208	£0.13	BF115	£0.25	TIP31B	£0.48	2N3703	£0.08
AC178	£0.29	BC132	£0.21	BC209	£0.14	BF152	£0.29	TIP31C	£0.51	2N3704	£0.08
AC179	£0.23	BC134	£0.21	BC212	£0.10	BF153	£0.29	TIP32A	£0.46	2N3705	£0.09
AC180	£0.23	BC135	£0.17	BC212L	£0.10	BF154	£0.29	TIP32B	£0.48	2N3706	£0.09
AC180K	£0.32	BC136	£0.21	BC213	£0.10	BF155	£0.40	TIP32C	£0.51	2N3707	£0.09
AC181	£0.23	BC137	£0.21	BC251	£0.17	BF156	£0.32	TIP41A	£0.51	2N3708	£0.08
AC181K	£0.32	BC139	£0.37	BC251A	£0.18	BF157	£0.32	TIP41B	£0.53	2N3709	£0.08
AC187	£0.21	BC140	£0.35	BC301	£0.32	BF158	£0.32	TIP41C	£0.55	2N3710	£0.08
AC187K	£0.32	BC141	£0.32	BC302	£0.33	BF159	£0.32	TIP42A	£0.51	2N3711	£0.08
AC188	£0.21	BC142	£0.25	BC303	£0.32	BF160	£0.35	2N706	£0.12	2N3772	£1.84
AC188K	£0.32	BC143	£0.25	BC304	£0.44	BF162	£0.35	2N707	£0.55	2N3773	£2.53
AD140	£0.69	BC145	£0.53	BC327	£0.18	BF163	£0.35	2N708	£0.16	2N3819	£0.21
AD142	£0.98	BC147	£0.06	BC328	£0.17	BF164	£0.55	2N1302	£0.17	2N3820	£0.40
AD143	£0.86	BC148	£0.06	BC337	£0.17			2N1303	£0.21	2N3821	£0.69
AD149	£0.69	BC149	£0.08	BC338	£0.17			2N1304	£0.21	2N3823	£0.69
AD161	£0.40	BC150	£0.23	BC440	£0.35					2N3903	£0.12

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7400	£0.1[illegible]	7422	£0.18	7448	£0.64	7489	£1.96	74123	£0.46	74175	£0.71
7401	£0.13	7423	£0.24	7450	£0.13	7490	£0.37	74136	£0.60	74176	£0.67
7402	£0.13	7425	£0.22	7451	£0.13	7491	£0.74	74141	£0.63	74177	£0.67
7403	£0.13	7426	£0.26	7453	£0.13	7492	£0.40	74145	£0.63	74180	£1.73
7404	£0.13	7427	£0.28	7454	£0.13	7493	£0.35	74150	£0.78	74181	£0.67
7405	£0.13	7428	£0.30	7460	£0.13	7494	£0.86	74151	£0.55	74182	£0.81
7406	£0.25	7430	£0.15	7470	£0.29	7495	£0.58	74153	£0.55	74184	£0.81
7407	£0.25	7432	£0.25	7472	£0.23	7496	£0.58	74154	£0.94	74190	£0.78
7408	£0.15	7433	£0.35	7473	£0.29	74100	£0.98	74155	£0.58	74191	£0.71
7409	£0.15	7437	£0.24	7474	£0.29			74156	£0.58	74192	£0.69
7410	£0.13	7438	£0.24	7475	£0.33	74104	£0.45	74157	£0.58	74193	£0.67
7411	£0.20	7440	£0.14	7476	£0.29	74105	£0.44	74160	£0.67	74174	£0.71
7412	£0.17	7441	£0.58	7480	£0.51	74107	£0.28	74161	£0.71	74195	£0.69
7413	£0.28	7442	£0.46	7481	£0.98	74110	£0.41	74162	£0.71	74196	£1.21
7414	£0.58	7443	£0.81	7482	£0.78	74111	£0.67	74163	£0.71	74197	£1.21
7416	£0.26	7444	£0.81	7483	£0.67	74118	£0.92	74164	£0.78	74198	£2.13
7417	£0.26	7445	£0.75	7484	£1.01	74119	£1.36	74165	£0.78	74199	£2.13
7420	£0.13	7446	£0.69	7485	£0.78	74121	£0.28	74166	£0.90		
7421	£0.23	7447	£0.55	7486	£0.25	74122	£0.45	74174	£0.75		

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CD4000	£0.16	CD4012	£0.22	CD4021	£0.94	CD4030	£0.55	CD4045	£1.61	CD4070	£0.20
CD4001	£0.23	CD4013	£0.48	CD4022	£0.94	CD4031	£2.30	CD4046	£1.50	CD4071	£0.20
CD4002	£0.18	CD4015	£0.94	CD4023	£0.22	CD4035	£1.38	CD4047	£1.00	CD4072	£0.20
CD4006	£1.06	CD4016	£0.49	CD4024	£0.75	CD4037	£1.09	CD4049	£0.55	CD4081	£0.20
CD4007	£0.20	CD4017	£0.94	CD4025	£0.22	CD4040	£1.01	CD4050	£0.55	CD4082	£0.25
CD4008	£1.06	CD4018	£0.98	CD4026	£1.38	CD4041	£0.87	CD4054	£1.27	CD4510	£1.27
CD4009	£0.52	CD4019	£0.48	CD4027	£0.58	CD4042	£0.83	CD4055	£1.15	CD4511	£1.44
CD4010	£0.55	CD4020	£1.04	CD4028	£0.78	CD4043	£1.01	CD4056	£1.55	CD4516	£1.15
CD4011	£0.23			CD4029	£0.98	CD4044	£0.94	CD4069	£0.20	CD4518	£1.15

LINEAR IC's

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CA3014	£1.55	CA3123	£2.19	MC1303L	£0.98	UA702C	£0.53	UA747C	£0.69	TBA810	£1.13
CA3018	£0.75	CA3130	£1.07	MC1304	£2.19	72702	£0.53	72747	£0.69	TBA820	£0.81
CA3020	£1.96	CA3140	£0.81	MC1310	£1.09	UA703	£0.29	UA748	£0.40	TBA9200	£2.88
CA3028	£0.92			MC1312	£2.19	UA709	£0.29	72748	£0.40	TCA270S	£2.30
CA3035	£1.61	LM301	£0.33	MC1350	£1.38	72709	£0.53	748P	£0.40	TBA800	£0.92
CA3036	£1.15	LM304	£1.84	MC1352	£1.61	709P	£0.29	SN76013N	£1.97		
CA3042	£.73	LM308	£1.15	MC1469	£3.39	UA710C	£0.46	SN76023N	£1.97		
CA3043	£2.13	LM309	£1.73	MC1496	£1.04	72710	£0.35	SL414A	£2.24		
CA3046	£0.81	LM320-5V	£1.73	NE536	£3.06	UA711C	£0.37	TAA550B	£0.40		
CA3052	£1.84	LM320-15V	£1.73	NE550	£1.09	72711	£0.37	TAA621A	£2.30		
CA3054	£1.27	LM320-24V	£1.73	NE555	£0.28	UA723C	£0.52	TAA621B	£2.88		
CA3075	£1.73	LM320-15V	£1.73	NE556	£0.69	72723	£0.52	TAA661	£1.73		
CA3081	£1.73	LM380	£0.98	NE565	£1.38	UA741C	£0.28	TAD100	£1.50		
CA3089	£2.30	LM381	£1.67	NE566	£1.73	72741	£0.28	TBA540	£2.42		

DIODES

AA110	£0.19	BA173	£0.17	BY127	£0.18	BYZ13	£0.46	OA81	£0.12	IN34	£0.08
AA120	£0.09	BB104	£0.46	BY128	£0.18	BYZ16	£0.47	OA85	£0.12	IN34A	£0.08
AA129	£0.09	BAX13	£0.08	BY130	£0.20	BYZ17	£0.41	OA90	£0.12	IN914	£0.07
AAY30	£0.10	BAX16	£0.09	BY133	£0.24	BYZ18	£0.41	OA91	£0.12	IN916	£0.07
AAZ13	£0.17	BY100	£0.25	BY164	£0.59	BYZ19	£0.41	OA95	£0.12	IN4148	£0.07
BA100	£0.12	BY101	£0.25	BY176	£0.86	OA5	£0.69	OA182	£0.15	IS44	£0.06
BA102	£0.37	BY105	£0.25	BY206	£0.35	OA10	£0.40	OA200	£0.09	IS920	£0.07
BA148	£0.17	BY114	£0.25	BYZ10	£0.52	OA47	£0.09	OA202	£0.09		
BA154	£0.14	BY124	£0.25	BYZ11	£0.52	OA70	£0.09	SD10	£0.07		
BA155	£0.16	BY126	£0.17	BYZ12	£0.46	OA79	£0.12	SD19	£0.07		

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Tant Bead .22, .47/35v **6p.** .1, 1/35v, 47/6.3v **8p.** .22/20v, 3.3/16v, 4.7/35v, 10/25v, .22/16v **9p.** 4.7/16v, 10/3v **10p.** 3.3/35v **12p.**

Wire End
63v 2.2, 4.7, 10, 33, **5p.** 2.5 **3p.** 1.5, 22, 47 **6p.** 100, 220 **8p.** 150 **$7\frac{1}{2}$p.** 330 **9p.** 470 **$17\frac{1}{2}$p.** 1000 **29p. 25v** 6, 6.4, 10, 12, 16, 22, 25, 30, 33, 40, 47, 50, 64 **4p.** 100, 150, 160, 330 **6p.** 220 **7p.** 250, 300, 470 **8p.** 1000 **$11\frac{1}{2}$p:** 22/16, 10/50 **4p.** 100/10, 47/16 **5p.** 100/16 100/35, 220/16 **6p.** 470/6.3, 10/350, 470/16 **8p.** 1000/16 **10p.** 1500/6.3 **$7\frac{1}{2}$p.** 2200/10 **20p.** 4700/10 **30p.** 15/160 **7p. CANS** 250/300, **45p.** 300/450 **90p.** 100/275 **14p.** 2000/100 **82p.** 1000/100 **70p.** 8+8/450 **9p.** 10,000/16 **50p.** 2000/50 **35p.** Full range in catalogue.

RS 100-0-100 micro amp null indicator
Approx. 2" x $\frac{3}{4}$" x $\frac{3}{4}$" £1.85

INDICATORS

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

CAPACITORS: up to 500v: **Ceramic** up to .01 **2p,** to .1 **5p,** to .68 **8p. Silvermica** up to 5000PF **5p,** to .01 **21p, Poly, etc** up to .1 **2p,** to .2 **3p,** to .47 **5p,** to .66 **7p:**
.1, .22/900v **15p.** .3/600v **4p.** .97/160v **$7\frac{1}{2}$p.** 1mFd up to 250v **10p.** 2.2mFd up to 100v **14p.** 4/16v **25p.** 6.8/63, 25/50 **19p.** 8/20v **40p.** CAN 1/350 **12p.** 8/660 vac **£2.** 3/660 vac **£1.75.** 5/150 **70p.**
Pulse Tube: 8-12kV, 10, 47, 56, 82, 320pF **2p each.**
Hundreds of others in Catalogue

SONNENSCHEIN/POWERSONIC DRI-FIT RECHARGEABLE SEALED GEL (Lead Antimony) BATTERY, 6 Volt 6 amp. hr. ($4\frac{1}{2}$" x 2" x 3") **£4.25**
Ex-equipment, little used.

CONNECTOR STRIP

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

$1\frac{1}{4}$ glass fuses 250 m/a or 3 amp (box of 12) 20p
Bulgin 5mm Jack plug and switched socket (pair) 40p

Reed Switch 28mm body length 5p
PP9 Battery Leads 8p
Aluminium circuit tape, $\frac{1}{8}$ x 36 yards—self adhesive. For window alarms, circuits, etc. **95p**

TV MAINS DROPPERS

5 assorted multiple units for 45p

100pF air-spaced tuning capacitor £1.30
$5\frac{1}{4}$" x $2\frac{1}{4}$" Speaker, ex-equipment 3 ohm 65p
2 Amp Suppression Choke 10p
3 x $2\frac{1}{2}$ x $\frac{1}{16}$" } **PAXOLINE** 5 for 35p
$4\frac{5}{8}$ x $\frac{1}{2}$ x $\frac{1}{8}$" } 10 for 15p
Nylon clip on MES bulb holder 4p
VALVE RETAINER CLIP, adjustable 5 for 15p

Sub-miniature Transistor Transformer **35p**
Valve type output transformer **90p**
POT CORES with adjuster
LA2508-LA2519 **43p per pair**
16 Watt Power Amp. Module
35v 1A power required, giving 16 watt RMS into 8 Ω **£3.45**
REGULATED TAPE MOTOR
Grundig 6V approx., 3" x $1\frac{1}{2}$", inc. shock absorbing carrier, or Jap 9V, $1\frac{1}{2}$" diam. £1.05
20mm fuse holder — **chassis 4p, panel 17p.**
Fane 8 ohm 3" sq. heavy duty communications speaker £1.60
RS neg. volt regulator 103, 306-099 (equiv. MPC900) 10A, 100 watt 4-30 volt. Adjustable sort circuit protection. **Sacrifice at £2.00**

Digital count unit. Counts in steps of 1, 2, 5 or 10 with total limit switch (2 x D.I.L. BCD), reed relay remote output. Mains power supply, relay and delay unit. UNUSED. Displays on 2 Minitron. 7 segments sold separately. **£5.60**

Crouzet 30-minute timer-programmer, multi-variable contacts **£7.80**

ACOS DUST JOCKEY
Automatic record cleaner
£1.30

AUDIO LEADS
3 pin din to open end, $1\frac{1}{2}$yd, twin screened 45p
5 pin din 180° to 2-phono 70p
3 pole jack plug to tag ends, 4ft. 45p

RELAY 6 amp changeover. Mains coil £1.10
200μA F.S.D. level Meter $1\frac{5}{8}$" x $1\frac{1}{2}$" £3.25

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

DEAC rechargeable NICAD 450K. Capacity 6V 450 m.a.h. at 10 hour rate. Ex-new equipment **£3.75.**

"Makaswitch" 1p 10-way wafer 15p
Wood cased 8-12V buzzer **£2.60**

2.5A r.f. thermo-couple and meter $2\frac{1}{4}$" square **£3.86**

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AF124/6/7	27p
AF139	23p
AF178/80	35p
AF181 33p AF239	35p
ASY27/73	35p
AU110£1.51 AU113	98p
BC107/8/9+A/B/C	6p
BC147/8/9 + A/B/C	5p
BC157/8/9 + A/B/C	5p
BC171B/173	8p
BC178A/B 179B	14p
BC182/184C/LC	5p
BC186 23p BC187	8p
BC204 12p BC173	4p
BC213L/214B	5p
BC238/338	5p
BC327/8/337	8p
BC547/8 + A/B/C	5p
BC556/7/7B/8/9	5p
BCW71R	1p
BCX32/36	15p
BCY31	59p
BCY40 31p BCY56	10p
BCY70/1/2	6p
BCZ11 32p BD113	57p
BD115	35p
BD116(BRC116T)	54p
BD131/2	16p
BD133/5/6/7/8	35p
BD137/8 match pr	60p
BD139 17p BD142	35p
BD140	27p
BD201/2/3/4	88p
BD232 52p BD234	13p
BD233/5	45p
BD238 28p BDX77	97p
BD437 35p BD438	28p
BF/115/167/173	18p
BF178/9 23p BF181	8p
BF180/2/3/4/5	18p
BF194/5/6/7	5p
BF194A, 195C	5p
BF200 13p BF258	17p
BF324 15p BF262/3	29p
BF336 31p BF274	8p
BFS28 Dual Mosfet	£1.15
BFT61	40p
BFW10/11 F.E.T	48p
BFW30	£1.15
BFW57/58	21p
BFX12	23p
BFX29	15p
BFX30/37	16p
BFX84/88.89	20p
BFX85 14p BLY10	23p
BFY50/51 13p BFY90	50p
BFY75	15p
BRY39/56	29p
BR101 34p BSV64	36p
BSV79/80 F.E.T.s	50p
BSV81 Mosfet	75p
BSX20/21	10p
BSY40 30p BSY95A	14p
BU204 + Mount Kit	78p
BU208	£1.85
CV7042 (OC41/44 ASY63)	12p
GET111/E112	45p
MA393	25p
MJE371	40p
MJ481 (BDY23)	23p
MPU131	18p
OC45(ME2)	13p
ON222	23p
R1039(2010)	54p
R2008B 92p R2010B	79p
TIP30 22p TIP48	33p
TIP31	24p
TIS43 (2N2646)	22p
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ZT1486	£1.15
ZTX300/341	9p
2G309	30p
2N393 (MA393)	35p
2N456A	57p
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2N929 16p 2N987	45p
2N1484	£1.15
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2N2222A 8p 2N2401	35p
2N2412 27p 2N2483	28p
2N2904/5/6/7/7A	9p
2N3053	16p
2N3055 R.C.A.	42p
2N3133/4062	24p
2N3283	25p
2N3553 56p 2N4037	30p
2N3716	23p
2N4918	15p
2N5484 FET	37p
2N6385 Pwr Darl	54p

Amp	Volt
1/2	1,600
1	140
5	100
0.6	110
5	400
2½	100
3¼	100

BRIDGE RECTIFIERS

BYX10	34p
OSH01-200	30p
Ex Equip	73p
EC433	20p
Texas	£1.10
I.R.	48p
B40C 3200	58p

RECTIFIERS

	Amp	Volt	
M1	½	68	5p
1N4002	1	50/100	3p
1N4004/6/8	1	4/6/800	3½p
1N4007/BYX94	1	1250	4½p
BY103	1	1,500	21p
SR100	1.5	100	9p
SR400	1.5	400	10p
REC53A	1.5	1,250	16p
LT102	2	30	15p
BYX22-200	1½	300	25p
BYX38-300R	2.5	300	48p
BYX38-600	2.5	600	52p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX49-300R	3	300	35p
BYX49-600	3	600	42p
BYX49-900	3	900	47p
BYX49-1200	3	1,200	60p
BYX48-300R	6	300	47p
BYX48-600	6	600	60p
BYX48-900	6	900	70p
BYX48-1200R	6	1,200	92p
BYX72-150R	10	150	42p
BYX72-300R	10	300	52p
BYX72-500R	10	500	65p
BYX42-300	10	300	36p
1N5401	3	100	13p
1N5402	3	200	15p
MR856	3	600	24p
BYX42-900	10	900	92p
BYX42-1200	10	1,200	£1.07
BYX46-300R	15	300	£1.19
BYX46-400R	15	400	£1.75
BYX46-500R	15	500	£2.00
BYX46-600	15	600	£2.30
BYX20-200	25	200	72p
BYX52-300	40	300	£2.05
BYX52-1200	40	1,200	£2.90
RAS310AF	1.25	1,250	48p

TRIACS

Amp	Volt		
25	900	BTX94-900	£3.00
25	1200	BTX94-1200	£5.00

Diode Characteristic, Equiv., and Substitution Book	82p
Transistor equivalents and substitution Book 1 38p Book 2	82p
Chrome Car Radio facia	28p
Rubber Car Radio gasket	10p
DLI Pal Delavline	90p
Relay Socket 4PCO or 2PCO:	10p
DIL sockets low profile: 8 8p, 16 8p, 28 22p	
Ferrite rod 7-8"x⅜" diam	40p
Earphone 3.5 12p, 2.5 15p, crystal	30p
Colour EHT Tray 3000/3500	£4.05
Nylon self-locking, 3½" tie clips	3p
1.5, 10, 22 or 750 µh choke	12p
Mullard Semiconductor, Valve & Component Data Book	50p

OPTO ELECTRONICS

Diodes		Photo transistor	
BPX40	57p	BPX29	92p
BPX42	92p	OCP71	40p
BPY10	92p		

(VOLTIAC)

BPY68	
BPY69	92p
BPY77	
Wire end neons	4p

L.E.D.'s

.2" Red Mullard CQY24 8p
TIL209 .25" red 9p or green 13p

PHOTO SILICON CONTROLLED SWITCH
BPX66 PNPN 10 amp £1.15

.3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v 19m/a segment, common anode	55p
HP .43 in yellow	£1.60
RS 0.6in. green	£1.77
Minitron 0.3in 3015F filament	£1.25
Infra red transmit diodes CQY11B or LD27 High power 1.6-2v or 3-3.5v Pulse	53p
H15B Photon coupled isolator I.R. diode & NPN Photo-Darlington amp	£1.05
Data Sheet	10p

Swivel aerial 6½ to 36"	60p
Multicore Solder ½kg. 16 or 18 or 20 s.w.g.	£5.20
3 inch 8 Ω speaker	£1.15

New unmarked, or marked ample lead ex new equipment

ACY17-20	10p	TIC44	17p
ASZ20	10p	2G240	£1.17
ASZ21	35p	2G302	6p
		2G401	6p
BC186	13p	2N711	28p
BCY30-34	24p	2N2926	5p
BCY70/1/2	5p	2N598/9	8p
BY126/7	5p	2N1091	10p
HG1005	12p	2N1302	10p
HG5009	4p	1N1907	£1.17
HG5079	4p	Germ. diode	2p
L78/9	4p	2N3055	26p
M3	12p	IN 4001	3p
OA81	2½p	GET120 (AC128 in 1" sq. heat sink	22p
OA47	4p		
OA200-2	4p		
OC23	27p	GET872	15p
OC200-5	24p	2S3230	34p
C106 THY	10p	TIS43	15p
BUY 12/13	50p	BDY30	35p

MINIATURE EDGE METERS

100µA f.s.d., scaled 0.5. 12V Illuminated blue perspex front, 35mm x 14mm £3.45

200µA level meter, clear front. 10 x 18mm 65p

CATALOGUE

38, 11 x 8 ins illustrated sheets., listing approx. 5,250 items, photo printed on day requested, from constantly updated masters, to ensure latest stock position, 75p (refundable with orders) plus 27p s.a.e. or label

TRANSFORMERS

Ferromag C core. Screens 95-105-115-125-200-220-240v input output 17v ½A x 2 + 24-0-24v 1.04A+20v 1mA. These current ratings can be safely exceeded by 50%. £5.00

Cassette Dynamic Microphone with switch and twin plug £1.35

Telephone Pickup, sucker with lead and 3.5 plug 62p

THYRISTORS

Amp	Volt		
1	240	BTX18-200	.35p
1	400	BTX18-300	.41p
1	240	BTX30-200	.35p
4	500	40506	.58p
15	500	BT107	£1.00
6.5	500	BT109-500R/SCR957/BRC4444	.71p
20	600	BTW92-600RM	£3.40
15	800	BTX95-800R Pulse Modulated	£8.75

	Plug	Chassis socket	Line socket
2.5	12p	10p	—
3.5	10p	6p	11½p
	plastic 11½p metal	switched	
¼	17p	20p	16p
Stereo	26½p	20p	24p
Speaker	7p	7p	—
		switched	
3DIN	11p	10p	14p
5DIN 180°	10p	10p	14p
5DIN 240°	13p	8p	16p
Phono	6p	8p	15p

Twin Socket 9p, Triple 20p, 4mm Plug or Socket 9p, TV coax plug 9p, Socket 8p, Line connector 9p, Surface outlet box 40p.

LINEAR I.C.'s

Many others in Catalogue

CA3001	86p
CA3028	75p
CA3044	£1.20
CA3046	40p
CA3054	£1.10
CA3086	50p
CA3132	£2.22
CA3146	90p
CA3065	£1.00
CA3083	65p
CA3183	80p
702 52p 741	16p
710/720 28p 724	20p
7805 (T03)	55p
2102 73p 709	15p
82S129	£5.00
LM300 86p LM309	60p
LM1303	97p
LM1458	32p
LM3900	40p
LM9311	£1.02
MC1306P	40p
MC1307P	35½p
MC1312P	40p
TAA263	75p
TAA550 Y or G	23p
TAA300	£1.00
TAA320	£1.15
TAA700	£2.30
MT300/305 8p Yes!	8p
AY58300	36p
C500 (GIMT4) Calculator chip	37p
SN76396N	35½p
SN76549N	35½p

40250 (2N3054)	35p
40310	23p

OTHER DIODES

1N916	4p
1N4009	9p
1N4148/1N914	1½p
BA145	15p
Centercel	29p
BZY61/BA148/OA81	12p
BB110 Varicap	24p
BB113 Triple Varicap	43p
BA182/BB 103 Varicap	6p
OA5/7/10	17p
BZY88 up to 43 volt	5p
BZX61 11 volt	15p
AA133 10p AA119	7p
BZY96C 10V	34p
BZY95C 33V or 15V	34p
10W Zener 18 or 68V	36p

RS Irravin high temperature wire, 19/0.16, minus 55° to 105°C. 600V 3A, white, black or red. Quarter trade price at 22½p 10M coil.

PVC QUALITY TAPE

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

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

GARRARD

GCS23T Crystal Stereo Cartridge	£1.20
Mono (Stereo compatible) Ceramic or crystal	£1.14

DIGITAL I.C.'s

7400/1/2/4	8p		
7410	6p		
74/20/30/50/51	9p		
7406	15p		
7414	39p		
7417/26	15p	7432	13p
		7442	26p
7437/38/54	12p		
7445	42p	7472/76	20p
7473	16p	7474	19p
7490/8280	25p		
7482	35p	7483	45p
7486	14p	7493	18p
74107	16p	74118	75p
74122	25p	74123	35p
74132	44p	74141	42p
74151	32p	74165	55p
74154/164/175	35p		
74167	23p	74173	44p
74192	33p	74193	38p
74196	36p	74293	80p
74490	£1.30		
74H Series			All 26p
00/01/10/40/50/73			
74L10/72/74/95		54L95	25p
5406	15p	5486	14p
5476	20p	5490	25p
5480	22p	54123	35p

M.O.S. and Schotcky see Catalogue

VEROBOARD

.15 strip approx 6"x4"	65p
3¾"x3¾" 34p 4¾"x3¼"	44p
Plain .1 4x4½"	35p
3¾"x2¾"	25p
3¾"x3"	31p

Miniature Axial Lead Ferrite Choke formers 5 for 13p

RS 10 Turn pot 1% 250 500 Ω 1K. £1.70

Copper coated board 18½" x 2¾" 28p

TBA800 50p any 5x5	22p
MC1314P	35½p
MC1350P	35½p
MC1349P	35½p
SN76115N	35½p
(T)CA270CW	35½p

MORE I.C.'s

MC846P	4p	963DC	4p	MC1310P	35½p
AJ371-002	4p	949DC	4p	SN75110	46p
930399-500	4p	937DC	4p	TAA661B	35½p
XK345	4p	TYA0171	4p	SN76666N	35½p
343-5DR	4p	SN15844	4p	SN76660N	35½p
MC863P	4p	930DC	4p	MC1357P	35½p
		MC862	4p	MC1315P	35½p
		MC837P	4p	946DC	4p

C90 Cassette Tape 45p

TNC plug or N plug or through connector 70p

50 ohm BNC plug through connector or round or flanged chassis socket 50p

250 Ω 50 watt + Resistor 40p

Mullard +12-0-12V 1A, 4A stabilized, regulated, power supply. £12.50

27V 5A Double section bobbin transformer £4.50

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

VAT & POST PAID

MINIMUM ORDER £3 (excluding catalogue) OTHERWISE ADD 50% FOR SMALL ORDER HANDLING COSTS (UNDER £1.00 TOTAL ALSO INCLUDE 10p S.A.E.)

Due to lack of space, items (i.e. pots, caps, etc.) can only be collectively priced. Catalogue often shows much lower individual value price

ALL ENQUIRIES, ETC., MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE

MARCO TRADING

To obtain a free copy of our 35 page list simply send a 20p postage stamp or a large SAE. This advertisement shows only a part of our range. (Our new list includes Tants, Electrolytics, Disc ceramics, etc.)

