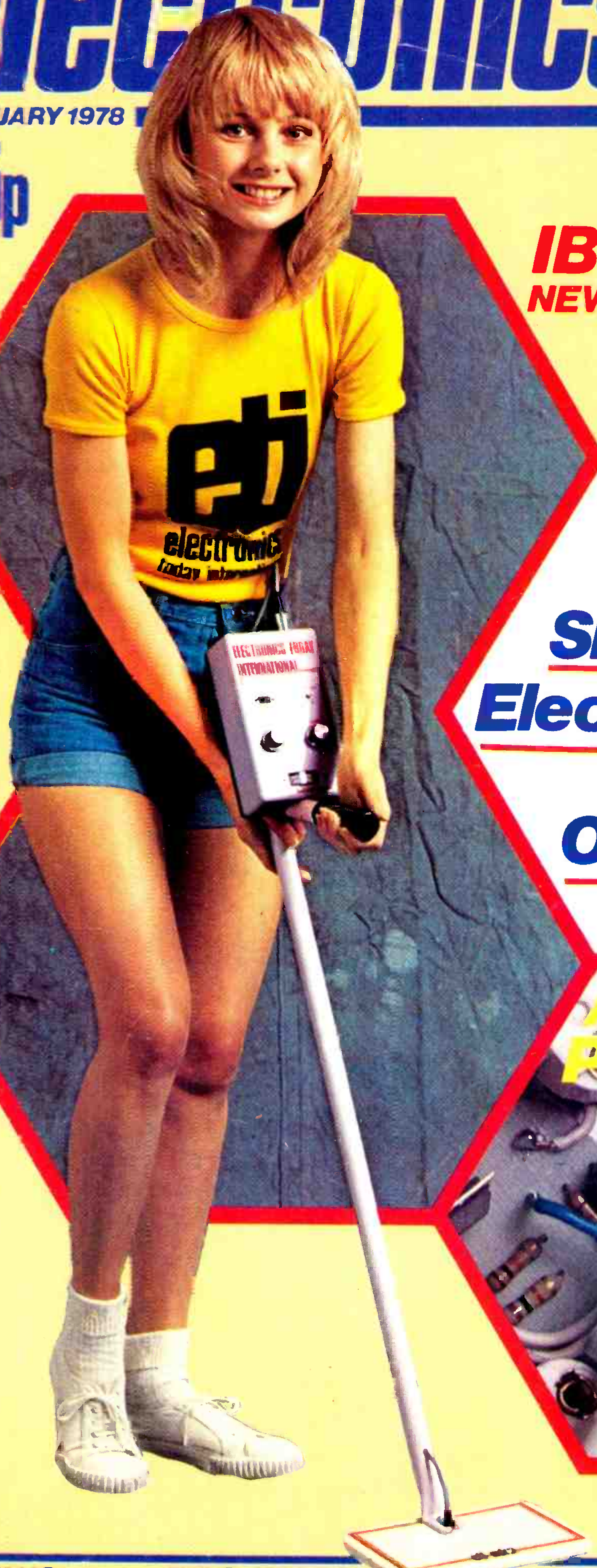
electronics today INTERNATIONAL

FEBRUARY 1978

45p



IB Metal Locator
NEW IMPROVED DESIGN

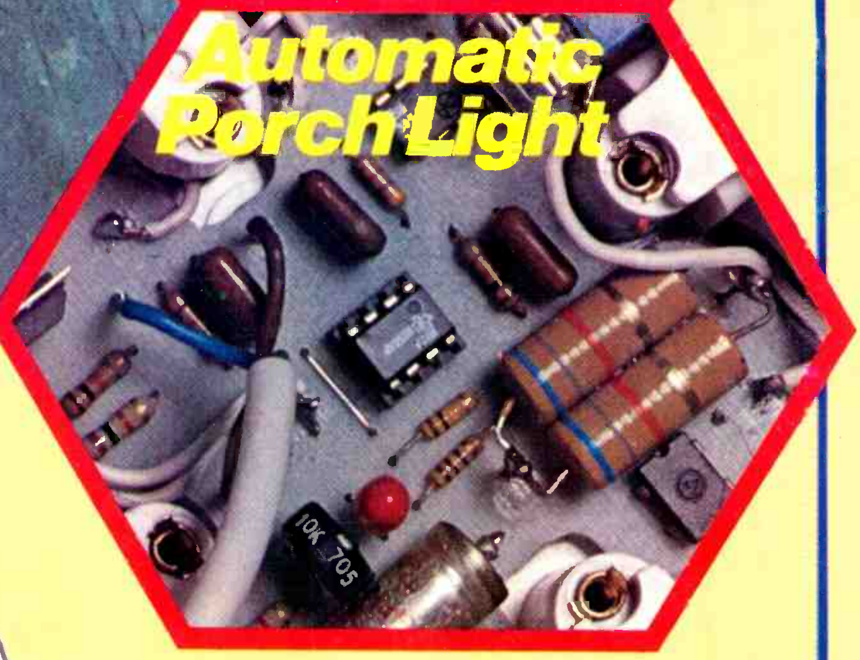
Ultrasonic Switch

Shutter Timer

Electronics On Tap!

Struck On Lightning?

Op Amps



Automatic Porch Light

. . . NEWS . . . . PROJECTS . . . . MICROPROCESSORS . . . . AUDIO . . .

not batteries p97

WATFORD ELECTRONICS

33 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDERS, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 25p TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. SEND S.A.E. FOR OUR FREE LIST.

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We stock many more items. Send S.A.E. for our free list. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type (Values are in μF) **400V:** 0.001 0.0015 0.0022 0.0033 **8p;** 0.0047 0.0068 0.01 0.015 0.018 **9p;** 0.022 0.033 **10p;** 0.047 0.068 **14p;** 0.1 **15p;** 0.15 0.22 **22p;** 0.33 0.47 **39p;** 0.68 **45p.** **160V:** 0.039 0.15 0.22 **13p;** 0.33 0.47 **22p;** 0.68 1.0 **29p;** 1.5 **33p;** 2.2 **38p;** 4.7 **47p.** **DUBILIER: 1000V:** 0.01 0.015 **16p;** 0.022 **18p;** 0.047 **16p;** 0.1 **34p;** 0.47 **43p.**

POLYESTER RADIAL LEAD (Values in μF) **250V:** 0.01 0.015 **6p,** 0.022 0.027 **7p;** 0.033 0.047 0.068 0.1 **8p;** 0.15 **12p;** 0.22 0.33 **14p,** 0.47 **16p;** 0.68 **20p;** 1.0 **24p;** 1.5 **27p;** 2.2 **31p**

FEED THROUGH CAPACITORS 1000pF 350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF) **63V:** 0.47 1.0 1.5 2.2 2.5 3.3 4.7 6.8 8 10 15 22 **9p;** 47 32 50 **12p;** 63 100 **27p. 50V:** 100 **7p;** 50 100 220 **25p,** 470 **50p;** 1000 2200 **68p, 40V:** 22 33 **9p;** 100 **12p;** 3300 **62p;** 4700 **64p; 35V:** 10 33 **7p;** 330 470 **32p;** 1000 **49p; 25V:** 10 22 47 **6p;** 80 100 160 **8p;** 220 250 **13p;** 470 640 **25p;** 1000 **27p;** 1500 **30p;** 2000 **34p;** 3300 **52p;** 4700 **54p; 16V:** 10 40 47 68 **7p;** 100 125 **8p;** 470 **16p;** 1000 1500 **20p,** 2200 **34p; 10V:** 4 100 **6p;** 640 **10p;** 1000 **14p.**
TAG-END TYPE: 70V: 2000 **98p;** 4700 **121p; 50V:** 3300 **75p; 40V:** 4000 **70p;** 2500 **65p; 25V:** 4700 **48p;** 2000 **37p; 40V:** 2000 + 2000 **95p 325V:** 200 + 100 + 50 + 100 **190p.**

TANTALUM BEAD CAPACITORS **35V:** 0.1μF 0.22 0.33 0.47 0.68 1.0 2.2μF 3.3 4.7 6.8 **25V:** 1.5 10 **20V:** 1.5 **16V:** 10μF **13p** each 4 100 **40p** **10V:** 22μF 33 47 **6V:** 47 68 100 **3V:** 68 100μF **20p** each

MYLAR FILM CAPACITORS
100V: 0.001 0.002 0.005 0.01μF **5p**
0.015 0.02 0.04 0.05 0.056μF **6p**
0.1μF 0.15 0.2 **7p. 50V:** 0.47μF **10p**

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10,000pF **3p**
0.015μF 0.022μF 0.033μF 0.047μF **4p** 0.1μF **6p**

SILVER MICA (Values in pF) 3.3 4.7 6.8 10 12 18 22 33 47 50 68 75 82 85 100 120 150 220 **9p** each
250 300 330 360 390 600 820 **16p** each
1000 1800 2000 2200 **20p** each

CERAMIC TRIMMER CAPACITORS
2.7pF 4.15pF 6.25pF 8.30pF **20p**

MINIATURE TYPE TRIMMERS
2.5-6pF 3-10pF 10-40pF **22p**
5.25pF 5.45pF 60pF 88pF **30p**

COMPRESSION TRIMMERS
3-40pF 10-80pF 25-190pF **25p**
100-500pF 1250pF **38p**

POTENTIOMETERS (AB or EGEN)
Carbon Track ¼W Log & ½W Linear values

1KΩ & 2KΩ (lin. only) Single gang	26p
5KΩ 2MΩ single gang	26p
5KΩ 2MΩ single gang D/P switch	55p
5KΩ 2MΩ dual gang stereo	70p

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm

5KΩ 500KΩ single gang	60p
10KΩ 500KΩ dual gang	70p
Self Stick Graduated Bezels	20p

PRESET POTENTIOMETERS

0.1W 50Ω 5MΩ Miniature Vertical & Horizontal	8p
0.25W 100Ω 3.3MΩ Horiz. larger	10p
0.25W 200Ω 4.7MΩ Vert.	10p

RESISTORS — Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL.	1-99	100+
¼W	2Ω 4.7M	E24	1.5p	1p
½W	2.2Ω 4.7M	E12	2p	1.5p
1W	2.2Ω 10M	E12	5p	4p
2% Metal Film	10Ω 1MΩ		6p	4p

100+ price applies to Resistors of each type, not mixed values.

FREE STOCK LIST
We stock thousands more items. Please send a large SAE for our list.

OPTO ELECTRONICS *

LEDs + clip	
TIL209 Red	13
TIL211 Grn	24
TIL212 Yellow	27
2" Red	17
2" Amber, Green, Yellow	21
OCP70	40
ORP12	68
2N5777	54
7 Seg Displays	
TIL312 C An 3"	125
TIL313 C Cth 3"	125
TIL321 C An 5"	130
TIL322 C Cth 5"	130
DL704 C Cth	99
DL707 C A	99
DL747 C A	180
FND 357	140
DRIVERS 75491 75492	85

SWITCHES*

TOGGLE 2A 250V	
SPST	28p
DPDT	38p
4 pole on/off	54p
SUB-MIN TOGGLE	
SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT centre off	79p
DPDT Biased	115p
SLIDE 250V:	
1A DPDT	14p
1A DPDT c/over	16p
½A DPDT	13p
4 pole c/over	24p
PUSH BUTTON Spring loaded	
PST on/off	60p
SPDT c/over	65p
DPDT 6 Tag	85p

JACK PLUGS	Screened chrome	Plastic body	SOCKETS: open metal	moulded with break contacts	in-line couplers
2.5mm	12p	8p	8p		11p
3.5mm	15p	10p	8p		12p
MONO	23p	15p	13p	20p	18p
STEREO	31p	18p	15p	24p	22p

Minimum order £2 please

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker 3, 4, 5 Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO (assorted colours, Metal screened)	9p 12p	5p single 8p double 10p 3-way	15p
BANANA 4mm 2mm 1mm	10p 10p 8p	12p 10p 8p	—

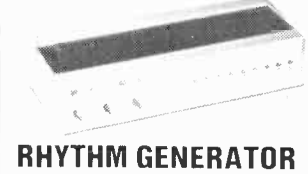
SWITCHES * PUSH BUTTON:
Miniature Non Locking Push to Make **15p** Push to Break **25p**
ROCKER: (white) 10A 250V **28p**
SPST changeover centre off **23p**
ROCKER: (black) on/off 10A 250V
ROCKER: (illuminated) (white) 10A 250V **52p**
ROTARY: ADJUSTABLE STOP: 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way **41p**
ROTARY: Mains 250V AC 4 Amp **45p**

DIL SOCKETS* (Low Profile Texas) 8 pin **10p;** 14 pin **12p;** 16 pin **13p;** 18 pin **20p;** 24 pin **30p;** 28 pin **42p;** 40 pin **58p.**

SPECIAL OFFER

TV GAMES

"Olympic Kit"	£20.80*
"Olympic" Colour Kit	£28.50*
(p&p insured add 95p)	
EconoGame Kit	£8.99*
COLOUR ADAPTOR for existing Black & White Games	£8.85*
"Sure Fire Rifle" Kit for "Olympic" Game	£8.50*
"Sure Fire Rifle" Kit for other makes	£9.25*
(p&p insured add 48p)	
"Joy Stick"	£1.95*
IC AY-3-8500	£4.50*
IC AY-3-8550	£7.50*
IC AY-3-8600	£9.00*



RHYTHM GENERATOR

Build this PE (Jan. '78) Easibuild Low Cost Rhythm Generator. We are the sole suppliers of the complete Kit including the case, pre-drilled printed front panel and the Printed Circuit Boards send sae for leaflet.

Complete Kit price incl. VAT **£49.95** only
Plus P&P £1

(TV Games & Rhythm Gen. Demonstration on at our shop)

TTL 74*

7400	14	7480	50	74161	116	4021	99		
7401	14	7481	97	74162	116	4022	90		
7402	16	7482	82	74163	121	4023	20		
7403	16	7483	95	74165	130	4024	76		
7404	20	7484	95	74166	141	4025	19		
7405	22	7485	110	74167	198	4026	180		
7406	38	7486	36	74170	240	4027	55		
7407	38	7489	320	74172	625	4028	90		
7408	20	7490	36	74173	175	4029	109		
7409	20	7491	80	74174	113	4030	58		
7410	15	7492	53	74175	90	4033	145		
7411	24	7493	35	74176	120	4034	196		
7412	23	7494	85	74177	116	4040	105		
7413	37	7495	70	74180	142	4042	81		
7414	74	7496	82	74181	299	4043	96		
7416	35	7497	262	74182	127	4044	95		
7417	39	74100	125	74184	225	4046	145		
7420	16	74104	62	74185	146	4047	130		
7421	33	74105	62	74188	650	4049	99		
7422	24	74107	33	74190	140	4050	58		
7423	32	74109	54	74191	140	4051	52		
7425	30	74110	54	74192	140	4052	52		
7426	36	74111	70	74193	140	4053	120		
7427	36	74116	198	74194	140	4054	134		
7428	38	74118	90	74195	110	4056	134		
7430	18	74119	115	74196	118	4060	115		
7432	32	74120	28	74197	118	4067	380		
7433	40	74121	48	74198	248	4068	22		
7437	30	74122	70	75150	110	4069UBE	22		
7438	33	74123	65	75491	75	4070	32		
7440	17	74125	60	75492	80	4072	21		
7441	74	74126	77	**CMOS* (RCA)**		4081BE	23		
7442	68	74128	73			4082	129		
7443	115	74132	56			[illegible]	40		
7444	112	74136	72	4000	15	4508	21		
7445	94	74141	280	4001	17	4510	22		
7446	94	74142	314	4002	17	4511	21		
7447	82	74143	314	4006	105	4512	120		
7448	74	74144	85	4007	18	4514	55		
7450	17	74145	175	4008	58	4515	135		
7451	17	74147	143	4009	58	4516	168		
7453	17	74148	118	4011	19	4517	98		
7454	17	74150	75	4012	18	4518	125		
7460	17	74151	82	4013	55	4520	102		
7470	30	74153	140	4015	93	4521	59		
7472	28	74154	82	4016	52	4522	108		
7473	32	74155	80	4017	99	4528	99		
7474	32	74156	225	4018	99	4532	127		
7475	42	74157	116	4019	60	4539	110		
7476	30	74160	116	4020	102	4558	101		

LINEAR IC'S

709C	75	[illegible]	198
709C 14 pin	35	MC1303	145
710*	48	MC1304	260
711 8 pin	22	MC1310	185
723C	70	MC1312P	195
741C	36	MC1314	1250
747C	150	MC1458P*	90
8038CC*	355	MC1496	101
AY-1-0212	580	MC1710CG	79
AY-1-5050	241	MFC6040*	97
AY-1-5051	125	MK50253*	550
AY-1-6721 6	195	MK50362*	550
AY-3-8500*	510	MM2101	210
AY-3-8550*	750	MM2112-2N*	298
AY-5-1224*	295	NE518A	210
AY-5-1230*	490	NE555*	36
AY-5-1317A	630	NE556DB*	90
CA3014*	137	NE560*	325
CA3018*	82	NE561*	410
CA3020	170	NE562*	410
CA3023	170	NE565A*	185
CA3028A*	99	NE566*	180
CA3035	140	NE567V*	187
CA3036	180	NE570	450
CA3043	190	RAM2102-2*	210
CA3046	80	RO3-2513*	700
CA3048	200	SG3402*	255
CA3075	175	SN76003N	125
CA3080	80	SN76013N	240
CA3081	190	SN76023N	240
CA3089E	210	SN76033N	140
CA3090AQ	390	SN76115N	230
CA3130	200	SN76115N	215
CA3140*	94	SN76227N	175
CA3140	95	SN76477N	228
ICM7205*	1150	SN76660	155
LM301A	170	TAA661B	300
LM309K	39	TAA263	150
LM318	195	TBA810	170
LM324	350	TBA800	90
LM339	55	TBA820	220
LM348	120	TCA270	355
LM370	398	TDA1022	250
LM380	98	TDA2020	180
LM381	170	TDA1008	90
LM382	125	TL081C	105
LM3900	65	TBA120	80
LM	70	[illegible]	350
LM	—	[illegible]	320
M	750	[illegible]	110
		[illegible]	130

TRANSISTORS

	p										
AC117	35	BC167A	11	BF197	15	OC45*	35	ZTX501	25	2N3703	11
AC126*	19	BC168	12	BF198	18	OC70*	35	ZTX531	28	2N3704	10
AC127*	19	BC169C	14	BF200	30	OC71*	30	ZTX550	25	2N3705	11
AC128*	18	BC170	18	BF224	18	OC72*	30	2N456A*	58	2N3706	10
AC128K*	18	BC171	11	BF241B	30	OC73	30	2N696*	35	2N3707	10
AC141*	24	BC172	10	BF256*	50	OC74*	76	2N697*	21	2N3708	11
AC141K*	38	BC177*	18	BF257*	29	OC75*	76	2N698*	39	2N3709	11
AC142*	24	BC178*	16	BF258*	29	OC76*	28	2N699*	50	2N3710	16
AC142K*	38	BC179*	18	BF259*	30	OC77*	45	2N706*	19	2N3771*	245
AC176*	18	BC182	13	BFR39	22	OC81*	45	2N706A*	50	2N3772*	170
AC176K*	20	BC182L	10	BFR40	40	OC81D*	48	2N708*	48	2N3773*	288
AC187*	20	BC183	10	BFR41	38	OC82*	44	2N914*	32	2N3819	22
AC188*	20	BC183L	13	BFR79	25	OC83*	115	2N916*	27	2N3820	38
ACY17	35	BC184	12	BFR80	28	OC84*	140	2N918*	30	2N3823	65
ACY18*	40	BC184L	11	BFR81	28	OC139*	125	2N930*	51	2N3866*	70
ACY19*	40	BC186	14	BFR84	28	OC140*	157	2N1131*	18	2N3866A*	90
ACY20*	40	BC187	28	BFX29	28	OC141*	40	2N1132*	61	2N3902	20
ACY21	35	BC212	12	BFX30	130	OC170*	40	2N1302*	22	2N3903	18
ACY22*	40	BC212L	11	BFX84*	24	OC171*	125	2N1303*	22	2N3904	18
ACY28*	40	BC213	13	BFX85*	28	OC200*	140	2N1304*	35	2N3905	17
ACY39	78	BC213L	14	BFX86*	28	OC201*	150	2N1305*	50	2N4037*	52
ACY40*	48	BC214	14	BFX87*	23	OC204*	150	2N1306*	50	2N4058	17
ACY44	39	BC214L	14	BFX88*	26	OC205	43	2N1307*	28	2N4060	17
AD140	60	BC261B	15	BFY50	50	TIP29A	44	2N1308*	35	2N4061*	120
AD149*	70	BC301*	15	BFY51	17	TIP29C	60	2N1309*	50	2N4062*	145
AD161*	42	BC303*	15	BFY52	17	TIP30	52	2N1308*	46	2N4126	20
AD162*	42	BC307	15	BFY53	17	TIP30A	52	2N1613*	20	2N4289	65
AF114*	20	BC338*	45	BFY71*	47	TIP30B	64	2N1671*	190	2N4348	42
AF115*	20	BC461*	38	BSX20*	18	TIP30C	70	2N1671B*	195	2N4360	42
AF116*	20	BC462*	45	BSY95A*	18	TIP31A*	50	2N1893*	28	2N4400	29
AF117*	22	BC548	15	BU105*	140	TIP31B*	50	2N1985	60	2N4427*	60
AF118*	55	BC549	13	BU204	190	TIP31C*	58	2N2160*	105	2N5172	60
AF124*	48	BC558	12	BU208*	225	TIP32A*	66	2N2219*	48	2N5191*	65
AF125*	55	BC559	30	BSY95	65	TIP32B*	55	2N2219A*	35	2N5294	40
AF126*	35	BD115*	30	MJ3001*	158	TIP32C*	60	2N2220A*	26	2N5296	35
AF127*	35	BD116*	13	MJ4001	90	TIP33A*	75	2N2221A*	26	2N5457	36
AF139*	35	BD121*	13	MJ491*	160	TIP33B*	77	2N2221A*	25	2N5458	36
AF178*	70	BD123*	90	MJE2955*	120	TIP33C*	85	2N2222A*	20	2N5459	38
AF180*	70	BD124*	15	MJE340*	45	TIP33B*	100	2N2297	45	2N5460	50
AF186*	50	BD131*	20	MJE370*	80	TIP33C*	110	2N2303*	50	2N6027	40
AF239*	42	BD132*	15	MJE371*	80	TIP34*	95	2N2368	25	40311*	56
ASY26*	40	BD115*	62	MJE520*	65	TIP34A*	95	2N2369*	15	40313*	125
ASY27*	45	BD121*	78	MJE521*	74	TIP34B*	120	2N2516	125	40316*	95
BC107*	9	BD123	98	MJE2955*	115	TIP35*	219	2N2483*	28	40317*	52
BC107B*	10	BD124*	115	MJE3055*	80	TIP35A	225	2N2484*	30	40326*	52
BC108*	9	BD131*	38	MPF102	36	TIP35C*	270	2N2646*	48	40327*	62
BC108B*	12	BD132*	38	MPF103	36	TIP36A*	280	2N2784	55	40347*	99
BC108C*	12	BD133*	43	MPF104	36	TIP41A*	66	2N2846	140	40348*	116
BC109*	9	BD135	38	MPF105	36	TIP41B*	73	2N2894	30	40360*	43
BC109B*	12	BD136	36	MPF106	36	TIP42A*	72	2N2904A*	22	40361*	45
BC109C*	12	BD137	36	MPF106	50	TIP42B*	82	2N2905A*	20	40362*	43
BC113	17	BD138	50	MPF107	50	TIP2955*	65	2N2906*	18	40411*	285
BC114	20	BD139	34	MPSA05	32	TIP3055*	52	2N2907*	20	40412*	65
BC115	20	BD140	36	MPSA06	32	TIS43	36	2N2926G	10	40576*	190
BC116	20	BD144	59	MPSA55	30	TIS44	45	2N2926O	8	40594*	98
BC117	20	BD181*	198	MPSA56	30	TIS46	45	2N2926R	8	40603*	113
BC118	20	BD182*	195	MPSA70	34	TIS50	47	2N2926Y	8	40636*	165
BC119	28	BD600*	110	MPSU02*	58	TIS74	47	2N3011*	30	40673*	68
BC131	20	BD611*	165	MPSU05*	50	TIS91	24	2N3053*	17		
BC135	20	BF115*	22	MPSU06*	56	ZTX107	22	2N3054*	49	Matched Pair 10p extra	
BC136	18	BF154*	25	MPSU52*	65	ZTX108	20	2N3055*	60		
BC137	20	BF156*	29	MPSU55*	55	ZTX109	25	2N3108	60		
BC140*	35	BF173*	25	MPSU56*	60	ZTX300	16	2N3121	40		
BC142*	28	BF177*	24	MPU131*	39	ZTX301	16	2N3133	43		
BC143*	28	BF178*	25	OC25*	120	ZTX302	25	2N3135	33		
BC147	7	BF179*	30	OC26*	170	ZTX303	25	2N3250	30		
BC148	7	BF180*	30	OC28*	105	ZTX304	24	2N3252	36		
BC149	8	BF181*	30	OC29*	160	ZTX311	17	2N3302	35		
BC153	27	BF182*	30	OC35*	100	ZTX314	24	2N3442*	142		
BC154	27	BF183*	30	OC36*	170	ZTX341	20	2N3563	32		
BC157	10	BF184*	20	OC41*	48	ZTX500	17	2N3614*	169		
BC158	11	BF194	10	OC42*	40	ZTX501	15	2N3615*	135		
BC159	11	BF195	10	OC43	65	ZTX502	19	2N3663	26		
BC160*	42	BF196	12	OC44*	35	ZTX503	19	2N3702	10		