TRANSISTORS

AC128	24p	BC213	10p	BF115	32p	BFY77	22p
AD149	58p	BC213L	10p	BF127	38p	BR101	32p
AD161	45p	BC213L	10p	BF159	25p	BRY39	32p
AD162	44p	BC214	10p	BF164	22p	BSY52	35p
BC107	10p	BC214B	12p	BF166	32p	BU105/02	£1.58
TO5 leg)	6p	BC214C	12p	BF167	26p	BU108	£1.80
BC108	10p	BC214L	12p	BF178	24p	BU124	£1.82
BC109	10p	(TO5 lead)	8p	BF180	29p	BU126	£1.50
BC125	12p	BC268A	28p	BF182	29p	BU204	£1.45
BC126	14p	BC301	36p	BF183	29p	BU205	£1.35
BC147B	8p	BC307B	13p	BF194	10p	BU206	£1.75
BC149	8p	BC308A	13p	BF194A	12p	BU208	£1.75
BC153	10p	BC309	14p	BF195	10p	GET872	15p
BC161	25p	BC441	36p	BF195C	12p	GET881	15p
BC177	18p	BC460	35p	BF200	28p	OC45	30p
BC178	18p	BC547	12p	BF224J	15p	OC71	25p
BC182	9p	BC558A	13p	BF241	15p	OC72	35p
BC182L	10p	BCY42	30p	BF257	28p	OC76	32p
BC183	9p	BCY70	17p	BF259	30p	TIP29A	44p
BC183B	9p	BCY71	20p	BF262	30p	TIP31A	36p
BC183L	10p	BCY72	20p	BF263	30p	TIP32A	40p
BC184	9p	BD116	54p	BF337	30p	TIP32C	70p
BC184L	10p	BD131	35p	BFT41	30p	TIP33A	65p
BC212	10p	BD132	35p	BFX84	22p	TIP41A	45p
BC212B	12p	BD135	34p	BFX89	65p	TIP42A	40p
BC212L	12p	BD136	34p	BFY50	20p	TIP3055	65p
BC212LA	12p	BD183	75p	BFY51	20p	TIS43	34p
		BDY20	£1.05	BFY52	20p	2N3055	48p

400m/w ZENER DIODES *Low Price*

3V, 3V3, 3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 6V8, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 13V5, 15V, 16V, 18V, 20V, 22V, 24V, 27V, 30V, 33V.

Price: **8p each** 100 any mix **£6.00**

1 watt ZENER DIODES

3V3 to 200V Full range
Price: **15p each** 100 any mix **£12.50**

8	DIL	10p
14	DIL	13p
16	DIL	15p
18	DIL	18p
20	DIL	22p
22	DIL	23p
24	DIL	24p
28	DIL	28p
40	DIL	40p

VEROBOARD (Copper Clad)

Size Inch	0-1"	0.15
2.5 x 1	20p	N/A
2.5 x 5	55p	56p
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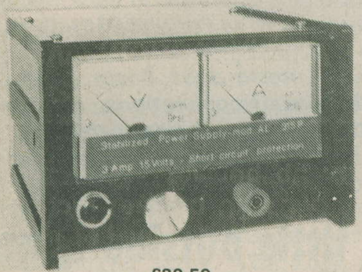

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RIPPLE	10mV 2,8 Amp
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WEIGHT	4,250 Kg.

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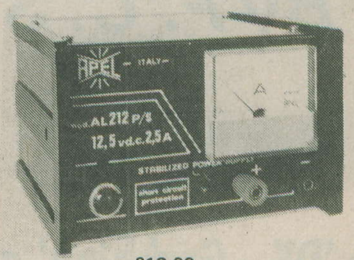
RIPPLE	< 2mV 4,5 Amp
DIMENSIONS (mm)	W210 × H155 × D250
WEIGHT	5,100 Kg.

AL.212 PS



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OUTPUT CURRENT MAX	2,5 Amp
LOAD REGULATION	<0,3% 0÷2,2 Amp
RIPPLE	<5mV 2,2 Amp
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WEIGHT	1,490 Kg.
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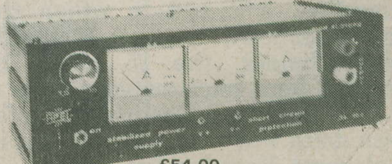

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OUTPUT VOLTAGE RANGE	± 1,7 ± 15 V dc
OUTPUT CURRENT RANGE MAX	3 Amp
LOAD REGULATION	< 0,2% 0-2,8 Amp
RIPPLE	< 3mV 2,8 Amp
DIMENSIONS (mm)	W270 × H90 × D155
WEIGHT	4,140 Kg.

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15 METRE DELTA BEAM

By F. C. Smith

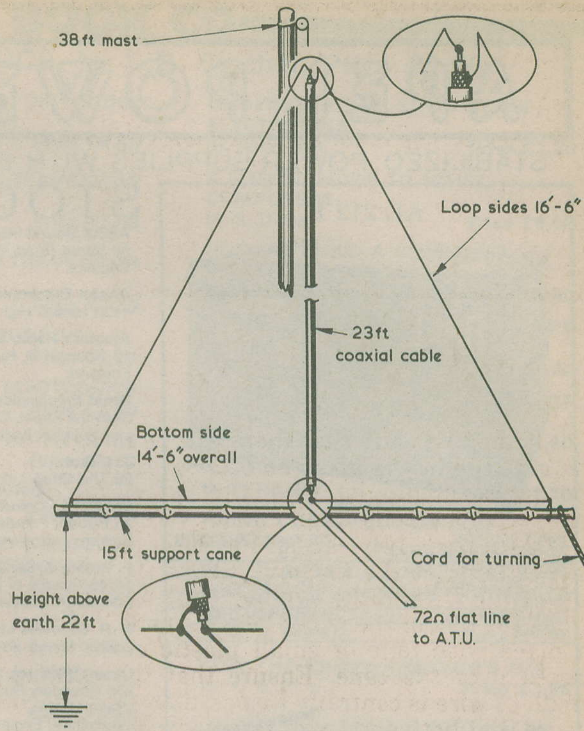

Fig. 1. The 15 metre delta beam array. Note the transposed connections, at top and bottom, to the coaxial cable

A 'DX - Grabbing' antenna which requires little outside space

The quad antenna is too well known to need description here. The delta loop antenna, although not so well known, is a worthy companion to the world-renowned quad. Both antennas can be space demanding, a condition which the writer, like many other town dwellers, is unable to satisfy.

Nevertheless, the 15 metre delta antenna described here requires very little space and is a real "Dx-grabber". Costing only a few pounds, this driven delta will work real Dx and is equivalent to a 3-element Yagi in performance. The writer has built quads over the years and finds the delta an improvement on the quad because of its greater bandwidth and sharper directivity. The delta first constructed by the writer was a single loop. Now, a single quad loop has a small gain over the dipole and, since the electrical parameters of the delta are similar to those of the quad, it follows that the delta also has a gain over the dipole.

PHASED ARRAY

The writer wanted to improve the performance of his delta loop without the addition of a space-demanding reflector and, after some thought, he came to the conclusion: why not make it a phased array? The result is the antenna shown in Fig. 1.

The two sides of the delta are each 16ft. 6in., and the bottom side has two 7ft. 3in. lengths, to give a total length of 14ft. 6in. Connected at the top to the side wires is a 23ft. length of coaxial cable of velocity factor 0.66, this being a physical half-wavelength at 21.3MHz. The lower end of the coaxial cable is connected to the inside ends of the bottom wires. It is important that the end connections to the coaxial cable be transposed. At the top the coaxial outer connects to the right hand side wire, as shown in the diagram, and the coaxial inner connects to the left hand side wire; at the bottom the coaxial outer connects to the left hand bottom wire and the coaxial inner to the right hand bottom wire. Also connected to the antenna at bottom centre is a 72 Ω flat twin line. This can have any length and it connects to the aerial tuning unit.

CONSTRUCTION

The loop requires 16 yards of wire, and this may be 16 s.w.g. copper or plastic covered flex.

The support cane employs two 8ft. long $\frac{3}{4}$in. bamboo canes. Having treated these for weather, they are made a tight fit into a 2ft. aluminium tube of 1in. diameter, as shown in Fig. 2. Push each cane

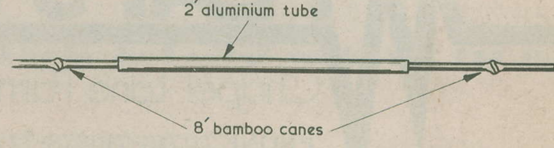

Fig. 2. The support cane consists of two 8ft. bamboo canes inserted, at the centre, in a 2ft. aluminium tube

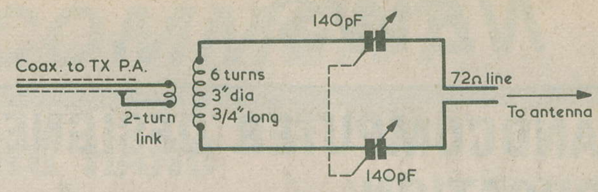

Fig. 3. The a.t.u. employed with the delta beam

well home to ensure that there will be no sag when the array is in the air. The total overall length of the canes should be 15ft. Cut off equal excess lengths at the ends to give this overall length.

Measure out 16ft. 6in. of the wire, fix its end to an insulator at the top and secure the measured end of the wire to the support cane near one end. Run 14ft. 6in. of the wire along the cane, holding it in place with tape or small plastic curtain rings passed over the cane. Ensure that the 14ft. 6in. length of wire is centrally disposed on the cane and secure it at both ends with tape to prevent the wire slipping. The remaining length of wire is now taken back up to the top insulator. Check that the length of this second side wire is also 16ft. 6in. and cut off any excess wire at the top.

The connections to the coaxial cable at the top and bottom are made by means of two 2-way barrier strips. The 14ft. 6in. bottom section is cut at its centre and the two inside ends connected to the bottom barrier strip. The 23ft. length of coaxial cable is longer than the distance between the top and bottom of the array. Coil up the excess at the bottom and tape the coiled cable to the aluminium tube. Then connect the coaxial cable bottom end to the bottom barrier strip, making certain that the connection is transposed as just described. Also connected to the bottom barrier strip is the 72 Ω flat twin line which passes to the aerial tuning unit.

The aerial is then ready to hoist.

An important point to observe is that the bottom of the delta should be a half wave above the earth to obtain best results. A height of 22ft. will be satisfactory. Measurement of resonance can then be made with a g.d.o. or antenna bridge, which should put the antenna at 21.3MHz in the 15 metre band. The writer's antenna measured almost spot-on and needed no adjustment.

The circuit of the author's a.t.u. is shown in Fig. 3. The two 140pF variable capacitors are widely spaced physically and are ganged by way of an insulated shaft coupling.

PERFORMANCE

When first employed with the author's 150 watt "Viceroy" transmitter, the antenna produced a marked improvement over the previous single loop, which had been in use for some three months. First to be noted were Dx contacts in Japan who gave the writer signal reports two S-points up on previous reports. The new antenna also has an increased low angle vertical lobe. Single CQ's brought back KH6, W6 and W7 contacts which had previously needed to be called several times. Also, this was at a time when the 15 metre band was in poor condition. Stations at 6,000 miles were worked daily with reports ranging from Q5-S5 to Q5-S8/9. The writer has not measured the gain of the new antenna but it should be at least 3dB over the delta loop in its unphased condition. Just as important is the increase of low angle vertical radiation given by the phased array.

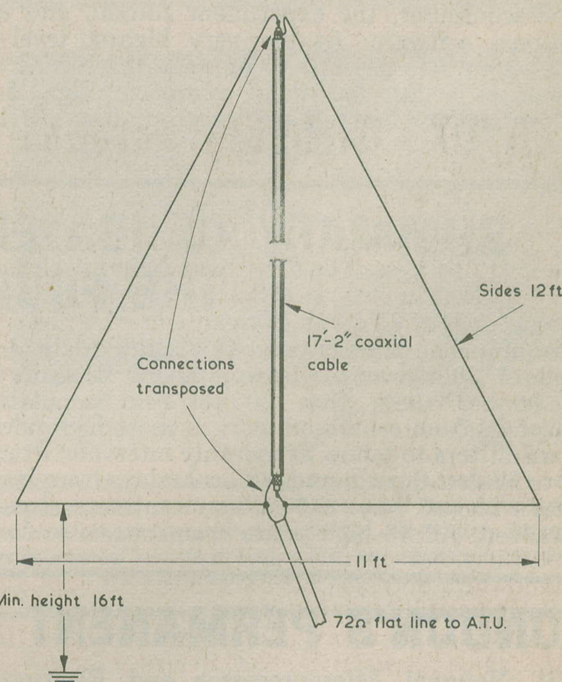

Fig. 4. Dimensions for a phased delta beam intended for working at 28.8MHz

The antenna is very simple to construct and can be airborne in a couple of hours. The results should satisfy the most critical Dx chaser.

Finally, Fig. 4 gives details for another driven delta, this being dimensioned for 28.8MHz in the 10 metre band. ■

NEWS . . . AND

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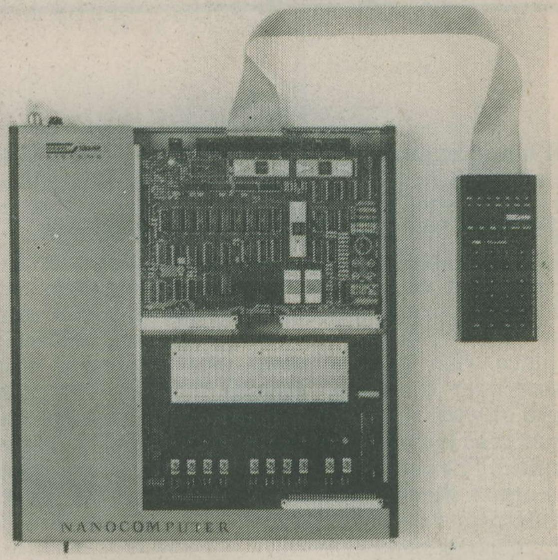

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LONDON'S PERMANENT ELECTRONICS EXHIBITION

The National Microprocessor and Electronics Centre, has just published its schedule of mini-exhibitions.

These mini-exhibitions are held in parallel with the centre's expanding permanent exhibition which at present, consists of displays from over 50 companies.

The centre's mini-exhibitions last for 3-days and are staged at least once every fortnight. They are deliberately restricted to a single product area so that visitors have a chance to see a comprehensive selection of similar products in one place at one time.

Mini-exhibitions scheduled for December and January are:–

December 4th to 6th — Bench — Top power supplies.

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The National Microprocessor and Electronics Centre, is situated in the London World Trade Centre, close to the Tower of London. It is open Monday to Friday between 10.00 to 16.00 hours.

Readers interested should contact the ME Centre, London World Trade Centre, Europe House, London E1 9AA.

. . . COMMENT

A HELPING HAND

Under the above heading we give news from time to time of organisations connected with radio and electronics whose main concern is with helping others.

Second to none in this sphere is The Radio Amateur Invalid and Blind Club (R.A.I.B.C.) which was founded in 1954 and has been celebrating its Silver Jubilee during 1979.

Very briefly, the Club is made up of invalid and blind members interested in the hobby of Amateur Radio; their Local Representatives who undertake to help members by visiting them, assisting with repairs to and advice on equipment, and generally extending friendship; supporter members whose financial contributions enable practical help to be given.

The sole condition of membership in any of the above categories is an annual subscription of a minimum of £1.00 for 'Radial', the club news-letter which is issued every 6 weeks.

Some idea of the scope of the Club can be gained from a list of its officials — Chairman, Vice Chairman, Secretary/Editor, Treasurer, Membership Secretary, Tapes Manager, Technical Aids Organiser, Net Controller.

There are three club nets, G4IBC 80m, Cheshire Homes and the Birmingham Group. Each year a number of the handicapped members pass the R.A.E. and in due course acquire their call signs.

Glancing through 'Radial' one cannot but be impressed by the friendly and helpful nature of the Club as expressed by the activities reported and the news given of individual members.

The foregoing can only be a sketch of the good work done. Readers who would like to become associated with such worthwhile activity should write to the Honorary Secretary at the Club's HQ, 9 Rannoch Court, Adelaide Road, Surbiton, Surrey KT6 4TE.

3M ELIMINATES STATIC BUG IN CBS CASSETTES MANUFACTURE

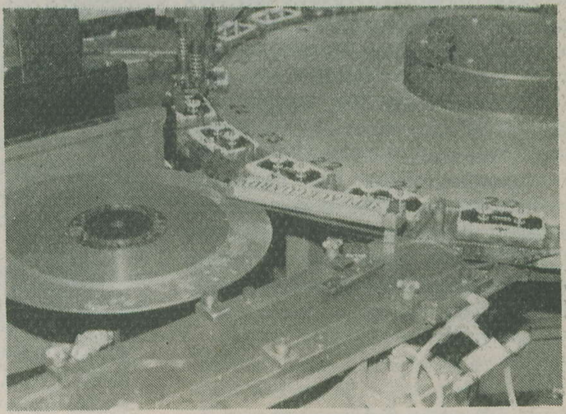
The recently opened highly automated 25,000 sq. ft. factory plant of C.B.S. Manufacturing, Bridgend, recognised as one of the most modern cassette production centres in Europe, had a problem.

With 13.2 million standard cassettes a year to be produced the elimination of any detrimental factor is of paramount importance.

In this instance the problem was an invisible one — static electricity. A build-up of static on the leader tape, where a length of 27 inches is used for each cassette, was resulting in the tape sticking during assembly procedure and slowing down the production line.

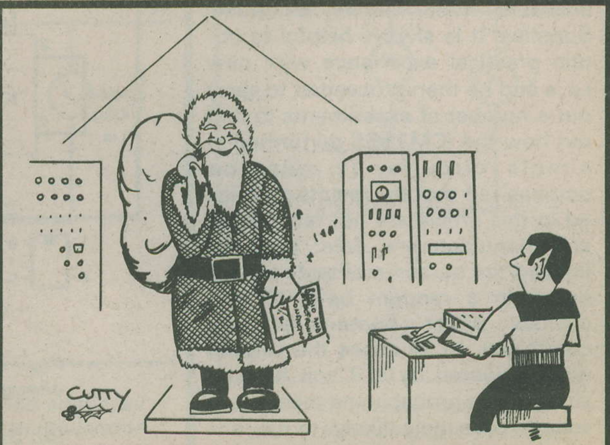
Following contact with 3M United Kingdom Limited, a 3M '210' static eliminator bar was introduced to the 'Rockford automatic assembly machine'. The static eliminator was positioned above the leader tape, this effectively neutralising any static charge present in the atmosphere prior to its entry into newly manufactured cassettes.

The 3M '210' static eliminator, is now giving a considerable saving in materials cost and offering greater production efficiency and has been in use at the Bridgend, Glamorgan, plant for the past four months.

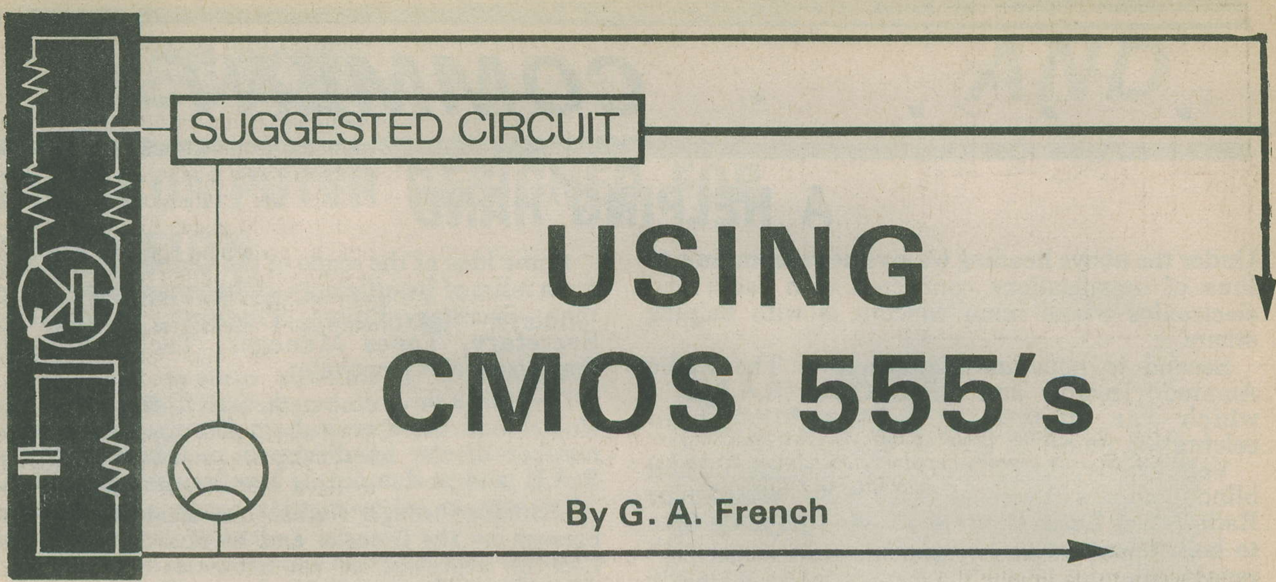


Positioned above the leader tape at C.B.S. Manufacturing, Bridgend, prior to it being incorporated into each newly produced cassette, the 3M Static Eliminator (marked 'replace guard') which prevents the tape sticking from static electricity build-up during assembly

Seasonal Greetings to all our readers



"O.K. Doctor Spock beam me down to earth"



USING CMOS 555's

By G. A. French

The CMOS 555 has now become available on the home constructor market. Known more properly as the ICM7555, it is fully pin-compatible with the well-established bipolar 555 i.c., but draws a much lower supply current. It is suitable for supply voltages from 2 to 18, and its output can drive both t.t.l. and CMOS devices. The trigger and threshold pins have much higher input impedances than do the corresponding pins in the 555. Whereas the 555 is capable of sinking or sourcing 200mA, the ICM7555 is specified as being able to sink 100mA with a supply of 18 volts.

Bearing in mind the widespread usage of the 555 the advent of the ICM7555 is of considerable interest to the electronics experimenter, and the author obtained a batch of these devices as soon as they first became available from Maplin Electronic Supplies. It is always helpful to obtain practical experience with new i.c.'s and he then proceeded to carry out a number of experiments to find out how the ICM7555 performed in simple circuits. It must be emphasised that the results described in this article are not taken from any manufacturers' data: they are instead the outcome of tests carried out with a random batch of the devices under home-constructor conditions. In all cases the circuits were powered by a 9 volt battery, since this is probably the most usual source of supply likely to be encountered in amateur applications.

SINK AND SOURCE

The first check to be made was of sink current performance, and the ICM7555 was consequently wired up in the circuit shown in Fig. 1(a). Pin 8 of the i.c. is connected to the positive rail as also, following usual practice, is the reset pin, pin 4. Pin 1 is the negative supply pin. Pin 2 is the trigger input for the internal comparator which responds to one-third of the supply voltage and pin 6 is the threshold input for the comparator which actuates at two-thirds of supply voltage. The output is at pin 3.

When the slider of the 10kΩ potentiometer in Fig. 1(a) takes pins 2 and 6 above two-thirds of the supply voltage, the output at pin 3 goes low. The output current sink performance at various output currents can then be found by adjusting the variable resistor (actually, two variable resistors switched in as required to cater for the lower and higher currents). Output current is indicated by the current-reading meter between the variable resistor and the positive rail, the corresponding voltage between pin 3 and the negative rail being monitored by the voltmeter.

Fig. 1(b) shows the results obtained with the ICM7555's checked by the writer. As sink current is increased from zero to 50mA, the voltage between pin 3 and the negative rail rises in fairly linear manner from zero to about 2 volts. Above 50mA the rate of voltage rise increases considerably, and the voltage is approximately 8 volts at 70mA. With a supply of 9 volts the useful sink current is therefore

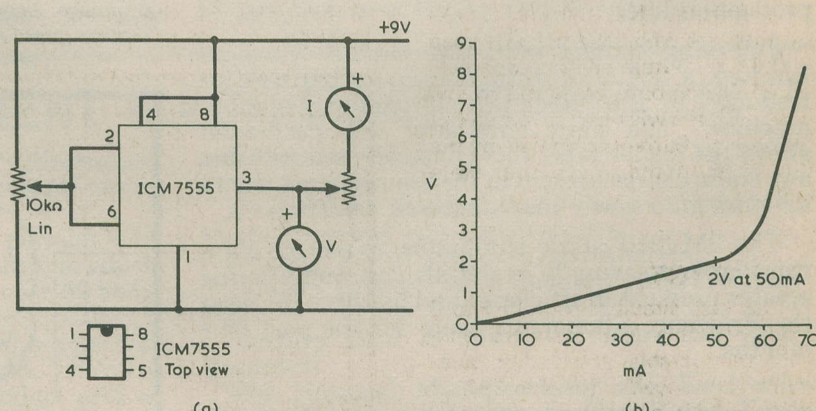


Fig. 1(a). A test circuit for checking the sink current characteristic of the ICM7555 when its output is in the low state
(b). Sink current-voltage curve for the devices checked by the author

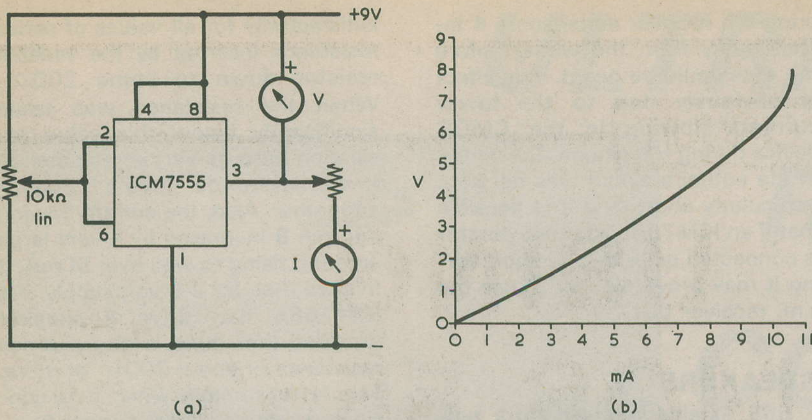


Fig. 2(a). The circuit employed for checking source current (b). Source current capability was found to be lower than sink current capability

about 50mA maximum, which would seem to tie in with the maximum of 100mA at a supply of 18 volts.

The circuit of Fig. 2(a) was next employed to find the source current characteristic. The output of the i.c. goes high when pins 2 and 6 are taken below one-third of supply voltage, and the variable resistor can then be adjusted for different current readings whilst the voltage between pin 3 and the positive rail is indicated by the voltmeter.

The curve of Fig. 2(b) illustrates source current performance. The current available is much lower than the sink current and the voltage dropped in the i.c. is about 3 volts at 5mA, rising to about 7 volts at 10mA. This low source current availability is perfectly acceptable for driving t.t.l. and CMOS logic. Although t.t.l. devices need a logical "0" input current of 1.6mA maximum per input, the input current for logical "1" is a matter of microamps only. At the same time, CMOS devices require extremely low input currents for both the "0" and the "1" states. Nevertheless, experimenters who have become used to the high output current capability of the 555 in both the high and low output states will need to remember that a high current is offered by the ICM7555 in the low output state only.

ONE-SHOT

The test circuit shown in Fig. 3 followed. This is a standard one-shot monostable application commonly employed with the 555. If the capacitor is discharged at supply switch-on, the output at pin 3 is high. As the capacitor charges the output goes low when the voltage across the capacitor reaches two-thirds of supply voltage. Also, the discharge pin, pin 7, then discharges the capacitor. The time delay in seconds is equal to 1.1 times RC, where R and C are in ohms and farads, or megohms and microfarads. The current drawn by the device in Fig. 3 is monitored by the current-reading meter, and the output state is indicated by the voltmeter which is returned to the positive rail. Any voltmeter current (which becomes significant in comparison with the tiny supply currents drawn by ICM7555!) is taken from the negative rail and should not have any significant effect on the current drawn by the i.c. from the positive rail.

The circuit behaved as it should, but it was found that it was rather "lively" insofar that device input current increased very noticeably if the author's hand was placed on or near the timing components or the i.c. itself. This effect is ascribed to the fact that the trigger pin 2 has no circuit connection made to it, whereupon this very high impedance input pin can pick up random noise or couple capacitively into other parts of the circuit. The ICM7555 is capable of working in microseconds and in consequence will offer gain at very high frequencies.

The current drawn by the device was approximately 50µA before and after the output transition, rising to a short-lived peak of about 2mA during the transition itself. The writer would guess that this peak is not a switching glitch, but corresponds to a period of r.f. instability as the threshold comparator passes through a linear state.

Since the circuit functioned quite satisfactorily the effect was not investigated further, but it would seem advisable, when using the ICM7555 in the monostable mode, to have fairly short wiring to the timing capacitor and to have as little metal area as possible in contact with pin 2. If the device is wired up on Veroboard it would be wise to cut the appropriate copper strip at the two holes immediately on either side of the hole to which pin 2 connects.

ASTABLE CIRCUIT

Next checked out was the standard astable circuit of Fig. 4. As with the 555, this has a frequency of oscillation which is equal, in Hz, to 1.46 divided by (RA + 2RB)C, where RA is the upper timing resistor (10kΩ in Fig. 4) and RB is the lower timing resistor (1MΩ). This calculates as 0.073Hz, and with a frequency as low as this it is possible to observe changes in currents and voltages with ordinary meters. It will be noted that the circuit causes both pin 6 and pin 2 to be coupled to the negative rail via the timing capacitor.

The circuit was perfectly stable in operation and oscillated at the correct frequency. Input current to pin 8 was about 50µA when the output was high and about 40µA when the output was low. At the output transition from low to high the input current merely increased to the

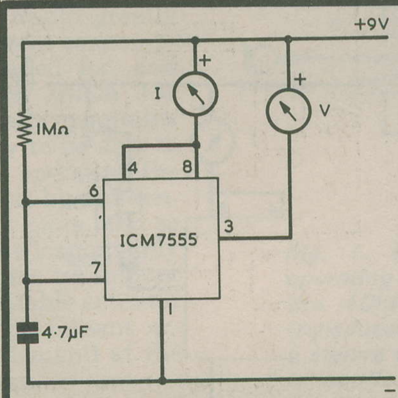


Fig. 3. The ICM7555 employed as a monostable multivibrator

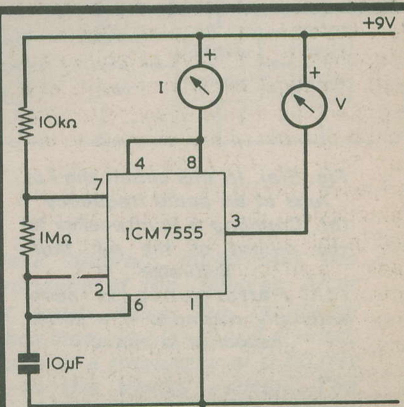


Fig. 4. An astable multivibrator with a low running frequency

higher value but at the transition from high to low the input current rose momentarily to a very brief proximately 60μA.

The timing capacitors employed in the circuits of Figs. 3 and 4 were plastic foil. They could just as well have been electrolytic components with low leakage currents.

The a.f. astable circuit of Fig. 5(a) was next made up, and this has a calculated frequency of 695Hz. The circuit performed exactly as it should and the current drawn from the 9 volt supply with no connection made to the output at pin 3 was approximately 60μA.

An old dodge for checking the operation of a 555 a.f. multivibrator is to hold an a.m. radio tuned to medium or long waves close to the multivibrator wiring. The radio will then pick up the transition pulses and reproduce the oscillation as an audio tone from its loudspeaker. This test not only shows that the multivibrator is running but also indicates its frequency. A 555 was fitted in the circuit (which employed an 8-way i.c. holder) and a medium wave receiver was set up such that the tone was just audible from its speaker when the receiver ferrite aerial was a foot away from the multivibrator wiring. The 555 was then removed, the ICM7555 refitted, and the check carried out again. This time it was necessary to bring the receiver aerial some 4 inches away from the wiring before the tone could be heard. This effect is obviously due to the lower currents flowing in the CMOS device during transitions. The wiring in the author's circuit was not kept particularly short, and it is possible that if an ICM7555 a.f. multivibrator is connected up with very short wiring it may prove difficult to use the a.m. receiver test.

SPEAKERS

555 astable multivibrators running at audio frequencies are often employed to drive speakers in bleeper circuits and the like, and it was decided to investigate the performance of the ICM7555 in this application. Since the available sink current is much greater than the source current the speaker was connected, in series with a 1kΩ wire-wound variable resistor, between the output of the i.c. and the positive rail as in Fig. 5(b). A 15Ω speaker was used, and the rest of the circuit was as in Fig. 5(a).

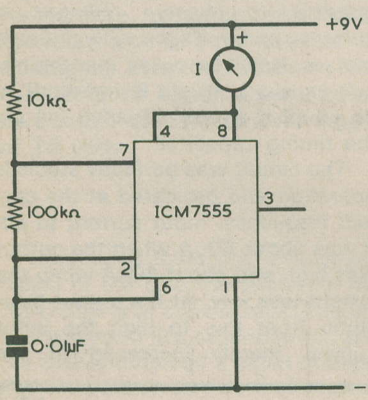
It is usually necessary to include resistance in series when a 555 output is coupled to a speaker, as the speaker inductance on its own can upset multivibrator operation. The same is true for the CMOS version. With the ICM7555 it was found that the speaker was driven satisfactorily for all values of series resistance inserted by the variable resistor down to some 200Ω. When the resistance was taken significantly below this value oscillation became very erratic and, at low resistance levels, ceased altogether. Also, the current flowing into pin 8 increased by a very large amount, rising to well over 50mA. It follows that, for a 9 volt supply, the ICM7555 can drive a speaker provided that there is also a series resistance of about 200Ω or more. This is reasonable when it is considered that the direct current flowing in 200Ω from a 9 volt source is 45mA. There was no change in operating frequency when the ICM7555 output was coupled to the speaker and a suitable series resistance.

When replaced by a 555 it was found that a much louder output could be obtained from the speaker. This is merely because the series resistance with a 555 can be reduced to a considerably lower value before oscillator operation becomes erratic.

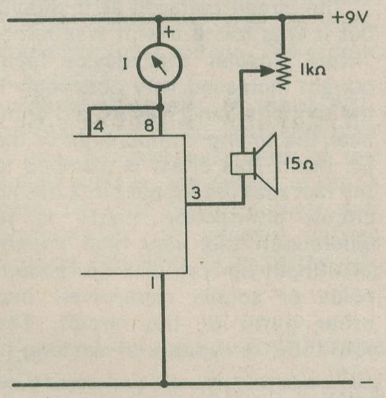
Finally, with the ICM7555 back in use, the effect of inserting a high value electrolytic capacitor in series, as in Fig. 5(c), was tried. This caused an almost surprisingly high degradation in oscillator performance, since it not only reduced the audible output but also altered oscillator frequency very noticeably as well. Presumably, the effect is due to the fact that the presence of the capacitor causes current to be drawn from the i.c. when its output is high whilst, without the capacitor, current is drawn by the speaker only when the output is low. The circuit of Fig. 5(b) is much to be preferred.

Summing up, it can be seen from these simple experiments that the ICM7555 is a very welcome newcomer to the array of i.c.'s available to the home constructor, its chief advantage being its very low supply current requirement. Although it is fully pin-compatible with the 555 it cannot be fitted directly into all 555 circuits, but the differences in characteristics can be readily catered for in initial circuit design work.

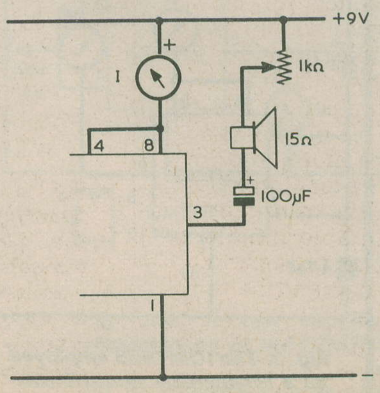
The ICM7555 appears to be as electrically robust as the bipolar 555. It is supplied in polystyrene foam in the same manner as bipolar devices and without pin short-circuiting material. The ICM7555 devices checked by the author were subjected to fairly rough electrical handling during the tests and were not in any way damaged as a result. ■



(a)



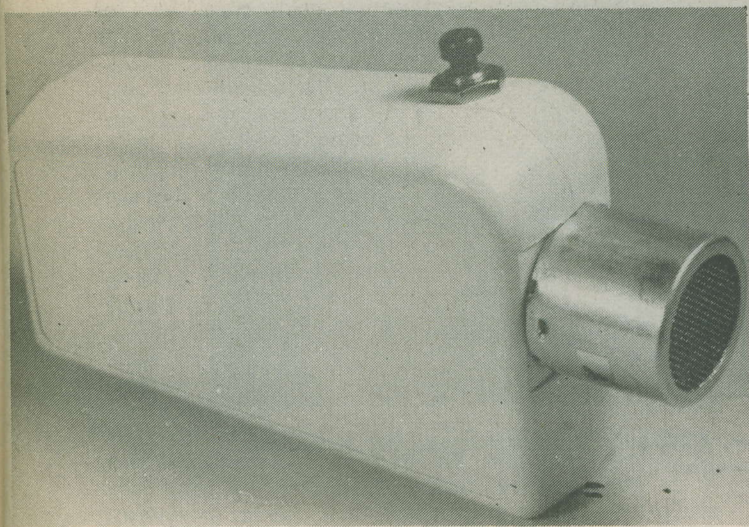
(b)



(c)

Fig. 5(a). In this circuit the i.c. runs at an audio frequency (b). Coupling a loudspeaker to the output of the a.f. multivibrator (c). Performance is considerably degraded if a series capacitor is added

ULTRASONIC REMOTE CONTROL



By
R. A. Penfold

Sequential on-off switching

Exceptionally low receiver consumption

Portable hand-held transmitter

This ultrasonic system was designed to meet the need for a remote control system which could be used to provide on-off switching for small battery powered equipment. The main requirement was for the ultrasonic receiver to have a very low stand-by current, as it would need to be continuously connected to a 9-volt battery and a current consumption of even just a few milliamps would greatly reduce the life of this battery. A current consumption of about $50\mu A$ or less was called for, and previous home constructor designs which the author has seen would seem to be totally unsuitable in this respect. It was also necessary to be able to switch the load on by momentarily operating the ultrasonic transmitter, to switch it off by momentarily operating the transmitter once more, and so on. Most previous systems switch the load on only while a signal is being received from the transmitter and need additional circuitry or a suitable actuator to provide sequential operation. The present arrangement results in a low power demand at the transmitter as well as at the receiver.

Fig. 1 shows in block diagram form the stage line-up finally adopted in the receiver. The output from the receiving transducer is amplified by a 3-

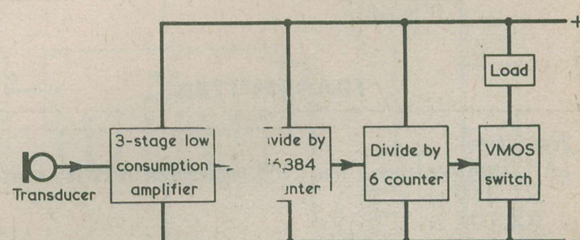
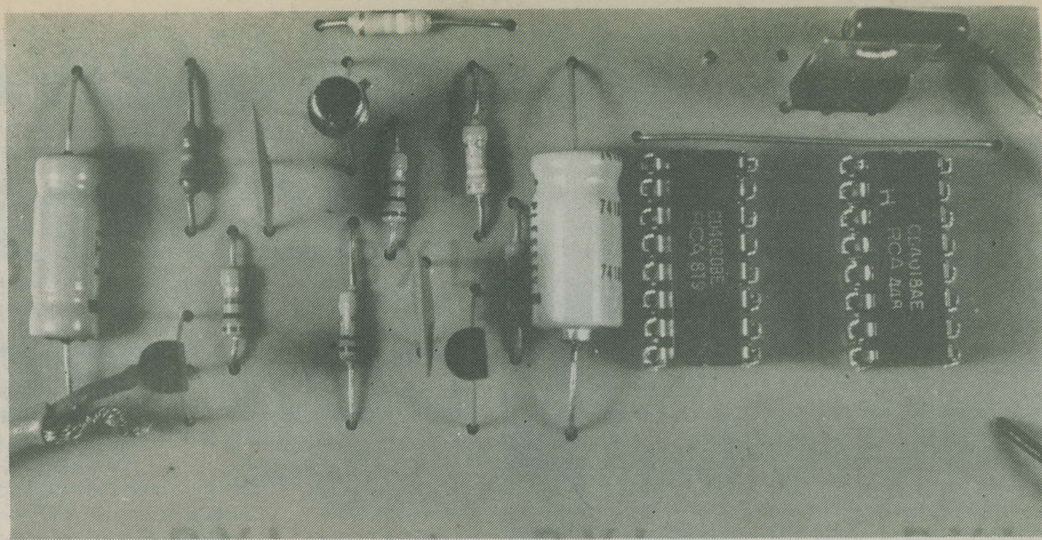


Fig. 1. Block diagram illustrating the operating principle of the receiver. After the 40kHz input from the receiving transducer has been amplified and divided, a square wave at a frequency of 0.407Hz is applied to the VMOS switch. The amplifier, logic and switch gating circuits consume a total current of about $33\mu A$ only



A close view of the receiver board. The two CMOS i.c.'s were plugged into soldercon connectors

COMPONENTS

RECEIVER

Resistors
(All ¼ watt 5% unless otherwise stated)
R1 10M Ω 10%
R2 270k Ω
R3 10M Ω 10%
R4 180k Ω
R5 390k Ω
R6 6.8M Ω 10%
R7 390k Ω

Capacitors
C1 2.2μF electrolytic, 10 V. Wkg.
C2 680pF ceramic plate
C3 680pF ceramic plate
C4 100μF electrolytic, 10 V. Wkg.
C5 0.1μF type C280

Semiconductors
IC1 4020
IC2 4018
TR1 BC650
TR2 BC179
TR3 BC650
TR4 VN88AF

Transducer
MIC1 40kHz transducer (see text)

Miscellaneous
9 volt battery
Phono plug (see text)
2-off 16-way i.c. holders or soldercon connectors (see text)
Materials for printed board
Wire, solder, etc.

TRANSMITTER

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 470 Ω
R2 100 Ω
R3 8.2k Ω
R4 22k Ω Pre-set potentiometer, 0.1 watt horizontal
R5 1.8M Ω 10%
R6 4.7k Ω
R7 680 Ω
R8 680 Ω

Capacitors
C1 0.022μF ceramic plate
C2 820pF polystyrene
C3 1,500pF ceramic plate

Semiconductors
TR1 TIS43
TR2 BC109
TR3 BC109

Transducer
LS1 40kHz transducer (see text)

Switch
S1 miniature push-button, press to make

Battery
BY1 9-volt battery type PP3

Miscellaneous
Verobox type 75-1799-E
Battery connector
Phono plug (see text)
Materials for printed board
Wire, solder, etc.

transistor common emitter circuit which is designed to have a very low current drain. Normally a 2-stage amplifier would give adequate gain, but the low collector currents that must be used result in the transistors having far lower gains than usual. Furthermore, the use of low collector currents tends to cause a greater loss of gain at high frequencies than at d.c. and low frequencies. Although the operating frequency of 40kHz is not particularly high, being not far above the upper limit of the audio frequency spectrum, it is quite high enough for this factor to significantly reduce the gain. Circuitry having two stages therefore proved to give insufficient gain, whilst a 3-stage circuit operating at a total current consumption of about 33μA was found to have adequate sensitivity.

The 40kHz output from the amplifier drives a 14 stage CMOS binary divider, which divides the frequency by 16,384 times. The output of this stage feeds a divide-by-six CMOS counter, giving a total division of 98,304 times. This last stage gives an output, therefore, of 0.407Hz, which is applied to the gate of a VMOS power device used in a switching mode. The VMOS device turns on when its gate goes positive and if the 40kHz input signal were maintained continuously it would be turned on for slightly more than a second, off for slightly more than a second, and so on. In practice of course, the transmitter is only turned on long enough to switch the load from the off to the on state, or vice versa, as appropriate. It would be possible to include circuitry which prevented the receiver from cycling back to its original state if the transmitter were accidentally operated for slightly too long, but this does not seem to be a problem when the system is actually being used and no circuitry of this kind is fitted to the final design.

The use of CMOS i.c.'s to perform the logic functions and a VMOS device to act as a switch means that no significant current is consumed by these stages in the receiver circuit.

RECEIVER CIRCUIT

Fig. 2 shows the complete circuit of the ultrasonic receiver. Apart from the high resistor values that are needed to produce the required low collector currents, the amplifier is a fairly conventional 3-stage capacitively coupled arrangement incorporating one p.n.p. and two n.p.n. devices. The transistors are high gain low noise types which work well with low collector currents. A direct coupled amplifier was also tried, but it gave inferior performance and reliability when compared with the a.c. coupled circuit. TR3 is biased by R6 so that only a low collector voltage is produced under quiescent conditions, causing the input of IC1 to be in the low logic state. Any reasonably strong input signal from the transducer will produce a large enough voltage swing at TR3 collector to drive IC1 reliably.

IC1 is the binary counter and all its fourteen stages are used, the outputs from the stages of the device before the last one being simply ignored. The reset input at pin 11 is tied to the negative rail as it is not needed in the present application. The divide-by-six stage uses a 4018 "divide-by-N" counter connected in the appropriate manner. This drives the inexpensive VMOS device, TR4, which is employed as a common source switch. TR4 and the load will be switched on when IC2 output is high, and will be turned off when it is low. TR4 can handle currents of up to about 200mA or so with little voltage drop, but for higher current loads, or a.c. loads, it is necessary to have TR4 operate a relay which in turn controls the load. If this is done it is essential to incorporate a protective diode across the relay coil, as shown in Fig. 3. The diode suppresses the high reverse voltage which would otherwise be generated across the relay coil as it is de-energised, and which could damage the semiconductors. The relay can be any type having a coil energise voltage of 6 to 9 volts, a coil

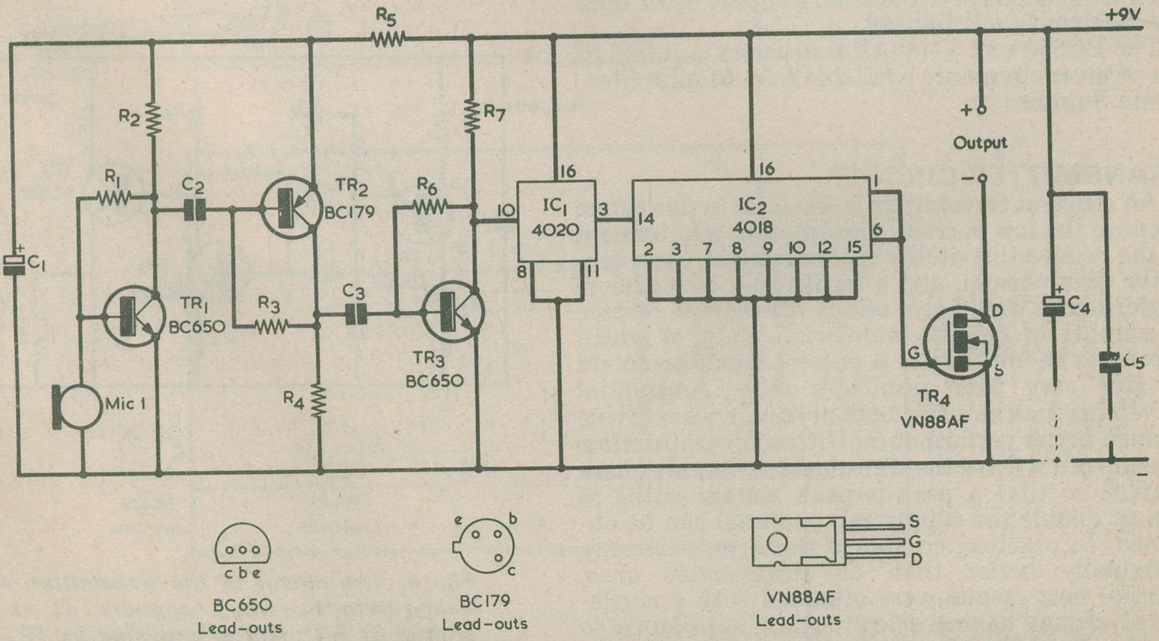
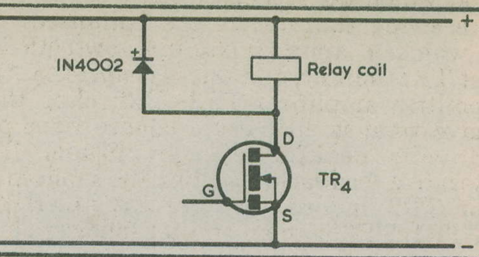
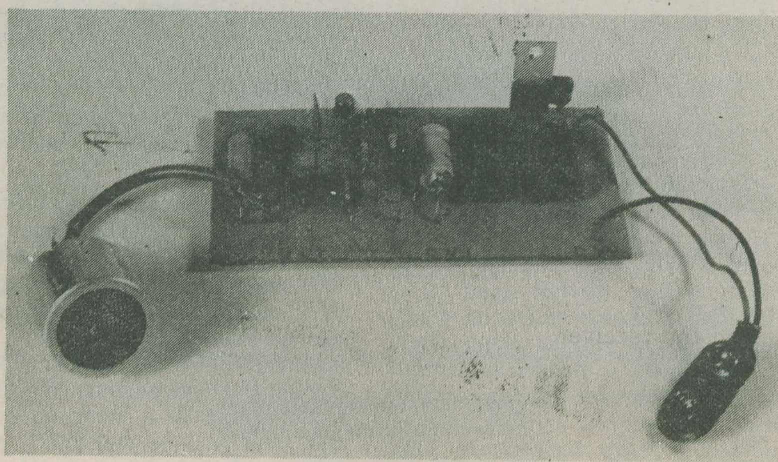


Fig. 2. The circuit of the receiver unit. TR1, TR2 and TR3 form the low consumption amplifier and are followed by IC1, a 14 stage binary divider, and IC2, which divides by 6. TR4 is the VMOS switch

Fig. 3. If the load switched by TR4 is a relay coil it is essential to add a protective diode across the coil





The receiver assembly. The receiving transducer connects to the printed board via a short length of screened cable

resistance of about 100Ω or more and contacts of adequate rating to control the intended load. If the relay contacts switch an a.c. mains circuit, the relay insulation must be adequate for mains voltages, and the negative supply rail of the receiver must be connected to the mains earth. As is described at the end of this article, TR4 may also control d.c. loads powered from a supply other than the receiver 9 volt battery.

The BC650 and VN88AF transistors required in the receiver circuit are available from Maplin Electronic Supplies.

TRANSMITTER CIRCUIT

An efficient transmitter is essential in this sytem because the low current consumption requirement of the receiver inevitably makes it slightly less sensitive than normal, and a transmitter of mediocre performance would give totally inadequate results. A number of circuits were tried, most of which proved to be ineffective. A pulsed signal was found to give very poor results, a more substantial waveform such as a sawtooth or square wave giving a much better performance. Ultrasonic transmitter circuits often drive the transducer from anti-phase outputs so that a peak-to-peak voltage swing of almost double the supply rail potential can be obtained. In practice, circuits of this type work only marginally better than do single-ended ones. Indeed, best results were obtained with a single-ended circuit having a low output impedance so that loading by the transducer does not significantly reduce the peak-to-peak output voltage swing. A double-ended low impedance output circuit can offer a small further improvement in range, but not by enough to justify the increased cost and complexity involved. The circuit of the transmitter finally employed appears in Fig. 4.

The 40kHz signal is generated by a standard unijunction relaxation oscillator incorporating TR1. This can be tuned by means of R4 to the precise

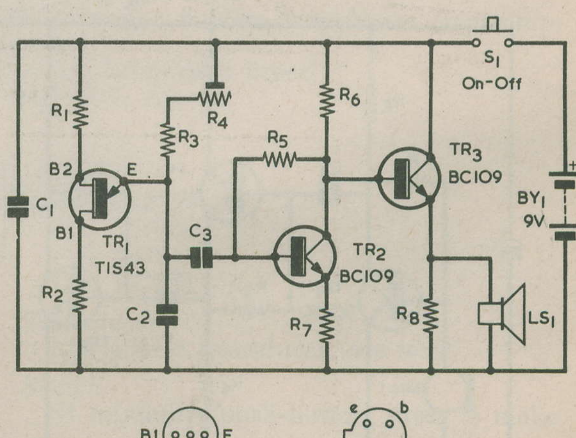


Fig. 4. The circuit of the transmitter. A near-sawtooth wave appears at the emitter of TR1 and is amplified by TR2, with TR3 producing a low impedance output. R4 is adjusted to bring transmitter frequency to the peak level for the pair of transducers employed

frequency at which the responses of the transmitting and receiving transducers are optimised. A waveform which is approximately a sawtooth is available at TR1 emitter, and this is coupled to the common emitter amplifier, TR2. TR2 clips the signal to give what is virtually a square wave of about 7.6 volts peak-to-peak amplitude. R7 provides negative feedback, boosting the input impedance of TR2 in order to prevent excessive loading on TR1. TR3 is in an emitter follower output buffer stage which gives a low impedance drive to the 40kHz transmitting transducer, LS1. The transducers are both piezoelectric devices which have very high resistances, and which do not therefore require series d.c. blocking capacitors. Various makes of 40kHz ultrasonic transducer are available at present and, although not checked by the author, any of these should work well in this system. Some types have identical transmitting and receiving units, but with others the two transducers are slightly different and optimum results will not be obtained if they are transposed. Where appropriate, the retailer's literature should make it clear which transducer should be used in the transmitter and which in the receiver.

The transducers used in the author's prototype were obtained from Ace Mailtronix Limited, Tootal Street, Wakefield, West Yorkshire, WF1.

RECEIVER CONSTRUCTION

Apart from the transducer the receiver components are all mounted on a printed circuit board, as detailed in Fig. 5. Other forms of construction could be used if preferred, but the layout of the amplifier section of the unit is inevitably rather critical, and a well conceived component layout is essential if instability is to be avoided. IC1 and IC2 are CMOS devices and the normal handling precautions should be observed when dealing with these components. If desired, they may be fitted into i.c. holders or soldercon connectors. The connection to the receiving transducer is made via a screened lead. Some transducers are fitted with a phono socket at the rear, the connection to the component then being made by way of a phono plug. Others simply have two pins to which soldered connections are made.

The receiver printed board can be housed in a suitable plastic or metal cabinet, or it may be fitted in the same case as the circuit which it controls.