NOISE DIODES Z5 105p

DIAC* ST2 25

DIODES	p		
AA215	15	OA90	6
AFY11	60	OA91	6
BA100	10	OA95	8
BY100	24	OA200	9
BY126	14	OA202	8
BY127	14	1N914	4
OA9	60	1N916	5
OA10	20	1N4001/2*	5
OA47	12	1N4003*	6
OA70	12	1N4004/5*	6
OA79	12	1N4006/7*	7
OA81	15	1N4148	4
OA85	12	3A 100V*	18
		3A 400V*	20

3A 600V*	27
3A 1000V*	30
6A 600V	54

ZENERS Range 3.3V to 33V 400MW **9p** 1.3W **17p**

VARICAPS

MVAM2	135p
BB104	40p
BB105B	40p
MVAM115	95p

***BRIDGE RECTIFIERS**

(plastic case)	p
1A50V	20
1A100V	22
1A200V	25
1A400V	29
1A600V	34
2A50V	35
2A100V	44
2A200V	46
2A400V	53
4A100V	72
4A400V	79

4A800V	120
6A100V	73
6A400V	92
BY164	56

TRIACS*

3A 400V	113
3A 500V	140
6A 400V	140
8A 400V	100
15A 400V	240
40430	110
40528	87
40669	110

THYRISTORS* SCRs

1A50V	38
1A 100V	42
1A 200V	47
1A 400V	52
3A 100V	43
4A 400V	110
5A 400V	120
7A 200V	120
7A 400V	125
8A 400V	150
C106D	55
TIC45	45p
TIC44	25
TIC45	37
2N4444	191

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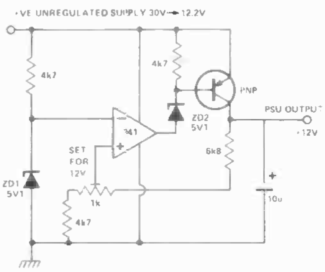
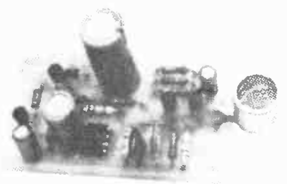


Plenty of Op-Amp circuits p.22



Remote control switch . p.62

FEATURES

PROJECTS

NEWS

INFORMATION

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Vol 4 P 484 — Matchbox radio

AUDIO MODULES—ALL REDUCED! TRANSISTOR PRICES SLASHED! MANY PAKS 33⅓% OFF

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No THY3A/200	3Amp	200 volt	T064	32p
No THY3A/400	3Amp	400 volt	T064	40p
No THY5A/50	5Amp	50 volt	T066	25p
No THY5A 400	5Amp	400 volt	T066	40p
No THY5A/600	5Amp	600 volt	T066	50p
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D32 **15p**

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	25p	BC177	12p	BF194	9p*	TIP32C	36p	2N1893	28p
AC126	14p	BC178	12p	BF195	9p*	TIP41A	34p	2N2218	15p
AC127	16p	BC179	12p	BF196	12p*	TIP41B	35p	2N2218A	18p
AC128	16p	BC182	9p*	BF197	12p*	TIP41C	38p	2N2219	15p
AC128K	24p	BC182L	9p*	BF200	25p	TIP42A	36p	2N2219A	18p
AC176	16p	BC183	9p*	BFX29	22p	TIP42B	37p	2N2221	15p
AC176K	24p	BC183L	9p*	BFX84	18p	TIP42C	38p	2N2221A	16p
AC187	16p	BC184	9p*	BFY50	12p	TIP2955	65p	2N2222	15p
AC187K	26p	BC184L	9p*	BFY51	12p	TIP3055	42p	2N2222A	16p
AC188	16p	BC212	10p*	BFY52	12p	ZTX107	6p*	2N2369	10p
AC188K	26p	BC212L	10p*	MPSA05	22p*	ZTX108	6p*	2N2904	14p
AD161/		BC213	10p*	MPSA06	22p*	ZTX109	7p*	2N2904A	15p
162MP	80p	BC213L	10p*	MPSA55	22p*	ZTX300	7p*	2N2905	14p
AF139	30p	BC214	10p*	MPSA56	22p*	ZTX301	7p*	2N2905A	15p
AF239	30p	BC214L	10p*	OC44	12p	ZTX302	9p*	2N2906	12p
BC107	6p	BC251	10p*	OC45	12p	ZTX500	8p*	2N2906A	14p
BC108	6p	BCY70	12p	OC71	9p	ZTX501	10p*	2N2907	12p
BC109	6p	BCY71	12p	OC72	12p	ZTX502	12p*	2N2007A	13p
BC118	10p*	BCY72	12p	OC75	10p	2N696	10p	2N2926G	8p*
BC147	8p*	BD115	40p	OC81	14p	2N697	10p	2N2926Y	7p*
BC148	8p*	BD131	35p*	TIP29A	35p	2N706	7p	2N3053	12p
BC149	8p*	BD132	37p*	TIP29B	36p	2N706A	8p	2N3055	35p
BC154	16p*	BF115	17p	TIP29C	38p	2N708	8p	2N3702	7p*
BC157	9p*	BF167	19p	TIP30A	36p	2N1302	12p	2N3703	7p*
BC158	9p*	BF173	20p	TIP30B	37p	2N1303	15p	2N3704	6p*
BC159	9p*	BF180	25p	TIP30C	38p	2N1304	15p	2N3903	11p*
BC169C	10p*	BF181	25p	TIP31A	32p	2N1307	18p	2N3904	11p*
BC170	6p	BF182	25p	TIP31B	33p	2N1308	22p	2N3905	11p*
BC171	6p*	BF183	25p	TIP31C	34p	2N1309	22p	2N3906	11p*
BC172	6p*	BF184	25p	TIP32A	34p	2N1613	15p		
BC173	7p	BF185	25p	TIP32B	35p	2N1711	15p		

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	BAX16/		BYZ17	28p	OA91	7p	IN5401	11p
AAZ13	4p	OA202	5p	BYZ18	28p	OA95	7p	IN5402	12p
BA100	6p	BY100	15p	BYZ19	28p	IN34	5p	IN5404	13p
BA115	5p	BY127	10p*	OA47	5p	IN60	6p	IN5406	16p
BA144	5p	BYZ10	32p	OA70	5p	IN914	4p	IN5407	17p
BA148	10p	BYZ11	32p	OA79	7p	IN4148	4p	IN5408	19p
BA173	10p	BYZ12	32p	OA81	7p	1S44	3p		
BAX13		BYZ13	30p	OA85	7p	IN5400	10p		
OA200	5p	BYZ16	30p	OA90	6p				

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LM381	14 pin DIL	£1.35*	UA741C	T099	20p	NE555	8 pin DIL	32p
72709	14 pin DIL	28p	72747	14 pin DIL	55p	NE556	14 pin DIL	60p
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No 16135 20 3 amp Sil stud Rect **40p**
No 16136 50 400mw Zeners D O 7 case **40p**
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No 16138 30 PNP Plastic trans like BC177/8 **40p***
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No 16140 25 PNP Trans like 2N2905 To 39 **40p**
No 16141 30 NPN Trans like 2N706 To 18 **40p**
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7402	0.11	0.10	7451	0.12	0.10	74141	0.68	0.65
7403	0.11	0.10	7453	0.12	0.10	74145	0.75	0.72
7404	0.11	0.10	7454	0.12	0.10	74150	1.10	1.05
7405	0.11	0.10	7460	0.12	0.10	74151	0.65	0.60
7406	0.28	0.25	7470	0.24	0.23	74153	0.70	0.68
7407	0.28	0.25	7472	0.20	0.19	74154	1.20	1.10
7408	0.12	0.11	7473	0.26	0.22	74155	0.70	0.68
7409	0.12	0.11	7474	0.24	0.23	74156	0.70	0.68
7410	0.09	0.08	7475	0.44	0.40	74157	0.70	0.68
7411	0.22	0.20	7476	0.26	0.25	74160	0.95	0.85
7412	0.22	0.20	7480	0.45	0.42	74161	0.95	0.85
7413	0.26	0.25	7481	0.90	0.88	74162	0.95	0.85
7416	0.28	0.25	7482	0.75	0.73	74163	0.95	0.85
7417	0.28	0.25	7483	0.88	0.82	74164	1.20	1.10
7420	0.11	0.10	7484	0.85	0.80	74165	1.20	1.10
7422	0.19	0.18	7485	1.10	1.00	74166	1.20	1.10
7423	0.21	0.20	7486	0.28	0.26	74174	1.10	1.00
7425	0.25	0.23	7489	2.70	2.50	74175	0.85	0.82
7426	0.25	0.23	7490	0.38	0.32	74176	1.10	1.00
7427	0.25	0.23	7491	0.65	0.62	74177	1.10	1.00
7428	0.36	0.34	7492	0.43	0.35	74180	1.10	1.00
7430	0.12	0.10	7493	0.38	0.35	74181	1.90	1.80
7432	0.20	0.19	7494	0.70	0.68	74182	0.80	0.78
7433	0.38	0.36	7495	0.60	0.58	74184	1.50	1.40
7437	0.26	0.25	7496	0.70	0.68	74190	1.40	1.30
7438	0.28	0.25	74100	0.95	0.90	74191	1.40	1.30
7440	0.12	0.10	74104	0.40	0.35	74192	1.10	1.00
7441	0.60	0.57	74105	0.30	0.25	74193	1.05	1.00
7442	0.80	0.70	74107	0.30	0.25	74194	1.05	1.00
7443	0.95	0.90	74110	0.48	0.45	74195	0.80	0.75
7444	0.95	0.90	74111	0.75	0.72	74196	0.90	0.85
7445	0.80	0.75	74118	0.85	0.82	74197	0.90	0.85
7446	0.80	0.75	74119	1.30	1.20	74198	1.90	1.80
7447	0.70	0.68	74121	0.28	0.26	74199	1.80	1.70

Devices may be mixed to qualify for quantity price Data is available for the above series of ICs in booklet form **price 35p**

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.14	CD4018	£0.85	CD4035	£1.40	CD4056	£1.15
CD4001	£0.16	CD4019	£0.45	CD4037	£0.78	CD4069	£0.32
CD4002	£0.16	CD4020	£0.95	CD4040	£0.78	CD4070	£0.32
CD4006	£0.80	CD4021	£0.85	CD4041	£0.68	CD4071	£0.20
CD4007	£0.17	CD4022	£0.80	CD4042	£0.68	CD4072	£0.20
CD4008	£0.80	CD4023	£0.18	CD4043	£0.78	CD4081	£0.20
CD4009	£0.50	CD4024	£0.64	CD4044	£0.78	CD4082	£0.20
CD4010	£0.50	CD4025	£0.18	CD4045	£1.15	CD4510	£1.10
CD4011	£0.18	CD4026	£1.85	CD4046	£0.95	CD4511	£1.25
CD4012	£0.17	CD4027	£0.48	CD4047	£0.75	CD4516	£1.10
CD4013	£0.42	CD4028	£0.80	CD4049	£0.46	CD4518	£1.10
CD4015	£0.80	CD4029	£0.95	CD4050	£0.46	CD4520	£1.10
CD4016	£0.42	CD4030	£0.46	CD4054	£0.95		
CD4017	£0.80	CD4031	£1.80	CD4055	£1.60		

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PS12	20-30V Power Supply for AL30A	~~£1.30*~~	£1.15*
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PA100	Stereo Pre-Amp for AL60/AL80	~~£13.75*~~	£12.45*
S450	Stereo F M. Tuner	~~£20.45*~~	£18.65*
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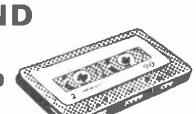

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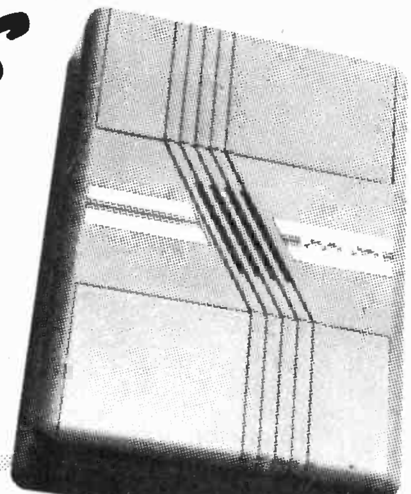

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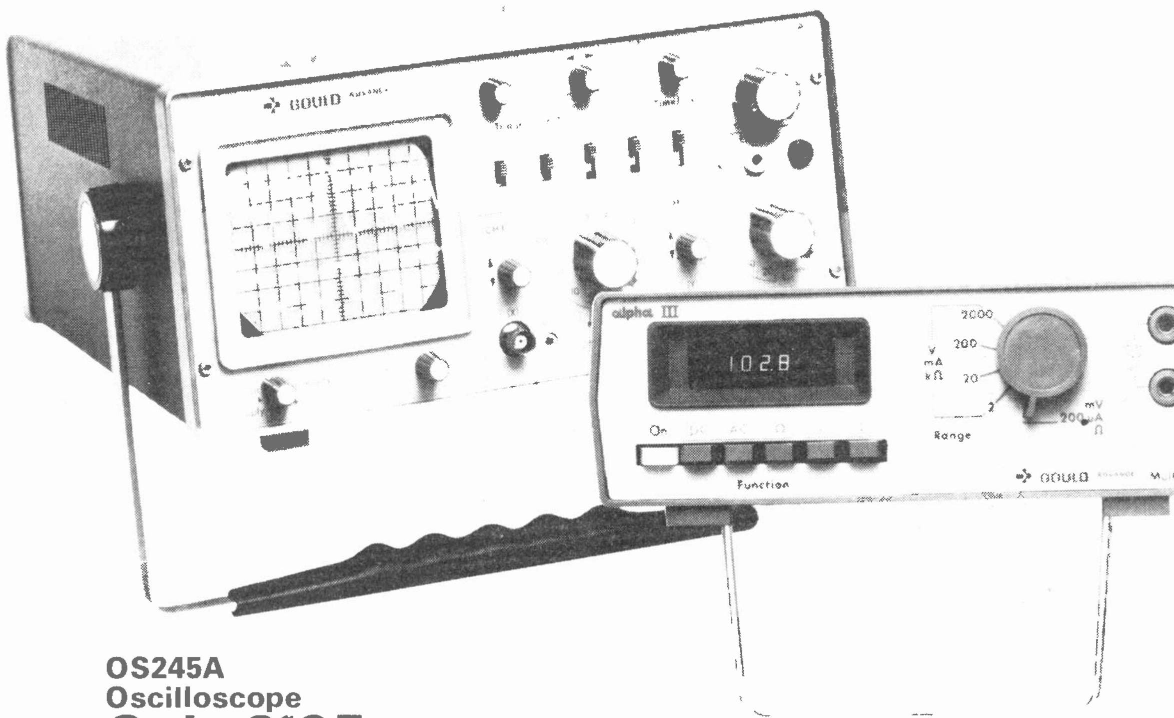

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CD4001	0.18	CD4024	0.80	CD4044	0.96	CD4070	0.51	CD4502	1.24
CD4002	0.17	CD4025	0.23	CD4045	1.45	CD4071	0.23	CD4510	1.41
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CD4010	0.58	C04030	0.58	CD4050	0.58	CD4077	0.45	CD4518	1.25
CD4011	0.20	CD4031	2.30	CD4051	0.94	CD4078	0.23	CD4520	1.19
CD4012	0.23	CD4032	1.02	CD4052	0.94	CD4081	0.23	C04527	1.64
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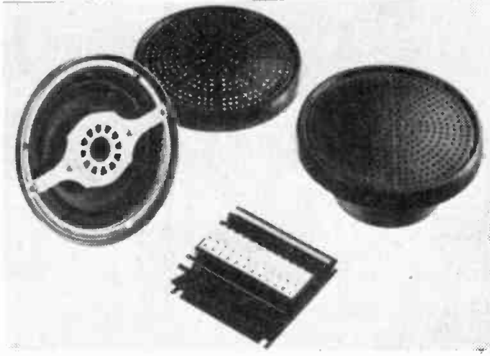

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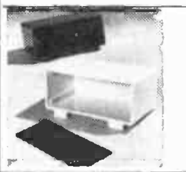

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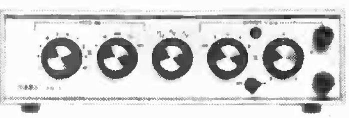

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2N914	0.35	2N3714	2.45	40595	0.90	BC179	0.23	BD241	0.45	BSX21	0.32	CA3046	0.89	LM3401	0.70	TAA930B	1.30
2N916	0.30	2N3715	2.55	40673	0.75	BC182	0.11	BD242	0.50	BU105	1.40	CA3048	2.23	LM3900	0.75	TAD100	1.95
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2N1613	0.30	2N3790	3.10	AC153	0.55	BC207	0.16	BD530	0.50	ME4104	0.10	CA3086	0.60	MC1305	1.40	TBA510Q	2.30
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2N2369A	0.25	2N4062	0.18	AF200	1.20	BC259B	0.18	BF178	0.25	MPF102	0.30	LM339N	1.40	SO42P	1.25	TBA700Q	1.61
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2N2647	1.40	2N4289	0.20	AF240	1.14	BC262B	0.24	BF180	0.35	MPSA06	0.25	LM360N	2.75	76003N	2.20	TBA750	1.98
2N2904	0.36	2N4919	0.65	AF279	0.80	BC263C	0.30	BF181	0.35	MPSA12	0.40	LM370N	2.50	76008K	1.50	TBA750Q	2.07
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2N2924	0.15	2N5195	0.90	BC116A	0.20	BC318	0.13	BF197	0.17	TIP29C	0.60	LM380-8	0.90	76115N	1.51	TCA160B	1.61
2N2925	0.17	2N5245	0.34	BC117	0.22	BC327	0.20	BF198	0.18	TIP30A	0.49	LM380N	0.98	76116N	1.66	TCA270	2.25
2N3019	0.55	2N5294	0.40	BC118	0.20	BC328	0.19	BF200	0.35	TIP30C	0.65	LM381A	2.45	76131N	1.20	TCA280A	1.30
2N3053	0.26	2N5295	0.40	BC119	0.30	BC337	0.19	BF225J	0.25	TIP31A	0.50	LM381N	1.60	76226N	1.56	TCA290A	3.13
2N3054	0.60	2N5296	0.40	BC121	0.45	BC338	0.21	BF244	0.35	TIP 31C	0.66	LM382N	1.25	76227N	1.20	TCA420A	1.84
2N3055	0.70	2N5298	0.40	BC132	0.30	BC547	0.12	BF245	0.40	TIP32A	0.55	LM384N	1.45	76228N	1.41	TCA730	3.22
2N3390	0.20	2N5447	0.15	BC134	0.20	BC548	0.12	BF246	0.75	TIP32C	0.75	LM386N	0.80	76530N	0.75	TCA740	2.76
2N3391	0.20	2N5448	0.15	BC135	0.20	BC549	0.12	BF254	0.24	TIP33A	0.80	LM387N	1.05	76532N	1.40	TCA750	2.30
2N3391A	0.20	2N5449	0.19	BC136	0.19	BCY30	1.00	BF255	0.24	TIP33C	1.10	LM388N	0.90	76533N	1.20	TCA760	1.38
2N3392	0.16	2N5457	0.32	BC137	0.20	BCY31	1.00	BF257	0.37	TIP34A	0.90	LM389N	1.00	76544N	1.44	TCA800	3.13
2N3393	0.15	2N5458	0.33	BC140	0.35	BCY32	1.00	BF258	0.45	TIP34C	1.20	LM702C	0.75	76545N	1.65	UAA170	2.00
2N3394	0.15	2N5459	0.29	BC141	0.40	BCY33	1.00	BF259	0.49	TIP35A	2.50	LM709C	0.65	76546N	1.44	UAA180	2.00
2N3439	0.88	2N5484	0.34	BC142	0.30	BCY34	1.00	BF459	0.50	TIP36A	2.80	LM709N	0.45	76550N	0.35	DIL	
2N3440	0.64	2N5486	0.38	BC143	0.30	BCY38	2.00	BFR39	0.28	TIP41A	0.70	LM710C	0.60	76552N	0.52	SOCKETS	
2N3441	0.81	2N6027	0.60	BC147	0.12	BCY42	0.60	BFS21A	2.60	TIP41C	0.90	LM710N	0.60	76570N	1.65	8 PIN	0.15
2N3442	1.35	2N6101	0.45	BC148	0.12	BCY58	0.25	BFS28	1.38	TIP42A	0.80	LM723C	0.85	76620N	0.90	14 PIN	0.16
2N3638	0.16	2N6107	0.42	BC149	0.14	BCY59	0.25	BFS61	0.30	TIP42C	1.00	LM723N	0.75	76650N	1.10	16 PIN	0.18
2N3638A	0.16	2N6109	0.50	BC153	0.27	BCY70	0.25	BFS98	0.30	TIP2955	0.65	LM741C	0.65	76660N	0.60	22 PIN	0.30
2N3639	0.30	2N6121	0.38	BC154	0.27	BCY71	0.26	BFX29	0.35	TIP3055	0.55	LM741N	0.40	76666N	0.92	24 PIN	0.35
2N3641	0.20	2N6122	0.41	BC157	0.14	BCY72	0.24	BFX30	0.35	TIS43	0.43	LM741-8	0.40	TAA320A	1.00	28 PIN	0.45
2N3702	0.13	2N6123	0.43	BC158	0.14	BD115	0.80	BFX84	0.35			LM747N	0.90	TAA350A	2.48	40 PIN	0.55

MICROPROCESSOR COMPONENTS

RAMS
2101-2N 3.00
2102-2N 2.10
2111-2N 3.00
2112-2N 3.00
74C920D 12.57

ROMS
MM5214 26.95

PROMS
74S287 5.33
MM5204 10.50
1702AQ 10.80
2708Q 35.00

TRISTATE BUFFERS
DM81LS95 1.45
DM81LS96 1.45
DM81LS97 1.45
DM81LS98 1.45

2102.2N RAM
£1.93 each for 25 pcs

8080A 8 BIT MICROPROCESSOR FAMILY

INS8080A	N Channel 40 Pin	£12.00
DP8224N	Clock Generator	£6.16
DP8228D	System Controller	£7.30
DP8212N	8 Bit Port	£3.08
ISP-8A/500D	SC/MP CPU chip	£12.00
ISP-8A/600N	N-channel CPU chip	£10.00

SC/MP

CLOCK MODULES DIGITAL

Built and tested — requires only switches and transformer to complete 12 or 24hr alarm modules

MA1002F 12hr. 5" display	£10.90
MA1002H 24hr. 5" display	£10.90
MA1010E 12hr. 84" display	£14.50
MA1010G 24hr. 84" display	£14.50

CAR CLOCK MODULE
MA1003 Built and tested 12v supply and four-digit module Crystal controlled £17.00
Data Sheet 5p + SAE

NATIONAL

"**What is a microprocessor?**" — a complete teach yourself course with cassettes + brochure **£9.95** incl. VAT & p&p

NEW SC/MP RETROFIT KIT
Now available from stock this new SC/MP/II Retrofit which enables existing SC/MP Intro Kit users to evaluate the new SC/MP/II Microprocessor **£18.40** excl. VAT p&p 75p.