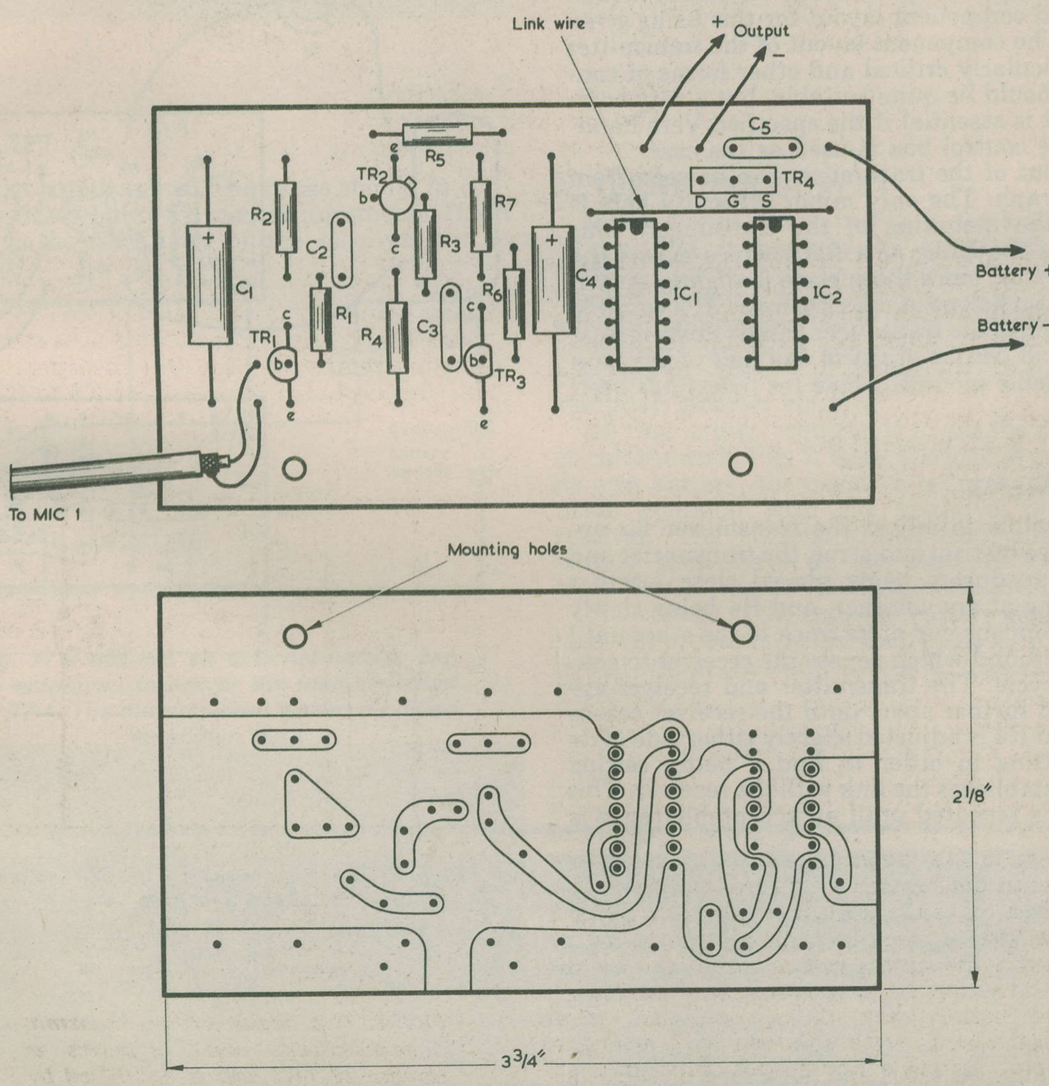
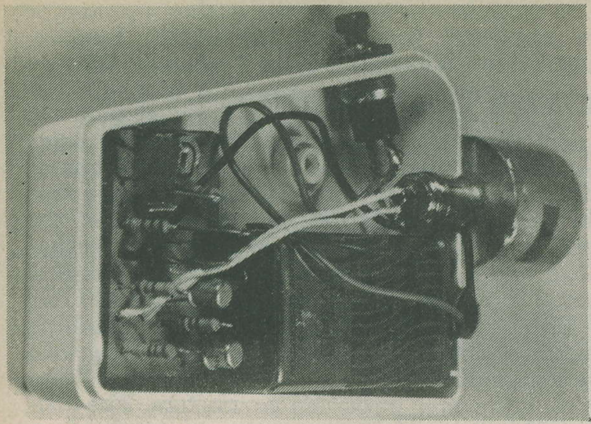


Fig. 5. The receiver is assembled on a printed circuit board with the layout given here. The board is reproduced full size for tracing



Layout inside the transmitter case. The push-button and printed board are mounted in one half of the case, to the front end of which the transducer is secured by means of adhesive

The 9 volt battery can be any type which the constructor feels will be adequate for the particular application involved.

TRANSMITTER CONSTRUCTION

Most of the transmitter components are assembled on a small printed circuit board, the foil pattern and component layout for this being given in Fig. 6. The component layout of the transmitter is not particularly critical and other forms of construction should be quite suitable, but a very compact layout is essential if the specified Vero hand-held plastic control box is used as the case.

The layout of the transmitter can be seen from the photograph. The only minor difficulty here is given by the mounting of the transducer. This necessitates the filing of a flat surface across the front of the box, since the surface is slightly angled where the two halves of the case meet. If a suitable area is filed flat the transducer will fit flush against the case, and can be glued to one half of the case after a suitable mounting hole (or holes) has been drilled.

ADJUSTMENT

It is possible to adjust the transmitter for optimum range by trial and error, the transmitter and receiver transducers being placed close together and pointing at one another, and R4 being slowly adjusted from one end of its track to the other until a setting is found which causes the receiver to continuously cycle. The transmitter and receiver are then moved further apart until the receiver ceases cycling, and R4 is adjusted slightly either side of its present setting in order to find a better setting which re-establishes the link with the receiver. This procedure is repeated until an acceptable range is obtained.

There is a much quicker method if a multimeter having a sensitivity of 20kΩ per volt or better is available. This is set to a 10 volt range (or some similar low volts range) and is connected between TR3 collector and the negative supply rail at the receiver. R4 is then simply adjusted for maximum meter reading. For this adjustment the transmitting and receiving transducers should be positioned about 1 or 2 metres apart and not aimed directly at one another, so that only a fairly modest input

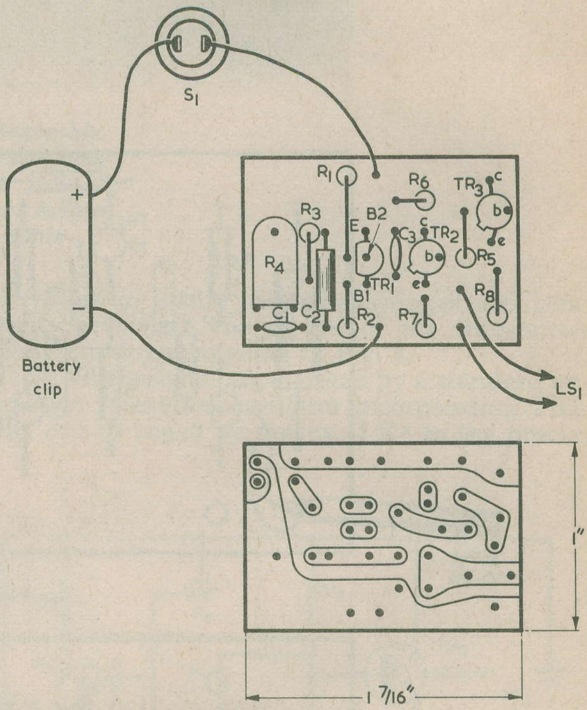
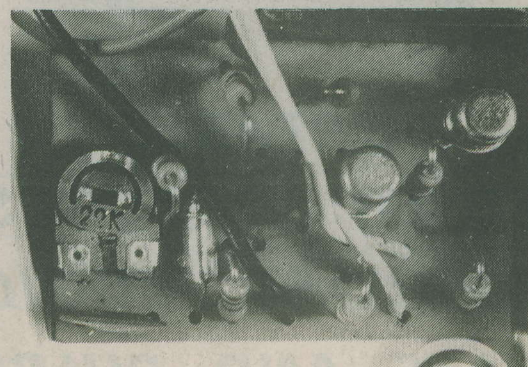


Fig. 6. The transmitter printed circuit assembly. This has to be small and compact in order that it may fit into the case specified

signal is obtained at the receiver. Otherwise the receiver will be saturated even with R4 well off tune, and there will be no setting which produces a definite peak.

The range of the system is reasonably large, being up to about 5 metres before the physical alignment of the two transducers becomes too critical, but ultrasonic systems are normally used only for short range applications. The range should in consequence be adequate for most requirements. If felt necessary, the sensitivity of the receiver can be boosted by reducing the value of R5, and it can even be replaced by a link wire if the highest possible sensitivity is required. A reliable range of up to about 10 metres can then be obtained, which is as good as virtually any other ultrasonic system. However, the current consumption of the receiver will be substantially increased, being about 90μA with R5 at zero resistance.

The transmitter board. Although small in size this still takes the transmitter components comfortably with adequate spacing



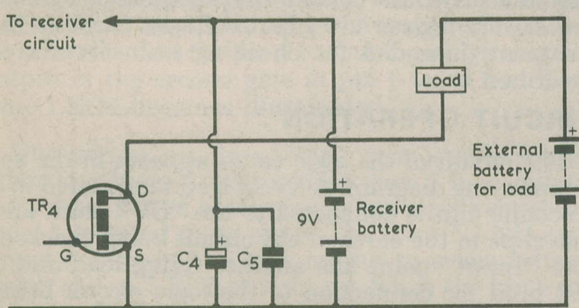


Fig. 7. If desired, an external battery can be employed to power the load switched by TR4. The output circuit is then modified as shown here

ALTERNATIVE SUPPLY

In the circuit shown in Fig. 2, the load switched on by TR4 is powered by the receiver 9 volt battery. There will be applications where this method of control is unsatisfactory, either because a load supply voltage other than 9 volts is required, or because the load supply current is high and prevents the use of a small battery for the low consumption receiver circuits.

All that is then required is to use the alternative circuit shown in Fig. 7. Here, the load is powered by its own battery, the negative terminal of which is made common with the negative rail of the receiver. The current drawn from the receiver battery then stays at the same very low level regardless of whether the load is switched on or off.

The voltage of the external battery supplying the load will probably be less than some 20 volts, which is well within the drain-source voltage rating of the VN88AF.

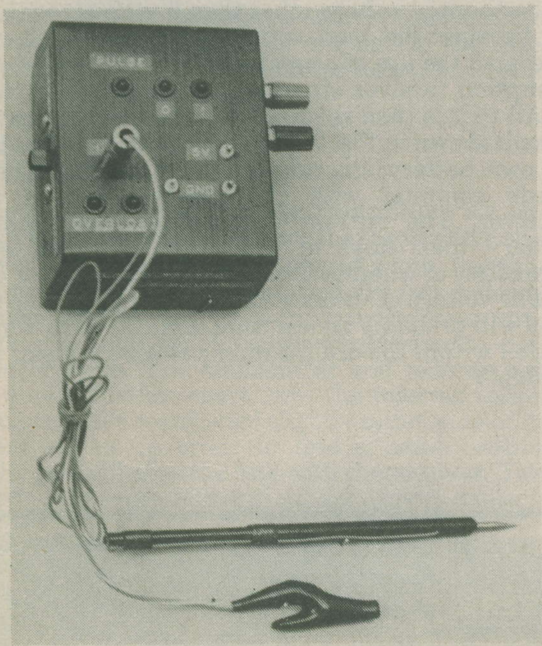
■

LOGIC TESTER

By

Peter Roberts

PORTABLE TESTER DETECTS OVERLOAD, LOGIC STATE AND PULSE VOLTAGES IN T.T.L. CIRCUITS.



The prototype logic tester. One of the three test points on the front panel connects to the positive supply and the other two to the negative supply. Switch S1 is on the side opposite the two external supply terminals

Digital techniques involve two voltage levels, often called "high" and "low" or "1" and "0". The use of only two levels gives logic circuits a high degree of noise immunity, particularly in the transmission of data.

When building logic circuits of any complexity, some method of testing the designs becomes a necessity. Possible checking instruments are the oscilloscope and the testmeter. The oscilloscope is very expensive for the purpose and is not always the best method for measuring d.c. voltages, particularly if its calibration is in doubt. However, it can show a train of pulses very nicely. On the other hand a meter can indicate static high or low logic levels but not a train of pulses. Nor can it give reliable readings of high or low levels in the presence of pulses.

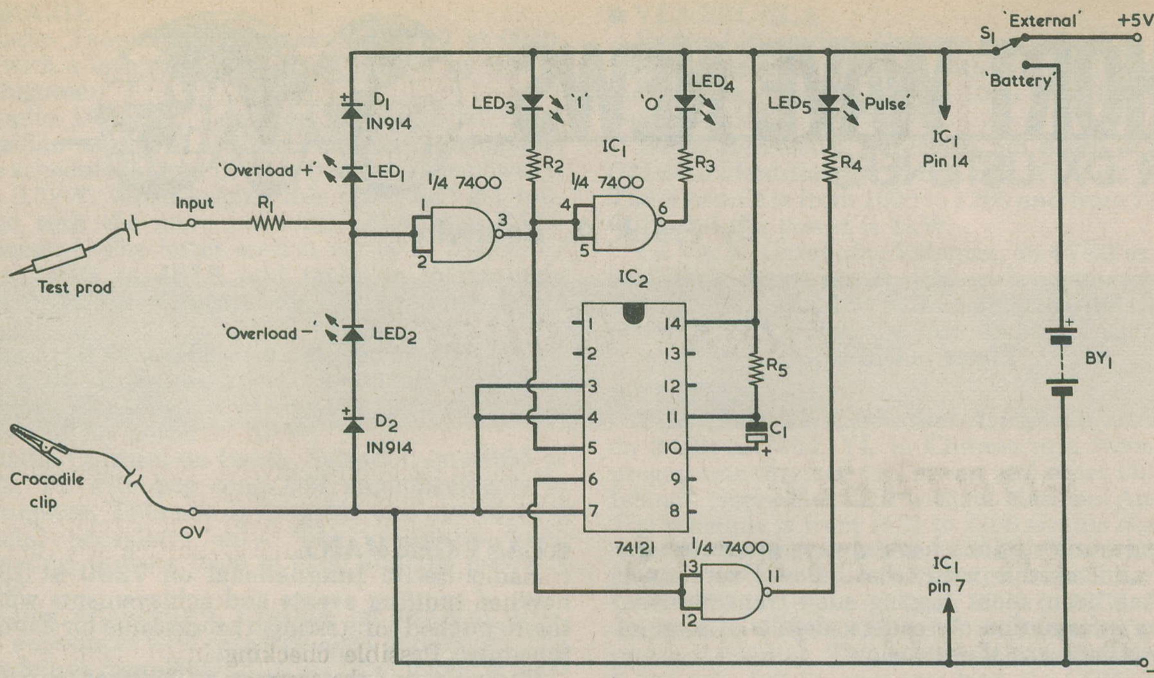
What is required is an instrument that gives a definite reading of high or low as well as indicating the presence of as little as a single pulse. Ideally, it should also include some form of protection against excessively high or low input voltages. Such an instrument, intended for checking t.t.l. circuits, is described here.

CIRCUIT OPERATION

The circuit of the logic tester appears in the accompanying diagram. A flying lead terminated in a crocodile clip is connected to the "OV" point and this clips to the earth of the circuit being checked. The "Input" point has another flying lead and a test prod for connection to the logic circuit being checked. Switch S1 selects a supply for the instrument. When set to "External", the instrument can obtain a 5 volt supply from the equipment being checked or from a suitable power supply unit. Setting S1 to "Battery" causes the instrument to be supplied by its own internal battery.

R1 is an input limiting resistor and it serves the dual purpose of input protection and limiting the current through the overload warning indicators, LED1 and LED2. If the input voltage exceeds the nominal VCC supply potential of 5 volts by the forward voltage drops of D1 and LED1 in series, LED1 lights up. Should the input go negative of earth by more than the forward voltage drops in D2 and LED2, LED2 turns on. Diodes D1 and D2 protect the overload indicating l.e.d.'s from reverse voltages which may exceed the specification of some devices. The value of R1 should not be increased to give added protection as this would prevent the rest of the circuit from responding to the various input voltages.

The logic tester employs three inverters, these



The circuit of the logic tester. LED1 and LED2 indicate overload whilst LED3 and LED4 show logic voltage state. LED5 lights up in the presence of one or more pulses

consisting of 2-input NAND gates with their inputs strapped. The three gates are part of a quad NAND gate type 7400, no connections being made to the unused fourth gate. If the "Input" test prod connects to a logic point which is high, the output of the first inverter at pin 3 of the 7400 goes low and LED3 lights up. Connecting the test prod to a low logic level causes the pin 3 output to go high and the output of the second gate at pin 6 to go low. This time LED4 becomes illuminated.

The second i.c. is a 74121 monostable multivibrator which is triggered to give a high output for a short period at its pin 6 when a positive-going pulse is applied to its pin 5. The third NAND gate inverter changes the high output to a low voltage which causes LED5 to light up. Since the pin 5 input is derived from the first inverter, the monostable fires for a negative-going pulse at the "Input" test prod.

The length of the monostable on period is governed by C1 and R5, and the monostable can be fired by a single pulse at the "Input" prod. A train of pulses spaced at less than the monostable period causes LED5 to remain alight virtually continuously.

The internal battery can be a 4.5 volt torch battery or a 6 volt battery made up from four 1.5 volt cells in series. A good choice consists of four HP7 cells, which may be fitted in a small battery holder. Current consumption is of the order of 25mA.

The author's logic tester is assembled in a plastic box measuring about 4 by 3 by 2¼in., and has the five l.e.d.'s mounted on the front panel. The "In-

Continued on Page 287

COMPONENTS

Resistors
(All ¼ watt 10%)

R1 220 Ω
R2 220 Ω
R3 220 Ω
R4 220 Ω
R5 18k Ω

Capacitor

C1 10μF electrolytic, 10V. Wkg.

Semiconductors

IC1 7400
IC2 74121
D1 1N914
D2 1N914
LED1-LED5 red l.e.d.'s

Switch

S1 s.p.d.t. slide or toggle

Battery

BY1 (see text)

Miscellaneous

Case (see text)
Test prod
Crocodile clip
3.5mm. jack plug
3.5mm. jack socket
Insulated terminal, red
Insulated terminal, black
5 panel-mounting bushes
(for LED1 to LED5)
Wire, solder, etc.

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

Clandestine stations have always interested the writer and together with other fellow Dxers much time has been spent logging such transmissions. For the information of readers, details of some of these stations are shown below.

● VOICE OF THE MALAYAN REVOLUTION

This one operates in various languages such as Chinese (and Chinese dialects), Malay and Tamil but also in English. The English transmissions are from 0930 to 1015, 1450 to 1530 on **11830** and **15790**. The programme content is pro-Peking, anti-Malaysia and Singapore Governments. The transmitters are thought to be located near Changsha in Hunan Province, China.

● VOICE OF THE PEOPLE OF BURMA

This station is pro-Peking in policy and is the voice of the Burmese Communist Party. Thought to be located on or near the Burma/Chinese border, it operates in Burmese, Standard Chinese, Shan and Jingpaw from 0030 to 0130 and from 1200 to 1300 on **5110** and from 1030 to 1130 on **6304** (in Burmese only) but the timings of this latter transmission varies according to a monthly pattern, that shown being correct for February, April, June, August, October and December. Identification in Burmese is "Myama-pye Pey-Thu Ahthan".

● RADIO 8-1

Radio 8-1 ("Ba Yi") has been reported on **12120** at various times from 1230 to as late as 1630 with transmissions attacking the policies of the Peking government, particularly with respect to Vietnam. The transmitter is thought to be one of the Russian 'black' clandestines operating on the Chinese border and purporting to represent the views of the People's Liberation Army. Such broadcasts are usually of 10 minutes duration in order to dodge the jammers!

● HUNGARY

Radio Budapest on **7200** at 1930, OM with station identification at the commencement of the German programme for Austria, scheduled on this channel from 1930 to 2000.

● CZECHOSLOVAKIA

Radio Prague on **7245** at 1911, YL with identification after the news in the English programme for Europe, scheduled from 1900 to 1930.

● EAST GERMANY

Radio Berlin International on **7260** at 1840, news of sporting events and achievements within the Republic in the English programme for Europe, scheduled from 1800 to 1845.

Radio Berlin International on **7300** at 1915, OM with identification at the commencement of the Portuguese programme for Europe and Central Africa, scheduled from 1915 to 2000.

● CANADA

Radio Canada on **7130** at 1902, OM with the local news in English for Europe, scheduled from 1900 to 1930. This is a BBC relay from Daventry.

● INDIA

AIR (All India Radio) Delhi on **11620** at 2000, OM with the local news in English after identification in the English programme for North and West Africa, West Europe and the U.K., scheduled from 1945 to 2045.

● U.S.S.R.

Radio Moscow on **7250** at 1830, OM with a newscast in English in the World Service. Also in parallel on **7185** and **7280**, the latter channel being best for reception here in the U.K.

● ISRAEL

Jerusalem on **11655** at 2030, YL signing off the English programme for Europe after the news headlines, this being followed by the French programme. The English programme is scheduled from 2000 to 2030.

● CLANDESTINE

Voice of the Malayan Revolution on **15790** at 1400, military music, YL announcer in Chinese. This is a pro-communist transmitter — see opening paragraphs.

● WEST GERMANY

Deutsche Welle on **7285** at 0128, OM with identification after a newscast in the English programme for Asia, scheduled from 0120 to 0220.

● ALBANIA

Tirana on **7120** at 0134, YL with a newscast in the English programme for North America, scheduled from 0130 to 0200.

● ITALY

Rome on **7275** at 2025, YL with identification and news in the Arabic programme for Morocco and Algeria, scheduled from 2025 to 2045.

● BRAZIL

Radio Tabajara on a measured **4797** at 0040, YL with a love song, local pops, after it by OM in Portuguese.

Radio Difusora, Londrina, on **4815** at 0044, Brazilian pops, OM announcements in Portuguese, The schedule is from 0900 to 0400 and the power is just 0.5kW. When logging this one, don't get confused with the more powerful Colombian Radio Guatapuri. The latter station varies in frequency from **4815** to **4818** and tends to increasingly 'block' Radio Difusora as the morning hours progress.

Radio Clube do Para, Belem, on **4855** at 0054, OM with an excited sports commentary in Portuguese. The schedule of this one is from 0800 to 0400 and the power is 10kW.

Radio Cultural da Bahia, Salvador, on **4895** at 0102, YL with pop song, OM announcements in Portuguese, This one is irregular and operates on special occasions only. The schedule, when operating, is from 0800 to 0400 and the power is 10kW.

Radio Anhanguera, Goiania, on **4915** at 0107, OM announcer with recorded local pop music. The schedule is from 0900 (Sunday from 1000) to 0400 and the power is 10kW. Signal mixed with that of R. Dif. de Macapa, another Brazilian.

Radio Borborema, Campina Grande, on **5025** at 0113, OM announcements in Portuguese, Brazilian discomusic. The schdule is from 0830 to 0400 and the power is 1kW.

● DOMINICAN REPUBLIC

HISD R. TV Dominicana, Santo Domingo, on a measured **5966** at 0138, OM with announcements in Spanish, including local addresses, OM pop song and local pops. The schedule is from 0930 to 0400 and the power is 50kW.

● COLOMBIA

La Voz de los Centauros (HJOQ), Villavicencio, on **5955** at 0133, OM announcements in Spanish, short excerpts light orchestral music — but mostly talk! The schedule is around the clock and the power is 5kW. The frequency of this one is apt to vary up to **5960**.

● GUATEMALA

Radio Mam, Cabrican, on **4825** at 0047, OM with a sports commentary in Spanish. This one operates in Spanish and vernacular and is on the air from 2200 to 0300, the power being 1kW.

● SURINAM

SRS Paramaribo on **4850** at 0050, YL with pop song, OM with announcements in Dutch. The schedule is from 0815 to 0330 and the power is 10kW. Reported closing sometimes as late as 0530, languages used are English, Dutch, Spanish and Indonesian.

● VENEZUELA

Radio Libertador, Caracas, on **3245** at 0020, OM announcer in Spanish with recorded local pop music. The schedule is from 1000 to 0400 and the power is 1kW.

Radio Barcelona, Barcelona, on **3385** at 0046, OM with identification in Spanish, YL with ballad. The schedule is from 1000 to 1200 and from 2100 to 0400 and the power is 1kW.

La Voz de Carabobo, Valencia, on **4780** at 0037, local-style dance music, OM with commercials in Spanish. The schedule is from 1000 to 0400 and the power is 1kW. This one also identifies as "Onda Nueva" on occasions.

● CHINA

PLA (People's Liberation Army) Fujian Front on **3400** at 2054, YL in Chinese in a Network 2 programme directed to Taiwan and other Offshore Islands. Sign-off at 2101 without National Anthem. The schedule is from 1131 to 2100 on this channel.

Radio Peking on **3360** at 2110, YL in Chinese (Amoy) in the Taiwan Service, scheduled here from 1000 to 1900 and from 2000 to 0130.

Lhasa on **4750** at 2318, YL with instructions for physical training. This transmission was thought at first (early July) to emanate from the CPBS Hulun Boir, Heilongjiang, station which is only rarely reported. Now thought to be Lhasa in agreement with other Dxers.

Nanning on **4905** at 2028, Chinese opera replayed from Radio Peking Domestic Service 1. The schedule is from 1100 to 1735 and from 2000 to 2300.

● EQUATORIAL GUINEA

Radio Ecuatorial, Bata, on a measured **4926** at 2130, OM identification "La Voz del Partido", anthem and sign-off after programme of local music. The schedule is from 0430 to 0630, 1000 to 1600 and from 1700 to 2140 (Saturdays until 2300). The power is 5kW.

● NIGERIA

NBC Benin City on a measured **4932** at 2335, local-style music and songs — very rhythmic! The schedule is from 0430 to 2305 in both English and vernaculars but has been reported closing as late as 2345. The power is 10kW.

VON (Voice of Nigeria) Lagos on **4990** at 0430, sign-on in English, time-check, programme review and religious service. The schedule is from 0430 to 1000 and from 1700 to 2305 in English and vernaculars. The power is 20kW.

● NOW HEAR THIS

Radio Alfonso Padilla Vega, Padilla, Bolivia, on **3480** at 0147, OM's with a local-style pop song. Schedule varies from 2215 to 0245, 2315 to 0315. Frequency varies from **3478** to **3488**. The power is 0.3kW.

LOGIC TESTER *Continued from Page 285*

put" and "OV" test leads connect to a 3.5mm. jack plug which fits into a jack socket on the panel. Also provided are terminals on one side which allow connection to the external supply, and test pins on the front panel (not shown in the circuit) for supply voltage monitoring and similar purposes. Construction and layout are not at all critical, and any reasonable method of assembly may be employed.

The test prod was made from a stylus used for writing on duplicating stencils. It should be available from most good stationers very cheaply. ■

'RING OF LED's' PRINT TIMER

By P. R. Arthur

● *Ideal attention-catching presentation.*

● *Unique display indicates 8 segments of timing period.*

This timer is designed to provide accurate timing for the development of photographic prints. It is primarily intended for dish development, but there is no reason why it should not be used with other equipment, such as colour drums, if required.

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1-R4 4.7MΩ pre-set potentiometer (see text)
R5 6.8kΩ
R6 3.3kΩ
R7 1kΩ
R8 100Ω
R9 18kΩ

Capacitors
C1 0.1μF type C280
C2 1.5μF type C280
C3 0.047μF type C280

Semiconductors
IC1 555
IC2 4022
D1-D8 T1L209 with panel-mounting bushes

Switches
S1(a)(b) 2-pole 2-way miniature rotary
S2 1-pole 4-way miniature rotary

Miscellaneous
9 volt battery, PP3 or PP6
Battery connector
Verocase type 75-1238-D
Veroboard, 0.1in. matrix
2 control knobs
16-way d.i.l. socket (if required)
Wire, solder, etc.