TRIACS Plastic pack 400V

6 amp	0.70	16 amp	1.10
8 amp	0.75	20 amp	1.70
12 amp	0.85	25 amp	2.00

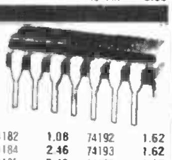
THYRISTORS Plastic C106/116

4 amp 100V	0.35	8 amp 100V	0.43	12 amp 100V	0.57
4 amp 200V	0.40	8 amp 200V	0.49	12 amp 200V	0.65
4 amp 400V	0.49	8 amp 400V	0.62	12 amp 400V	0.81

VOLTAGE REGULATORS

500MA T0202 positive 5, 12, 15, 24V	1.10
500MA T0202 negative 5, 12, 15, 24V	1.05
1 amp T0220 positive 5, 12, 15, 24V	1.35
1 amp T0220 negative 5, 12, 15, 24V	2.85

TTL FROM NATIONAL, ITT, TEXAS, SIGNETICS, ETC.



7400	0.16	7412	0.21	7438	0.55	7460	0.21	7485	1.85	74118	0.90	74160	1.41				
7401	0.16	7413	0.51	7440	0.21	7470	0.46	7486	0.41	74119	1.80	74161	1.41				
7402	0.16	7414	1.80	7441	1.03	7472	0.38	7490	0.61	74121	0.49	74162	1.41				
7403	0.16	7416	0.61	7442	0.78	7473	0.43	7491	0.98	74122	0.45	74163	1.41				
7404	0.26	7417	0.61	7445	1.35	7474	0.43	7492	0.61	74123	0.58	74164	1.23				
7405	0.26	7420	0.21	7446	1.23	7475	0.58	7493	0.61	74141	1.03	74165	1.23	74182	1.08	74192	1.62
7406	0.74	7423	0.39	7447	1.17	7476	0.51	7494	0.74	74145	1.06	74167	3.70	74184	2.46	74193	1.62
7407	0.74	7425	0.39	7448	1.17	7480	0.45	7495	0.78	74151	1.11	74174	1.52	74185	2.46	74196	1.17
7408	0.29	7427	0.39	7450	0.29	7481	1.10	7496	1.03	74153	1.11	74175	1.35	74188	2.00	74197	1.17
7409	0.29	7430	0.21	7451	0.21	7482	0.67	7497	4.60	74154	1.85	74176	1.23	74189	3.99	74198	2.93
7410	0.21	7432	0.39	7453	0.21	7483	1.33	74100	1.15	74155	1.11	74180	1.77	74190	1.91	74199	2.93
7411	0.29	7437	0.55	7454	0.21	7484	0.85	74107	0.43	74157	0.98	74181	3.70	74191	1.91		

OPTO ELECTRONICS

Full range of Opto devices in our New Catalogue
LEDS TIL209 **0.12** 100 + pcs
3mm Red **0.18** Green **0.25** Yellow **0.25**
5mm Red **0.21** Green **0.26** Yellow **0.25**
Many more types — listed in our new catalogue — Solar cells, light switches, etc.

DISPLAYS 7 Segment

	Single	Double	Display
DL704	2.00	3.00	3" Red
DL707	2.00	3.00	3" Red
DL747	2.50	3.40	5" Red
DL750	2.50	3.40	5" Red

CMOS & LOW POWER SCHOTTKY

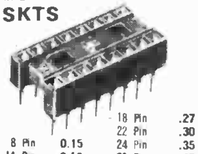
CD4000	0.24	CD4018	1.15	CD4041	0.96	CD4059	5.45	CD4081	0.25	74LS02	0.24	74LS138	1.27		
CD4001	0.24	CD4019	0.70	CD4042	0.96	CD4060	1.27	CD4082	0.25	74LS04	0.27	74LS151	1.13		
CD4002	0.24	CD4020	1.27	CD4043	1.15	CD4063	1.25	CD4085	0.81	74LS08	0.24	74LS157	1.17		
CD4006	1.34	CD4021	1.15	CD4044	1.06	CD4066	0.80	CD4086	0.81	74LS10	0.24	74LS160	1.40		
CD4007	0.24	CD4022	1.10	CD4D45	1.59	CD4067	4.25	CD4089	1.77	74LS13	0.65	74LS161	1.50		
CD4008	1.10	CD4023	0.24	CD4046	1.52	CD4068	0.25	CD4093	0.91	74LS32	0.25	74LS162	1.50		
CD4009	0.64	CD4024	0.84	CD4047	1.15	CD4069	0.25	CD4094	2.13	74LS42	1.01	74LS163	1.50		
CD4010	0.64	CD4025	0.24	CD4049	0.64	CD4070	0.66	CD4095	1.19	74LS74	0.48	74LS164	1.52		
CD4011	0.24	CD4027	0.64	CD4050	0.64	CD4071	0.25	CD4096	1.19	74LS75	0.60	74LS173	2.35		
CD4012	0.24	CD4028	1.02	CD4051	1.06	CD4072	0.25	CD4510	2.00	74LS76	0.40	74LS174	1.20		
CD4013	0.60	CD4029	1.30	CD4052	1.06	CD4073	0.25	CD4511	2.30	74LS85	1.45	74LS175	1.20		
CD4014	1.15	CD4030	0.64	CD4053	1.06	CD4075	0.25	CD4516	2.00	74LS86	0.48				
CD4015	1.15	CD4031	2.53	CD4054	1.32	CD4076	1.17	CD4518	2.00	74LS90	1.00				
CD4016	0.64	CD4035	1.34	CD4055	1.50	CD4077	0.66	CD4520	2.00	74LS92	0.90				
CD4017	1.15	CD4037	1.10	CD4056	1.50	CD4078	0.25	74LS00	0.24	74LS107	0.44				

74LS

74C MOS

74C00	.26	74C85	1.90
74C02	.26	74C86	.68
74C04	.26	74C90	.91
74C08	.26	74C107	1.30
74C10	.26	74C151	2.62
74C20	.26	74C157	2.35
74C30	.26	74C160	1.18
74C32	.26	74C161	1.18
74C42	.92	74C162	1.18
74C48	2.30	74C163	1.18
74C73	.58	74C164	1.04
74C74	.59	74C173	.95
74C76	.58	74C174	.95

LOW PROFILE SKTS



		18 Pin	.27
		22 Pin	.30
8 Pin	0.15	24 Pin	.35
14 Pin	0.16	28 Pin	.45
16 Pin	0.18	40 Pin	.55

MICROPROCESSOR SYSTEMS

SC/MP INTROKIT £68.61 exc VAT
Budget introduction to SC/MP microprocessing — Board, CPU, Memories, Crystal, etc. Built-in debugging. Complete with explanatory data and applications — National Semiconductors.

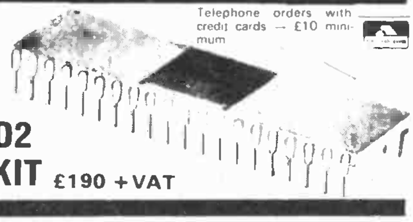
KEYBOARD KIT £65.84 exc VAT
Budget VDU for Teletype substitute, the calculator type keyboard provides manual I/O commands to Introkit. Full instruction and data supplied with each kit. Complete kit easily mates with cassette recorder.

SC/MP

DATA PACK £1.50
46 instruction set
8 bit tristate bus I/O
12 bit tristate address
512 bytes rom
256 bytes ram

NEW FROM MOTOROLA 6800

A build-it-yourself microcomputer designed around the Motorola M6800 Family
Kit contains CPU (MC6800), 256 x 8 RAM (2 x MCM6810 AP), 2 x P.I.A. (MC6820), 1 x ACIA (MC6850), Hex-Keyboard, Hex-display interface to audio cassette, plus all additional components. Easily expanded. Single 5V supply needed. 72 basic instructions



D2 KIT £190 + VAT

Telephone orders with credit cards — £10 minimum

news digest. . . . . . .

ETI in technicolour........

Frankly we won't know how good this edition of ETI will look until it's too late to change our minds—we're perfectly prepared to admit that it's an experiment and it may not work out.

In the same way we don't mind telling you the reasons for the experiment. In Germany two hobby-electronic magazines, including Elrad (ETI—Germany) have 4-colour editorial and they not only look beautiful but so much more information is conveyed than with straight black and white. However our main reason is that a colour-revolution has been taking place in TV and in most magazines—the hobby electronics magazines, us as well as the competition—are very traditional and sooner or later we'll have to go all-colour. We're doing it now to get some experience in handling it.

We'd like to thank several people for their co-operation in this experiment including Dave Messer our regular photographer and especially the boys at Q.B. our printers who put up with a lot at the best of times and have excelled themselves over this issue.

Halvor Moorshead. Editor.

paw programming............

Sticking doggedly to her task, System Aids newest programmer trys to pick the bones out of the software. Lead in time was short, and her boss collared her for growling on the job. The whole point of the exercise being to enter records of New South Wales canine population (circa 500 000) for the Agricultural Society.

totally US..............

What the US does today, Britain does tomorrow but California did yesterday. During a brief visit to Los Angeles, one of the ETI staff drank in the electronics scene and it's elixir.

The bottom has already fallen out of the CB market in a big way and prices reflect the massive stocks which need to be moved, 23-channel, 5 W transceivers—all you need is antenna and hook-ups to the car's power supply are being retailed for about £11 and even the 40-channel models, only introduced at the start of 1977 are crossing the counter for under £20, about a quarter of their price when introduced. Although US made equipment is available, we have been told that every domestic manufacturer has pulled out of the market and that the Japanese are even unable to compete with the Korean, Hong Kong and Singapore makers. The optimists claim that the CB market is still enormous but there's every indication that the on-going market is a tiny fraction of what it was a year ago.

TV games are clearly the thing of the moment with literally hundreds of models available—prices start at about £11 and rarely exceed £20 for the four or six game units. What is interesting are the super advanced games—tank battles, pontoon etc.—all in colour with very much higher prices—up to £100 but they're obviously selling in huge quantities. The US authority governing broadcasting (The FCC) has to approve the designs and this held up the colour units until the last few months but clearly TV games are going to be in the stockings of many US kids this Christmas.

Calculators have gone even lower in price. One supermarket is selling a four-function calculator *with* battery for $2.99 (£1.64)! Home computers are still growing in popularity but perhaps the most interesting aspect are frequent and enormous ads for small business computers—even hoardings carry the message!

science fiction..

One of those not-to-be-ignored correlations would seem to exist between electronics and science fiction. Anyone seriously interested in electronics can usually be relied on as a sci-fi fan as well. (Well we are anyway!) Accordingly we are giving notice, somewhat in advance, of the next annual science fiction convention, Skycon 78. This will be held next Easter at the Heathrow Hotel in London, and lists amongst its attractions '. . . chance to meet people involved in micro and mainframe computers, TV and audio, as well as many other sections of electronics.'

Authors appear to regard these dos as a way of meeting the readers, so if you want to meet any of them, this could be your chance. Since Skycon runs for a weekend generous bar extensions have been arranged to ensure lift-off.

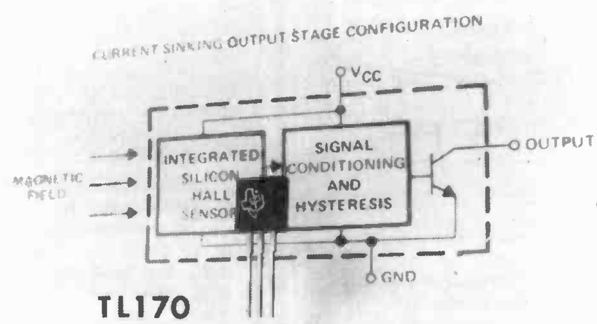
If interested contact, ASAP; SKYCON 78, 5 Aston Close, Pangbourne, Berkshire.

hall of fame..........

A new low-cost electronic switch has been introduced by Texas as a replacement for mechanical switches. The TL170 is a bipolar magnetically-activated electronic switch that uses the Hall Effect for sensing a magnetic field.

This switch, offered in a three-pin TO-92 package is priced at £0.25 in 100-piece quantities. The device consists of a silicon Hall sensor, signal conditioning, hysteresis function and an output stage.

The output of the TL170 can be interfaced directly with TTL or MOS logic circuits. Applications include keyboard, limit, push button and proximity switches, tachometer and electronic ignition sensors as well as virtually any switch application. Nick Lidington, Linear Circuits Dept., Texas Instruments Ltd., Manton Lane, Bedford. MK41 7PA.



on line (central!) computers........

London Transport is to equip itself with a £200 000 Ferranti computer to control the power distribution on the Underground.

The system, which will be installed on the Central Line, comprises a dual ARGUS 700E computer system and five MARK 2 tele-control stations. Later extensions could cover up to sixteen additional sites. Each station has the capacity to handle up to sixty-four controllable items, such as circuit breakers.

The central computer system will be located in premises at Leicester Square and each of the two computers will have 64K words of core store and 5 Mbytes of disc memory. The two computers will be in continuous communication, so that should the on-line unit fail the standby machine will take over automatically, with minimal interruption to service(?). No comments please commuters.

Ferranti Limited, Simonsway, Wythenshawe, Manchester. M22 5LA.

Sparkrite mk2

Capacitive discharge
electronic ignition kits

VOTED BEST OF 8 SYSTEMS TESTED BY 'POPULAR MOTORING' MAGAZINE Oct. '74

* Smoother running
* Instant all-weather starting
* Continual peak performance
* Longer coil/battery/plug life
* Improved acceleration/top speeds
* Optimum fuel consumption

Sparkrite Mk. 2 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 15/30 mins.
Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Ready drilled pressed steel case coated in matt black epoxy resin, ready drilled base and heat-sink, top quality 5 year guaranteed transformer and components, cables, coil connectors, printed circuit board, nuts, bolts, silicon grease, full instructions to make the kit negative or positive earth, and 10 page installation instructions.

OPTIONAL EXTRAS
Electronic/conventional ignition switch.
Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device, includes: switch connectors, mounting bracket and instructions. Cables excluded.
Also available RPM limiting control for dashboard mounting (fitted in case on ready built unit).

CALLERS WELCOME. For Crypton tuning and fitting service – 'phone (0922) 33008.

Improve performance & economy NOW

Note: Vehicles with **current** impulse tachometers (Smiths code on dial R.V.1) will require a tachometer pulse-slave unit. PRICE £3.35

PRICES INCLUDE VAT, POST AND PACKING.

POST TODAY!

Quick installation
No engine modification required

Electronics Design Associates, Dept. ETI 2
82 Bath Street, Walsall, WS1 3DE. Phone: (0922) 33652

Name ....
Address ....
....

	QUANTITY REQD.
Mk. 2 DIY Ass. Kit @ £11.80	
Mk. 2 Ready Built Negative Earth @ £14.97	
Mk. 2 Ready Built Positive Earth @ £14.97	
Ignition Changeover switches @ £4.30	
R.P.M. Limit systems in above units @ £2.42	

I enclose cheque/PO's for £ ____________

Cheque No.

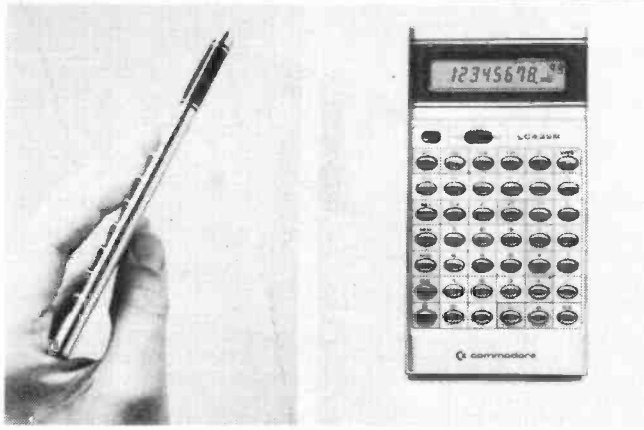
Send SAE if brochure only required.

. . . news

kitted out.............

Leader on home constructors. A new range from Arrow Electronics of test equipment kits offers a chance to build up a matching range of gear; since all use the same case. One of the aims behind the range is to provide complete and comprehensive kits, down to nuts and bolts level (literally!) from de-bugged designs with instructions which are easy to follow, even for the totally inexperienced. Our photo shows the bench supply LPU 102 (based on our short circuits design) which sells for £18.75 all inclusive.

Details of the 'Leader' range which includes a clock and test oscillator can be had from Arrow Electronics, Leader House, Coptfold Road, Brentwood, Essex.



CBM's thin(scientific)line..........

Bearing a not-so-coincidental resemblance to the LC5K1 of ETI offer fame comes CBMs new LC435R–a fully scientific LCD calculator. With twenty functions ready at finger, including trig and standard deviation and all the usual power stuff, the machine promises to make itself a name. RRP is £26.50 inc., but don't be surprised if this is met by the fateful cry of 'discount' once it gets to the shops.
Commodore Business Machines, 446 Bath Road, Slough, Berkshire. SL1 6BB.

amplifier module from Sterling Sound........

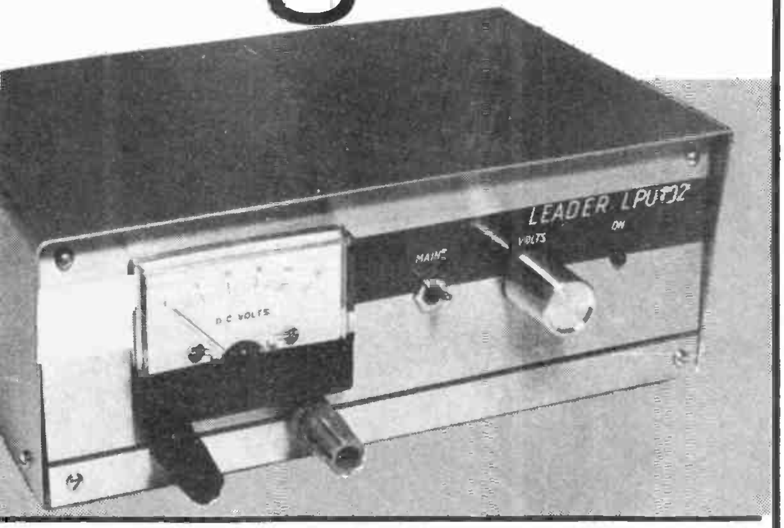
Recently from their Shoeburyness headquarters, Sterling Sound have launched a 60 W RMS amplifier module - the SS160 which the makers feel fills a gap in the power levels currently available. Power into four ohms is actually 64 W from a 50 V supply. Output into eight ohms is 38 W. THD is claimed to be typically 0.1%.

Fully inclusive price is £8.50, a suitable power supply (the SS360) is available for £12.75. Included on the board is a take off point (stabilised) for a preamp.
Sterling Sound, 37 Vanguard Way, Shoeburyness, Essex.

CCTV Camera: Dec 77.
Crofton Electronics have asked us to point out that the copyright for both the circuit and PCB designs of this project is jointly held by Crofton and ETI.

In order to protect the mains transformer in the event of failure of D6 or D12 we recommend that a 1k8 ½ W resistor be included in the 350 V rail and an 820R ¼ W resistor in the 80 V rail.

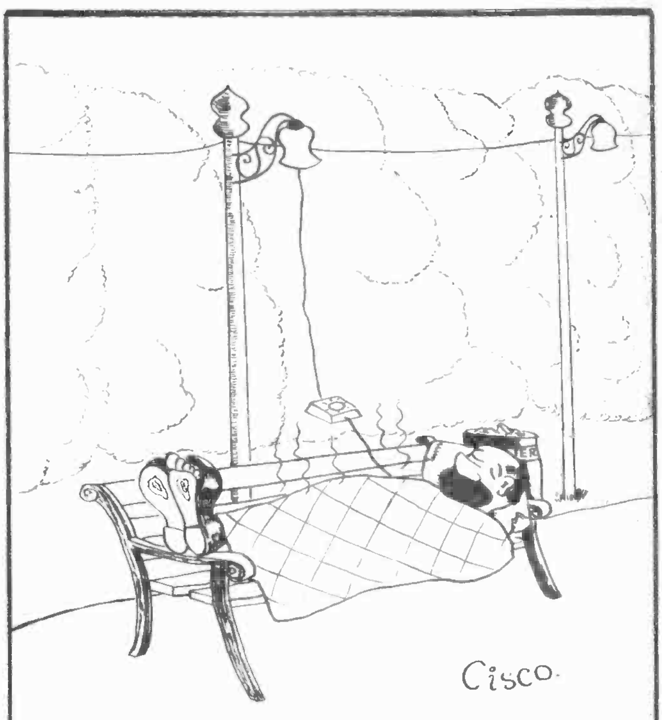
digest...



.......and line of thins..........

No doubt leaning on their experience gained in calculators, the same CBM have just launced a range of LCD watches. The 8000 series on the left is for ladies, and the 9000 for men. The display is claimed to be 50% larger than competitors, and both should sell under £25 and are covered by one year guarantee. No, you don't need the address again – now do you?

THE CISCO KID



Now available from Kramer . . .

TRULY PORTABLE, CORDLESS, ELECTRONIC ALARM CLOCK

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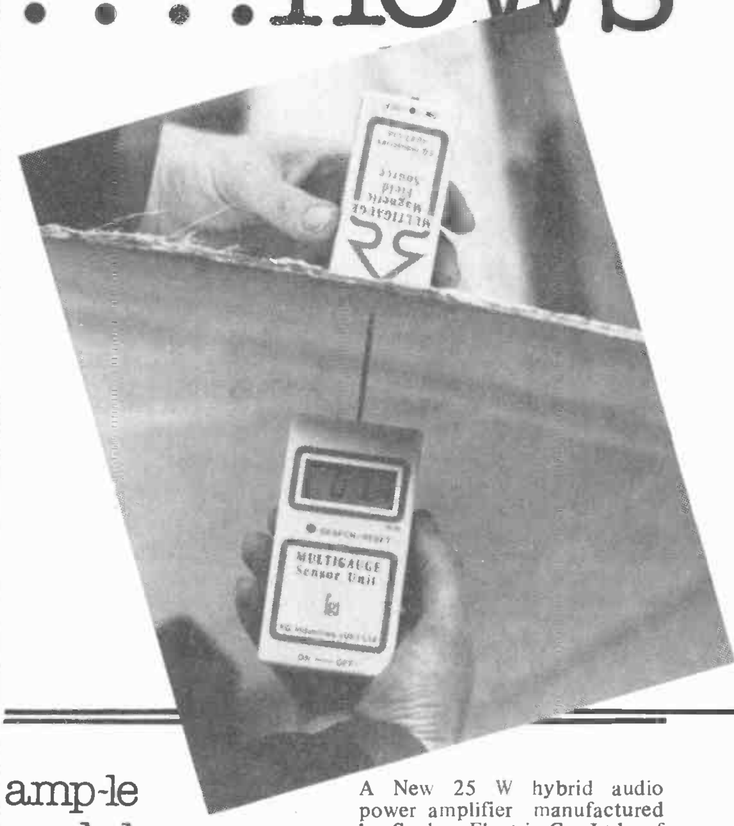
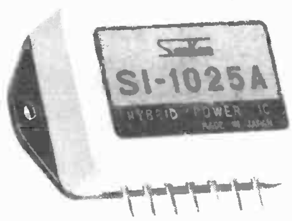


amp-le module.........



A New 25 W hybrid audio power amplifier manufactured by Sanken Electric Co. Ltd., of Japan is now available from Photain Controls Ltd.

Full spec. is shown below, and a leaflet is available from Photain giving circuits and full performance figures.

At a price of £9.00 each (plus 12½% VAT) these modules provide a simple path to a fairly powerful hi-fi, especially for the beginner, at a fraction of the cost of a ready made unit.

Photain Controls Ltd., Unit 18, Hanger 3, The Aerodrome Ford, Arundel, West Sussex.

Maximum RMS power	25 W
Output Load	8 ohms
Supply Voltage	48 V
Absolute Max. Supply Voltage	55 V
Supply Current	0.8 A
Suggested Fuse	1 A
Harmonic Distortion at Full Output	0.5% max.
Voltage Gain, Full Feedback	30 dB typ.
Input Impedance	70 k typ.
Output Impedance	0.2 ohms typ.
Output Coupling Capacitor	2200 u 50 WV DC
Signal to Noise Ratio	90 dB typ.

digest...

how thick are you?..........

An electronic thickness gauge which can measure *any* material generally classed as non-magnetic has been introduced by F.G. Industries of Slough.

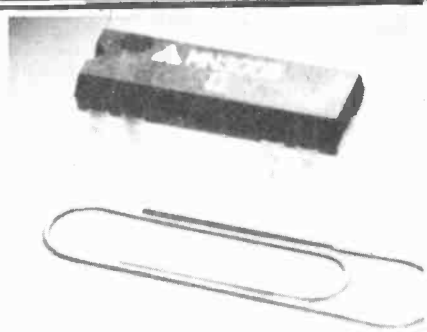
The 'Multigauge' consists of a stable alternating magnetic field source and a separate magnetic field level sensor incorporating a rectilinear transducer which is activated by a probe.

The field source is placed on one side of an object to be measured. From the other side the sensor unit accurately locates the field source and reads the distance between the two units. Read out is on an LCD display, in millimeters.
F.G. Industries (UK) Ltd., 185/187, Liverpool Road, The Trading Estate, Slough, Berkshire. Sl1 4QZ.

game set and repaired.........

Metac International have launched a new service to TV game retailers and users. They are starting a repair service, in time for the expected Xmas rush. With many of the Far Eastern produced units, rapid repair or replacement is often difficult or impossible.

Metac offer a one week turnaround service and either those selling or those using the games may send them to:– The Service Manager, Metac Electronics, Service Centre, 2 Middle March, Long March Industrial Estate, Daventry, Northants. NN11 4PQ.
PS Please check the batteries before sending them back–most game faults are simply too-dry cells!



a big bucket.......

Panasonic have produced a 4096 stage bucket-brigade chip, capable of delays up to 205 milliseconds with audio-frequency signals. Name of the chip is the MN 3005 and we think a lot more will be heard about it in the not so distant future. Intended for use in echo and reverberation machines (with the growing music market in mind), it can also be used for voice scrambling, time compression etc. in communication systems. Needless to say it can also be used as a general purpose analogue delay line with fixed or variable delay time. Insertion loss is said to be virtually zero, and signal to noise ratio 75 dB. Supplied in an pin dual-in-line package the MN 3005 is selling for about £25 in the USA.
Panasonic, One Panasonic Way Secaucus, N.J. 07094 U.S.A.

logical pair bond.............

Two new quadruple TTL-to-MOS driver ICs have been announced by Texas Instruments Ltd. The SN75357 features three-state outputs; the SN75375 has individual supply voltages for each of the four drivers, capable of being operated from five to 24 volts.

Individual supply voltage pins on the S75375 allow individual adjustment of V_{OH} levels to match various load conditions. Control of each player output V_{OH} level allows independent application of each channel as a TTL-to-MOS or CMOS driver, data line driver, LED digit driver, LED segment driver or TTL-to-CCD driver as well as many other interface applications.

Typical propagation delay of only 31 ns makes the SN75375 a versatile logic level shifter while its output current drive capability of 150 mA makes it a versatile peripheral driver, as well. This circuit comprises two NAND drivers and two inverting drivers.
Linear Circuits Dept., Texas Instruments Ltd., Manton Lane, Bedford. MK41 7PA.

ETIPRINTS

Yes folks, it's you the readers at home whose vote really counts, (we mean that most sincerely) and your vote is that ETIPRINTS should become a regular part of our readers' services. The response to ETIPRINTS 001 has been overwhelming so that we have decided to make this new method of PCB production a regular ETI feature.

In case you have missed out on ETIPRINTS thus far, they are a complete PCB pattern already to rub down in seconds. The patterns are produced from our original artwork so that the results they produce are nice and sharp.

We think that ETIPRINTS are such a good idea that we have patented the system (Patent numbers 1445171 and 1445172).

ETIPRINTS 004 is now available, and joins 001-003 as part of the regular system.

Details of ordering the ETIPRINTS are shown below.

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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Inc. VAT and P & P.

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001 *With patterns for skeet, clock board A, and the compander from Nov 77 plus the spirit level, three-channel tone control, and the digital thermometer from Oct 77.*

002 *With patterns for hammer throw and race track from Jan 78 plus the freezer alarm from Dec 77.*

003 *With patterns for the burglar alarm from Jan 78 plus clock board B and the rev monitor from Dec 77.*

004 *With patterns for the ultrasonic transmitter-receiver, metronome, IB metal locator and porch light from Feb. '78 plus 5 / w stereo amplifier Mk. 2 from Jan. '77.*

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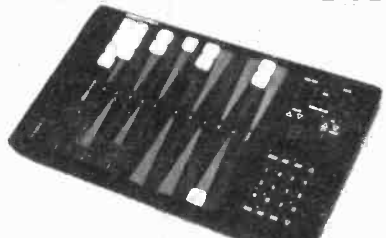

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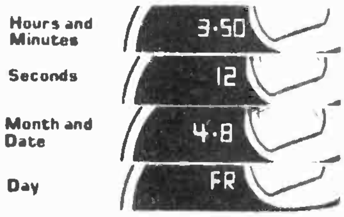

This wafer thin **Golden Dot** watch has a metal casing with simulated gold finish and matching mesh bracelet designed for him and her.
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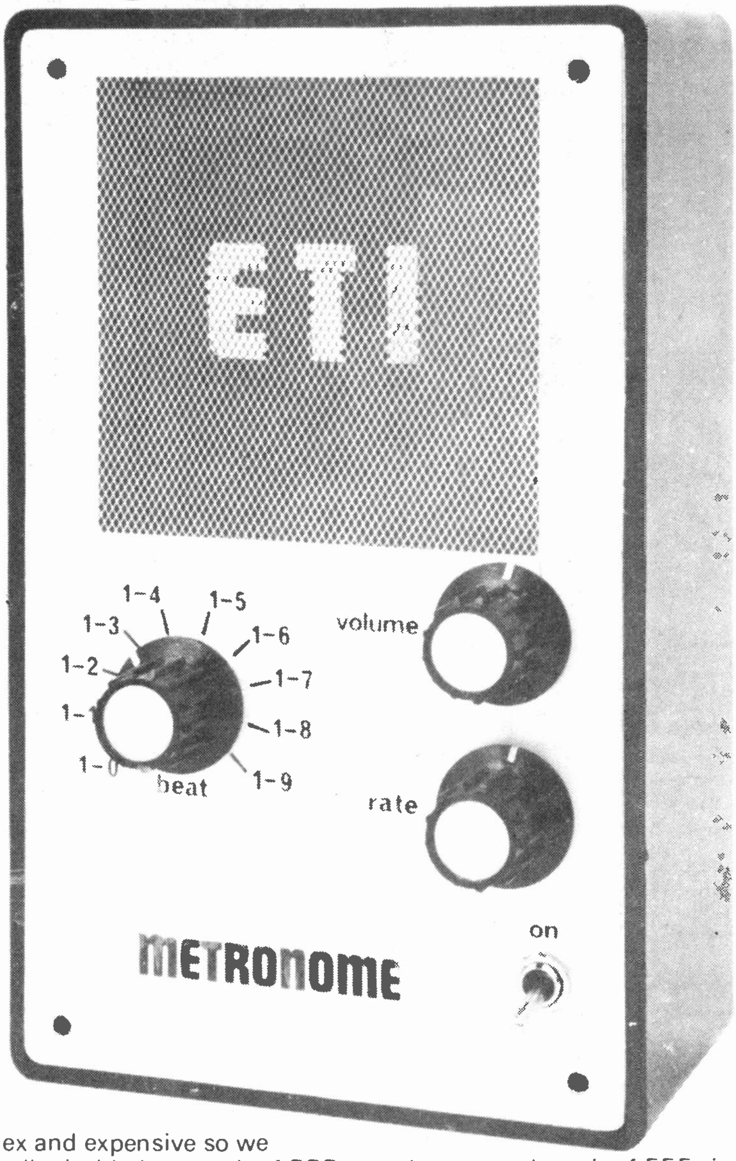
ACCENTUATED BEAT METRONOME



This metronome design accentuates one beat out of every bar to help with complex rhythms

THE THOUGHT of yet another metronome circuit is probably enough to bring tears to the eyes of anyone who has read ETI, or, if you must, any of the other Electronic Magazines over the past few years. The design we present here is, though, a cut above the run of the mill projects that have gone before.

The major advantage of this new circuit is that it will accentuate any particular beat in a bar. Our metronome is designed to help those starting out in music, in whom a sense of rhythm is often lacking.

Accent On Design

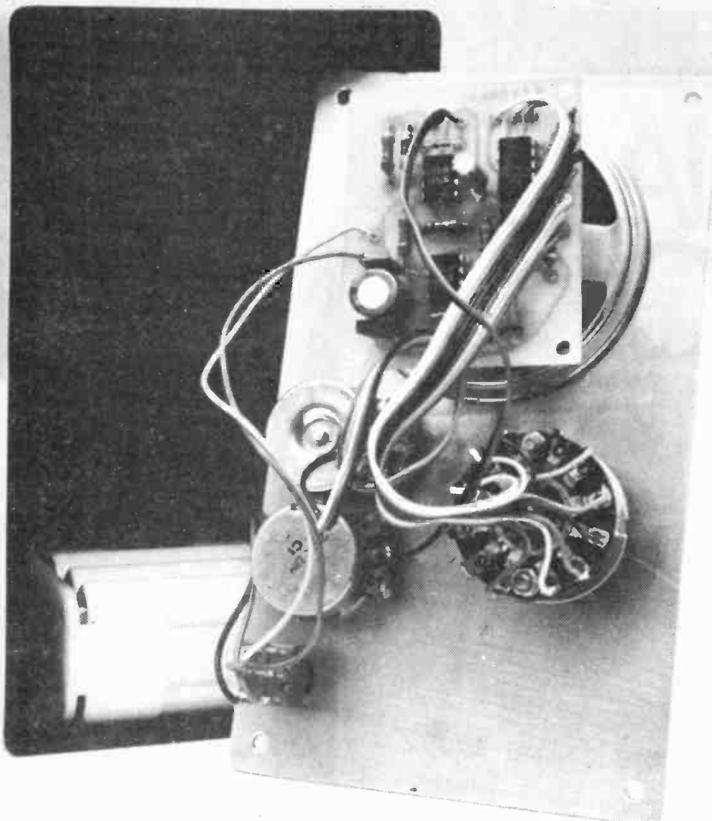
The method employed to produce the beats is to produce a tone burst for each, rather than the simple DC pulse often employed in other designs. The only way to change the sound output in this latter type of circuit, to give the required accentuation, is to change the pulse's amplitude. We found this to be unsatisfactory — hence the tone burst.

Initially we tried a pulsed LC network which, while producing excellent results was a little too complex and expensive so we eventually decided on a pair of 555 timers. For those of you who wonder why we used a pair of 555s instead of the 556 dual timer, just look at the prices of these two devices. For some reason that we cannot understand the 556 is more than twice the price of a pair of 555s. Add to this is the fact that if one half of a 556 is destroyed the whole device is useless, and in most applications and you see why 555s are the best buy.

When faced with the PCB design for this project we considered mounting the wafer switch directly to the board. We finally decided against this approach because of the large ▶

SPECIFICATION

Rate	1 / sec. to 15 / sec.
Beat	Off, 1—1 to 1—9
Output power	
9 volt supply	8 watts peak
Output frequency	800 Hz, 2 500 Hz
Power supply	6 — 15 volts DC



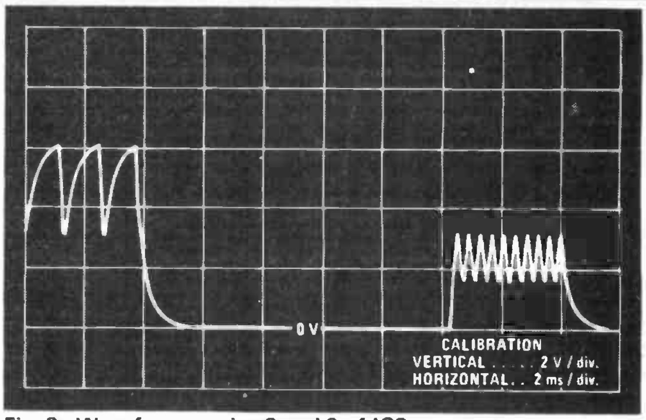


Fig. 2a Waveform on pins 2 and 6 of IC3.

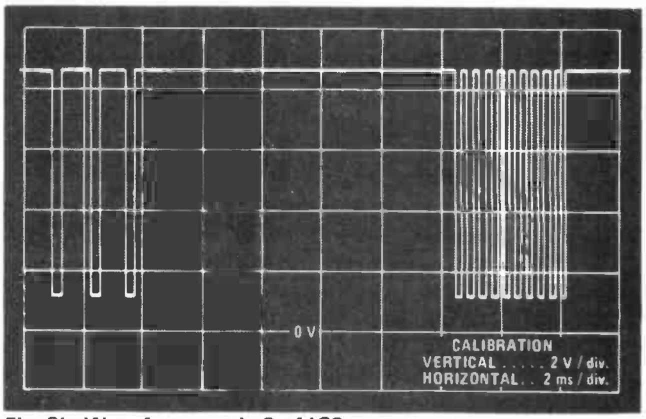


Fig. 2b. Waveform on pin 3 of IC3.

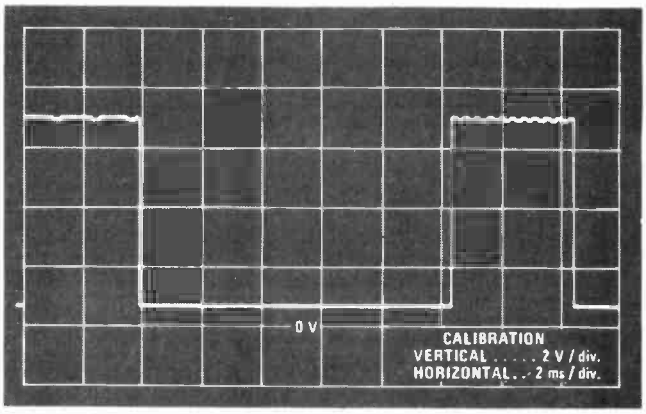


Fig. 2c. Waveform on pin 3 of IC1.
On these waveform diagrams the beat rate has been increased to show the two different outputs available.

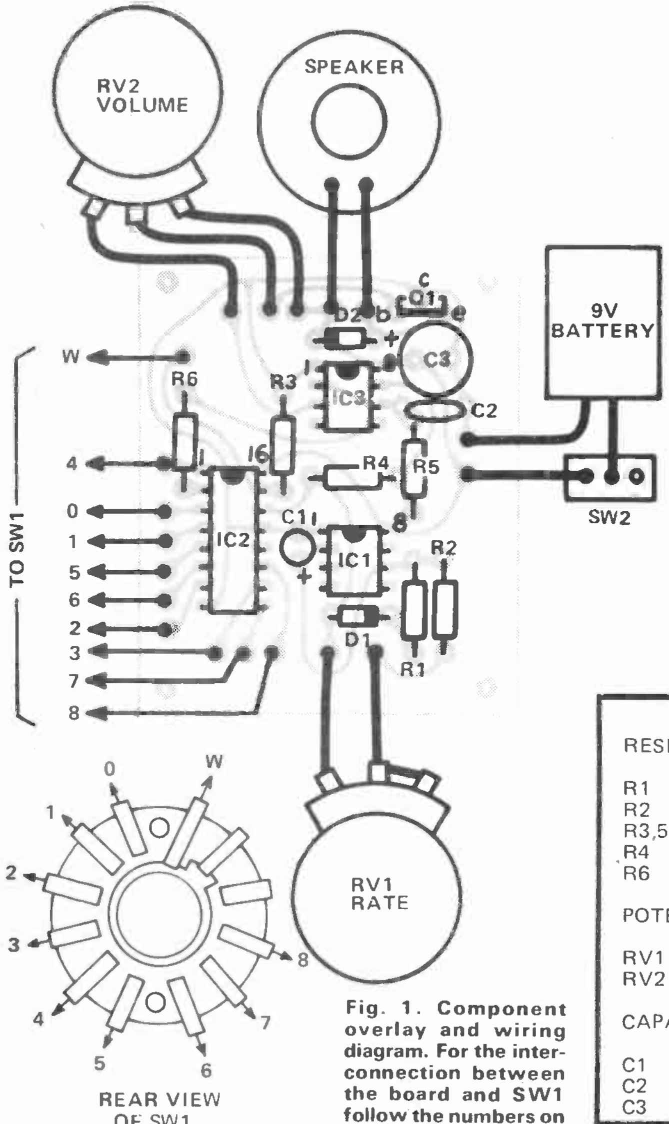


Fig. 1. Component overlay and wiring diagram. For the interconnection between the board and SW1 follow the numbers on each end.

PARTS LIST

RESISTORS all ½ W 5%

R1	2k2
R2	47k
R3,5	15k
R4	1k
R6	4k7

POTENTIOMETERS

RV1	1M lin rotary
RV2	500R lin rotary

CAPACITORS

C1	1u 16 V
C2	22n polyester
C3	100u electrolytic

SEMICONDUCTORS

IC1,3	555
IC2	4017
Q1	BD140
D1,2	1N4004

SWITCHES

SW1	single pole 11 position switch
SW2	single pole toggle switch

MISCELLANEOUS

PCB as pattern, speaker, plastic box, batteries plus holder to suit, 3 knobs.

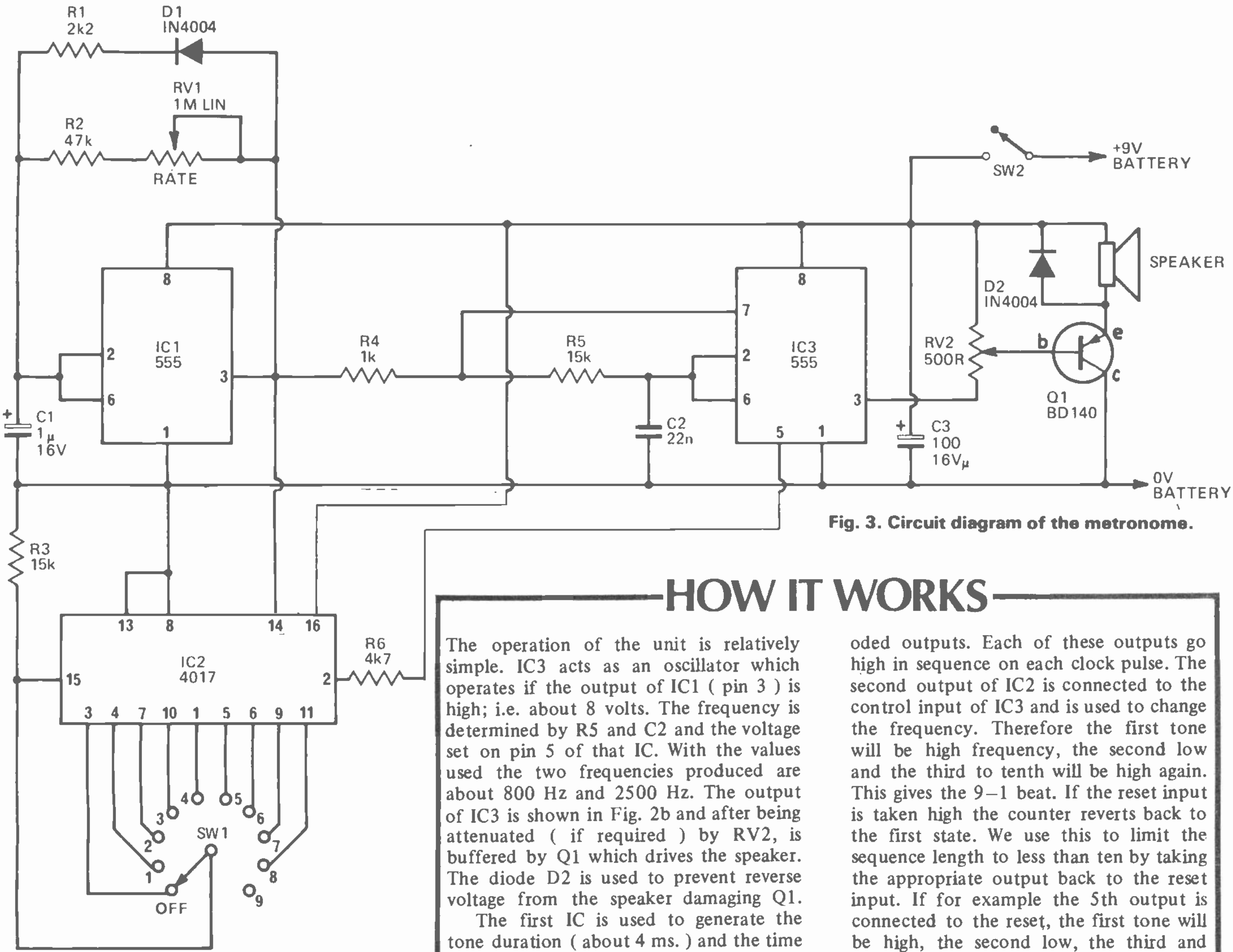


Fig. 3. Circuit diagram of the metronome.

HOW IT WORKS

The operation of the unit is relatively simple. IC3 acts as an oscillator which operates if the output of IC1 (pin 3) is high; i.e. about 8 volts. The frequency is determined by R5 and C2 and the voltage set on pin 5 of that IC. With the values used the two frequencies produced are about 800 Hz and 2500 Hz. The output of IC3 is shown in Fig. 2b and after being attenuated (if required) by RV2, is buffered by Q1 which drives the speaker. The diode D2 is used to prevent reverse voltage from the speaker damaging Q1.

The first IC is used to generate the tone duration (about 4 ms.) and the time interval between beats. The interval is adjustable by RV1 while the tone duration is set by R1. Diode D1 isolates R1 in the interval period. The output of IC1 is shown in Fig. 2c.

The output of IC1 also clocks IC2 which is a decade counter with ten decoded outputs. Each of these outputs go high in sequence on each clock pulse. The second output of IC2 is connected to the control input of IC3 and is used to change the frequency. Therefore the first tone will be high frequency, the second low and the third to tenth will be high again. This gives the 9–1 beat. If the reset input is taken high the counter reverts back to the first state. We use this to limit the sequence length to less than ten by taking the appropriate output back to the reset input. If for example the 5th output is connected to the reset, the first tone will be high, the second low, the third and fourth high, then when the 5th output goes to a '1' it resets it back to the first which is a high tone. We then have 3 high and one low tone or a 3–1 beat. Actually the 5th output goes high only for about 100 ns. while the counter resets.

BUYLINES

All of the components used in this project should be generally available from your local component shop or from most of the mail order firms advertising in ETI.

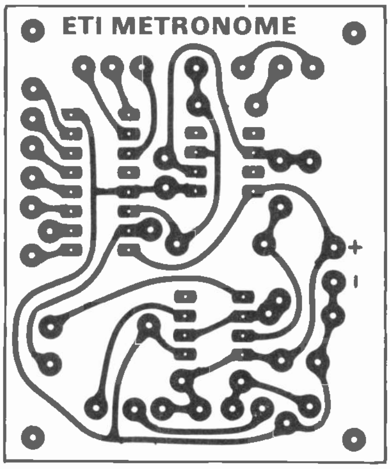


Fig. 4. Printed circuit layout. Full size 60 x 50 mm.

number of different switches available, each with their own connection pattern.

Construction

Assembly of the metronome should cause no problems if the PCB is used. Mount all the components according to the overlay diagram, taking care to orientate the transistors, ICs, diodes and polarised capacitors correctly. We recommend that the 4017 be mounted in an IC socket and that it be the last component installed.

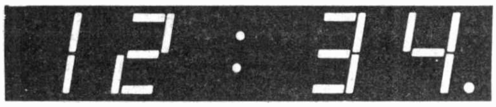
We built the unit into a plastic box with potentiometers, switches and speaker mounted on the front panel. The photographs of the prototype show clearly the layout we adopted.

Beat In Time

Upon switching on the rate and beat controls should be adjusted to provide the required rhythm. The volume control enables the output power to be adjusted over a wide range.

Hopefully the metronome will soon make itself redundant as a sense of rhythm is acquired by our aspiring musician — keep it handy though, because as we said earlier it will be able to help with the more complex of beats tackled at a later stage. ETI

WIRELESS TIME :



approx. ¾ full size digits shown here

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DETECKNOWLEDGEY

Metal locator principles and practise, including some of the facts and information manufacturers of £100+ detectors would rather you didn't know. £1.00 each.