The unit is unusual for a photographic timer because it does not simply give an audible or visual warning at the end of the timing period but has, instead, a ring of eight l.e.d.'s which light successively in clockwise order during the period. The ring of l.e.d.'s display is easily seen in both good and poor lighting conditions, The required development time is indicated by one complete lap, or "revolution", of the light around the ring of l.e.d.'s and this avoids the confusion which can occur when timing by watching the sweep second hand of a clock. One may, in the dark, be unsure whether the second hand is on the first or second time round. The prototype gives nominal timing periods of 1, 2, 3 and 4 minutes, but these periods can be modified to suit individual requirements.

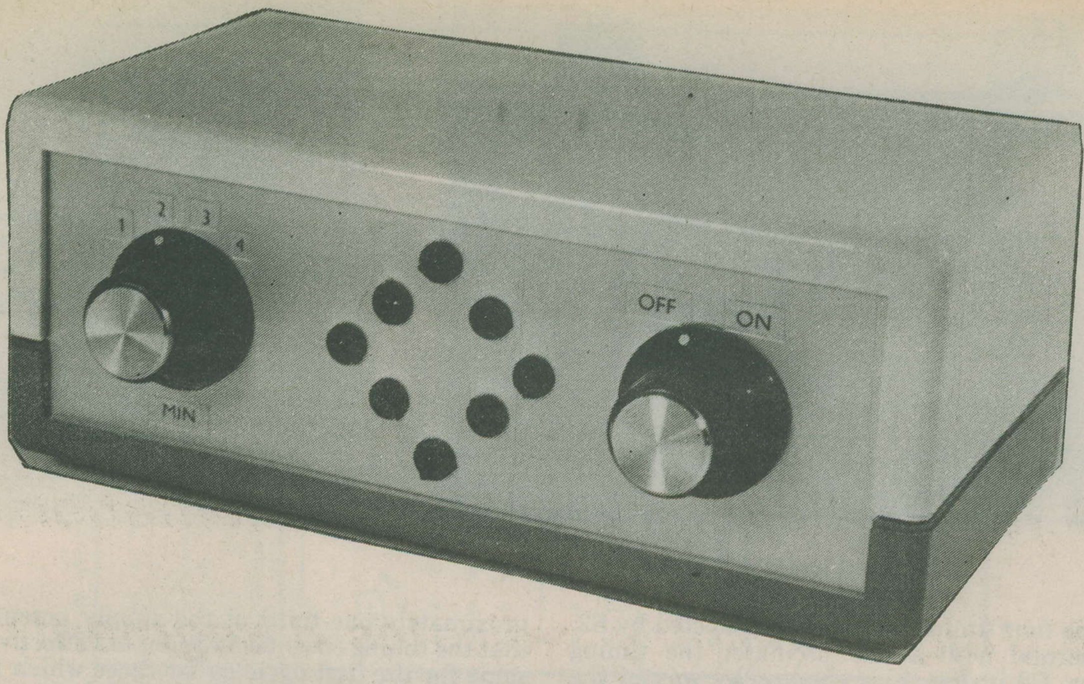
The ring display has the further advantage, when compared with conventional electronic timers, of indicating the approaching end of the development time. This enables one to prepare for the next processing stage. After the set time the display continues to cycle until the unit is switched off, and the subsequent cycles, can, if desired, be used for timing later processing stages.

In use, the timer is very convenient and gives good results. Like most other timers it has possible applications other than its intended one. It could for instance be employed for timing STD telephone calls, and there are without doubt many other applications.

THE CIRCUIT

The circuit of the timer is shown in Fig. 1, and it consists basically of a clock oscillator, IC1, feeding a divide-by-eight counter, IC2, which drives the eight l.e.d.'s in the ring. The "0" to "7" outputs of the counter go high successively with each positive-going input pulse edge from the clock.

The clock oscillator employs a 555 in the astable



The ring of l.e.d.'s appears on the front panel of the timer. The top l.e.d. lights up at the start of the timing period, then extinguishes as the next l.e.d. turns on. The l.e.d.'s become illuminated in turn in clockwise order and the timing period is at an end when the eighth l.e.d. gives way to the first one in the ring

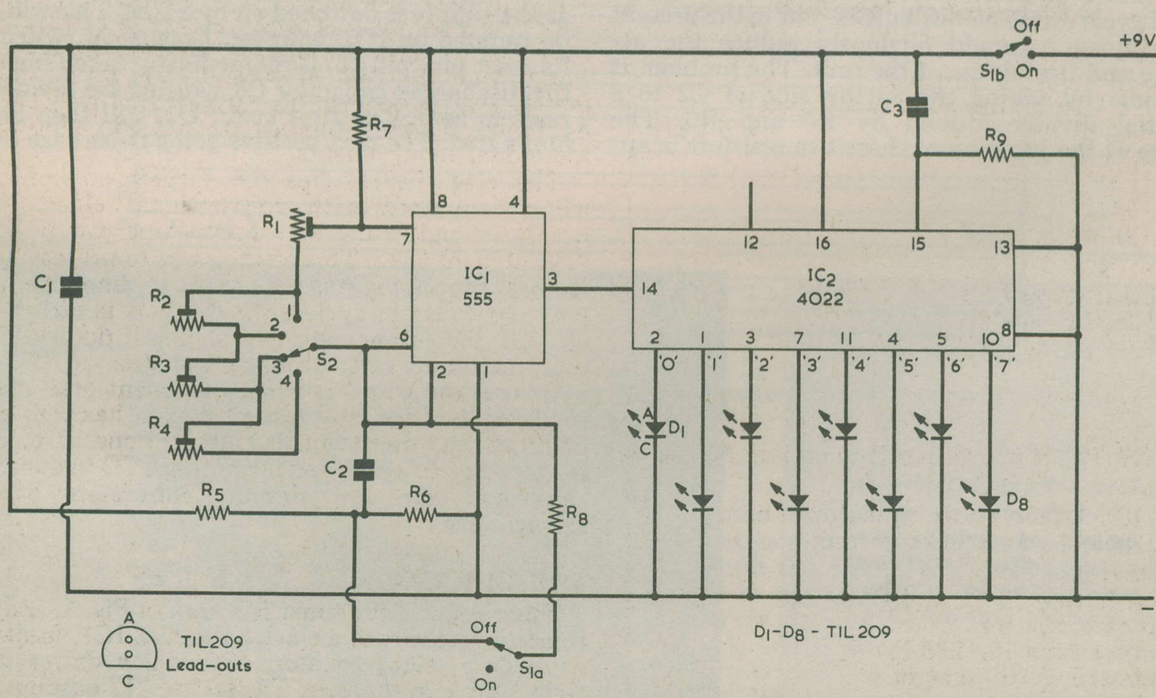
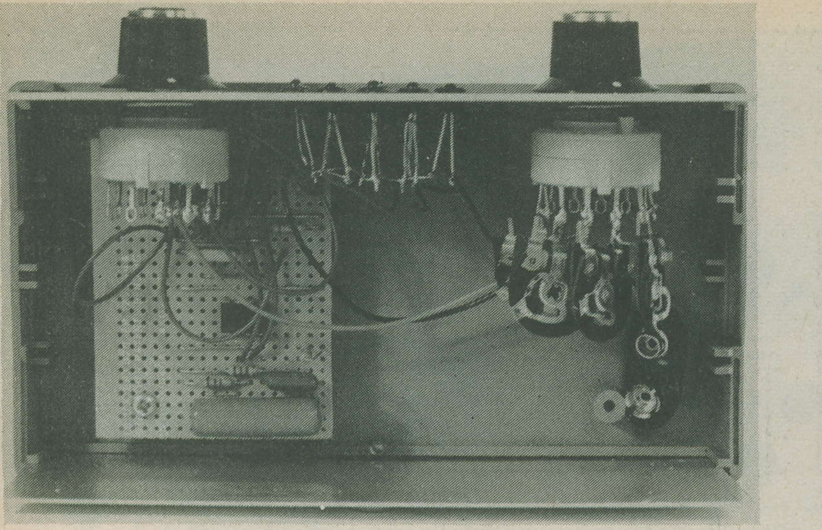


Fig. 1. The circuit of the ring of l.e.d.'s print timer. Each of the eight light-emitting diodes is illuminated in turn by IC2



Most of the components are assembled on a Veroboard panel which is positioned behind the on-off switch

mode, the four timing periods being slected by S2. As is normal with a 555 oscillator the timing capacitor, C2 in Fig. 1, is charged by way of the resistance coupling it to the positive rail until the voltage across it reaches two-thirds of the supply potential. Pin 7 of the i.c. then goes low and the capacitor discharges via the resistance coupling it to this pin until the voltage across it is one-third of the supply voltage. Pin 7 then goes open, allowing the capacitor to charge once more in the following cycle. With a normal 555 circuit, in which the capacitor is returned to the negative rail, the first charge period is longer than all the subsequent charge periods, because the capacitor has to charge from zero volts to two-thirds of supply voltage whereas in the later periods it charges from one-third to two-thirds of supply potential.

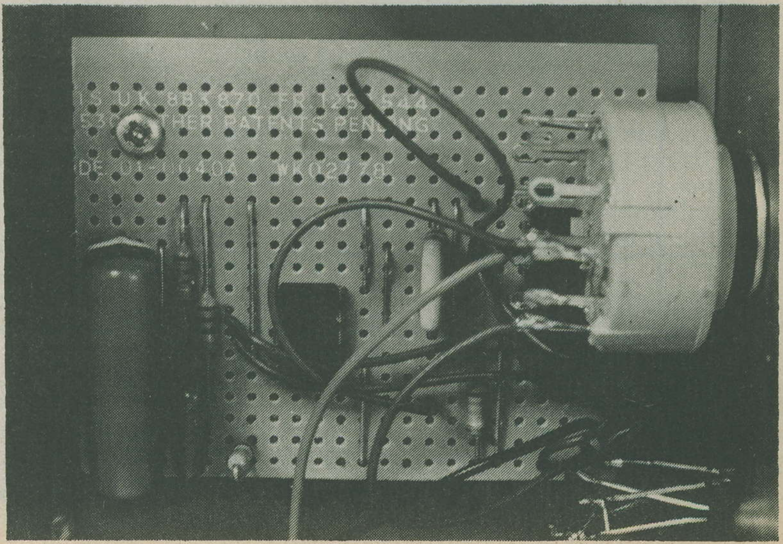
In many instances the consequently elongated initial cycle raises no difficulties, but in the present applications it would obviously reduce the accuracy and usefulness of the unit. The problem is overcome by taking the earthy side of C2 to a potential divider formed by R5 and R6. The voltage at the junction of these two resistors is approximately one-third of the supply potential, so that the timing circuit conditions are effectively the same for the first cycle as for those which follow.

Any large errors in the initial clock cycle are thereby eliminated. Although there may still be a small discrepancy it will be of an insignificant proportion.

S2 switches in four pre-set variable resistors to provide the timing cycles of 1 minute, 2 minutes, 3 minutes and 4 minutes. To obtain repeatable and consistent results, a non-electrolytic capacitor is used in the C2 position. It will still be necessary to trim the time constants of the circuit to obtain good accuracy, of course, and this is why pre-set variable resistors are employed.

The output pulses from pin 3 of the 555 are applied direct to the clock input, pin 14, of the 4022 divider. The output of IC1 will go positive as soon as the supply is switched on by S1(b). This will not be counted by IC2, however, because at switch-on its reset pin, pin 15, is momentarily taken high by the discharged capacitor C3, causing the divider to reset to zero. The first l.e.d., D1, will then be illuminated. The next positive-going pulse edge from

Two self-tapping screws, of which one is hidden below the switch here, secure the Veroboard panel to mounting pillars moulded into the case



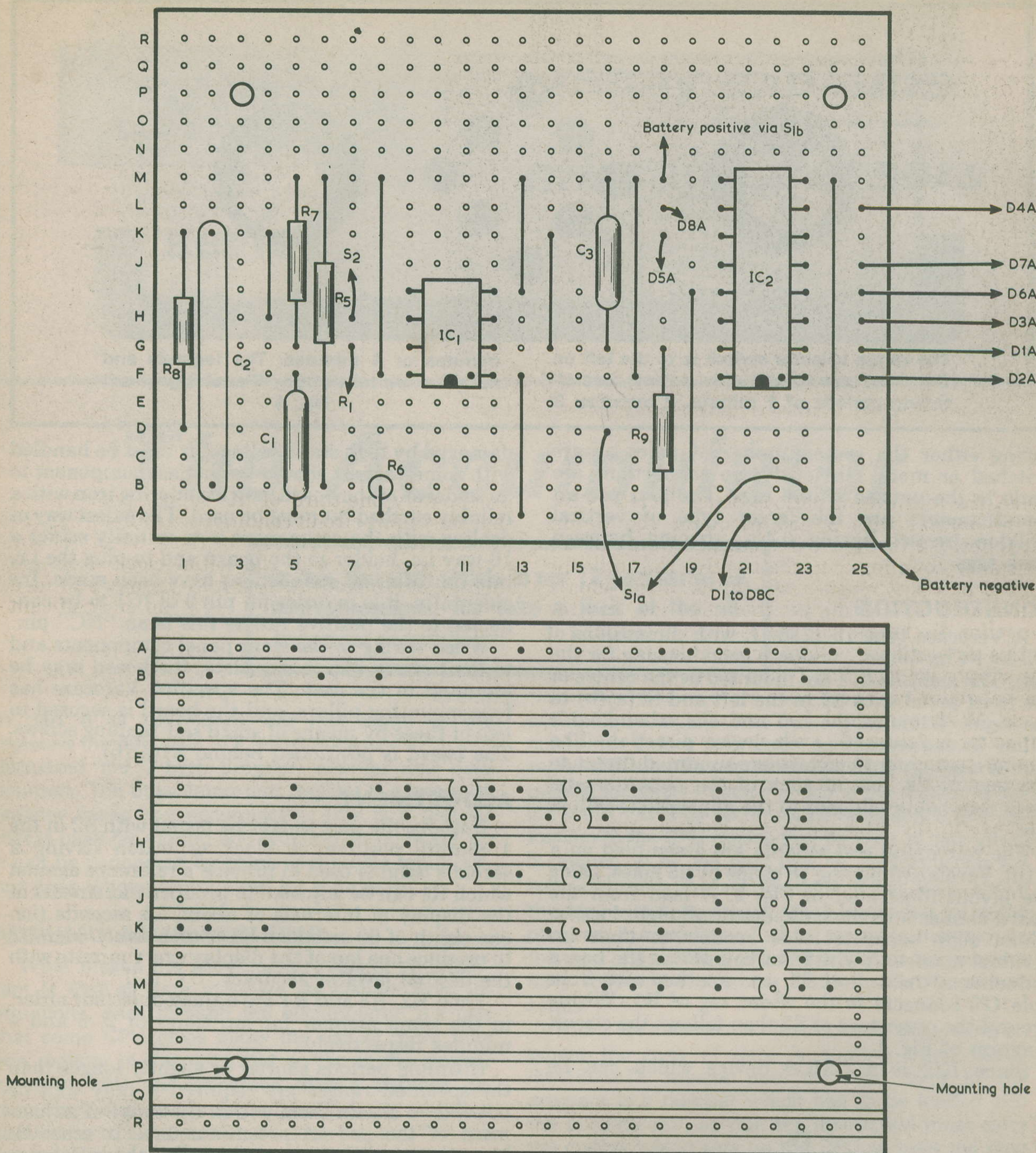


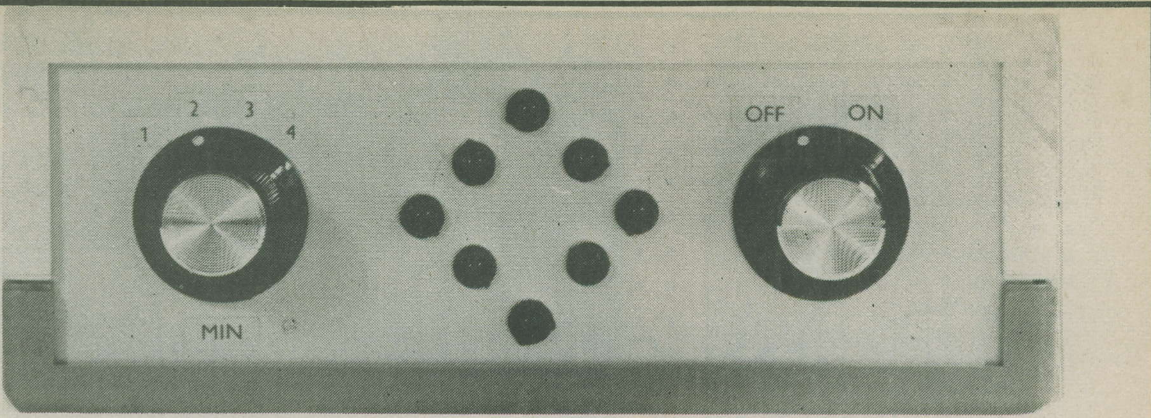
Fig. 2. Most of the timer components are assembled on a Veroboard panel. Layout details are given here

IC1 will cause D1 to extinguish and D2 to light up. The l.e.d.'s will then light up in sequence until D7 is turned off and D8 becomes illuminated. The following clock pulse will extinguish D8 and cause D1 to light up again, and the sequence will repeat. The precise end of the timing period is given when D8 extinguishes and D1 lights up for the second time. Thus, each l.e.d. is alight for one-eighth of the overall timing period. No connection is made to pin 12 of IC2, which is the "carry out" pin.

The timer is switched off by moving S1(a)(b) to the "Off" position. S1(a) then short-circuits C2 via the low value current limiting resistor R8. No residual charge will in consequence be left in C2 when the unit is switched on again and good accuracy will be maintained.

The average current consumption of the unit is about 15mA, and this can be provided by a 9 volt battery such as a PP3 or, if the unit is to be used extensively, a PP6.

All the components are readily available. The rotary switches can be miniature types with adjustable end stops, and the small number of ways selected by each makes it possible to employ types



The range selector switch is to the left on the front panel, and this selects overall timing periods of 1 minute, 2 minutes, 3 minutes or 4 minutes. The legends and numbers are taken from "Panel Signs" set No. 4

having either the same number of poles as are switched or more. Obviously, no connections are made to the unused switch tags. The four pre-set potentiometers are the larger type of vertical skeleton pre-set having 0.4in. spacing between track tags.

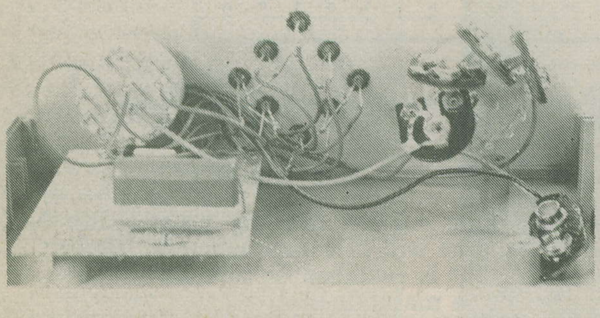
CONSTRUCTION

A Verocase type 75-1238-D, with dimensions of 153 by 84 by 59mm., makes a good housing for the unit. The eight l.e.d.'s are mounted at the centre of the front panel with S2 to the left and S1(a)(b) to the right. D1 is at the top and the other l.e.d.'s follow in sequence in a clockwise direction. The four pre-set potentiometers are mounted direct to the tags of S2, one of each of the potentiometer track tags being soldered to the appropriate switch tag.

The remaining components are assembled on a 0.1in. Veroboard having 18 strips by 25 holes, using the layout illustrated in Fig. 2. A lead from the board connects to the cathodes of all eight l.e.d.'s, whilst eight separate leads connect to their individual anodes. A wire from hole H7 on the board connects to the arm of S2, and another wire from hole G7 connects to the slider tag of R1. Wiring around the outer tags of S2 then follows the circuit diagram of Fig. 1.

Since IC2 is a CMOS device which can be damaged by high static voltages it must be handled with some care. It should be the last component to be soldered to the board, and a soldering iron with a reliably earthed bit must be used. The safest way of dealing with the component is to initially solder a 16-way i.c. holder to the board and to plug the i.c. into this after all connections have been made. Incidentally, it is in order for pin 9 of IC1 to be connected to the positive rail as this is an "NC" pin.

When wiring to the front panel components and to the battery clip is complete, the board may be mounted in the case. The specified Verocase has four mounting pillars, and the board is secured to two of these by means of small self-tapping screws. The board is positioned behind S1(a)(b).



The four pre-set potentiometers are mounted by having one track tag soldered to the appropriate tag of switch S2. A single wire connects together all the cathodes of the l.e.d.'s and individual wires run from the component panel to the anodes

ADJUSTMENT

Initially the unit should be tested with S2 in the 1 minute position. A clock or watch having a seconds hand is used to provide a reference against which R1 can be adjusted to produce increments in the display at intervals of about 7.5 seconds (i.e. one-eighth of 60 seconds). R1 is then finely trimmed to produce one lap of the display every minute with the desired level of accuracy.

Then R2, R3 and R4 are adjusted, *in that order*, in the same manner for lap times of 2, 3 and 4 minutes respectively.

If timing periods shorter or slightly longer than the specified ranges are required it may well be possible to obtain them within the range of adjustment of the pre-set potentiometers. It must be borne in mind that, apart from R4, the resistance inserted by each pre-set potentiometer appears in the timing circuit for the longer period range or ranges. If, for example, R1 is adjusted for a short timing period on the first range, the maximum available timing period will be limited on the other three ranges.

If it is necessary to alter the timing component values, the overall timing period (one complete lap) is approximately 11 times CR where C is the value of C2 in μF, R is the resistance in MΩ between pins 6 and 7 of IC1, and the period is in seconds. The timing resistance should not exceed 20MΩ. It is advisable to avoid the use of electrolytic capacitors for C2 because, apart from the question of leakage current, tolerances in R5 and R6 and in IC1 could cause the capacitor to be reversed biased by a small voltage during the oscillation cycle, giving reduced reliability in timing accuracy. ■

DATABUS series No. 6

really explains microprocessors

By Ian Sinclair

The Accumulator

In this, the sixth article in our 12-part series on microprocessors, we take a look at the all-important accumulator.

In part 4 of DATABUS, we met some of the registers that are used in a microprocessor CPU, and discussed the 2-byte program counter and data counters. The other important register is a one-byte register called the accumulator. This is a register that is used for storing and working on numbers, so it can be connected by gates to the data input/output lines whenever required by a program.

ACCUMULATOR REGISTER

What makes the accumulator register so important is that all data numbers, as distinct from instructions, pass through the accumulator. It's true that some CPU chips allow the use of more than one register in this way, but so far as the simpler types of CPU are concerned there's just one accumulator, and every number that is acted on has at some time to be placed in the accumulator. This is a feature of calculators and computers generally, so a few rules are worth noting.

First of all, when a number byte is loaded into the accumulator register, the byte which was in the accumulator before it is lost. You can see why if you remember that the accumulator is a register with parallel loading — each flip-flop in the register is being set to 1 or 0 by each new bit of data. A LOAD instruction to the CPU means that the byte of data which is referred to by the next byte of the instruction will be loaded into the accumulator in this way; and if the byte which is already there is needed for some purpose, it must first of all be stored in memory — this sort of procedure will be familiar to readers who have followed the recent "Tune-In To Programs" series.

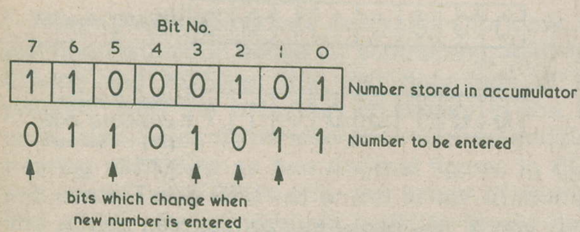


Fig. 1. Accumulator entry. When a new number is entered into the accumulator, several bits will be changed so that the old number is no longer stored

There are several load instructions, depending on where the byte of data is coming from. LOAD IMMEDIATE means that the next byte in the program is a number which has to be loaded into the accumulator, so that the instruction must carry the coding which sets up the CPU to treat the next byte in from program memory as a number rather than as an instruction. Suppose we want to load in a byte taken from some part of memory which lies outside the part in which the program is stored. A different sort of load instruction then has to be used. For the simpler types of CPU this is a two-byte instruction, with the first byte carrying the load part of the instruction, and the second a displacement number. As described in Part 5, this displacement number causes a new address number to be generated, equal to the sum of the number in the program counter and the displacement number itself. The byte which is loaded into the accumulator is therefore taken from the memory position whose address is given by the program count number plus the displacement.

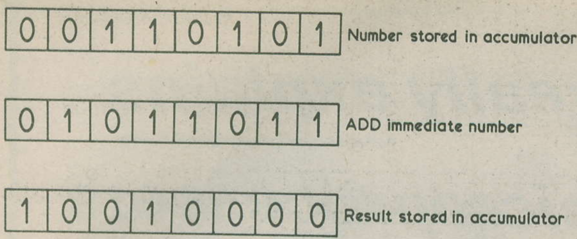


Fig. 2. The ADD BINARY IMMEDIATE operation. The number which follows the instruction ADD IMMEDIATE in the memory is added to the number in the accumulator, and the result is stored in the accumulator

The simpler types of CPU may use just these two basic types of load instruction, usually with the option of incrementing or decrementing the number in an index register at each load instruction so that each load is from a different address, one higher or lower than the previous one. Such indexed and auto-indexed arrangements have been dealt with in Part 5.

The more eleborate types of CPU use many other load instructions which can make some types of program easier to devise. Keeping at the moment to accumulator loading instructions, these CPUs can load the accumulator from any address in memory, so that two bytes of address need to follow the instruction code. These two bytes are loaded into the data counter or address register (according to the design of CPU) and form an address to memory from which the data byte will be taken to load the accumulator. In addition, however, it is usually possible to load other registers, or to shift data bytes from one register to another. The Z80, for example, has a total of 21 different single byte load instructions, and more than 14 double-byte load instructions.

BYTE TRANSFERENCE

Now what else? Obviously, if we can load a data byte from memory into the accumulator, we ought to be able to store a byte that is in the accumulator into some part of memory. Once again, ther simpler types of CPU will offer one main method of doing this by the use of a displacement number relative to the program counter or to an index number in some other register. As before, the instruction code (a store instruction this time) will be followed by a displacement number which adds to the number in the program counter or other register. This new number is now used as the address of a chunk of memory which will be employed to store the data byte that is in the accumulator. This does ***not*** remove the data byte from the accumulator, it merely copies it into the memory location. As before, it may be possible to use a modified instruction so that the index number is incremented or decremented each time the instruction is carried out, so that data bytes can be stored into consecutive memory locations. Note, however, that all relative displacement will operate only over a limited range, −128 to +127, which is equivalent to half of an 8-bit memory "page" in each direction.

Another method which is available on some simpler CPUs is to copy the byte from the accumulator into various other registers, using a different instruction code for each different destination. The more advanced CPUs will also permit the contents of the accumulator to be copied into any place in RAM memory, using the address directly rather than by having to calculate a displacement. The addressing can also be implied, taken from a pair of bytes which themselves are stored in two consecutive memory addresses.