The Bionic Ferret 4000 - a VCO metal locator based on the PW seekit, including all parts, plasticwork, ready wound coil etc. Inc. free copy of deteckknowledgey. £34.26 in pp and VAT at 8%.

Special announcement. The Bionic Radiometer metal locator is at last to be released. A full VLF discriminator, with simultaneous display of ferrous, non-ferrous and foil objects. With a little practise, you can actually find objects obscured by junk. Outperforms units costing £150+. Digital control. Demo available at Brentwood, on sale soon for less than £75.SAE info:

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ZTX451	60v/1w	0.18
ZTX551	60v/1w	0.18
BD515	45v/10w	0.27
BD516	45v/10w	0.30
BD535	60v/50w	0.52
BD536	60v/50w	0.53
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91196 ha1196 decoder	12.99
91197 mw/lw v/cap tun.	11.35
7122 3 v/c mw (OR lw) tuner KIT 15v tuning	9.00
810k 7w af kit comp.	£3
940k 10w af kit	3.95
tda2020k pr. tda2020 ics, pcb, heatsinks for pa	9.35

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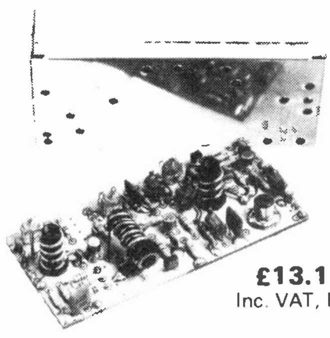

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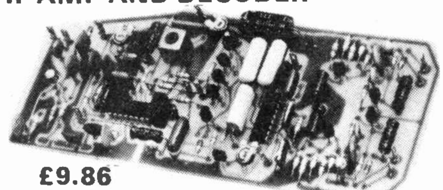

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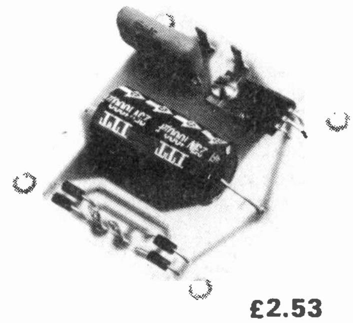

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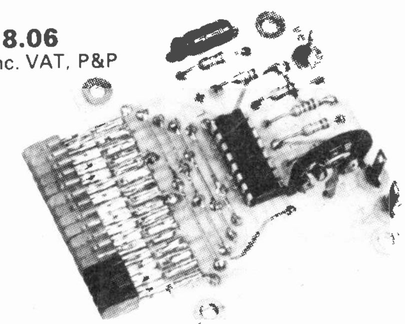

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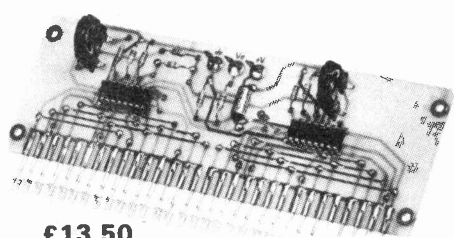

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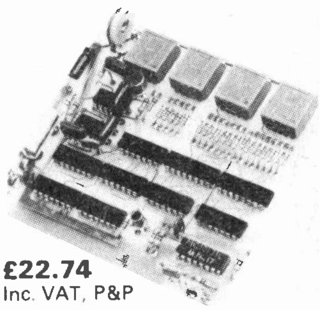

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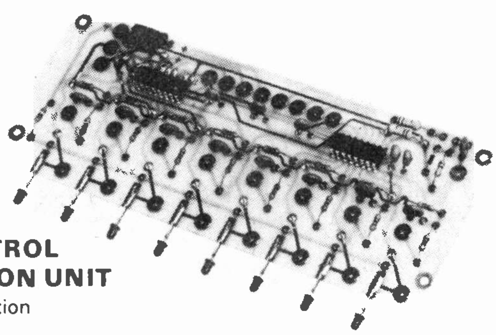

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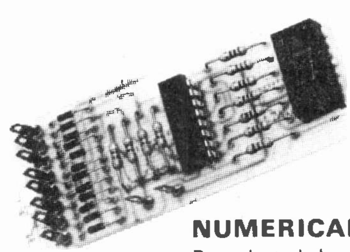

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OP-AMPS

Open up any data sheet on a particular op-amp and you will be confronted with a many as forty different electrical parameters and performance graphs which should reveal all that you need to know about the device. Most of these parameters will be qualified by the conditions under which they were measured and the test arrangements used to make the measurements. This apparent 'overkill' of data is likely to be very confusing to the newcomer, however it need not be so. Tim Orr explains.

LET'S DISCUSS SOME basic principles. An op-amp (or operational amplifier) is just a high gain amplifier, you stick a voltage into it and a much larger voltage comes out of it. Op-amps have two inputs, inverting and non-inverting, which are denoted by — and + respectively. The op-amp amplifies the difference in the voltages applied to these two inputs, the output going positive if the + input is positive with respect to the — input, and vice versa, however, virtually useless, because the voltage gain is uncontrollably large and the distortion high. The way in which both of these parameters are controlled is by the use of negative feedback. An op-amp with negative feedback is shown in Fig. 1. It employs two resistors to set the closed loop voltage gain, and as long as this is small compared to the open loop gain, it will be determined by the resistor ratio RF/RI. The open loop gain, the voltage gain when RF is removed, is typically of the order of 100 000. This massive gain is clearly much too large to be used without feedback. Closed loop voltage gains of 100 are about as much as it is practical to use.

Biased Example

The arrangement in Fig. 1 is known as a 'virtual earth' amplifier. The non-inverting input is connected to earth, and the inverting input is maintained by the feedback applied via RF at a voltage which is virtually earth potential.

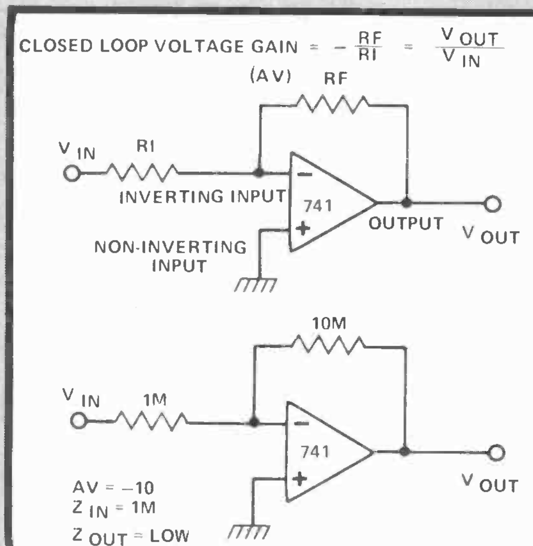
The input impedence of the amplifier in Fig. 1 is simply RI. The output impedence is a little more complicated, it is approximately

$$\frac{\text{output impedence of the op amp x closed loop gain}}{\text{Open loop gain}}$$

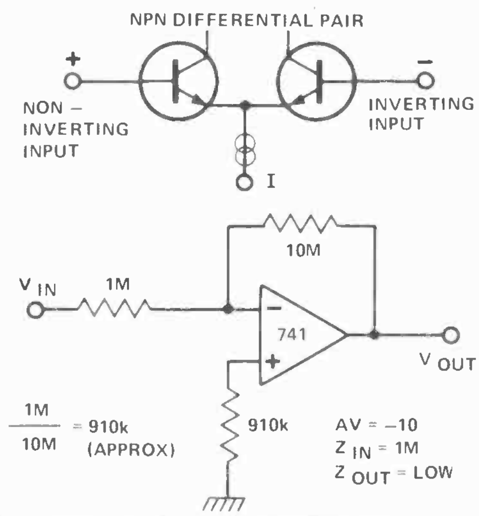
Suppose we want an amplifier with a gain of 10, and an input impedance of 1M. This means that RI is 1M. Therefore RF must be 10M (see Fig. 2). With a 1 V sinewave as the input signal we get a 10 V sinewave as the output. However, when the input signal is held at 0 V (ground potential), the output voltage is not 0 V, it is positive! This is an error voltage, which may be undesirable. The cause of the problem is the 'INPUT BIAS CURRENT' of the op-amp. The input of many op-amps looks like the circuit shown in Fig. 3 If these transistors are to operate correctly they need a standing emitter current which implies that they need an input base current. It is this base current which is the op-amp's 'INPUT BIAS CURRENT.' For a 741 this current can be as large as .05 uA. In the arrangement of Fig. 2 this current can only come through RF, which means that the output voltage could be as large as 0.5 uA X 10M, which is +5 V! One way to remedy this error is to use a circuit shown in Fig. 4 A resistor has been inserted between the non-inverting input and ground. This resistor has the value of RF in parallel with RI. It allows both the inputs to sink slightly and thus maintain the voltage balance at the inputs. The output voltage is then early 0 V. However, the two input transistors may not be that well matched, so the input bias currents may be different into each input. This is known as the 'INPUT OFFSET CURRENT' and its effect can be nulled by making the 910 k resistor in Fig. 4 a variable resistor. If the bias currents (for a 741 say) were zero, then the output voltage would still not be 0 V.

Get Set, They're Off

The output voltage could range between ± 60 mV. This is due to the 'INPUT OFFSET VOLTAGE' which for a 741 can be as much as ±6 mV, which is then multiplied by



Figs. 1 and 2 (far left) show (upper) the basic inverting op-amp stage. Gain is given by the ratio of resistors RF/RI, input impedance is simply RI while the output impedance is more complicated (see text). Fig. 2 (lower) shows a stage with a gain of 10 and an input impedance of 1M.



Figs. 3 and 4 (left) show (upper) a typical op-amp input stage. This is a differential amplifier made up of a pair of NPN transistors driven by a constant current source. Fig. 4 (lower left) shows a 910k resistor in the + input of the op-amp. This reduces the effects of the INPUT OFFSET CURRENT.

the closed loop voltage gain of the stage (in this case 10) giving us ±60 mV. This can be compensated by using the circuit shown in Fig. 5. Terminals 1 and 5 on a 741 can be used to compensate for the input offset voltage. The input offset voltage is the V_{be} imbalance between the two input transistors.

Now that we know how to eliminate the spurious DC offsets, we can try designing some dynamic circuits and find out why they don't work as expected! For example, try putting a 1 V sinewave at 200 kHz into a circuit of Fig. 5. What you would expect is a 10 V, 200 kHz sinwave at the output — but you don't get one. What appears is a rather bent 200 kHz triangle waveform. This is because the 'slew rate' of the op-amp has been exceeded. The slew rate is the speed at which the output voltage can move, and for a 741 is typically 0.5 V/μsec when it crosses zero, so the op amp faced with this demand just gives up and SLEW limits, drawing out straight lines as it does so.

Listen To The Band(width)

Another problem is 'BANDWIDTH'. A 741 has a GAIN BANDWIDTH product of approximately 1 MHz. This means that the product of the voltage gain times the operating frequency cannot exceed 1 MHz.

For example, if you want the amplifier to have a gain of 100, then the maximum frequency at which this gain can be obtained is 10 kHz. Fig. 6 illustrates this phenomenon. Curve A is the open loop response, note that the voltage gain is 1 at 1 MHz, hence the gain bandwidth product of 1 MHz. The slope of the curve is −20 dB/decade, which is caused by a single 30p capacitor inside the IC. Now, if the resistor ratio is set to give a voltage gain of 100, then the op-amp gives a frequency response shown by curve C, which is flat up until 10 kHz. A gain off 10 rolls off at 100 kHz (D) and a gain of 1 000 rolls off at 1kHz (B). Thus it is very easy to see just what the closed loop frequency response will be. However, don't forget the slew rate problem. You may be able to construct an amplifier with a voltage gain of 10, which works up to 100 kHz, but the output voltage will be limited to less than 3 V pp! Another problem is distortion in the op-amp. Negative feedback is used to iron out any distortion generated by the op-amp, but negative feedback relies on there being some spare voltage gain available. For instance, say the op-amp generates 10% distortion and there is a surplus voltage gain of 1 000,

$$\text{i.e.} \left(\frac{\text{open loop gain}}{\text{closed loop gain}}\right),$$

then the distortion will be reduced to approximately,

$$\frac{\text{open loop distortion}}{\text{surplus voltage gain}} = \frac{10\%}{1\,000} = 0.01\%$$

So, negative feedback is used to eliminate distortion products. However, if there is no surplus voltage gain, as in the case of a 741 amplifier working at 10 kHz, with a closed loop gain of 100, then the distortion will rise dramatically at this point.

Current Thinking

Most op-amps have a voltage output, although some have a current output. If you short-circuit a voltage output them large currents could flow and thermal destruction might follow. To overcome this problem, most op-amps have a current limited output so that they can suffer an indefinite short to ground. A 741 is limited to about 25 mA. Another current of note is the supply 'BIAS CURRENT. This is the current consumed when the op amp is not driving any load. For a 741 this current is typically 2mA, which makes it rather unsuitable for small battery applications.

There are some op-amps which can be programmed by inserting a current into them so that their supply current can be controlled. This means that they can consume only micropower when in their 'standby' mode, and they can by quickly turned on to perform a particular task.

Voltages Differently

In the few examples shown so far, the op-amp has been used to amplify voltages which have been generated with respect to ground. However, sometimes, it is required to measure the difference between two voltages. In this case you would use a 'Differential' amplifier, Fig. 7. By using two matched pairs of resistors, the formula for the voltage gain is made very simple. It is thus possible to sumperimpose 1 V sine wave on both the inputs, and yet have the output of the amplifier ignore this common mode signal and only amplify any differential signals. The amount by which the common mode signal is rejected is called the CMRR (the Common Mode Rejection Ratio) and is typically 90 dB for a 741. Thus a common mode 1V signal would be reduced to 33 uV.

$$\text{VOLTAGE GAIN AV} = \frac{V_{OUT}}{V_{IN}}$$

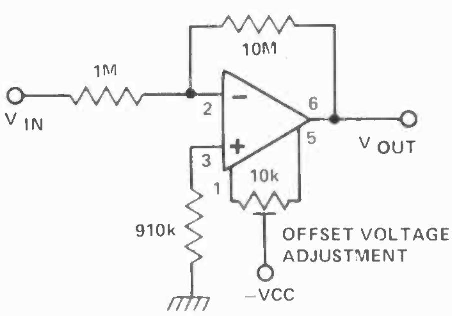
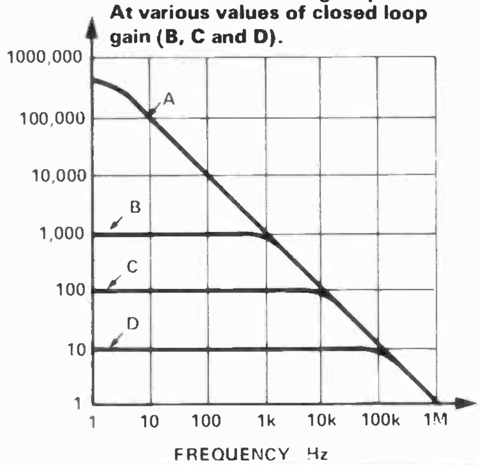


Fig. 5. A variable resistor connected between pins 1 and 5 of a 741 can be used to reduce the effects of the INPUT OFFSET VOLTAGE.

Fig. 6. Graph of open loop response of a 741 (A) together with curves indicating response At various values of closed loop gain (B, C and D).



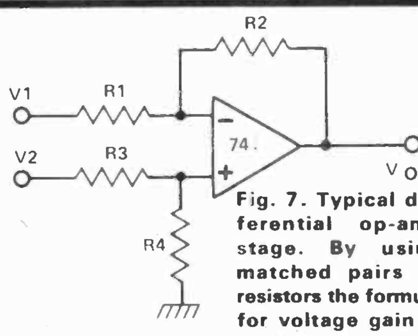


Fig. 7. Typical differential op-amp stage. By using matched pairs of resistors the formula for voltage gain is made simple.

$$V_{OUT} = \left[\left(\frac{R1+R2}{R3+R4}\right)\frac{R4}{R1}V2\right] - \frac{R2}{R1}V1$$

BUT IF WE MAKE R1 = R3
AND R2 = R4
THEN $V_{OUT} = \frac{R2}{R1}(V2 - V1)$

Another rejection parameter to be noted is the supply voltage rejection ratio. For a 741 the typical rejection is 90 dB, that is, if the power supply changes by 1 V the change in voltage at the op-amp output will be 33 uV.

When designing with op-amps it is very important to know what voltage range the inputs will work over, and the maximum voltage excursion you can expect at the output. For instance, the 741 can operate with its inputs a few volts from either power supply rail, and its inputs can withstand a differential voltage of 30 V (with a power supply of 36 V).

This is not true of all op-amps, some have a very limited differential input voltage range, for instance the CA3080 will zener when this voltage exceeds 5 V and the amplifier performance will then be drastically changed.

The output excursion of the op-amp is also important. The 741 can only typically swing within about 2 V of either supply rail, whereas the CMOS op-amp can swing to within 10mV of either rail so long as the load into which they are driving is a very high impedance.

NON-INVERTING AMPLIFIER:

An op-amp is used to provide voltage gain, but in this case the output is in phase with the input. The minimum voltage is unity and occurs when RB is an open circuit. The op-amp has maximum bandwidth at unity gain, and any increase in the gain will cause a reciprocal decrease in bandwidth.

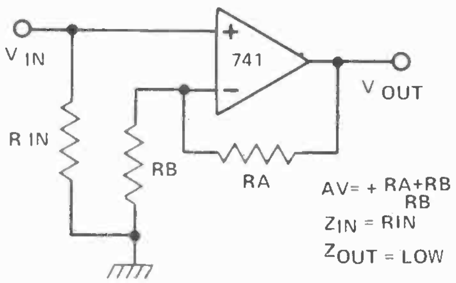


Fig. 8. Non-inverting amplifier.

HIGH SLEW RATE AMPLIFIER:

The slew rate of the op-amp has been increased by increasing the overall current generating capability, by the addition of a pair of transistors. These transistors increase the output voltage range by allowing the voltage to swing to within 0V5 of either supply rails. The output of the op-amp hardly moves at all. Without an input signal, the output voltage is 0 V and the op-amp drains approximately 2 mA from the supply rails.

This current passes through the 180R resistors and sets up a voltage which is not quite sufficient to turn on either transistor. When a positive voltage is applied to the input, the op-amp tries to swing negative but it has a 47R (R4) resistor connected from its output to ground.

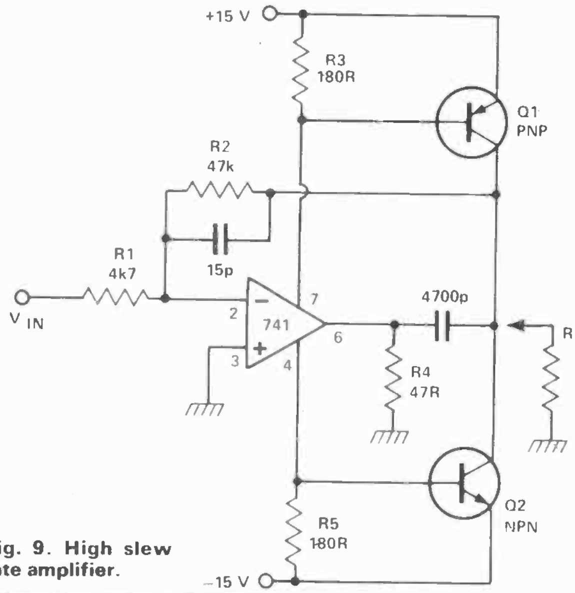


Fig. 9. High slew rate amplifier.

SIMPLE INTEGRATOR:

An op-amp and a capacitor can be used to implement, to a high degree of accuracy, the mathematical process of integration. In this case, current is summed over a period of time and the resultant voltage generated is the integral of that current as a function of time. What this means that if a constant voltage is imputed to the circuit, a ramp with a constant slope is generated at the output. When the input is positive, the output of the op-amp ramps negative.

In doing so it pulls the inverting terminal negative so as to maintain a 'virtual earth' condition. In fact the input current (Vin/R1) is being equalled by the current flowing through the capacitor, thus equilibrium is maintained. The equation governing the behaviour of a capacitor is C × dV/dt = i, where dV/dt is the rate of change of voltage across the capacitor.

Therefore

$$\frac{dV}{dt} = \frac{i}{C}$$

Thus

$$\frac{dV}{dt} \quad \frac{Vin}{R1C}$$

So, when a square wave is applied to the circuit in Fig. 10, triangle waveforms are generated. R2 was added to provide DC stability. Its inclusion does slightly corrupt the mathematical processes, but not enormously. A good point about this integrator design is that it has a very low output impedance. You can put a load on the output and the op-amp will still generate the same waveform — that's what is so nice about negative feedback.

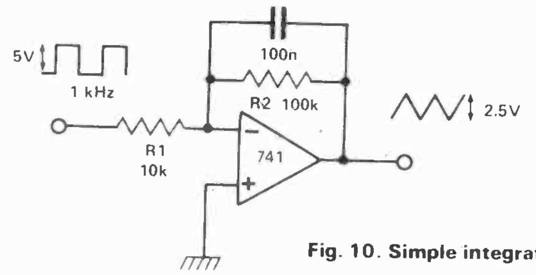


Fig. 10. Simple integrator.

Thus, as it tries to swing negative, it draws lots of current from the negative rail. This current flows through R5, and in doing so turns on Q2. This transistor then pulls R2 down and thus provides negative feedback. The same sequence of events occurs when the input is negative except that R3 and Q1 are then involved. Thus the high current capabilities of descrete transistors are combined with a high voltage gain of an op-amp to produce a moderately powerful amplifier. The voltage gain is set by R2/R1.

Transistors Q1 and Q2 introduce a phase shift, which may give rise to a high frequency instability and oscillation. This can be cured by some frequency compensation applied to the amplifier or by increasing the overall voltage gain.

No Noise Is Good Noise

The last op-amp characteristic to be discussed is 'Noise'. The noise figures given in the specifications are very confusing. This is due to the fact that noise is specified in so many different ways that it is often difficult to compare devices. One may be specified in terms of Equivalent Input Noise and another device in terms of $nV/\sqrt{Hz}$ (nano volts per root Hertz)! As a generalisation it is true to say that most op-amps are relatively noisy. Some op-amps are labelled low noise, and these are quieter than the average op-amp but more noisy than a well designed descrete component amplifier. For audio work you can use ordinary op-amps for processing high level signals (100 mV to 3 V), but for amplifying low level signals (1 mV to 100 mV) you would be advised to use a low noise device. The larger the voltage gain you obtain from an op-amp stage, the worse will be the noise, therefore keep the closed loop gain to a bare minimum.

That is the end of the theory, now for some practical examples of op-amps in use. ETI

SIMPLE DIFFERENTIATOR:

Mathematically, differentiation is the reverse process to integration. Thus, in the differentiator circuit the C and the R are reversed with respect to the integrator circuit.

The input waveform is a triangle with a constant rise and fall slope. This constant slope, when presented to a capacitor will generate a constant current. When the slope direction reverses, then so will the current flow. This current when passed through a resistor (R1), will then generate a square wave.

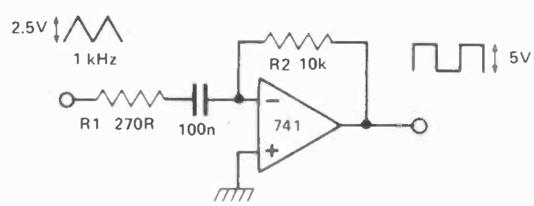


Fig. 11. Simple differentiator.

12 V REGULATED POWER SUPPLY:

The large open loop voltage gain of an op-amp is very useful in providing a regulated low output impedance power supply. A 5V1 voltage reference is generated by a zener diode ZD1 (this voltage reference could be made more stable by running it at constant current). A PNP transistor is used as a series regulator. However, this transistor inverts the signal from the op-amp output, and so, in order to get negative feedback, the feedback is taken to the non-inverting input! The operations is as follows. The inverting input is held at 5V1. If the 'PSU OUTPUT' tries to fall, the voltage at the non-inverting input falls. Therefore the op-amp's output will also fall, thus turning on the PNP transistor which then pulls up the 'PSU OUTPUT.' Thus the output voltage is stabilised. Also, the output impedance is very low, due to this negative feedback. The output impedance at high frequencies (where the op-amp gain is low) is further reduced by the 10u capacitor. To squeeze the last drop of voltage out of the system, before a collapsing unregulated supply rail causes the regulated supply to drop out, a 5V1 zener diode (ZD2) has been included. This allows the op-amp output to work at about 7 volts below the unregulated supply rail. Thus, a regulated output is maintained until the PNP transistor saturates. This means that the unregulated rail can fall to within about 200 mV of the regulated rail!

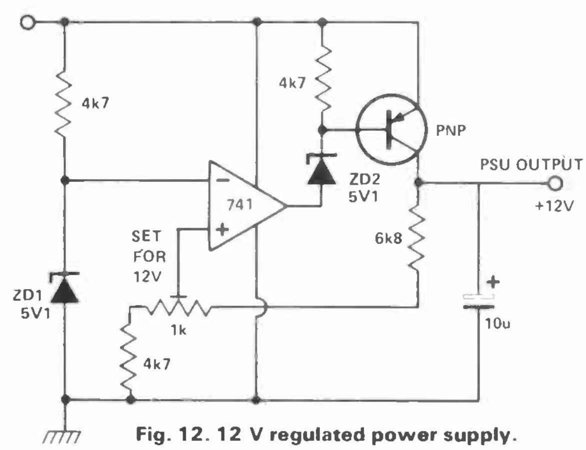


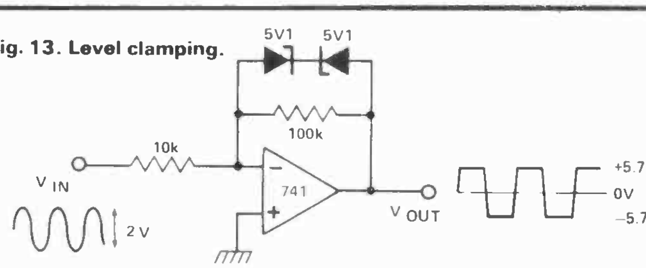
Fig. 12. 12 V regulated power supply.

LEVEL CLAMPING:

It is sometimes required to limit the excursion of the output voltage of a linear amplifier. This can be achieved by using non-linear feedback, in this case with zener diodes. Once the voltage at the op-amp's output exceeds the zener breakdown voltage plus a forward diode drop (0V7) from the forward biased Zener), the effective impedence of the feedback becomes very low. Thus the voltage gain, above this zener voltage, also becomes very low. The output voltage appears to be clamped at a fixed potential. By changing the zener value, this potential can be varied at will. Also, by making the two zeners have different values, correspondingly different negative and positive levels can be obtained. This circuit is, however, far from ideal. The zener diodes don't have very sharp 'Knees' in their transfer characteristics and the clamping can sometimes be very sloppy, particularly when low voltage zeners are used. Also, the zener diodes tend to have a large amount of charge storage, which impairs the high frequency performance.

Sometimes, however, sloppy clamping is considered useful. For instance, if the zeners are replaced by two ordinary diodes in parallel and pointing in different directions. Then any signal applied to the input will receive some non-linear distortion. This distortion is rich in odd harmonics, and is the basis of many FUZZ box designs for musical effects units.

Fig. 13. Level clamping.



VOLTAGE TO CURRENT CONVERTER

The virtual earth of an op-amp and the current source characteristic of a transistor can be combined to produce a precision linear voltage to current converter. Consider the 'SOURCE' circuit. A positive voltage is applied and the op-amp adjusts itself to that a 'virtual earth' condition is maintained. This means that a current i flows through the input resistor R, where i = Vin/R. Now this current has got to go somewhere, and so it flows through the PNP transistor and comes out of the collector and into its load. Thus, the input voltage generates a current which is lineally proportional to it. There are, however, three sources of error that will affect this linearity. First the input offset voltage of the op-amp may become significant at low levels of Vin. Second, the input bias current may well rob a lot of the current when Vin is low. Third, the base current of the transistor must be subtracted from the final output current. Note that the current gain of the transistor will change with collector current variations, and so the base current loss is not a fixed percentage. However, a precise voltage to current converter can be made using an op-amp with a FET input so that the bias current is low. Also, an input balance can be used to zero out the input offset voltage, and if a FET is used to replace the bipolar transistor, then the base current problem can be removed.

The 'SINK' circuit merely swaps the transistor for an NPN type. Note that the input voltage now must be negative.

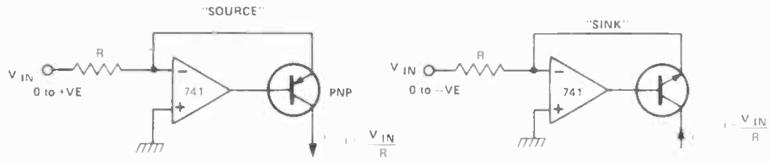


Fig. 14. Precision linear voltage to current converters.

SCHMITT TRIGGER

When DC positive feedback is applied around an op-amp, its output will come to rest in one of two states, that is in its most positive or most negative position. This type of circuit is known as a Schmitt Trigger and it is said to exhibit the property of hysterysis. Consider the circuit shown in Figure 15. Let us assume that RB is 2k and RA is 1k and the output voltage is +10V. Therefore the voltage at the non-inverting terminal is +3V3. When the input voltage becomes more positive than +3V3, the output of the op-amp will start to swing negative and in doing so will increase the voltage difference between the inputs. This will in turn make the output swing even more negative. Thus the process becomes regenerative, the output finally 'snapping' into its negative state (−10V say). The only thing that will now change the op-amp's output is if the inverting input goes more negative than the non-inverting input. When this occurs it will revert back to its original state. The two input voltages at which these transitions happen are known as the upper and lower hysterysis levels. The graph in Fig 15 shows the circuit's transfer function. Figure 16 is another Schmitt trigger circuit, but the mode of operation is inverted.

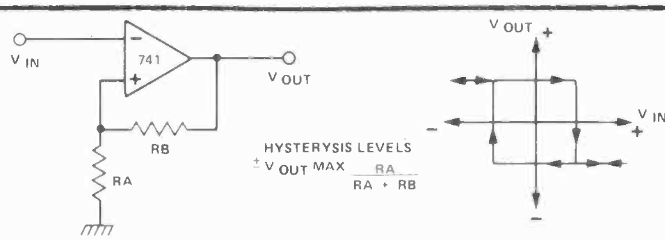


Fig. 15. Schmitt trigger configuration.

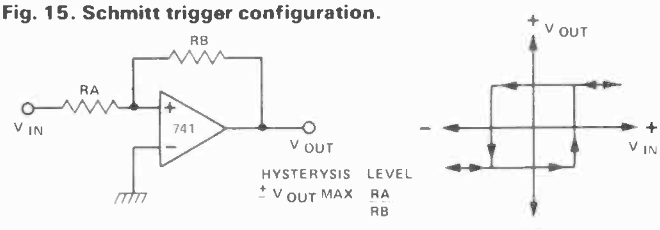


Fig. 16. Schmitt trigger with mode of operation inverted with respect to that shown in Fig. 15.

TRIANGLE SQUARE OSCILLATOR

A Schmitt trigger and an integrator can be used to construct a very reliable oscillator which generates triangle and square wave forms. The operation of the circuit is very simple and always self starting. The Schmitt trigger is formed from IC1, the integrator from IC2. Suppose the output of the Schmitt is positive. This will cause the integrator to generate a negative going ramp. This ramp is then fed back to the input of the Schmitt. When the lower hysterysis level has been reached the output of the Schmitt snaps into its negative state, current is taken out of the integrator which then generates a positive going ramp. The integrator's output ramps up and down between the upper and lower hysterysis levels. The speed at which the integrator moves is determined by the magnitude of the voltage applied to it. In this circuit, the magniture of the voltage and hence the oscillation frequency, are controlled by a potentiometer, giving a 100 to 1 control range. This circuit is the basis of most function generators. By bending the triangle it is possible to synthesis an approximation to a sinewave. With a bit more electronics it is also possible to make the oscillator voltage controlled.

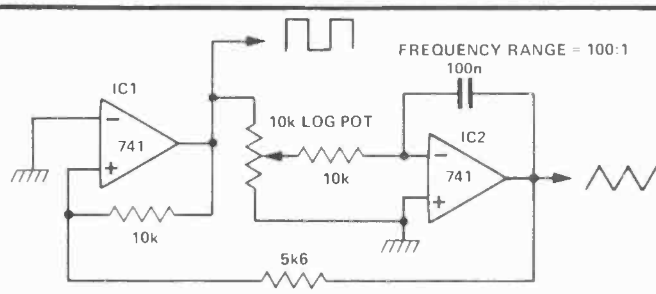


Fig. 17. A Schmitt trigger and integrator combined to produce a triangle and square wave generator.

This series continues next month with many more Op-Amp circuit configurations including envelope shapers, sample and hold circuits and various oscillators.

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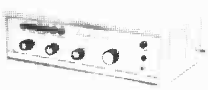

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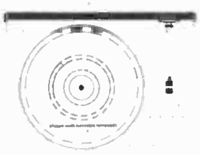
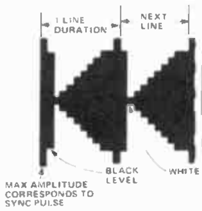


HIFI 2008: Ron Harris had help here — someone somewhere up in the future sent us a history book. So we **know** this one is true!

VIDEO TOMORROW: Angus Robertson peers into his crystal CRT and discovers the future is plain today if you know where to look. (Like in his article.)



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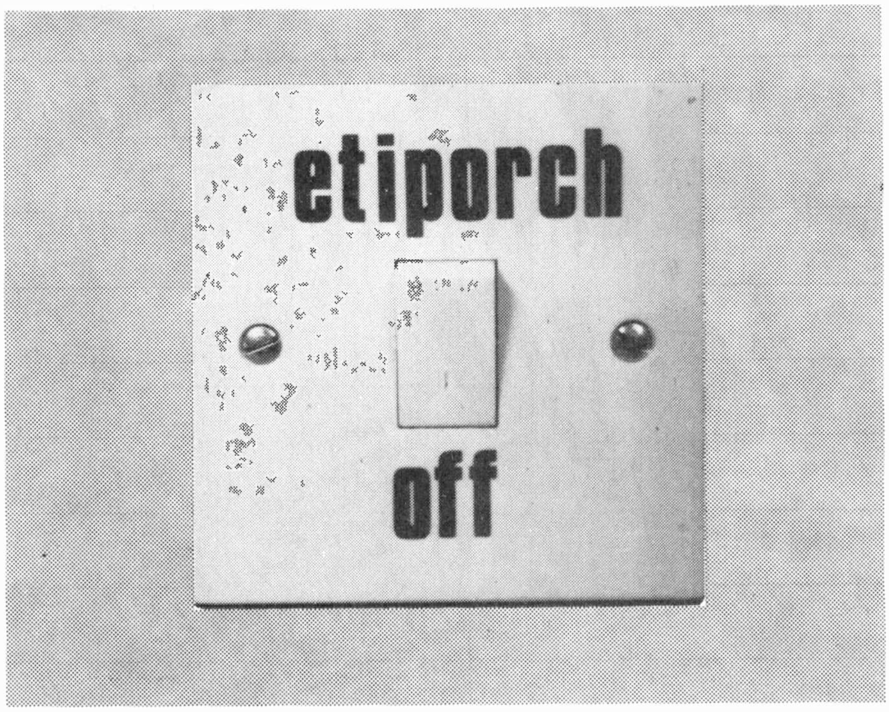
PORCH LIGHT

An attractive project that should banish winter gloom from the front door step.



WHEN RETURNING HOME on a dark winter's night, with gusting winds and pouring rain making the thought of gaining the inner warmth of home very appealing, it is no fun when the front door proves difficult to find in the gloom. The solution is to install a porch light to banish the all prevailing gloom forever. Things being what they are, however, in order to ensure that this guiding light is present whenever it is required would mean an extortionate demand from your friendly local Electricity Board.

The answer is the circuit presented here. It arranges for the porch to be lit for a short time when required, and here's the clever bit, it uses the bell push to turn it on — No need to install a separate switch.

The unit will only operate when it is dark enough to require it — you choose the level, and turns off automatically unless latched on from inside the house. Flicking the internal switch also operates the light.

As well as saving money the circuit is also a valuable addition to the domestic security arrangements. Thus, while friends will soon realise that just because the porch light comes on you need not be at home, the light should put off any unwelcome callers.

Taking the . . . .

Nowadays it seems almost obligatory to think of a witty acronysm to grace the launch of anything from the latest in Frying Pans to the most sophisticated of ICBMs. We at ETI were beginning to feel left out, as we do not often play this game — this project was to be an exception.

The first idea we came up with emphasised the economies that the circuit can realise, but Miser's Porch Unit was not thought to be a flattering handle. A second reason to reject this attempt was that the initials MPU might mean that our circuit is confused with another component that is making a name for itself.

The second attempt brought out the increased security that the circuit affords, but Porch Integrated Security System was rejected for reasons that we leave you to work out.

The names finally chosen, Porch Orientated Circuit for the House, are not as colourful as some, cheating a bit, but at least conveying the spirit of the project and getting past the editor's red pen.

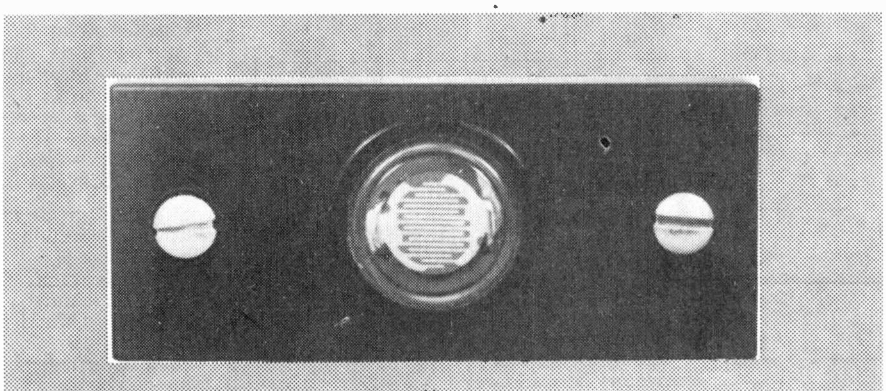
Constructive Thinking

Construction of the project should pose no problems if the PCB shown is used and the component overlay followed carefully. Take care to ensure that the components are mounted close to the board as space is at a premium in the MK box we used.

Putting It In

When installing the unit note that the bulb is powered by a DC voltage and thus if an existing porch light is used care must be taken when installing the unit as two separate wires are required from the porch unit to the bulb.

The other points to note are the connections to the bell push. If the bell circuit is operated with an AC supply there will be no problem. If a



The light sensitive resistor was mounted in a standard bell push unit (not the one that operates the bell!)

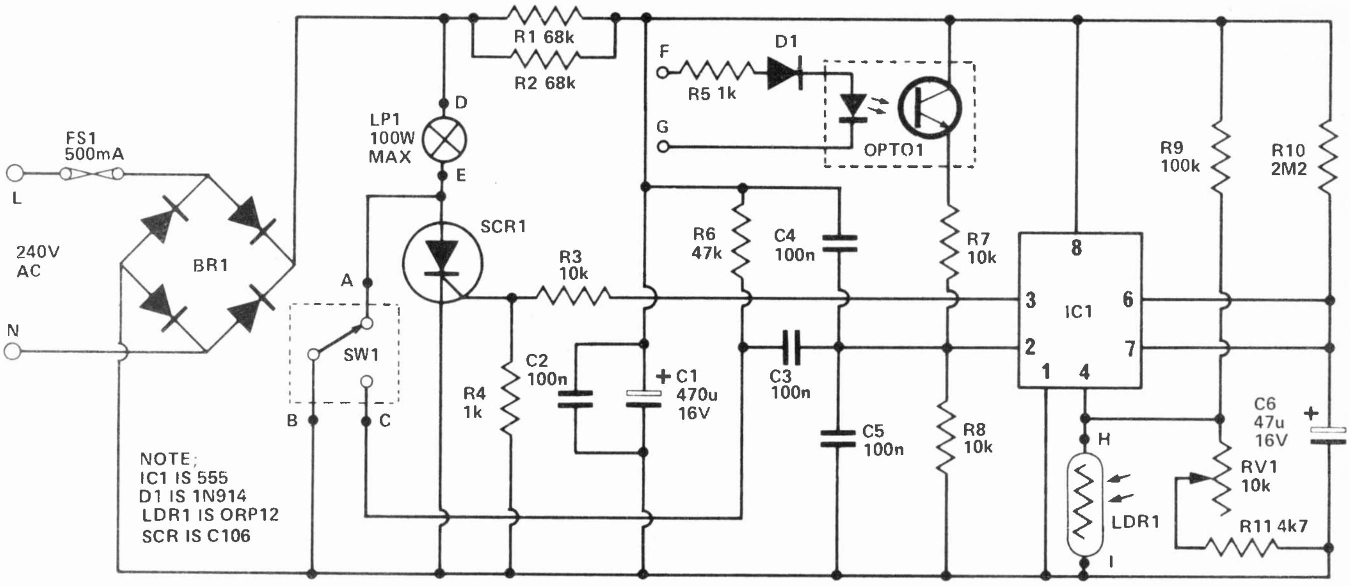
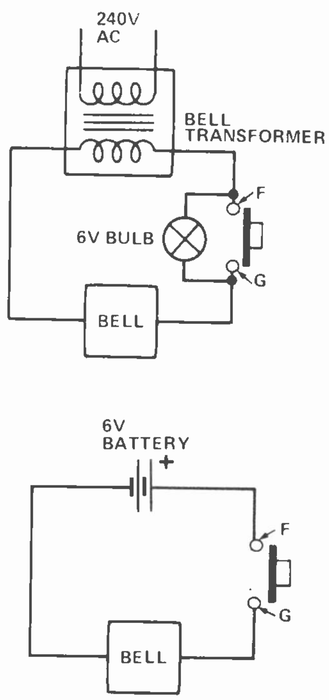


Fig. 1. The full circuit diagram of the Porch Light is shown above.

Fig. 2. The diagrams below show two of the most common bell circuits. In each case the diagrams indicate the points that should be connected to the Porch Light circuit.



DC supply is used take care to ensure that the positive side of the push is connected to point F

When installed the unit can be operated in three different ways. It will be activated when the bell push is operated, if the interior switch is turned on briefly. The porch light can also be turned on for as long as is required by moving the interior switch to the on position. ETI

HOW IT WORKS

THE porch light circuit is formed by a timer, based on IC1, with an isolated trigger circuit formed by OPTO 1, circuitry to control the lamp, and finally a power supply section.

The timer is formed by a 555 configured in the monostable mode. Under quiescent conditions the output of this device (pin 3) is low. If, however, the voltage at the trigger input (pin 2) is taken below one third of supply voltage, the output at pin 3 will go high for a period of time determined by the timing components R10, C6.

The voltage at this trigger input is usually held high by the action of the opto-isolator, OPTO 1. This device consists of an optically coupled infra-red Gallium Arsenide LED and silicon photo-transistor encapsulated in a six pin DIL package.

The action of the photo-transistor is similar to that of other transistors, except that collector current flow can be initiated (the device turned "on") either by biasing the base in the usual manner, or by illuminating the exposed semiconductor junction with light. In our application, with the base open circuit, device operation is controlled solely by the amount of light falling on the junction, which in turn is controlled by the current flowing in the infra-red LED.

This current, derived from the voltage applied to points F and G, is limited by R5. D1 is included to protect the LED from any reverse bias voltage. The voltage referred to above is supplied by the external bell circuit. This circuit must supply a voltage to this point at all times except for the period of time when the bell push is pressed. Thus the photo transistor is turned on, maintaining a high voltage at the 555's trigger pin until the bell is operated, when R8 pulls pin 2 low to activate the timer.

The time period may also be initiated by a negative pulse applied to the trigger input via C3. This pulse is derived from S1 which, in normal operation, connects point B to point C. By momentarily operating this switch a negative pulse is generated to activate the timer.

The potential divider network formed by R9, R11, RV1 and LDR1, which is connected to the 555's reset pin (pin 4), also controls timer operation. If the reset pin is held below OV4 the timer's action is inhibited. The LDR's resistance varies between 10 m and 130R, the more light incident upon it the lower the resistance, and with the values shown this ensures that the circuit is inoperative during daylight hours.

The output of the 555 is fed, via the potential divider R3 and R4, to the gate of the thyristor SCR1. This is a sensitive gate device which is triggered by an OV8, 0.2mA gate pulse.

The thyristor is connected in series with the porch light and is powered by the 100 Hz mains voltage derived from the bridge BR1. Thus the lamp is on at all times when the 555's output is high.

Power to the rest of the circuit is derived via R1 and R2.

The circuit is protected from spurious triggering by components C1, C2, C4 and C5.

BUYLINES

Most of the components used in this project will be familiar. Note, however, that SCR1 is a sensitive gate type and the device specified should be used to ensure satisfactory performance. The device is available from RS stockists.

PARTS LIST

RESISTORS (all ¼ W 5% unless stated)

R1,2	68k 2 W
R3,7,8	10k
R4,5	1k
R6	47k
R9	100k
R10	2M2
R11	4k7

POTENTIOMETER

RV1	10k preset

LIGHT DEPENDENT RESISTOR

LDR1	ORP 12

CAPACITORS

C1	470u 16 V electrolytic
C2,3,4,5	100n polyester
C6	47u 16 V tantalum

SEMICONDUCTORS

IC1	555
D1	1N914
SCR1	C106
BR1	0.9 A 400 V
OPTO 1	Opto-Isolator (Doram 65-670-0)

SWITCH

SW1	MK SPDT Switch

MISCELLANEOUS

MK surface mounting 13 A box, 500 mA 20 mm fuse plus holder, PCB as pattern.

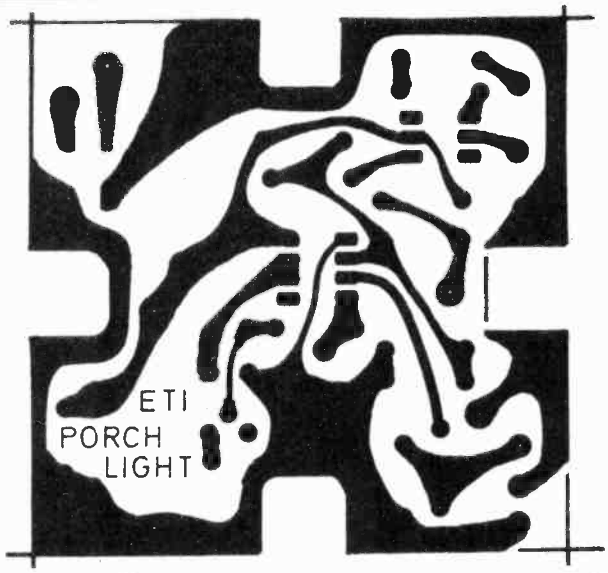
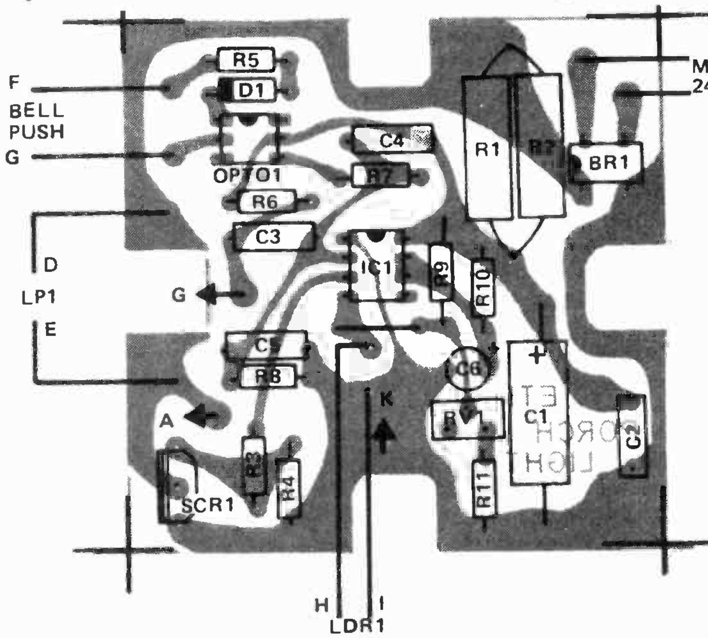
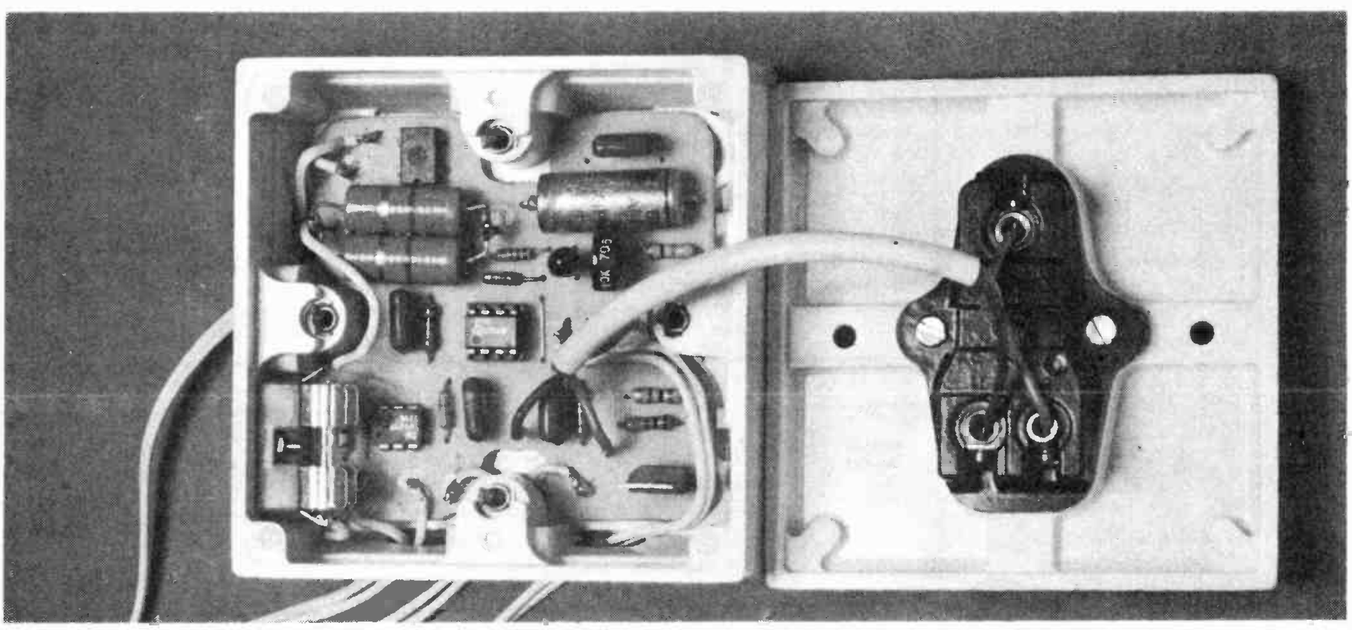


Fig. 3. The foil pattern for the Porch Light is shown full-size (70 x 70 mm).