All this means that any CPU will have quite a large number of possible instruction codes just for the operations of loading the accumulator from memory or for storing the contents of the accumulator into memory. In general, different CPUs will have quite different binary codes for the same instruction — the only exceptions being the 8080 and the Z80, which share a large number of codes. This is the reason for using what are called mnemonic instructions — groups of letters which are shorthand for an instruction and which "translate" to a different binary code for each microprocessor. For example, the mnemonic (the m is silent, like the p in bathing!) LDI usually means LOAD IMMEDIATE, which on one CPU may be binary 11000100, and on another 10000110, but which will always mean the same thing to the user. An assembler is a circuit or program (to be described in Part 12) which does this "translation" automatically for a given CPU, so that the letters

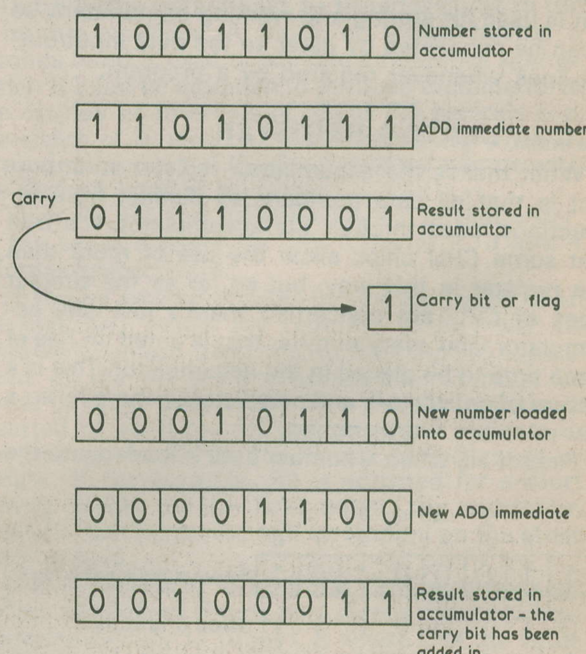


Fig. 3. The carry bit. An addition with a carry out of the eighth place causes the carry bit (or flag) to be set (to logic 1). This logic 1 is automatically added in to the least significant place of the next addition unless the carry bit is reset to zero by a program instruction

LDI could be tapped out on a keyboartd which is connected to the assembler, and the correct binary code then is put out to the CPU.

INSTRUCTIONS

What else can be done using the accumulator? It's like asking what can be done with electricity! To start with, there will be a set of IMMEDIATE instructions, all of which must be followed in the program by a data byte. The instruction, ADD BINARY IMMEDIATE, for example, causes the byte that follows the instruction in the program to be added, bit by bit, to the byte that is already in the accumulator. The result of the addition is then held in the accumulator awaiting the next instruction. Sounds simple? It is, but there are complications. One is that when we add two eight-bit numbers, the result may very well need nine bits, and we can fit only eight bits into the accumulator. This problem is solved by using a bit from another register, called the status register. This bit, called the carry bit, is set to 1 if there is a carry from an addition; bits such as the carry bit are sometimes referred to as "status flags". When such a bit is at logic 1, we say that the flag is set. The reason for such a pictorial description is that this bit can't be ignored; it is part of the sum, so that its existence has to be signalled. If the addition is extended into a second byte, as it will be when we add two sixteen-bit numbers, the carry bit can be added in again (Fig. 3). There's another status flag, called OVERFLOW, which indicates another sort of carry-out — this one isn't so simple and we'll leave it for the moment.

1	1	0	0	1	0	1	0	Number in accumulator
1	0	1	1	1	1	0	1	Number to be AND-ed
1	0	0	0	1	0	0	0	Result stored in accumulator

1 AND 1 = 1 , all other AND's give 0

Fig. 4. The AND IMMEDIATE operation. Each bit of a byte in the accumulator is separately ANDed with the corresponding bit which is fed in from the memory place following the instruction. The result is stored in the accumulator

Staying with immediate instructions for now, we will find instruction codes for subtracting, AND-ing, OR-ing and XOR-ing the next data byte of the program with the byte that is already in the accumulator. Some CPUs also offer decimal addition, treating each byte as two decimal figures in BCD, and some Texas CPUs offer the luxury of multiply and divide instructions as well. In every case, though, when an IMMEDIATE number is added to, subtracted from, OR'd, AND'd or XOR'd with the number in the accumulator, the result is stored in the accumulator and the original number that was in the accumulator is lost, unless it exists somewhere

1	1	0	0	1	0	1	0	Number in accumulator
1	0	0	1	0	0	0	1	Number to be OR-ed
1	1	0	1	1	0	1	1	Result stored in accumulator

1 or 0 = 1 only 0 or 0 gives 0

Fig. 5. The OR IMMEDIATE operation. Each bit of a byte in the accumulator is separately ORed with the corresponding bit of the byte fed in from memory by the immediate instruction. The result is, as usual, stored in the accumulator

in memory. All the operations which are carried out by the instructions are carried out inside the CPU, using what is called a microprogram. A microprogram is a set of instructions built into the CPU, and not alterable in any way. For immediate addition, for example, the microprogram has to guide the bits stored in the accumulator and the bits read in from the program into an adder, then gate the result back to the accumulator, and place any carry bit into the status register. Microprogramming is an activity which is solely for the CPU designer, so don't be tempted to buy books on microprogramming under the impression that they deal with the programming of microprocessor systems!

USE OF MEMORY

There is also a set of instructions, similar to the IMMEDIATE instructions but involving the use of memory. We can, for example, add the byte contained in some memory location to the byte in the accumulator, storing the result in the accumulator as usual. The other operations of subtraction, AND, OR, XOR can also be carried out using bytes taken from memory rather than from program. As you might expect by now, the simpler CPUs will locate the correct memory address by using a displacement number, so that the number of the byte following the instruction is added to the number of the program counter or an index register. The more

1	1	0	0	1	0	1	0	Number in accumulator
1	0	0	1	0	0	0	1	Number to be XOR-ed
0	1	0	1	1	0	1	1	Result stored in accumulator

1 XOR 1 = 0 ; 0 or 0 = 0 , all others 1

Fig. 6. The XOR IMMEDIATE operation. This is similar to the OR, but gives a zero result for 1 OR 1

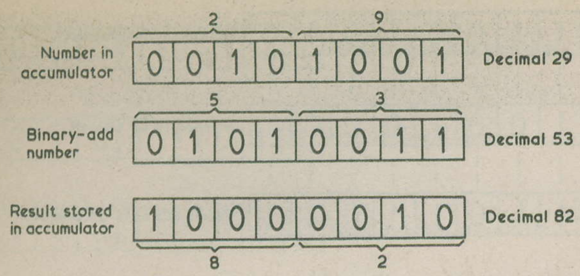


Fig. 7. BCD addition. Each byte is treated as two four-bit BCD numbers, so that the laws of addition are rather different from those used for binary arithmetic

complex CPUs will fetch a byte from memory using a memory address which has been loaded into the data register in two steps.

In addition (sorry about that!) all of these operations can be carried out using bytes loaded in from other registers and using, of course, different instruction codes. In every case, any carry from an addition will "set the carry flag" by dumping a 1 bit into the carry part of the status register. The carry bit may also be used in a subtraction operation. Are we finished yet? Not quite! There are two other sets of instructions which can be carried out on the accumulator — the shift and rotate instructions. SHIFT A one bit means just what it says, that each bit in the accumulator register is shifted by one place. Some CPUs allow only right shift, others permit left or right shift; a few allow another bit to be shifted in from another register, such as the carry bit from the status register to fill up the empty bit on one side of the register. The shift instruction is used in some CPUs as a method of shifting data out or in bit-by-bit; this is referred to as a serial input or output. Other CPUs need a separate chip to convert 8-bit bytes into serial outputs for recording or for displays.

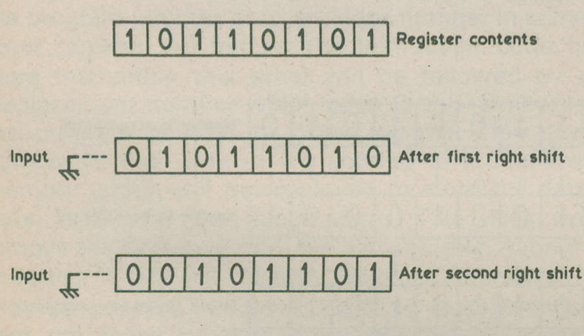


Fig. 8. A right-SHIFT operation. Each bit in the register is shifted by one place at each SHIFT instruction. Some microprocessors permit a new bit to be shifted in for an input, others simply allow a zero to be shifted in at each instruction

The rotate instruction is found on most CPUs — it means shift each bit along one place, and move the bit which "falls out" of one end of the register back into the other end of the register. A few CPUs allow only right rotation, others permit left or right rotation. Each type of rotation needs a different instruction, and only one step of shifting is carried out for each program instruction. No data byte needs to follow a shift or rotate instruction, and there is, of course, no displacement.

LOGIC UNIT

What does it all amount to? Well, this chapter shows how the microprocessor CPU can be used as

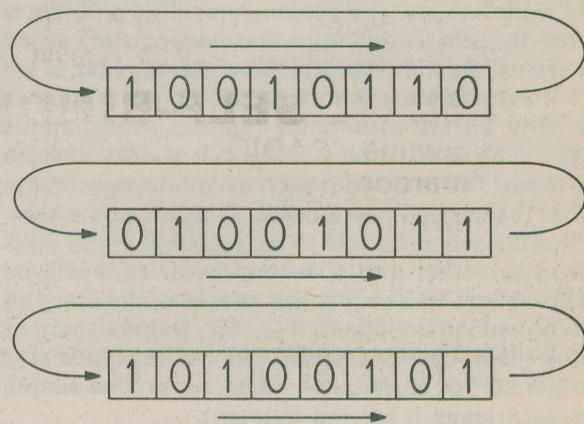


Fig. 9. The ROTATE operation. Each bit shifts one place along at each ROTATE instruction, and the bit which is forced out at one end of the register is fed into the other end

a universal logic unit. Operating on eight bits at a time, we can instruct the CPU to add, subtract, AND, OR and XOR. One set of bits to be operated on must be in the accumulator, the other can be in the program (using immediate instructions) or in a memory. By making use of the shift or rotate along with add or subtract, we can also devise programs (using blood, sweat and tears as well) to carry out multiplication and division in binary. Whatever combination or sequence of inputs we require to produce a desired output can be made to do so by a suitable program in ROM, rather than by wiring up logic chips.

There's one problem we haven't dealt with yet. Up to now, we've assumed that the CPU can mumble away to itself, crunching away at number bytes stored in program memory or in data memory (both, of course, might be in the same chip). If we're going to use the CPU for any logic jobs, we need some way of getting data in and out. That's for next time.

(TO BE CONTINUED)

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WIRE GAUGE MEASUREMENT

By C. P. Finn

Finding wire diameter without a micrometer.

There are many occasions when the constructor needs to find the diameter of a piece of copper wire but does not have a micrometer screw gauge. The author originally described the measurement method to be discussed here, which requires only a flat household ruler and a small strip of wood, in the December 1966 issue of this journal. This previous article dealt with s.w.g. sizes only but, since those days, metrication has arrived and wire is now gauged in millimetres according to a new British Standard, BS 4391. In consequence the measurement method has been updated and revised, and the present article applies to the new metric wire sizes whilst still including details of the earlier s.w.g. sizes.

THE METHOD

A small sample, say 50mm., of the wire to be measured is cut off and bent into an 'L' shape. The longer arm of the 'L' is sandwiched between the ruler and the strip of wood, as shown in the accompanying diagram. The wire is placed over one of the main divisions of the ruler with the short projecting arm pointing downwards.

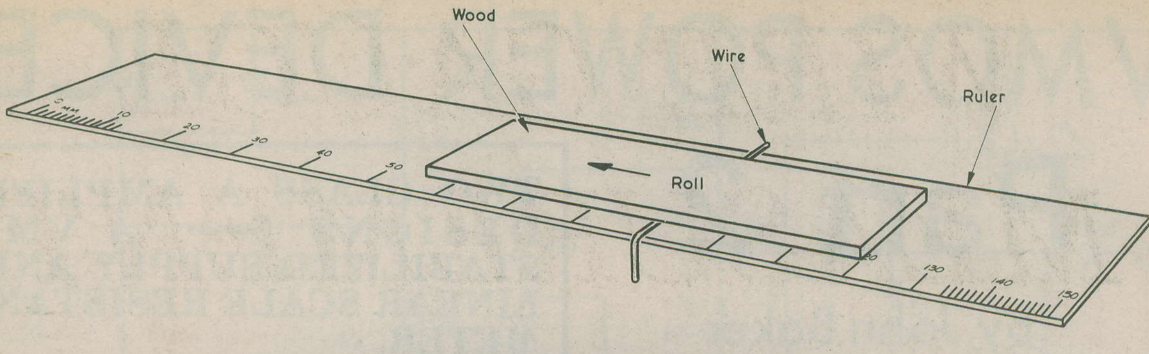
With the aid of the wood strip, the wire is then rolled along the ruler for a convenient distance (say 10mm. or 50mm.) and the number of turns and part turns through which the wire passes is counted by observing the protruding arm of the 'L'.

From this number, and the distance travelled, the diameter of the wire may be readily calculated from the equation:

$$d = \frac{D}{\pi N}$$

STANDARD WIRE SIZES

IMPERIAL		METRIC		
S.W.G.	Dia. mm.	First Choice (R10 Series) Dia. mm.	Second Choice (R20 Series) Dia. mm.	N (D)
45	.071	—	.071	45 (10)
44	.081	.080	—	40
43	.091	—	.090	35
42	.102	.100	—	32
41	.112	—	.112	28.4
40	.122	.125	—	25.5
39	.132	—	.140	22.7
38	.152	.160	—	19.9
37	.173	—	.180	17.7
36	.193	.200	—	15.9
35	.213	—	—	—
—	—	—	.224	14.5
34	.234	—	—	—
33	.254	.250	—	12.7
32	.274	—	.280	11.4
31	.294	—	—	—
30	.315	.315	—	10.1 (10)
29	.345	—	.355	44.8 (50)
28	.376	—	—	—
27	.417	.400	—	39.8
26	.457	—	.450	35.4
25	.508	.500	—	31.8
24	.559	—	.560	28.4
23	.610	.630	—	25.3
22	.711	—	.710	22.4
21	.813	.800	—	19.9
20	.914	—	.900	17.7
19	1.02	1.00	—	15.9
—	—	—	1.12	14.2
18	1.22	1.25	—	12.7
17	1.42	—	1.40	11.4
16	1.63	1.60	—	10
15	1.83	—	1.80	9
14	2.03	2.00	—	8 (50)



Setting up the wire for diameter measurement. All that is required is to roll the wire along the ruler for a fixed distance and observe the number of revolutions it makes

where d is the diameter of the wire, D is the distance rolled and N is the number of turns made. Both d and D are in mm.

In many cases the wire will be enamelled and will in consequence have a diameter slightly greater than the bare copper wire to which the enamel is applied. In the writer's experience the effect of the enamel thicknesses, in most instances, is to increase the overall diameter by not quite one 'gauge'. For example, a 0.400mm. wire with an enamel coating may measure about 0.440mm.

For convenience, a table is given showing the comparison between the old s.w.g. sizes and the metric wire diameters (as per BS 4391) together with the calculated values for N, using D as 10 or 50 as appropriate. ■

CAN ANYONE HELP?

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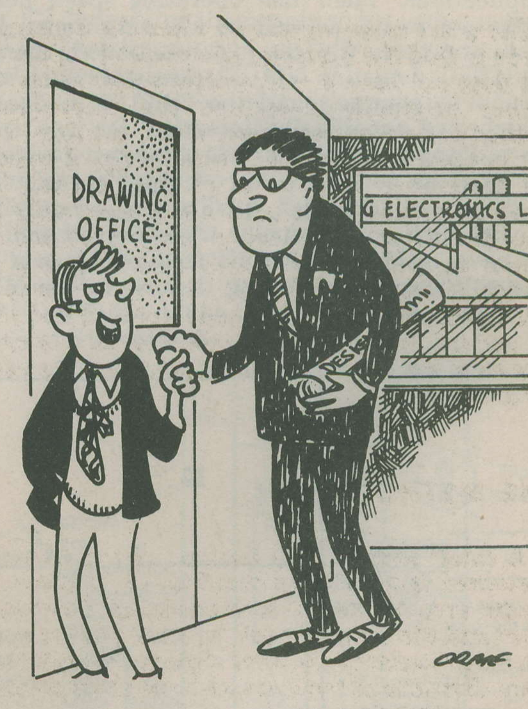


"It's no use going in there — they're all working to rule

VMOS POWER DEVICES

Part 2

By John Baker

TWO CLASS A AMPLIFIER DESIGNS — A VMOS STABILIZED SUPPLY AND A LINEAR SCALE RESISTANCE METER.

In last month's article we described the basic operation of VMOS devices in the VN46AF, VN66AF and VN88AF range, and showed how they can be particularly useful in switching applications where they are driven by circuits having low output current capability. They can, for instance, be driven directly by CMOS logic. We look next at the use of VMOS transistors in audio amplifier output stages.

CLASS A AMPLIFIER

VMOS f.e.t.'s are perfectly suitable for linear circuits and are not restricted to switching applications. Their fast operating speed permits their use in r.f. as well as a.f. amplifiers. Apart from the three devices just mentioned, there are JUGFET depletion VMOS transistors such as the 2SJ50 (p channel) and the 2SK135 (n channel) which are specifically intended for use in a.f. amplifying applications, and these two devices can be used as complementary output transistors in high power very high quality audio equipment. Unlike high power bipolar transistors, which tend to have rather low cut-off frequencies and may thereby introduce slewing distortion, the VMOS transistors have high operating speed and consequently high slew rates. However, amplifiers incorporating the 2SJ50 and 2SK135 are rather complex and expensive, and fall outside the scope of this present article, which is intended to deal with simpler applications.

The circuit of a Class A amplifier using a VMOS transistor in the output stage is shown in Fig. 4. TR3 is a common source output transistor having a constant current load formed by TR1, TR2, R5 and R6. It is driven by a Texas JFET operational amplifier which gives low levels of noise and distortion. (The TL081CP is pin compatible with the 741, and the pin numbers shown in the diagram are for an 8 pin device). R4 and R1 provide negative feedback between TR3 drain and the non-inverting input of IC1, and they set the closed loop gain of the amplifier at about 12 times. C3 is a d.c. blocking capacitor. Note that the feedback is taken to the non-inverting, and not the inverting input of IC1; this is because of the phase inversion in TR3. R7 and R3 bias the circuit and keep the quiescent output voltage central between the supply rails, and they are fed from the positive rail via the decoupling network consisting of R2 and C6. The

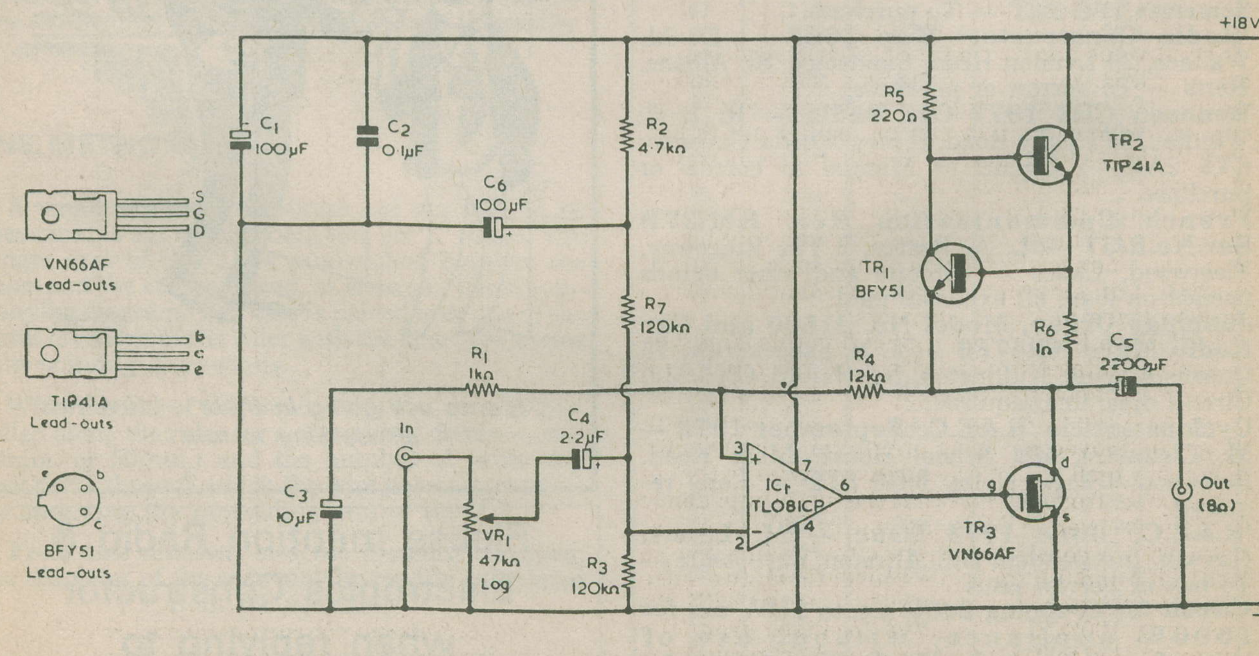


Fig. 4. Class A a.f. amplifier incorporating a VMOS transistor in the output stage. All resistors are $\frac{1}{4}$ watt with the exception of R6, which should be a 1 watt component

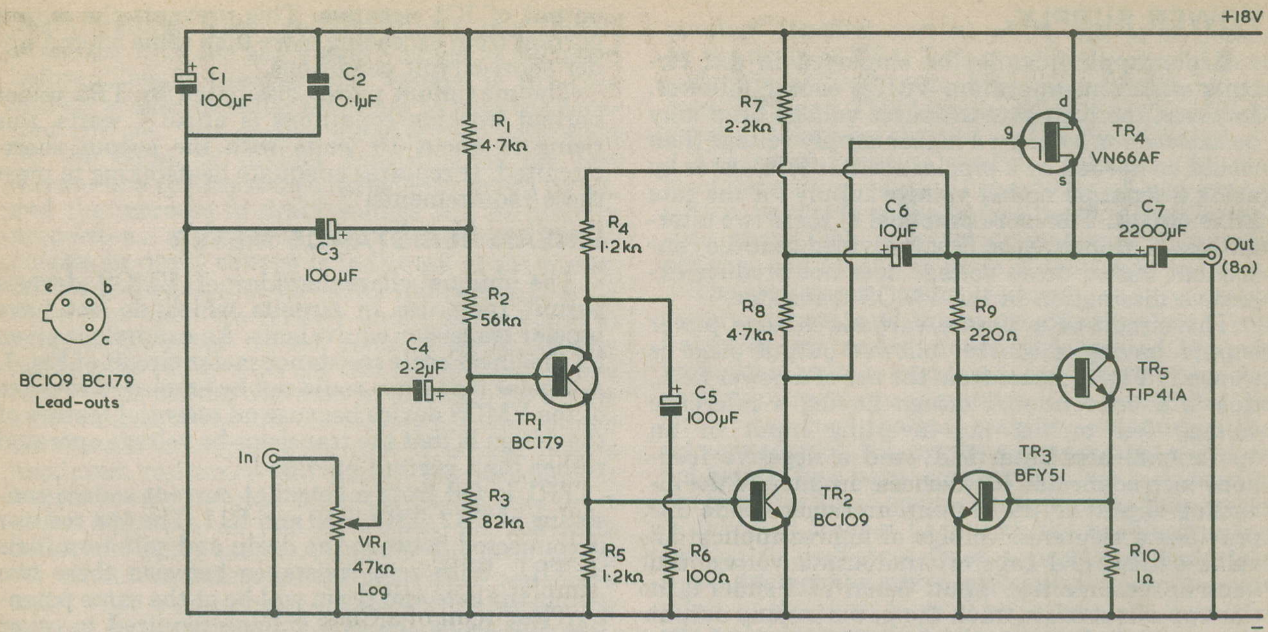


Fig. 5. In this a.f. amplifier the VMOS device functions as a source follower output transistor. Again, all resistors are ¼ watt except for the 1Ω resistor, R10, which should be 1 watt

network gives the circuit good rejection of hum and noise on the supply lines.

The amplifier has a current consumption of about 700mA, and gives an output of 2.7 watts r.m.s. (4 watts peak). The input impedance is of the order of 25kΩ and approximately 375mV r.m.s. is required at the input to produce maximum output. The distortion is less than 1% up to the onset of clipping, whereupon the distortion rises rapidly. It should be noted that TR2 and TR3 require substantial heatsinking. The heat tab of TR3 is connected internally to its drain.

SOURCE FOLLOWER

An obvious application for a VMOS device in an a.f. amplifier output stage is as a source follower, where its very high input impedance and large current drive capability can be readily put to use. The VMOS device has the disadvantage, however, of having a substantial voltage drop of some 4 to 6 volts from its gate to its source when it is employed in this way. This is, of course, considerably higher than the voltage drop from input base to output emitter of an emitter follower stage employing two or even three bipolar transistors.

With the a.f. amplifier application this large gate to source voltage drop need not be too much of a problem, as bootstrapping can be used to effectively increase the drive voltage to the gate. Bootstrapping is employed in the a.f. amplifier circuit shown in Fig. 5, which has a performance similar to that of Fig.4, apart from the fact that the input impedance is slightly lower. TR4 is the source follower transistor with a constant current circuit as its source load. TR1 and TR2 are in a conventional two stage common emitter direct coupled circuit, with R4 providing 100% d.c. negative feedback from the output source to TR1 emitter. At a.f., capacitor C5 exhibits a low impedance and brings R6 into the feedback loop, giving an overall a.f. gain of about 12 times. R2 and R3 bias the input voltage, with R1 and C3 decoupling the supply to these two resistors.

The bootstrapping is provided by giving TR2 a split collector load, R7 and R8, and coupling the output to the junction of these two resistors via C6. The junction of the resistors is taken more positive on positive output excursions, and on large excursions will actually be taken positive of the positive supply rail. This gives the required high drive voltage for TR4 gate, and gives a considerable improvement in the performance of the amplifier as compared with a circuit which does not include bootstrapping. Again, TR4 and TR5 require substantial heatsinking.

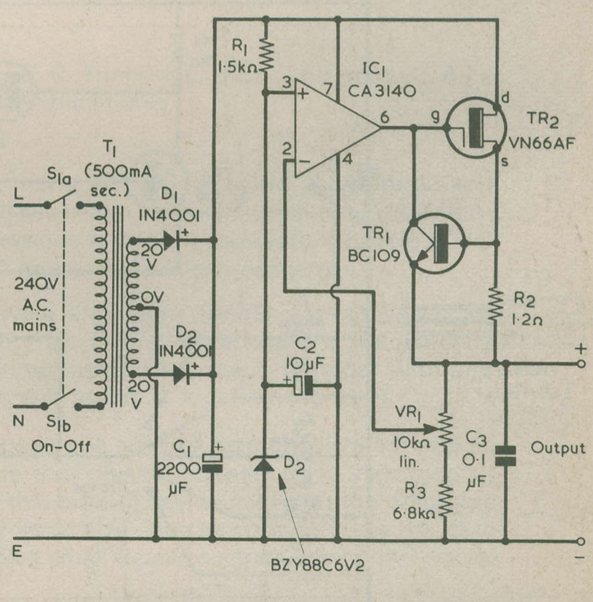


Fig. 6. Variable voltage power supply with a maximum output current rating of 500mA. The gate of TR2 imposes virtually no loading on the output of IC1. R1 and R3 are ¼ watt and R2 is ½ watt

POWER SUPPLY

Bootstrapping cannot be employed in d.c. circuits which incorporate a VMOS source follower. In these, the high gate to source voltage drop may be catered for by using a higher supply voltage than would be needed by a bipolar emitter follower or by using a separate higher voltage supply for the gate drive circuit. The more practical of these two alternatives is probably the first, provided that the consequent higher drain voltage does not produce excessive dissipation in the VMOS transistor.