Fig. 4. (below) shows the component overlay for the Porch Light project.



Photograph showing the internal layout of the project. Note — a set of ventilation holes should be drilled in the mounting box above and below resistors R1 and R2. These holes will also allow access to RV1.



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0–9–17V	4A	4·35*
20–0–20V+	1A	3·25*
24–0–24V	500mA	2·15*
0–19–25–33–40–50V+	½A	3·25*
0–19–25–33–40–50V+	1A	3·85*
0–19–25–33–40–50V+	2A	5·45*
0–12–15–20–24–30V+	1A	3·25*
0–12–15–20–24–30V+	2A	4·35*

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BA145	20p	BY127	12p	OA202	10p
BA148	20p	BY133	25p	IN914	5p
BA155	15p	BY182	1·85	IN4003	7p
BA156	15p	BY250	30p	IN4007	8p
BAX16	12p	OA47	12p	IN4148	5p
BB105B	50p	OA79	12p	IN5401	15p
BY103	25p	OA90	10p	IN5407	25p

BRIDGES

1A 50V 25p	1A 400V 30p	2A 50V 40p
1A 100V 25p	1A 600V 35p	2A 100V 45p
1A 200V 25p	1A 100V 40p	2A 200V 50p

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BZY88	400mw 2·7v–33v	10p
1ZS	1w 3·6v–100v	20p

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TIL209 Red	15p*	13p*	11p*
TIL212 Yellow (H.B.)	27p*	22p*	17p*
TIL216 Red (H.B.)	27p*	22p*	17p*
TIL232 Green (H.B.)	27p*	22p*	17p*
0·2" (inc. Clip)			
TIL220 Red	15p*	13p*	11p*
TIL224 Yellow (H.B.)	30p*	26p*	20p*
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0·033µf	5p	0·22µf	8p	1·5µf	34p
0·047µf	5p	0·33µf	9p	2·2µf	40p

Mullard C281 Series 400vw

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0·022µf	10p	0·15µf	18p		
0·033µf	12p	0·22µf	25p		
0·047µf	15p	0·33µf	30p		

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7403	18p*	7445	70p*	7485	78p*	74145	65p*
7404	17p*	7447	59p*	7486	27p*	74151	49p*
7408	19p*	7448	65p*	7489	2·32*	74154	85p*
7410	16p*	7451	18p*	7490	38p*	74174	72p*
7413	27p*	7470	27p*	7492	41p*	74192	88p*
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3·3pf	18pf	100pf	680pf	2700pf
3·9pf	22pf	120pf	820pf	3300pf
4·7pf	27pf	150pf	1000pf	3900pf
5·6pf	33pf	180pf	1200pf	4700pf
6·8pf	39pf	220pf		
8·2pf	47pf	270pf		
		330pf		

8p each

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0·01uf 0·022uf

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3	14p	10p	18p
4	14p	10p	18p
5 (180)	14p	10p	18p
5 (240)	14p	10p	18p
6	14p	10p	18p
7	14p	10p	18p

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4001	18p*	4015	97p*	4025	18p*	4052	86p*
4002	18p*	4016	53p*	4026	1·78*	4060	1·18*
4006	1·09*	4017	97p*	4027	58p*	4068	22p*
4007	19p*	4018	97p*	4028	87p*	4070	22p*
4009	62p*	4019	58p*	4029	1·18*	4071	22p*
4010	82p*	4020	1·08*	4040	1·08*	4081	22p*
4011	18p*	4021	97p*	4042	83p*	4082	22p*
4012	21p*	4022	88p*	4049	58p*	4510	1·24*
4013	58p*	4023	19p*	4050	58p*	4511	1·54*

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15pf	150pf	1500pf	
22pf	220pf	2200pf	
33pf	330pf	3300pf	
47pf	470pf	4700pf	8p each
56pf	560pf	5600pf	
68pf	680pf	6800pf	
82pf	820pf	8200pf	

JACK CONNECTORS

Type	Plugs Plastic	Plugs Chrome	Sockets
2·5mm	15p	25p	12p
3·5mm	15p	25p	12p
Mono	—	30p	20p
Stereo	—	37p	25p

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AY-5-4007	£7·99*	MC1351P	£1·00	TBA530Q	£2·00
CA3045	£1·50	MC1352P/TDA1352	£1·20	TBA540Q	£2·00
CA3046	80p			TBA550Q	£2·00
CA3053	85p	MC1357P/LM2111N	£1·70	TBA651	£2·25
CA3075	£2·00			TBA750Q	£2·00
CA3080	80p	MC1375P	£1·50	TBA800	£1·00
CA3081	£1·50	MC1456CG	£2·50	TBA810S/AS	£1.10
CA3082	£1·50	MC1495L	£4·90	TBA820	£1.00
CA3089/TDA1200	£2·30	MC3302P	£1·65	TBA990Q	£2·00
CA3090Q	£4·25	MFC6030A	£1·00	TCA730	£4·20
CA3123E/LM1820	£1·50	NE540L	£2·25	TCA740	£4·89
CA3097E	£1·75	NE546	£2·15	TCA940	£1·75
CA3130S	99p*	NE555	35p*	TDA2020	£3·50
CA3140S	99p	NE556	90p*	ZN414	£1·10
CA3160S	£1·60	NE560	£4·40*	ZN417E	£1·60
CA3600E	£1·75	NE561	£4·40*	ZN423T	£1·08*
LM301AN (8 pin)	40p	NE562	£4·40*	ZN424E	£1·35
LM301AT (TO99)	50p	NE565	£1·40*	ZN425E	£3·78*
LM308N (8 pin)	90p	NE566	£1·65*	ZN1034E	£2·03*
LM308T (TO99)	£1·40	NE567	£1·85*	ZN1040E	£8·43*
LM339N	£1·00	SL414A	£1·90	ZNA116E	£8·75*

SILVER MICA CAPACITORS

2·2pf	10p	68pf	10p	500pf	15p
3·3pf	10p	75pf	10p	560pf	15p
5pf	10p	82pf	10p	680pf	15p
10pf	10p	100pf	10p	820pf	15p
18pf	10p	120pf	10p	1000pf	20p
20pf	10p	150pf	10p	1500pf	20p
22pf	10p	180pf	10p	1800pf	20p
25pf	10p	200pf	10p	2200pf	20p
27pf	10p	220pf	10p	2700pf	30p
30pf	10p	250pf	10p	3600pf	30p
33pf	10p	270pf	15p	4700pf	30p
39pf	10p	300pf	15p	5000pf	30p
47pf	10p	330pf	15p	6800pf	40p
50pf	10p	390pf	15p	8200pf	40p
56pf	10p	470pf	15p	0·01µf	40p

SWITCHES

D.P.D.T. toggle	·50p*
S.P.S.T. toggle	·30p*
D.P.D.T. Slide	·18p*
D.P.D.T. Slide Miniature	·15p*
Push to Make Miniature	·18p*

MYLAR CAPACITORS

1000pf	5p	0·04µf	8p
2000pf	5p	0·047µf	8p
2200pf	5p	0·05µf	8p
4700pf	5p	0·068µf	9p
5000pf	5p	0·1µf	10p
0·01µf	8p	0·2µf	12p
0·02µf	7p	0·22µf	12p
0·022µf	7p		
0·03µf	8p		

RESISTORS

Type	Range	
¼ watt 5% Carbon film	E12 Series 10R-1M	2p each
½ watt 5% Carbon film	E24 Series 3·3R-10M	2p ea.
1 watt 5% Carbon film	E12 Series 10R-1M	5p each

TANTALUM BEAD CAPACITORS

0·1µf	35v	15p	10µf	25v	20p
0·22µf	35v	15p	10µf	35v	22p
0·47µf	35v	15p	22µf	16v	22p
1·0µf	35v	15p	47µf	16v	25p
2·2µf	35v	15p	100µf	3v	22p
4·7µf	35v	18p	100µ	6·3v	25p
10µf	16v	17p	100µ	10v	34p

POTENTIOMETERS

5K 250K, 10K 500K, 25K 1M, 50K 2M, 100K

Lin and Log less Switch (inc. 1K Lin)	·27p
Lin and Log Dual less Switch	·75p
Lin and Log with Switch	·60p
10K, 100K, 500K, 1M Dual log with Switch	·75p
10K Log + 10K Antilde less Switch	·75p

LOW VOLTAGE DISC CERAMIC CAPACITORS

0·022µf 18V 0·047µf 12V 0·22µf 6V 5p each

PRESETS

100R	5K	250K	·1 watt
250R	10K	500K	Horizontal
500R	25K	1M	and
1K	50K	2·5M	Vertical
2·5K	100K	5M	7p each

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REGULATORS

723 Variable		45p*
78L05AWC	5V	65p*
78L12AWC	12V	65p*
78L15AWC	15V	65p*
7805KC	5V	2·17*
7812KC	12V	2·17*
7815KC	15V	2·17*
7805UC	5V	1·25*
7812UC	12V	1·25*
7815UC	15V	1·25*
7818UC	18V	1·25*
7824UC	24V	1·25*
L005T1	5V	1·50*
L036T1	12V	1·50*
L037T1	15V	1·50*
L129	5V	85p*
L130	12V	85p*
L131	15V	85p*
TBA625A	5V	1·25*
TBA625B	12V	1·25*
TBA625C	15V	1·25*
LM309K	5V	1·50*
Negative		
7905UC	5V	1·25*
7912UC	10V	1·25*
7915UC	15V	1·25*
7918UC	18V	1·58*
7924UC	24V	1·25*

TRANSISTORS

AC126	20p*	BC558	15p	MPF104	40p	2N1302	45p*
AC127	20p*	BC559	15p	MPF105	40p	2N1304	45p*
AC128	20p*	BC547	15p	MPSA05	25p	2N1305	30p*
AC176	20p*	BC548	15p	MPSA06	25p	2N1306	45p*
AC187K	35p*	BC549	15p	MPSA55	30p	2N1308	30p*
AC188K	35p*	BCY70	18p*	MPSA56	30p	2N1309	45p*
AD161	45p*	BCY71	18p*	MPSU05	50p	2N1711	25p
AD162	45p*	BCY72	18p*	MPSU06	55p	2N1893	35p
BC107	10p*	BD131	50p*	MPSU55	55p	2N2646	50p*
BC108	10p*	BD132	50p*	MPSU56	60p	2N2925	10p
BC109	10p*	BD135	40p	TIP31A	55p*	2N2926G	10p
BC147	9p	BD136	40p	TIP32A	60p*	2N3053	22p*
BC148	9p	BD139	40p	TIP41A	65p*	2N3054	55p*
BC149	10p	BD140	40p	TIP42A	75p*	2N3055	60p*
BC157	11p	BD239C	35p*	TIS43	40p*	2N3442	1·50
BC158	11p	BF180	35p*	TIS91	25p	2N3702	11p
BC159	11p	BF181	35p*	ZTX107	12p	2N3703	11p
BC169C	12p	BF184	25p*	ZTX108	12p	2N3704	11p
BC177	18p*	BF185	25p*	ZTX109	12p	2N3705	11p
BC178	18p*	BF194	12p	ZTX300	15p	2N3706	11p
BC179	18p*	BF195	12p	ZTX301	15p	2N3708	12p
BC182L	11p	BF196	12p	ZTX302	17p	2N3709	12p
BC183L	11p	BF197	12p	ZTX303	20p	2N3710	12p
BC184L	11p	BF200	35p	ZTX311	15p	2N3711	12p
BC212L	11p	BF244B	35p	ZTX312	17p	2N3772	1·50*
BC213L	11p	BFY50	20p*	ZTX341	20p	2N3819	25p
BC214L	11p	BFY51	20p*	ZTX500	15p	2N3904	20p
BC441	35p	BRY39	50p*	ZTX501	17p	2N3906	20p
BC461	35p	MJ2955	1·20*	ZTX502	17p	2N5447	18p
BC477	25p	MJ3055	1·20*	ZTX503	20p	2N5449	19p
BC478	25p	MJE340	50p	ZTX504	25p	2N5777	50p*
BC479	25p	MPF102	40p	ZTX531	25p	3N141	1·90
BC557	15p	MPF103	40p	ZTX550	17p	40673	75p*

ELECTROLYTIC CAPACITORS

uf	V6·3	10	16	25	40	63
1	—	—	—	—	—	7p
1·5	—	—	—	—	—	7p
2·2	—	—	—	—	—	7p
3·3	—	—	—	—	—	7p
4·7	—	7p	—	7p	—	7p
6·8	—	—	—	—	7p	7p
10	—	—	—	7p	—	7p
15	—	—	—	—	7p	8p
22	7p	7p	7p	7p	7p	8p
33	—	—	7p	—	7p	—
47	7p	7p	—	7p	7p	12p
68	7p	—	7p	8p	—	—
100	—	—	7p	8p	12p	25p
150	—	—	7p	8p	12p	25p
220	—	8p	8p	12p	15p	25p
330	—	8p	8p	—	—	30p
470	—	15p	—	25p	30p	35p
680	—	15p	20p	25p	30p	—
1000	15p	15p	30p	25p	40p	65p
1500	—	—	25p	—	—	—
2200	—	30p	35p	45p	70p	90p
4700	—	35p	—	55p	80p	95p

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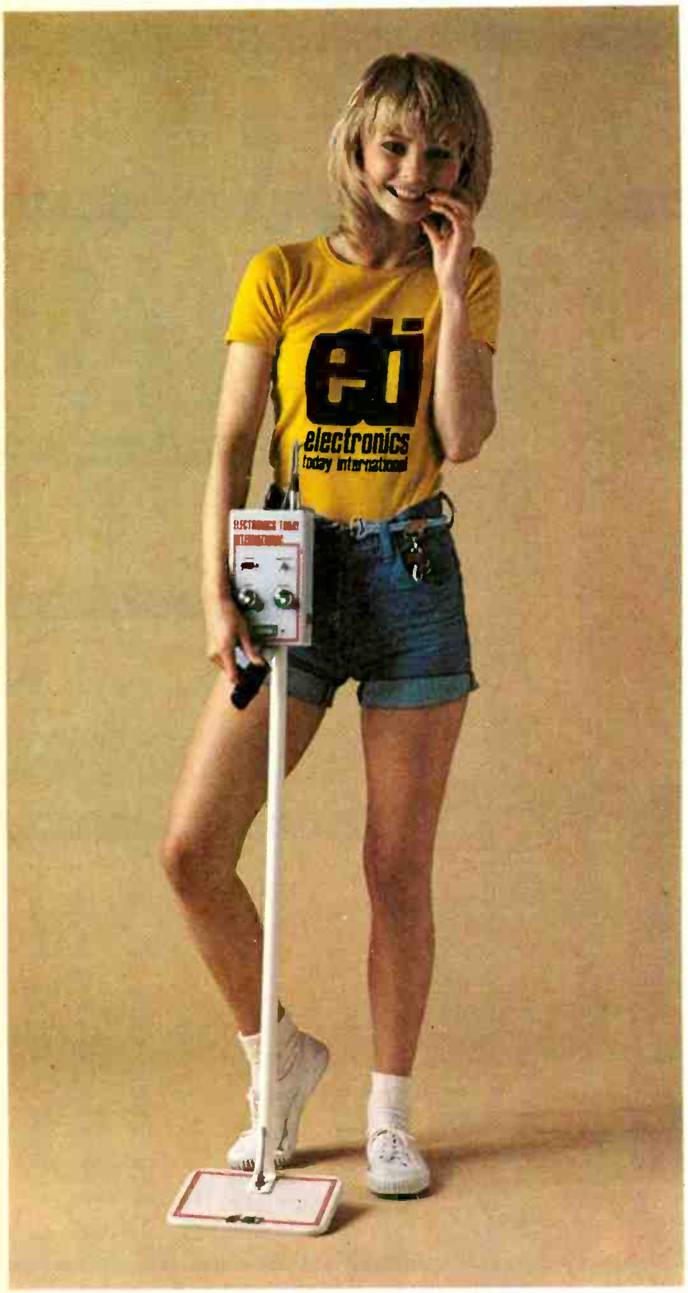
IB METAL LOCATOR MK2

A year ago we described a really excellent metal locator using the induction balance principle. The ETI Project Team have taken another look at the design and come up with an alternative way of using this principle.



EXACTLY A YEAR AGO, in the February 1977 issue of ETI we described the first (and to date only) DIY project yet published in Britain of an Inductance Balance metal locator. We know that literally thousands upon thousands of these were built and although a few readers did have problems, most of them were accounted for by poorly set up search coils.

Treasure Hunting

The hobby of treasure hunting using a metal locator started in America about ten years ago and has been growing in popularity ever since; in Britain the hobby has grown to enormous proportions. Commercial metal locators are not cheap — starting with kits at the £15 mark but with a big gap before most of the built models appear. The average price is in the £50 region (there are notable exceptions of course) yet the circuitry in these is by no means complex. The important part about an induction balance metal locator is the search head and no one should underestimate this — this accounts for a significant part of the total cost and, if you tackle this project, expect to devote a lot of time to lining up and experimenting with this.

The reason for the popularity of treasure hunting is that it works — using a reasonable metal locator you can hardly fail to find coins and other items lost or thrown away. Our fields and pathways are littered with metal which has been there for hundreds, even thousands of years. The art of knowing where to look is almost more important than the technical performance of the machine: a good detector helps of course but it's how it is used that's important.

Designing the Mark 2

Because of the enormous popularity of the Mark 1 we couldn't resist the temptation of having a good look at the circuit and design to see if it couldn't be improved upon. Readers who are interested in this field are strongly recommended to see the February 77 issue (not unfortunately available as a backnumber) or the reprint in Top Projects No. 5 (available).

Our first step was to look at the original design — in the light of experience could we improve it? We came up with a dozen variations to try but to our surprise we were unable to make any real improvement on the first circuit using the general principles. We could have reduced the package count by using an LM389 (which includes three independent transistors plus an audio

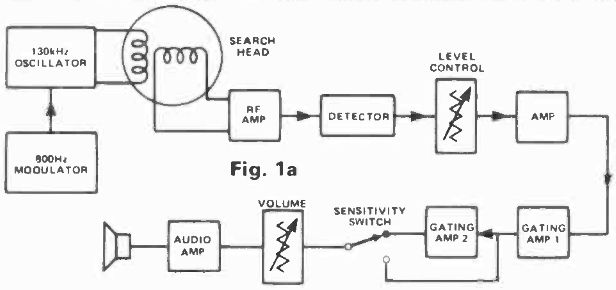


Fig. 1a

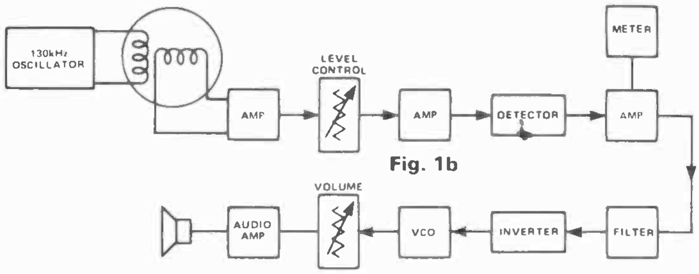


Fig. 1b

Fig 1. a) On the left shows the block diagram of the Mark 1. In this the peaks of the modulated signal were gated and enormously amplified. On the right is shown the new arrangement, the RF signal, which is unmodulated, is converted to a DC signal which drives a voltage controlled oscillator (VCO).

output amplifier) but that would have cost more with no real change.

In the original design the transmitter was modulated and the peaks of the detected signal were gated and enormously amplified (See How It Works and Fig 1a). Although we refer to the signal being modulated, it was actually switched on and off and this resulted in ringing in the tuned circuit.

After literally three weeks solid experimenting we decided to take another approach. We decided to dispense with a modulated transmitter and work with DC until the final stages. In the original design the audio frequency was fixed, being dependent upon the modulator and metal was sensed by an increase in audio level. However, our ears are highly insensitive to changes in level, they are, however, very sensitive to a change in audio frequency. Once we had decided to tackle it from this side everything fell into place. For a long while our voltage controlled oscillator was a unijunction transistor and although we achieved excellent results we were not satisfied with the unit in practice and eventually adopted the circuit shown in Fig. 3.

The Coil

We cannot emphasise enough that the search head is the key to the whole operation: be prepared to spend some time on this, our own workshop is full of discarded experiments.

The housing of the coils is not important. In the Mk 1 we adopted a circular head but this is difficult for the non-woodworkers to tackle so we went for a rectangular shape. The coils L1 and L2 should be sandwiched between two pieces of hardboard or plywood separated by thin battens — about 6mm thick. The top should be built first and the battens fitted — for a better appearance you can then file off the corners slightly.

Despite the extremely low emmission, all electronic metal locators used in the United Kingdom require a licence. This costs £1.20 for five years and application forms are available from:

Ministry of Posts and Telecommunications,
Waterloo Bridge House,
Waterloo Road,
London SE1

To wind the coils you'll need to get hold of a cylinder about 140mm (5½in) in diameter. Using 32 swg enamelled copper wire, trap one end onto the former with a piece of tape and carefully wind 40 turns as close together as possible. Carefully remove the coil and then wrap tape around it at intervals to keep it from spreading.

Two identical coils are required.