The circuit of a simple variable voltage power supply having a source follower output stage is shown in Fig. 6. Apart from the use of a power f.e.t., this is a conventional design having a reference voltage fed to the non-inverting input of an operational amplifier, IC1, and a negative feedback loop connected between the output and the inverting input of the amplifier. Zener diode D3 provides a reference voltage of approximately 6.2 volts, whilst VR1 taps off the output voltage fed back to the inverting input. When VR1 slider is at the upper end of its track the power supply output is connected direct to the inverting input of IC1, and the output stabilizes at the reference voltage of 6.2 volts. Taking VR1 slider down the track increases the output voltage needed to give 6.2 volts at the inverting input, whereupon VR1 functions as an output voltage control. The maximum output voltage, with VR1 slider at the bottom end of its track, is approximately 15 volts.

The unit will give an output current of up to 500mA. The use of a source follower power f.e.t. has the advantage that there is negligible loading on the output of IC1.

TR1 and R2 form a conventional current limit circuit. In the event of a severe overload or output short-circuit, the voltage dropped across R2 is sufficient to turn TR1 on and its collector pulls the output of IC1 negative. This prevents the output current from exceeding more than some 550mA under short-circuit conditions.

The maximum power dissipated by TR2 under normal working conditions is about 7 watts, this rising to about 10 watts with the output short-circuited. It requires adequate heatsinking to meet these requirements.

LINEAR RESISTANCE METER

The unique characteristics of VMOS devices permit their use in circuits which do not have bipolar transistor equivalents. An example is given by the linear scale resistance meter circuit of Fig. 7. A bipolar transistor could not be employed in place of the VMOS device because an essential feature of the design is that the transistor be voltage operated rather than current operated.

TR1 is fed from a constant current source consisting of TR2, TR3, R10 and R11. The test resistor is connected between the drain and gate terminals of TR1. With zero resistance between these two points the gate and drain will be at the same potential, this being the gate voltage required to cause the drain to draw the constant current. The gate voltage is stabilized at this level by a negative feedback action. A higher gate voltage cannot be given as this would reduce drain voltage, similarly a lower gate voltage cannot be applied as it would increase drain voltage.

R9 is adjusted for a slider voltage which is equal to TR1 drain voltage when the test terminals are connected together. This gives zero voltage across the meter circuit consisting of M1, D1, R6 and R7, and results in a zero indication in the meter. The purpose of D1 and R6 is to protect the meter from being subjected to severe overloads.

If the short-circuit is taken off the test terminals and a resistor is connected between them, TR1

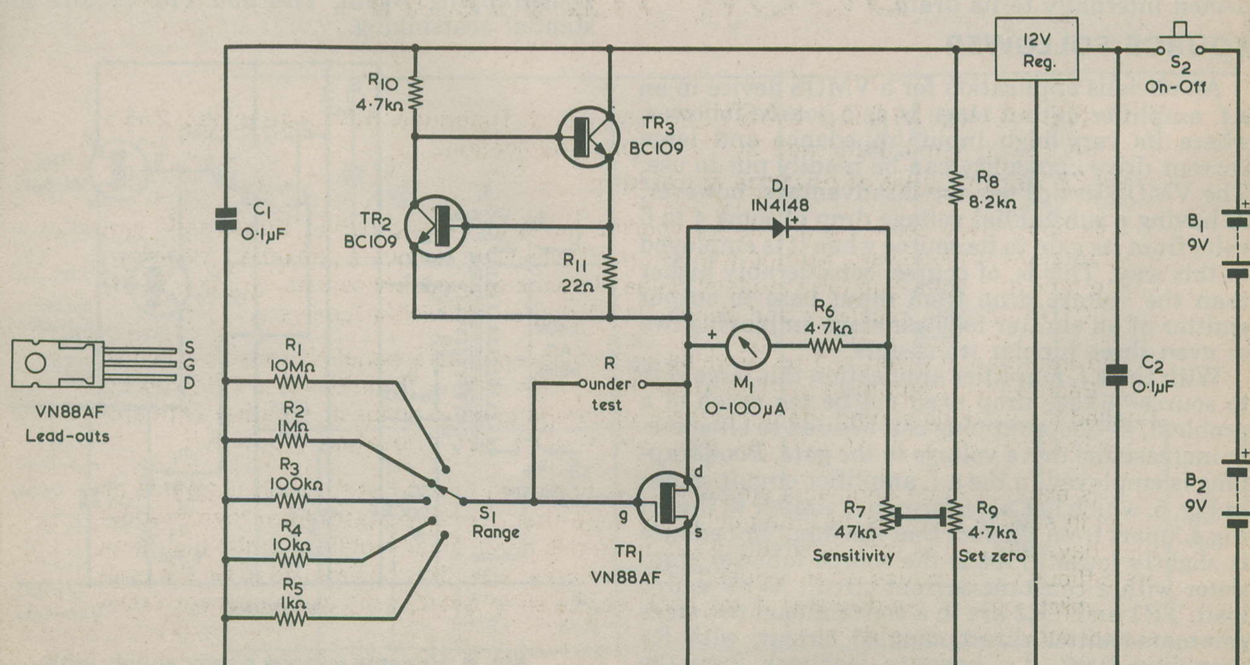


Fig. 7. A linear scale direct reading ohmmeter. The meter gives an f.s.d. indication when the resistance under test is equal to the range resistor (R1 to R5) selected by S1

drain voltage goes positive until the circuit stabilizes with the same gate voltage as occurred before. This is because that voltage is the gate voltage needed to cause the drain to pass the constant current. The drain voltage is then controlled by the potential divider consisting of the test resistor and the resistor switched into circuit by S1, and the increase in drain voltage will be directly proportional to the value of the test resistor. The increases in drain voltage is indicated in the meter. R7 is adjusted so that the meter indicates full-scale deflection when the resistor under test is equal in value to the range resistor selected by S1. It only needs to be set up with one test resistor and on one range as its setting will then be accurate for all the other ranges. (After the circuit has been assembled R7 should be adjusted so that it always inserts maximum resistance into circuit. The resistance it inserts is only reduced when the time comes for it to be adjusted, as just described, for full-scale deflection in the meter). After R7 has been set up the circuit functions as a linear scale resistance meter with a zero meter indication corresponding to zero test resistance and an f.s.d. reading corresponding to a test resistance equal to the range resistance selected by S1.

A slight flaw in the circuit design is that part of the constant current from TR2 and TR3 flows through the test resistor and the selected range resistor. Since the current passed by these resistors varies with different test resistors and on different ranges there is a corresponding change in the nominal constant current which has to be passed by the drain of TR1. This problem is reduced to an insignificant level by making the constant current from TR2 and TR3 large in relation to the highest current drawn by the test and range resistors.

The range resistors should, preferably, have a low tolerance on value. S1 should be a 5-way rotary switch having a make-before-break action to ensure that TR1 gate is always coupled to the negative rail by one or more of the range resistors.

The resistance meter requires a very stable supply voltage, and this is provided by two 9 volt batteries in series connecting to a 12 volt monolithic voltage regulator. Any 12 volt negative earth type regulator is suitable. It is found that the circuit has good thermal stability, whereupon the set zero control, R9, can be a pre-set type and does not have to be a panel control. If power is applied to the circuit with no test resistor connected the meter is deflected beyond f.s.d. with the needle pressing against its end-stop. Over a period of time this could damage the meter, although it would have no effect in the short term. The instrument therefore has a non-locking push-to-make press button as the on-off switch. This is only operated when a test resistor has been connected into circuit and a reading is required, and it ensures that the meter is not overloaded for long periods.

(Concluded)

BOOK REVIEW

T.V. REPAIRS MADE EASY. Edited by F. C. Tunbridge, B.Sc. 146 pages, 245 x 190mm. ($8\frac{1}{2}$ x $7\frac{1}{2}$in.). Published by TV Technic Publications.
Price £5.30 inclusive of postage & packing

This book gives servicing details for specific faults in Korting hybrid Supermatic and Vienna television receivers, Korting transistorised television receivers (including precision-in-line tube and delta-gun tube models), Kuba Florence television receivers, Grundig 5010 and 6010 television receivers and Zanussi 110 degree television receivers.

The information given will be of value to service engineers handling these particular sets. Each fault symptom (e.g. "Too Much Red", "No R-Y", "Striations") is followed by detailed instructions stating the component or components to suspect, together with any other information, such as voltages, etc., which will assist in locating the fault.

It is expected that engineers employing the book will use full size circuit diagrams as given in service manuals, but the publishers state that due to requests from their readers they have decided to include circuit diagrams in this book. They explain that the diagrams are difficult to reproduce when reduced to book format size. This has proved to be the case and whilst some of the diagrams in the book resolve small details such as component values clearly other diagrams do not.

The address of the publishers is 76 Church Street, Larkhall, Lanarkshire, ML9 1HE.

Radio Topics

By Recorder

It had to happen.

By the time these notes appear in print almost everybody will be aware that the new CMOS version of the 555 timer i.c. is with us. This, the ICM7555, is pin-compatible with the old bipolar 555, uses the same formulae for frequency and timing cycle in the astable and monostable configurations, but draws currents (apart from output sink and source currents) which are measured in microamps rather than milliamps.

Indeed, one has to think seriously about the current drawn by the timing resistors, when compared with the very low currents drawn by the ICM7555. If, in the astable mode, the upper timing resistor is 100k Ω and the device is producing a near square wave, the current drawn by that 100k Ω resistor on its own is at least 50μA with a 10 volt supply, which is comparable with that drawn by the device itself.

So, out goes the poor old 555. When did it first appear? The i.c. was originally introduced by Signetics, and my Signetics data book on it is dated 1973. At a rough guesstimate, therefore, the first 555's were appearing around late 1972, whereupon its useful unchallenged life has been about seven years.

Seven years is a long time in electronics.

S.R.B.P.

There must always be newcomers to any hobby. Inevitably, they find difficulty in understanding terms and methods of functioning which the more experienced take in their stride.

One recent query we received was concerned with the term "s.r.b.p." What in heck, our reader asked, *is* s.r.b.p.? The answer is that "s.r.b.p." is the present unlovely description for what used to be known by trade-names such as "Paxolin". Indeed, you may still occasionally find it referred to as "paxolin". Indeed, you may still occasionally find it referred to as "Paxolin" now and again. The letters stand for "synthetic resin bonded paper", and it is the brown insulating material which is used in Veroboard, in most tag strips and tag boards, and in most printed circuits.

Another indigestible pill for beginners is the direction of flow of an electric current. After having learnt at school that an electric current consists of a flow of electrons moving from negative to positive, the newcomer finds that electronic texts refer to current as flowing from positive to negative. Surely something must be wrong here?

Something is indeed wrong, and the error dates from the early days of electricity. In those times nobody had even heard of electrons, but they did know that they could make up electric cells and batteries of which one terminal produced one sort of electricity and the other produced another sort of electricity. Connect the two terminals together and a current flowed. An arbitrary decision was made to name one terminal of a cell or battery "positive" and the other "negative". No problems so far. Next to be settled was the direction in which electric current flowed. Their luck here was equivalent to mine with a one-armed bandit, and they chose precisely the wrong direction. From positive to negative.

All subsequent engineering work proceeded on this assumption and, when the mistake was eventually brought to light, it was too late to set things right and alter all the work that had been done.

You see, so far as mathematical treatments of the effect of current are concerned, it doesn't matter if you ***are*** working to an incorrect conception of the direction of current flow provided you stick to that conception all the way through. Nevertheless, it can be irritating at times, as when one sees that current consists of actual electron movement (say, from the negative cathode to the positive anode of a cathode ray tube) to still keep referring to current as flowing from positive to negative. We ratify the situation as best we can by describing the supposed flow from positive to negative as "conventional current" flow. The term "conventional" arises because the convention is accepted that the flow is from positive to negative.

VERO TRANSFORMERS

Did you know that Vero Electronics supply mains transformers? They certainly do and two of them, standing on the odd sheet of Veroboard (what else?), can be seen in the photograph.

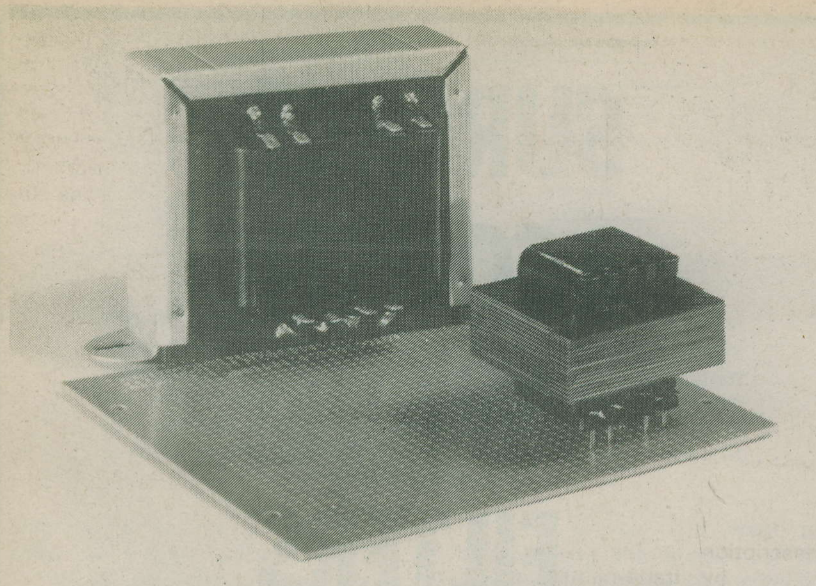
These transformers are competitively priced high quality components, conforming with BS2214. All the transformers are fitted with full shrouds and are varnish protected. The primary consists of two 120 volt windings which may be connected in series or in parallel for operation at 50 or 60Hz. There are also two secondary windings on each transformer, again suitable for series or parallel working. Various output voltages from 0-3 to 0-20 are available within a range from 1.2VA to 50VA.

Further details on the transformers, which are handled by the Verospeed branch of Vero Electronics, are contained in the current catalogue available direct from Verospeed, Barton Park Industrial Estate, Eastleigh, Hampshire, SO5 5RR. Enquiries about the transformer should quote the reference "Transformers AB 075".

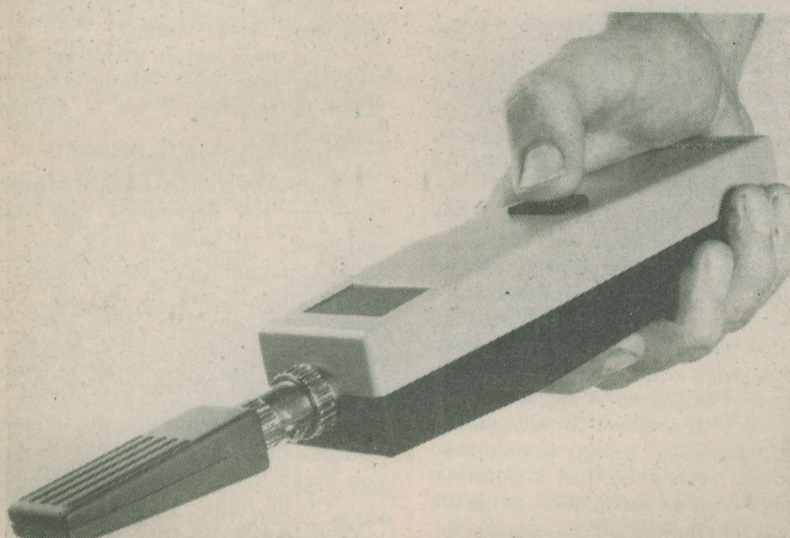
RH AND TEMPERATURE

The neat and unusual looking instrument in the second photograph measures RH (relative humidity) and temperature. Introduced by Kane-May Instrumentation, this pocket-sized instrument has the type number KM 5001.

Kane-May consider that this hand-held digital instrument, offering the benefit of RH and temperature readings in one unit, is a valuable tool in the field of humidi-



Two of the range of Verospeed mains transformers which are currently available. Suitable for 50Hz or 60Hz, the primaries consist of two 120 volt windings which may be connected in series or in parallel



Humidity and temperature measurement in the palm of your hand. This RH and temperature measuring instrument is pocket-sized and offers readings of high accuracy by way of a digital readout

ty measurement. Weighing only 250 grams, the KM 5001 measures RH from zero to 100% with a resolution of 0.1% and an accuracy of 2%. The temperature range is from −10 to 95°C, with a resolution of 0.1°C and an accuracy of 0.5°C. The rectangular window at the end near the sensor contains a 3-digit l.e.d. display with a character height of 7.6mm. There are connection arrangements which allow for greater flexibility in the positioning of the sensor.

The manufacturers, Kane-May Limited, Burrowfield, Welwyn Garden City, Herts, have world-wide outlets for their existing range of pocket thermometers and other temperature measuring devices, as well as instruments for the measurement of pH and rotary motion.

■

In your workshop

SURFACE ACOUSTIC WAVE FILTERS

"Smithy."

"Hallo!"

"What do you think is the worst thing that has arisen from modern technology?"

Smithy surveyed the contents of his disreputable tin mug. Even he had quaffed sufficient tea to satisfy his post-lunchtime thirst.

"The worst thing?" he repeated. "Shopping bags on wheels!"

"What?"

"Shopping bags on wheels," repeated Smithy firmly. "I've only got to venture down our local High Street to get a little shopping done and I am immediately assailed on all quarters by shopping bags on wheels. Horrible tatty things they are, with nasty clattering little wheels."

"Come on, Smithy. Be serious."

"I ***am*** being serious. As soon as any woman trundling one of those bags spots me the light of battle gleams in her eyes like a beacon." A tone of bitterness entered his voice. "They've all got the same technique, you know; they go for the ankles every time. Those shopping bags are scaled-down versions of the old Roman chariots which had knives sticking out of the wheel centres. Only the bags haven't got knives, they've got bits of sharpened wire poking out at ankle height instead. If it wasn't for fast footwork on my part I'd have had my ankles stripped down to the bone scores of times before now."

Dick sighed.

"All right then," he said, "think of some of the good things that have come out of technology."

Smithy pondered.

"Well," he said eventually, "there are all manner of good things coming up all the time. New integrated circuits, improved types of testmeter, Teletext transmissions, precision-in-line colour TV tubes. All sorts of things."

Not for the first time, Dick reflected on Smithy's way of life. So far as he could see, Smithy existed solely for the servicing of electronic equipment, sallying forth into the dangerous outside world only when sustenance was necessary to maintain that existence. A scene arose in his mind of a future Smithy, slowly and gradually being transformed without resistance into a potential decay until on completion of his life cycle he shuffled off his mortal coil, to be received into that great big Workshop up in the sky.

SAW FILTERS

"Quite an exciting new development has come out recently," remarked Smithy, obviously continuing his review of the latest good things to arise out of technology, "and that is the SAW television i.f. filter."

Dick pricked up his ears.

"What's that?"

"It's a new frequency selective device for the i.f. stages of a TV set. One SAW filter can replace nearly all, if not all, the i.f. tuned circuits in a television receiver, and it doesn't have any inductive or capacitive parts whatsoever."

"Blimey, that ***is*** new! What does the word 'SAW' mean?"

"The three letters stand for 'surface acoustic wave'. Sometimes the filter is referred to as a 'surface wave filter'."

"How does it work?"

Smithy looked at the avid expression on his assistant's face and grinned. "If ever there's anyone who's completely committed to electronics it has to be you. I've never met anybody who asks as many questions about it as you do."

"What, ***me*** committed to electronics?" replied Dick, astounded. "I just have a passing interest in electronics, that's all. Give me some gen on these SAW filters, Smithy!"

"Oh all right," chuckled Smithy. "Well, to start off with, a SAW filter is fitted in the i.f. stages of the new Ferguson colour receiver type TX9. This filter is in the Plessey SW150 range. I'm rather surprised you haven't heard about it, incidentally, because there's been plenty of publicity about it in the trade press. Basically the SAW filter idea is fairly simple although there must have been a fantastic amount of development complications involved in getting it to work in practice. Come on over here and I'll see if I can show you how it works."

As Dick picked up his stool and carried it over to Smithy's bench the Serviceman pulled a ball-point pen out of his breast pocket and drew his note-pad towards him. With

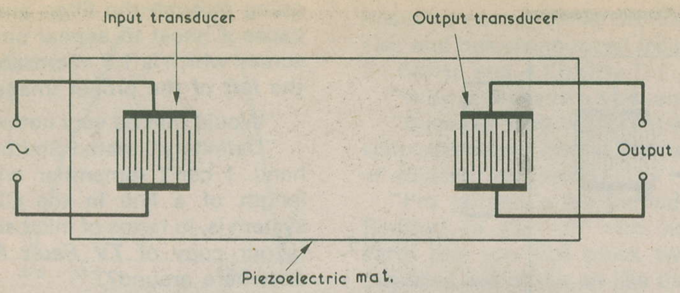


Fig. 1. Theoretical concept to introduce SAW filter functioning. Surface waves produced in the piezoelectric material by the alternating signal at the input transducer travel to the output transducer where they are reconverted to an electrical signal. The amplitude of the surface waves is much greater at one frequency than at other frequencies

Dick watching, he proceeded to draw out a sketch. (Fig. 1.)

"What we have here," said Smithy, when the sketch was completed, "is a flat piece of piezoelectric material on which have been deposited two grids of thin interleaving metal electrodes, or lines. We can refer to one grid as the input transducer and the other as the output transducer. If we apply an alternating signal to the input transducer the surface of the piezoelectric material will be deformed physically in sympathy."

"Would that be the same sort of effect that you have in a crystal earphone?"

"Roughly. The earphone has a piezoelectric crystal in it which changes shape in sympathy with the a.f. signal applied to it and reproduces the signal as sound. Which is, of course, the piezoelectric effect. Now, on the piece of piezoelectric material I've just drawn the physical distortions in the material caused by the alternating voltage at the input travel along the surface like ripples along the surface of a pond. However, they do not travel out in circles but move in two broad bands at right angles to the lines in the input transducer grid. Like this."

Smithy added arrows to his sketch. (Fig. 2.)

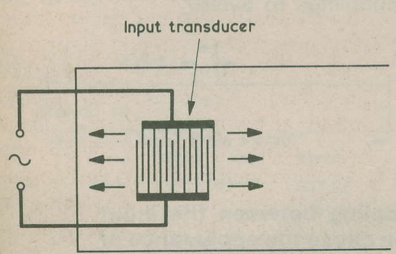


Fig. 2. The surface waves generated by the input transducer travel out at right angles to the lines of the transducer grid

"These waves," he went on, "travel along the surface of the piezoelectric material at a constant velocity. Let us for the time being assume that all the metal lines in the input transducer have the same length and that there is equal spacing between them. Now, if you think about it you can visualise that there must be one input frequency at which the amplitude of the surface waves is considerably higher than at all other frequencies. This will be given when each grid line produces a surface distortion which, after travelling to the next grid line connected to the same input terminal, finds itself subject to the same distortion all over again. All of the grid lines are producing waves which are in phase as the waves travel along inside the grid itself."

"That's the same as soldiers going over a bridge," stated Dick suddenly.

"I beg your pardon," said Smithy, puzzled.

"Soldiers are supposed to break step when they cross over a bridge," explained Dick. "If they march in step over a weak bridge it is possible for them to all put their feet down at a frequency at which the bridge has a mechanical resonance, whereupon the bridge could break up!"

"Well," said Smithy dubiously, "that isn't exactly similar to what goes on at the SAW filter input transducer, but I will agree that a large resonance can be produced by a lot of individual small excitations when they are all in phase. In the surface acoustic wave filter the deciding factors are the velocity of the surface wave and the spacing between the lines of the input transducer. At the frequency at which each transducer line augments the disturbances produced by the other transducer lines there is a dramatic increase in the amplitude of the surface waves travelling away from the transducer grid on either side. It's not exactly a resonance as you have in a tuned circuit, but the effect is almost the same as a resonance."

OUTPUT TRANSDUCER

"Do these surface waves travel across the surface of the material to the output transducer?"

"They do," confirmed Smithy. "When they reach the output transducer the reverse piezoelectric effect takes place and they cause voltages to be produced in the lines of the output transducer grid. If the lines in this grid have exactly the same length and spacing as those in the input transducer grid a second quasi-resonant effect will take place, with in-phase voltages being produced in the lines as the surface waves travel under them. The overall result is that the output signal given by the second transducer has been through not one but two frequency selective mechanisms."

"Stap me," breathed Dick, "that's crafty. There must have been some real development work required to get these TV i.f. filters up to a stage where they could be mass-produced in quantity."

"There very definitely has been," agreed Smithy. "Manufacturers have been working on SAW filters for the last ten years at least, and these filters have become well established in military equipment. But it's only now that they've advanced to the very sophisticated level at which they can be used as TV i.f. filters. As I've described the SAW filter up to now I've said that the lines in the input and output transducer grids all have the same length. In practice the response is doctored to that required for a television i.f. filter by having differing lengths of line in the input transducer grid. Another problem which has had to be overcome is the fact that, as well as producing waves which pass along the surface of the piezoelectric material the input transducer also produces waves which pass through the body of the material as well. These are prevented from reaching the output transducer by shifting that transducer to one side, out of the way of the output from the input transducer."

Dick frowned.

"I don't get that," he remarked. "If you shift the output transducer to one side it won't receive the surface waves either."

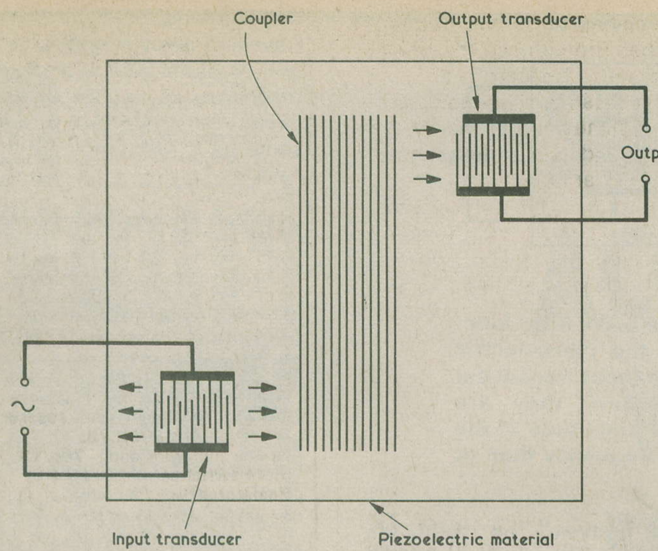


Fig. 3. To prevent it being affected by waves passing through the body of the piezoelectric material, the output transducer is displaced to one side. Coupling is then effected by way of a grid of parallel lines of metal deposited on the surface of the material

Smithy became busy with his pen once more. (Fig. 3.)

"That problem," he said, "is resolved by adding a coupler between the input and output transducers. This is done in the Plessey device and it consists of a number of equally spaced lines of metal deposited on the surface of the piezoelectric material like this. The coupler grid picks up the surface wave from the input transducer and then redirects it to the output transducer. Waves passing through the body of the material pass under the coupler and are not picked up by it."

"This," said Dick, "is getting rather complicated."

"We haven't finished yet," replied Smithy cheerfully. "One big difficulty is to get rid of surface wave paths between the input and output transducers other than the required one by way of the coupler. The first thing to attend to here is the band of surface waves from the input transducer which, in my sketch, passes out to the left of that transducer. These are taken up by a special absorbent mounting material at the edge of the piezoelectric material. Other techniques are used to ensure that there are no other edge reflections which could cause unwanted couplings between the input and output transducers."

Dick slowly absorbed this information. A thought suddenly occurred to him.

"Why," he asked, "do they call them *acoustic* filters?"

"Because," replied Smithy, "the surface wave travels across the piezoelectric material at a relatively slow speed which is more in keeping with an acoustic coupling than it is with an electronic coupling."

Dick frowned.

"Doesn't the wave pass almost instantaneously from the input transducer to the output transducer?"

"Oh no," said Smithy. "Speaking in electronic terms it takes quite a long time. With the Plessey SAW filter, the wave takes about 1.6 microseconds to travel from the input to the output. This raises further design factors."

CAPACITIVE COUPLINGS

"Such as?"

"Stray capacitive couplings between the input and output terminals of the filter. These have to be kept to an absolute minimum. If there is a sufficiently strong capacitive coupling, this will pass on to the output a signal which is 1.6 microseconds ahead of the signal going through the filter, and it will cause a ghost to appear on the TV screen which is 1.6 microseconds to the *left* of the proper image."

"Would that be very noticeable?"

"Definitely," stated Smithy. "Offhand, I can't remember what the length of a line in the 625 line system is, in terms of microseconds. Is our copy of ***TV Fault Finding*** anywhere around?"

"It's on my bench," volunteered Dick.

He hurried to his bench and returned with the battered Workshop copy of ***TV Fault Finding***. Smithy took it from him and consulted the first few pages.

"Ah, here we are," he remarked brightly. "This book tells us that the total line period in the 625 line system is 64 microseconds, of which 12 microseconds are taken up by the line blanking period, leaving 52 microseconds for picture information. So, the width of the line on the picture tube screen is effectively 52 microseconds, whereupon a spacing of 1.6 microseconds would be approximately equal to one thirtieth of the picture width. A nominal 20 inch screen is roughly 16 inches wide, so that 1.6 microseconds would correspond to a spacing of, rough check, slightly more than half an inch." (Fig. 4(a).)

"Blimey," exclaimed Dick. "That ***would*** be noticeable."

"Because of this effect," stated Smithy, "it is necessary to use a careful layout and circuit design with a SAW filter to ensure that there are no significant stray capacitive couplings between the input and output terminals of the filter. Care has also to be taken to ensure that there are no other unwanted electronic couplings too, such as impedances common to input and output circuits, and things like that. Obviously, these requirements can be satisfactorily met in practice because the SAW filter is being used in a production colour TV receiver."

"Are there any other unwanted couplings to avoid?"

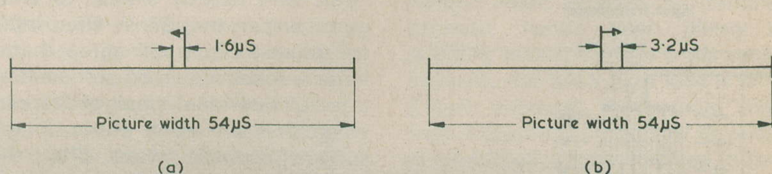


Fig. 4(a). Stray capacitive coupling between the input and output of the SAW filter can cause the appearance of a ghost displaced to the left of the proper image by 1.6 microseconds (b). A reflection inside the filter from output transducer to input transducer, and then back again, would produce a ghost 3.2 microseconds to the right of the correct image

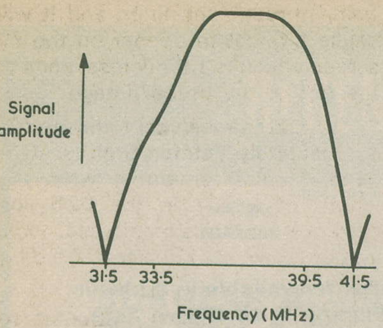


Fig. 5. Simplified presentation of a SAW filter response curve. Of most significance are the troughs at 31.5 and 41.5MHz

"There's an internal reflection effect inside the filter which has to be overcome," stated Smithy. "This occurs if the output transducer reflects a wave back to the input transducer which, in turn, reflects it back to the output transducer again. Since the reflected wave travels twice through the filter it can produce a ghost image which is about 3.2 microseconds after the required image." (Fig. 4(b).)

"Which," stated Dick, frowning, "would be equal to a spacing of rather more than an inch on a 20 inch screen?"

"Right," confirmed Smithy. "Fortunately, this particular reflection can be easily killed by simply driving the input transducer from a low impedance source, or by coupling the output transducer into a low impedance circuit. No real problem there."

"What sort of response does the SAW filter provide?"

Smithy drew out a response curve on his note-pad. (Fig. 5.)

"This is only a generalised idea of what is given," he remarked, "and is not an actual response curve, as would be given in the filter manufacturer's literature. As you know, the commonly used vision carrier i.f. in 625 line TV receivers is 39.5MHz, with the sound carrier i.f. being at 33.5MHz. The SAW filter response covers these two frequencies and has pronounced troughs at 31.5MHz and 41.5MHz."

"Why at these two frequencies?"

"Because they represent the vision and sound carrier frequencies of adjacent channels."

"I'm getting a bit baffled here, Smithy! To start off with, how on earth can you just pluck two frequencies out of the air like that and then refer to them as adjacent channel i.f. carrier frequencies?"

"I've got accustomed to these two frequencies," explained Smithy, "because TV sets using ordinary i.f. coils have traps tuned to them. However, let me convince you of what I'm taking about."

He picked up the copy of ***TV Fault Finding***, and turned to a table of u.h.f. television channel frequencies at the rear of the book.

"Now," he resumed, showing the table to Dick, "all the vision carriers in Bands 4 and 5 are spaced out at 8MHz intervals. I'll take three channels in this list at random. These can be channel 50 which has a vision carrier of 703.25MHz and a sound carrier of 709.25MHz, channel 49 which has a sound carrier of 701.25MHz, and channel 51, with a vision carrier of 711.25MHz. If we've got a TV set tuned to channel 50 the vision carrier will enter the i.f. amplifier from the tuner at 39.5MHz and the sound carrier will go into the i.f. stages as 33.5MHz. The sound carrier of channel 49 is 2MHz removed from the vision carrier of channel 50, and the corresponding i.f. is 41.5MHz. Similar reasoning tells us that the vision carrier of channel 51 will pop up in the tuner output at 31.5MHz. There you are then: 41.5MHz is the adjacent channel sound carrier i.f. and 31.5MHz is the adjacent channel vision carrier i.f."

Smithy had written the figures on his pad as he was talking, and Dick leaned over to look at them. (Fig. 6.)

"That makes sense to me now," he said in a satisfied tone. "Those frequency relationships will hold

Fig. 6. Frequency relationship for three neighbouring TV channels. Below the transmitted vision and sound frequencies are the corresponding i.f. carrier frequencies. All frequencies are in MHz

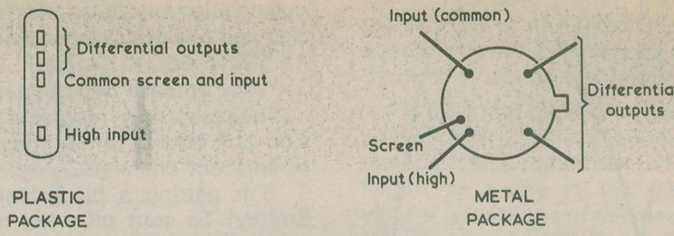


Fig. 7. The Plessey SW150 filter is available in a plastic or a metal encapsulation. Pinning is as shown here

good for any three neighbouring channels in Band 4 or Band 5, won't they?"

"They will. Apart, of course, from the channels right at the ends of each Band, which have only one neighbouring channel."

"What do these SAW filters look like?"

"The Plessey SW150 filter comes in two encapsulations," said Smithy. "One consists of a plastic package with four single-in-line pins. These are for input, common screen and input, and two differential outputs. The other encapsulation is a round metal case with locating tab. This has a diameter of about half an inch and has five pins. These pins give high input, screen, common input and two differential outputs. The filter which is used in the Ferguson TX9 receiver is the one with the metal encapsulation." (Fig. 7).

"Differential outputs? What are those?"

"The output terminals of the SAW filter are balanced about earth and can feed into a differential amplifier. Which is like feeding directly into the inverting and non-inverting inputs of an operational amplifier. The input, on the other hand, can be driven by a single-ended amplifier. With the 5-pin filter the amplifier couples into the high input pin, and the common input and the screen both connect to earth. The screen, incidentally, is an internal screen in the filter to reduce stray capacitive couplings between the input and the output."

"Phew," said Dick. "Well, I've certainly discovered a thing or two today. Can a SAW filter replace *all* of the i.f. tuned coils in a TV set?"

"So far as I know, it can," said Smithy. "But in normal use there may still be one or two tuned coils left in the circuit. Design here depends on the TV manufacturer who is using the filter. The u.h.f. tuner in the TV set will almost inevitably have an i.f. output coil and this could be coupled by a capacitor to an external coil to give a bandpass pair. After that, the i.f. signal can go through an amplifier, through the SAW filter and then on to another amplifier before it hits the vision demodulator. So that means that there are only two i.f. coils to adjust: the one in the tuner and the one which immediately follows it. There are no other coils in the i.f. amplifier at all. No coils tuned to intermediate frequencies, no coils in adjacent channel traps, no nothing! Add to that the fact that the 6MHz intercarrier sound signal can be taken off through a 6MHz ceramic filter, and you can begin to see how drastic will be the reduction of tuned coils in the TV sets of the future."

"And that's good?"

"Good? It's excellent! To start off with, manufacturing costs are reduced because fewer coils are required and much less alignment is needed at the factory. Secondly, there can be no drift in the i.f. alignment with time, as can happen with ordinary tuned coils. And thirdly, servicing is eased because there are fewer components to go wrong. A minor disadvantage with the SAW filter is that it incurs a loss in signal level but this can easily be made good by a suitable integrated circuit amplifier."

Smithy looked at his watch.

"I see," he remarked, "that another of our lunch breaks has gone, with me nattering away as usual to satisfy your curiosity about electronics."

"Come off it, Smithy. You know you love holding forth on technical things."

"Ah yes, but that's only whilst I'm at work. How will you be spending your evening today? More electronics?"

"Well, certainly not servicing. I might while away the time with a little short wave listening. And you?"

"I'll probably pop round to my club for a jar and a natter. Their p.a. amplifier has been playing up recently, and so I might have a look at that."

The pair beamed at each other, each fondly under the impression that it was the other who devoted too much of his life to electronics.

RECENT PUBLICATIONS

BURGLAR ALARM SYSTEMS. **By Vivian Capel. 159 pages, 215 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.). Published by Newnes Technical Books. Price £3.95.**

This reviewer, always interested in the electrical and electronic devices which lurk almost unnoticed in our midst, has for some time been mildly mystified by the presence of two round objects about an inch in diameter affixed to the bottom of the two adjacent windows of a small local shop. A thin wire connects to each of the objects, whereupon they undoubtedly represent items of electronic security; but what? The answer is given in this book: the round objects are contact crystal microphones with built-in filters designed to pass only the frequencies, of around 6 to 8kHz, which are given by breaking glass. The alarm system is activated if either shop window is broken.

This is only one item in a comprehensive and all-embracing treatment of burglar alarm systems which are dealt with in Vivian Capel's very interesting book. Security affects virtually all of us these days, whether it is aimed at preventing the shoplifter or, at the other extreme, detecting the light emitted by a thermal lance.

The book covers all currently available domestic and business intruder protection systems ranging from simple open and closed wired loops to the more complex ultrasonic Doppler and microwave beam interruption installations. A chapter deals with audible alarm units, including bells, sirens and electronic sound generators, whilst another chapter describes the manner in which closed circuit television may be used for security purposes. Also covered is the matter of installing a burglar alarm system, including meeting the all-important requirement of fitting wiring which is both concealed and protected.

Anybody requiring general information on intruder protection devices and installations will find "Burglar Alarm Systems" a useful and very helpful book.

★★★

PRACTICAL CONSTRUCTION OF PRE-AMPS, TONE CONTROLS, FILTERS AND ATTENUATORS. By A. D. M. Smith, B.Sc., C.Eng., M.I.E.R.E., M.B.K.T.S. 111 pages, 180 x 105mm. (7 x $4\frac{1}{4}$in.). Published by Bernard Babani (Publishing) Ltd. Price £1.45.

This book gives details of the circuit operation and then the construction of a large and varied range of pre-amplifiers, tone controls, audio filters and attenuators, dealing with each item on its own and using concise explanations with an absence of mathematics.

The first section of the book covers magnetic tape recording pre-amplifiers, giving two 3-transistor circuits and an integrated circuit configuration. Two microphone pre-amplifiers are described in the next section, one for high impedance input and one for low impedance input. These are followed by disc pre-amplifier circuits for piezoelectric cartridges and magnetic cartridges, and by bass cut, bass boost, treble cut and treble boost tone control circuits, as well as circuits for a comprehensive tone control and for a "presence unit". This last item applies boost or cut over a limited band of frequencies.

The book continues with filters, taking in a high pass filter, a low pass filter, a rumble filter and a scratch filter. Also included here is an interesting circuit which gives simulation of sound as passed over a telephone. Attenuators and pads appear next, and the book ends with a short section dealing with the preparation of printed circuit boards.

All but the very simplest circuits are treated as constructional projects, and are accompanied by component lists and full-size printed circuit layouts.

TOUCH CONTROL SWITCH

By R. Otterwell

Attractive presentation combined with sequential operation.

Many ideas for the construction of touch contacts for CMOS projects have been put forward since the use of these devices became widespread. Almost all suffer from at least one or more disadvantages, these being unattractive appearance, difficulty in mounting or unwarranted complexity. Common methods of providing the touch contacts have included copper areas on printed circuit boards, drawing pins or adapted phono plugs. The touch control to be described has none of these shortcomings. The materials required are inexpensive, consisting of a 3.5mm. jack plug, a short length of plastic sleeving capable of passing over the jack plug sleeve and tip, a fairly thick panel of insulating material such as tinted Perspex, and a "silver" eyelet. The last is a shiny metal eyelet having an internal diameter of about 4mm., and is available from almost all craft or hobby shops. It should be capable of taking the jack plug and sleeving in the manner to be described.

This article will also give details of a sequential CMOS switching circuit which can be employed with the touch control.

CONSTRUCTION

Fig. 1 shows the way in which the touch control is assembled. First, as in Fig. 1(a), drill a hole in the insulated panel which is just wide enough to accept the eyelet. Using a screwdriver blade, flatten the back of the eyelet to secure it to the panel. See Fig. 1(b). Next, as shown in Fig. 1(c), take up the jack plug and pass the plastic sleeving over its sleeve and tip. Solder an insulated wire to the tag which connects to the plug tip. Following Fig. 1(d), solder a second insulated wire to the rear of the eyelet, then pass the end of the plug through the eyelet so that its tip is flush or just slightly proud of the front surface of the eyelet. The tip is insulated from the eyelet, of course, by the plastic sleeving. With an eyelet having the required internal diameter, the plug will then stay fixed in position.

The front view of the completed touch contact assembly is as in Fig. 1(e). The control is actuated by bridging the plug tip and the eyelet by a finger.

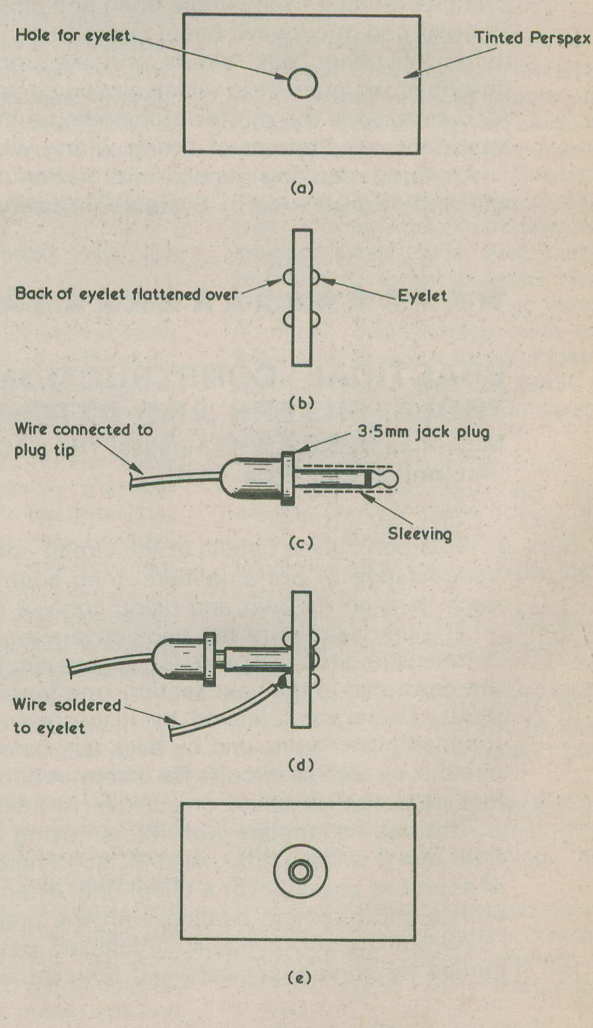
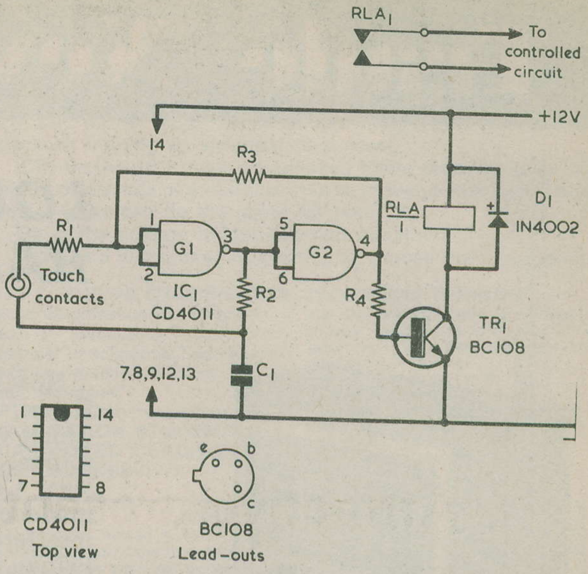


Fig. 1. Successive steps in making up the touch contact assembly

Fig. 2. The sequential touch control switch circuit. The relay energises, and then de-energises, at each successive bridging of the touch contacts by a finger



COMPONENTS

Resistors
(All ¼ watt 10%)
R1 4.7kΩ
R2 14.1MΩ (see text)
R3 9.4MΩ (see text)
R4 2.2kΩ (see text)

Capacitor
C1 0.039μF polycarbonate

Semiconductors
IC1 CD4011
TR1 BC108
D1 1N4002

Relay
RLA Relay (see text)

Miscellaneous
Materials for touch contacts
Wire, solder, etc.

CONTROL CIRCUIT

The sequential touch control circuit appears in Fig. 2. In this, two gates of a CMOS quad NAND gate type CD4011 are employed as inverters and make up a flip-flop. Let us assume that the flip-flop is in a state where the input to gate G1 is low. G1 output will then be high, causing G2 output to be low, maintaining the low at G1 input via R3. The low output from G2 causes TR1 to be turned off, and no current flows through the relay coil, RLA/1, in its collector circuit. The relay is thus de-energised. Because of the high voltage at G1 output, C1 becomes charged via R2.

If the touch contacts are bridged by a finger, the high voltage from C1 causes the input of gate G1 to go high. Its output goes low and G2 output goes high, keeping the flip-flop in its new state when the finger is removed. The high output at G2 turns on TR1 and the relay energises. C1 discharges through R2 into the low output of G1.

When the touch contacts are next bridged, the discharged C1 pulls the input of G1 low again, and the flip-flop reverts to its previous state, with the relay de-energised. The relay will energise once more when the touch contacts are bridged again, and so on.

The unusual values for R2 and R3 are made up of three 4.7MΩ resistors in series (for R2) and two 4.7MΩ resistors in series (for R3). With R4 at its specified value of 2.2kΩ the output of gate G2, when in the high state, is about 1 volt below the voltage of the positive rail. The relay coil should not draw an energising current in excess of 100mA. If a fairly sensitive relay (such as the "Open Relay" with 410Ω coil available from Maplin Electronic Supplies) is employed, the value of R4 can be increased to 10kΩ, with a consequently higher voltage at G2 output when this output is in the high state.

In Fig. 2 the inputs of the two unused gates of the CD4011 are connected to the negative rail. If desired, the circuit could be duplicated by using these two gates in a second switching circuit with its own touch contacts, transistor and relay.

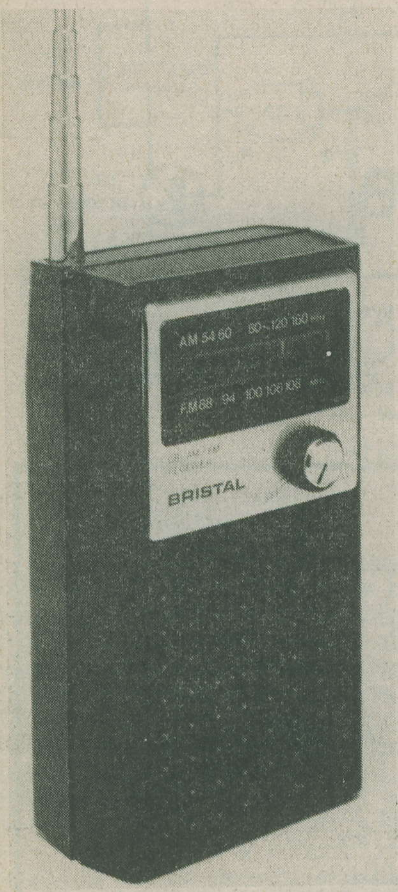
The author's touch control switch was powered by a 12 volt supply. It will work satisfactorily, also, with a 9 volt supply.

■

STYLUS ORGAN

In this article, which appeared on page 78 of the October issue, C8 was specified as 2,200μF ceramic plate. The value should, of course, have been 2,200pF.

Trade News . . .



LOW COST MONITOR FOR RADIO MODELLERS

Now being marketed in the UK by Chromatronics of Coach House, River Way, Harlow, Essex, is a low-cost radio monitor which warns radio-control model enthusiasts of any potential sources of interference on the 27MHz wave band, including illegal Citizens' Band radio transmissions, other nearby radio modellers, or even sunspot activity. The early detection of such interference sources by the Chromatronics monitor receiver can help to prevent expensive models being 'shot down' or sent out of control.

Costing only £17.95 (including V.A.T. and postage and packing), the Chromatronics monitor is a 3-band superheterodyne receiver which can be continuously tuned over the whole 27MHz model band, and which also receives the normal broadcast a.m. and f.m. bands. As well as detecting potential interference, the monitor can be used to check transmitter operation. A telescopic aerial ensures high sensitivity.

The Chromatronics monitor receiver measures only 170mm x 90mm x 50mm (6½in x 3½in x 2in) and weighs 0.45kg (1lb). It is powered by a single 9V battery, and output is via a built-in 76mm speaker, with a jack socket provided for an earpiece.

The Chromatronics device was used by the organisers of the 8th Sywell Radio Controlled Model Expo at Easter, and proved invaluable in locating one interference source — a faulty portable generator on a candy-floss stall — which could have been the direct cause of at least one crash.

SUREFIRE ELECTRONIC IGNITION SYSTEMS

Surefire electronic ignition came top of all systems tested by "Which" magazine in July 1979.

Suretron have now released two new ignition kits, the C300 and ES200, to fit all vehicles up to 8 cylinders.

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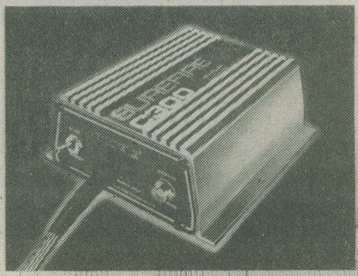
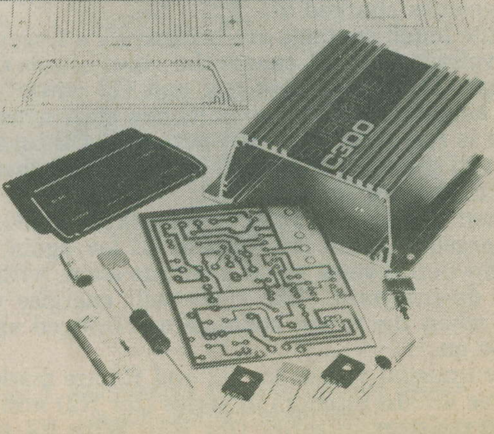
The ES200 is a high performance inductive discharge system incorporating a selected output darlington (Motorola), electronic variable dwell circuit to maximise spark energy at all engine speeds, pulse processor circuit and coil governor to protect the coil. Produces a long burn output and is suitable for *all* cars. Negative earth only.

The kits comprise an anodised aluminium extruded case, fibreglass p.c.b., p.c. mounted security changeover switch, static timing light, special selection Motorola power semi-conductors, capacitors and resistors etc. The prices (V.A.T., postage and packing inc.) are: ES200 – £13.95, C300 – £17.95 from Suretron Systems Ltd., Piccadilly Place, London Road, Bath BA1 6PW.





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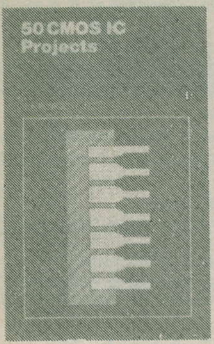

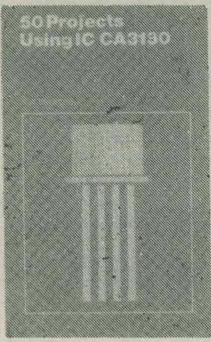

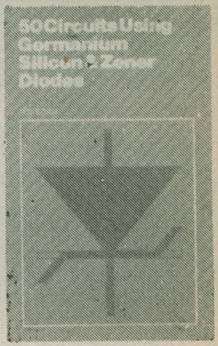

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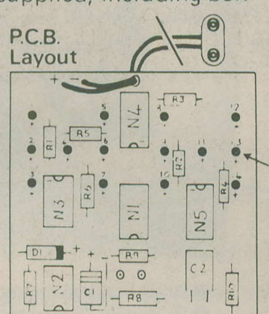

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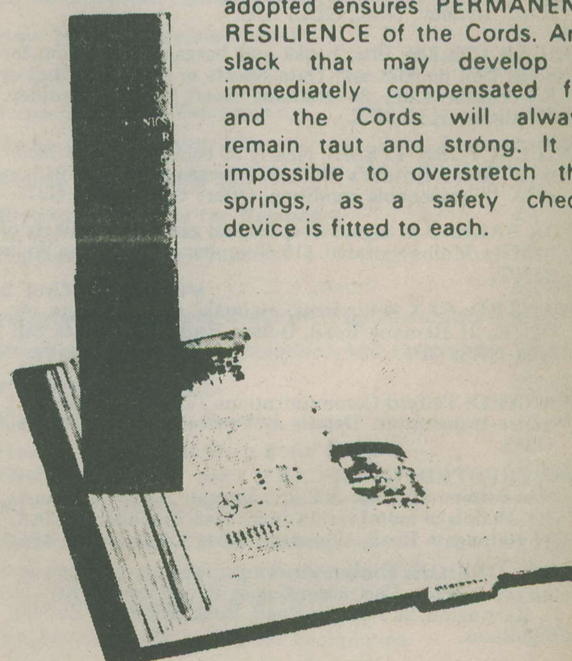

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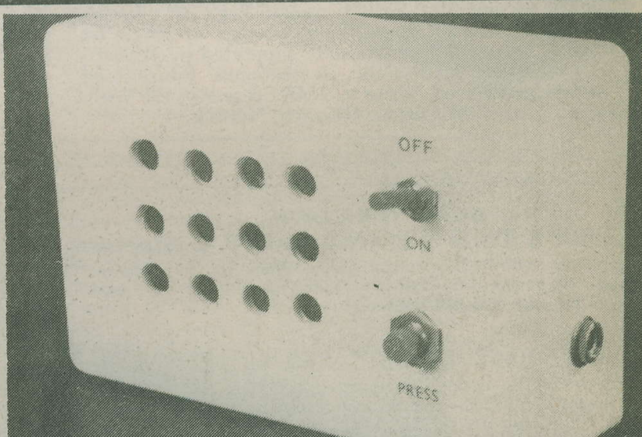

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