Lay one of the coils into the dish formed from the top of search head and the battens as you see in the photograph and spot glue it into place except on the part near the middle. Lay the other coil next, again spot gluing it except near the middle. A hole should be made in this piece of wood to feed through the

Continued on page 36

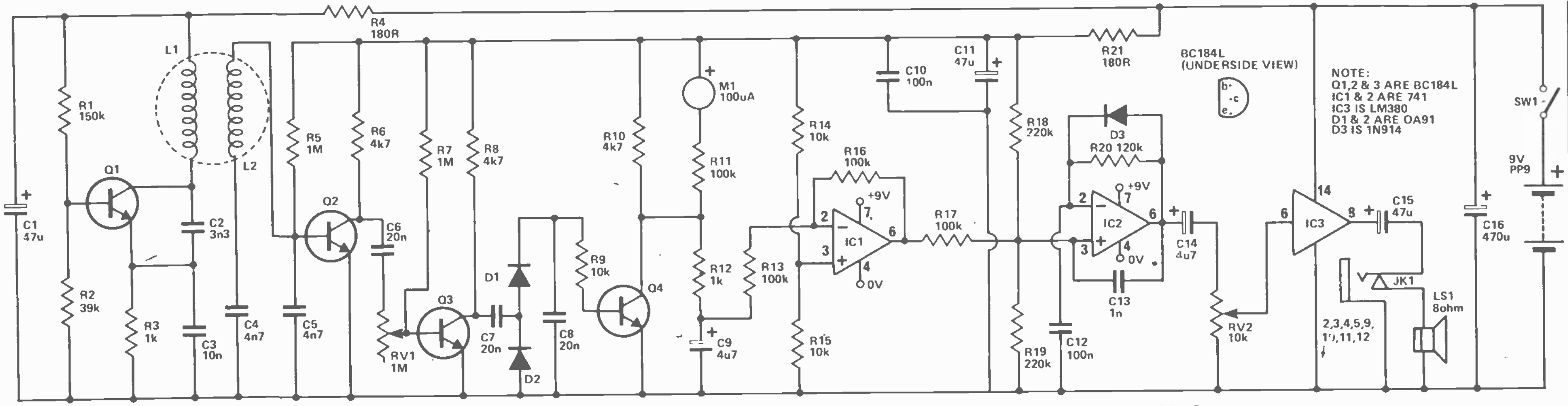


Fig 3. The complete circuit of the IB Metal Locator Mk 2.

HOW IT WORKS

The heart of the circuit is the search coil, L1 and L2. These two coils, which are essentially identical, are arranged in the same plane with a small overlap in such a way that there is practically no inductive coupling between the two. There is minimum pickup when the fields generated in L1 are cancelled in L2 when in free air. Any metal brought into the electro-magnetic field of L1 will distort the field, causing pickup in L2.

Q1 is a straightforward Colpitt's oscillator working at a nominal 130 kHz. This type of circuit is very stable and the use of polystyrene capacitors also help with stability. The supply to this stage is separately decoupled by R4 and C1.

The pickup coil L2 is tuned by means of C4 and C5 and amplified by Q2 which feeds to the level control RV1. This controls the "free air" state of the circuit and is set to the point where the later stages are just operating. The signal is further amplified by Q3 (here it is still an RF signal) and is detected by D1 and D2. When no metal is in the vicinity of the search coil and with RV1 correctly adjusted, a DC voltage of about 500 mV appears across C8. R9 increases the effective input impedance of Q4 as seen by the detector stage.

Q4 is just held off by the voltage available but as soon as any metal distorts the electromagnetic filed, L2 produces a larger RF signal, a higher voltage across C8 and a consequent fall (from 8 V) in the voltage at the collector of Q4. This voltage is also monitored by the meter in parallel with the load resistor of Q4. The fall in voltage is dependent upon the proximity and/or size of the metal near the search coil.

It is necessary to ensure that the DC voltage fed to the next stage is clean and R12 and C9 act as a filter to remove any residual AC even if this is at low frequencies.

IC2 (the next but one stage) is a voltage controlled oscillator — but to operate this so that metal is indicated by a rising note, rather than a falling one, the voltage at the junction of C9 and R12 has to be inverted and this is achieved by IC1: in "no-metal conditions there is about 2 V at the output of this op-amp which rises when metal is near. This stage quickly saturates to give about 7 V at pin 6. IC1 has unity gain.

IC2 is a voltage controlled oscillator. In "no-metal" conditions it gives about 70 Hz which rises to 500 Hz when metal is present, diode D3 gives a rapid recharge to C12 and affects the mark/space ratio of the output which results in lower battery consumption. R20 and C12 can be altered to give a different range of audio frequencies if desired.

The output is taken to a volume control and fed to the LM380 audio power amplifier which in turn feeds the speaker.

The levels of signal around Q2, 3, 4 are all dependent upon transistor gain, temperature and supply voltage but this doesn't matter because the level control RV1 is adjusted until Q4 just begins to conduct.

Current drain for the complete circuit is in the order of 50 mA.

PARTS LIST

Resistors. All ⅛W, 5%

R1	150k
R2	39k
R3, 12	1k
R4, 21	180R
R5, 7	1M
R6, 8, 10	4k7
R9, 14, 15	10k
R11, 13, 16, 17	100k
R18, 19	220k
R20	120k
RV1	1M linear (level)
RV2	10k log (volume)
CAPACITORS	
C1, 11	47u 16V tantalum
C2	3n3 polystyrene, 5%
C3	10n polystyrene, 5%
C4, C5	4n7 polystyrene, 5%
C6, 7, 8	20n polystyrene
C9, 14	4u7 16V tantalum
C10, 12	100n polyester
C13	1n polyester
C15	47u 16V electrolytic
C16	470u 16V electrolytic
SEMICONDUCTORS	
Q1, 2, 3, 4	BC184L or equivalent
IC1, 2	741 8-pin DIL
IC3	LM380
D1, D2	OA91
D3	1N914

PROJECT: IB Mk2

MISCELLANEOUS
LS1 8 ohm miniature loudspeaker
JK1 stereo jack socket
M1 100uA level meter
L1, L2 — see text
PCB — see drawing
4-core, individually screened cable
Battery & clip (PP9)
Marley 22mm cold water plumbing
Bicycle hand grip
Verobox, 4¼" x 7½" x 2¼"

BUYLINES

No problems with the parts: your problems will only lie in setting up the coil. Enamelled copper wire is available on small reels from most retailers. Signal level meters are also widely sold though the actual appearance may vary from that in our photograph. The stem is made from Marley push-fit 22mm cold water fittings available from most plumbers.

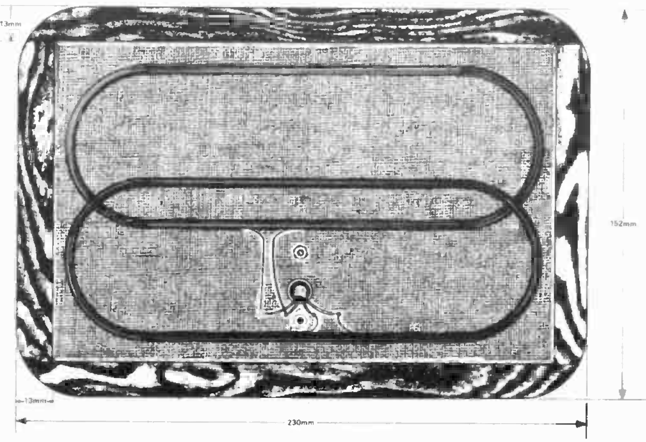


Fig 2. The search coil. This comprises L1 and L2 which are made from two coils originally wound on a 140 mm former and then squeezed into the shapes shown.

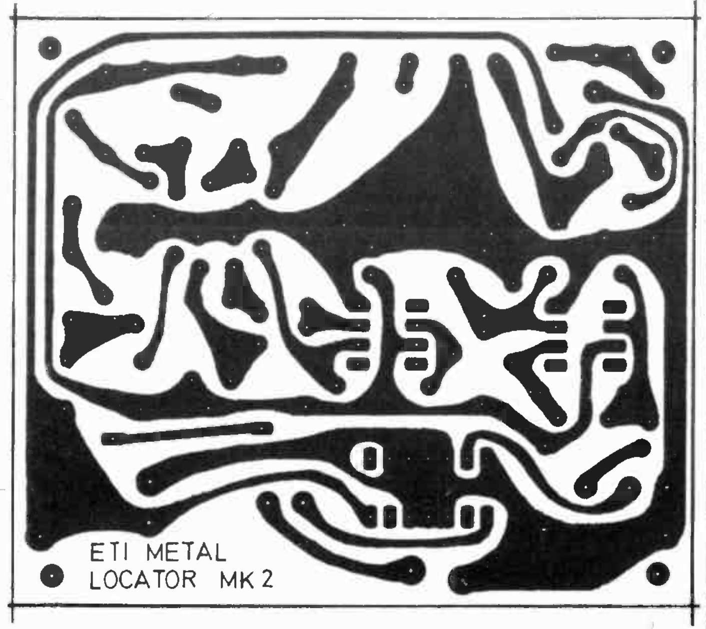


Fig 4. The PCB for the IB Mk 2. Full size is 89 x 77 mm.

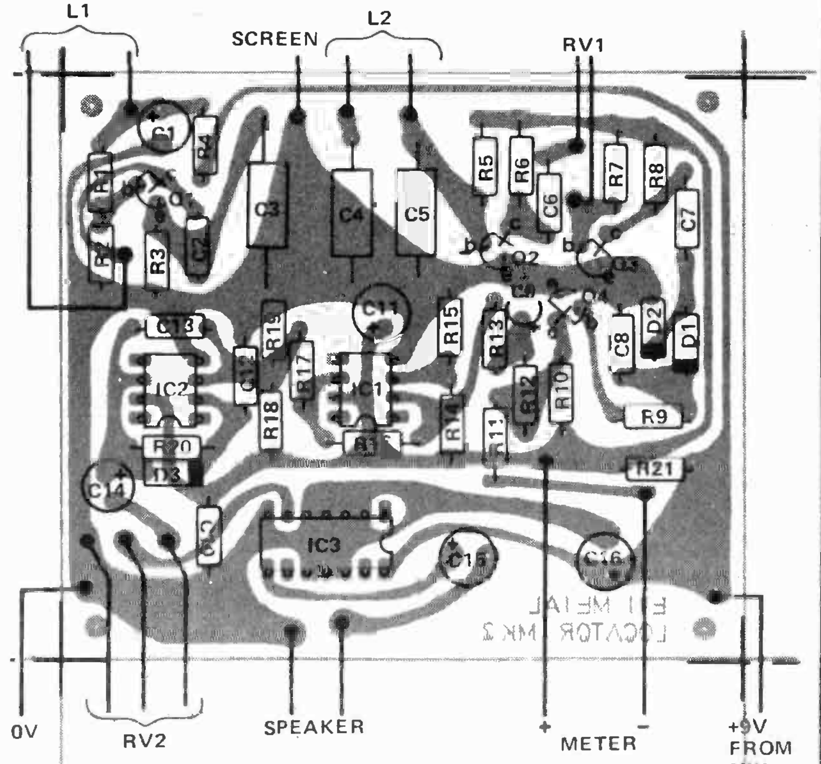
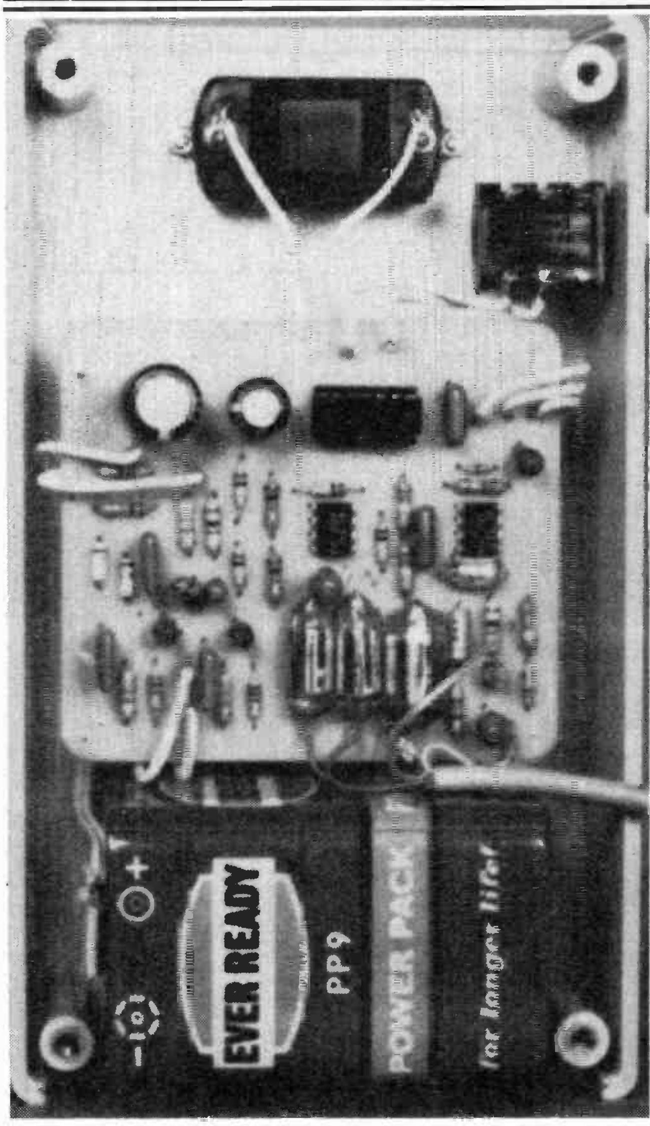
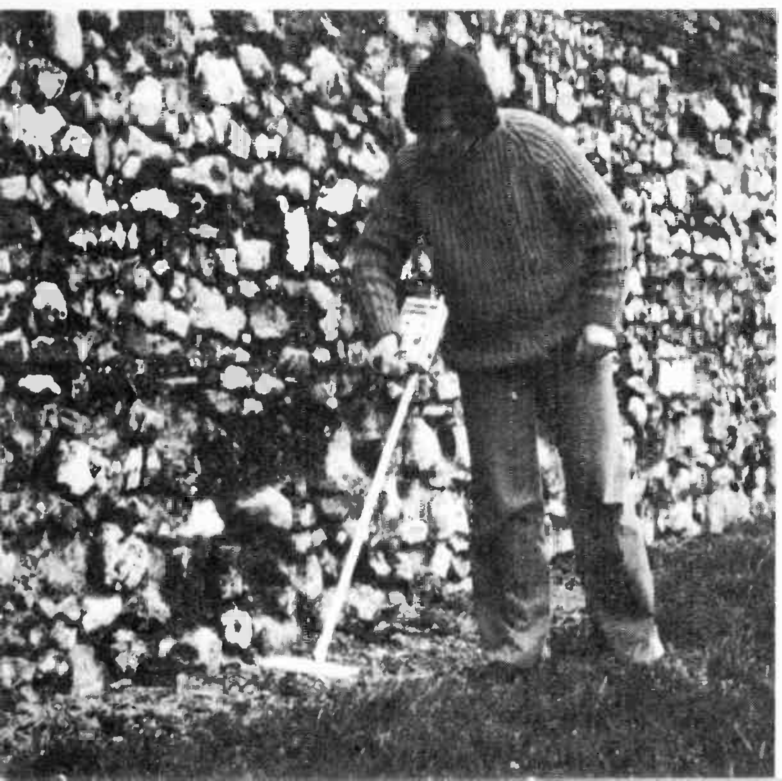


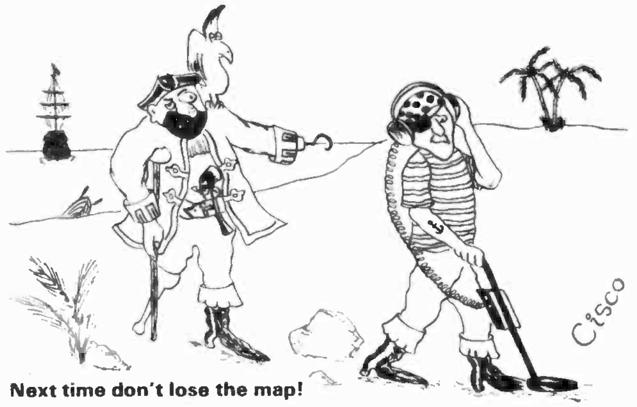
Fig 5. The component overlay on the PCB with the wires leading off to other parts of the circuit.



Internal view of the control box

connecting cable to the main circuit. This cable must be a four-wire type with individual screening — the screens are not used at the search coil end but don't cut them too far back: we still have a few experiments to try





Next time don't lose the map!

out on our prototype and access to this screening may be used.

The Control Box

The circuit should be built up next. Everything except for the controls, the speaker and the meter are on a single PCB. Building this up should present few problems. Spacing is designed for eighth watt resistors and tantalums are used, again to save space though the control box has plenty of room in it.

Fit terminal pins to the points shown in the PCB overlay as this will make connections far easier to make later on.

Setting Up

We repeat — don't rush this part — it's what counts.

Assuming you haven't got the coil in exactly the right position by luck in the original setting, you should get an audio tone of about 700Hz from the speaker and the meter (if connected) will be hard over.

If you don't get this, adjust RV1 and it should appear. Back off RV1 until the frequency falls and then increase it a bit so that the tone is slightly higher than the minimum.

Now gently and slowly bend the coils and adjust the overlap till the tone falls. Add a few more blobs of glue but leave yourself with some adjustment. Readjust RV1 again and repeat. Continue to do this until you can no longer get any lower adjustment on RV1.

Now check that no metal is in the vicinity (don't forget cuff-links, watches and rings) and continue the manipulation.

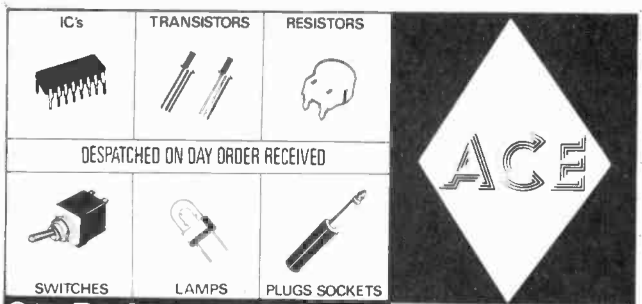
If you use a scope, monitor the level of the signal of the collector of Q2: when you are near to a minimum the level should fall considerably.

If all works as described, bringing a piece of metal near the coil should result in the frequency rising. If the frequency falls instead of rising, continue adjusting. Near the minimum you can reach a point where the metal firstly adds to the cancellation.

Don't glue down the final tiny, tiny adjustments until you are quite certain that all is OK. The amount of final adjustment is extremely critical as you'll find out.

General Construction

The general design can be seen from the photographs. We used a Verobox to house the main circuit and cut a piece of broom-handle at an angle and fitted a bicycle hand-grip to this. The stem is made up from Marley 22 mm cold water plastic tubing, available from many plumbers. The connection to the search-head was accomplished by softening a short length of the stem plastic in hot water and quickly clamping this in a vice. The connectors on the stem are also Marley fittings. ETI



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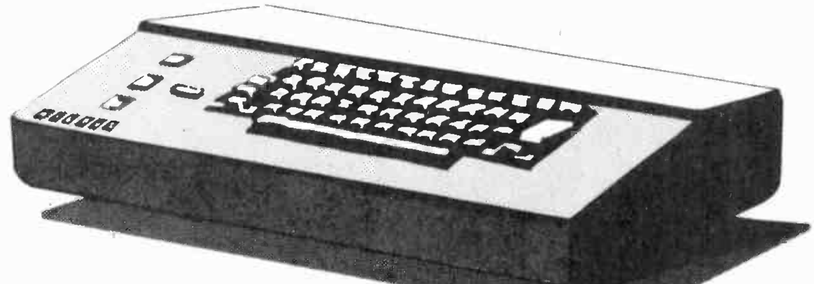

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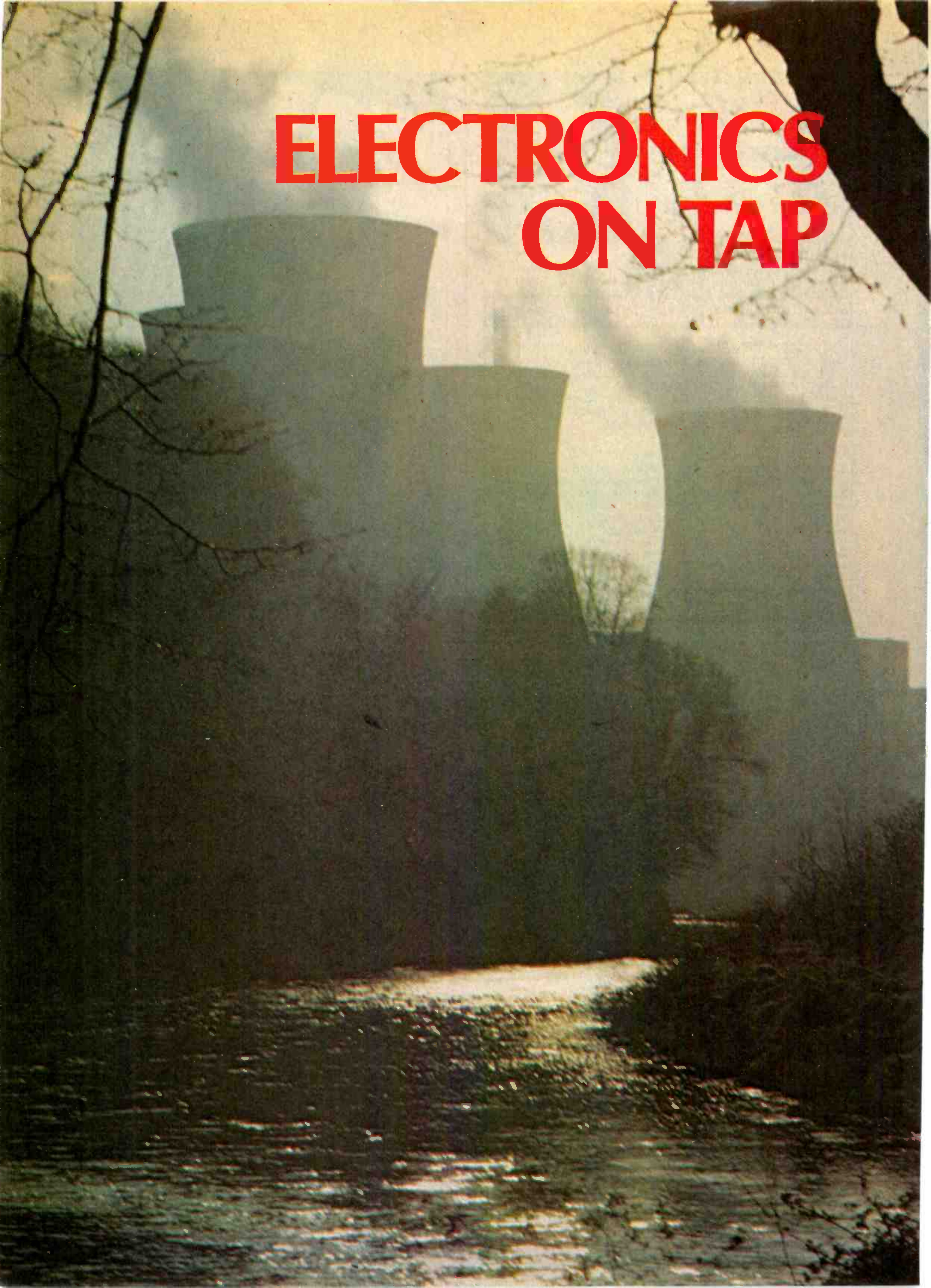

ELECTRONICS
ON TAP

Turn on the tap and out it gushes.Water. In this feature,Dr.Peter Sydenham looks at the ever-growing brigade of electronic methods that are being employed "up the pipe" to ensure clear and bacteria free water.

IN EARLY TIMES of the development of man the population density was such that natural methods of water supply were generally quite adequate. Early civilisations settled by freshwater rivers, lakes and springs because these provided potable water that was not injurious to health.

The people realised the need to use the water for various purposes in a sequence that maintained adequacy at each stage. Figure 2 from the well-known treatise ''Water in England'', by Dorothy Hartley, illustrates how clean spring water eventually runs to lower levels through increasingly dirtier uses to flow away as effluent. Within reason, natural processes would purify it before it arrived back in the spring — or someone else's spring — by the evaporation-to-precipitation cycle, or through biological purification by water plants, animals, and bacteria. This simple state of affairs is reasonably adequate provided the sequence is maintained and the volume of pollutants not greater than natural processes can absorb.

Progress

The early people knew quite a lot about such things from direct experience. In densely populated regions, such as the Thames Valley, the breweries were placed well upstream. As you moved towards the estuary the processes became dirtier — abbatoirs, refuse dumps, fish smoking, and the like being found downstream.

Eventually, of course, settlement begins to blur the distinctions and each settlement region begins to creep into those adjacent. The result is that the water supply of one region draws in water which could contain the outfall of another. Then the trouble begins. Diseases spread at epidemic proportions, fishing industries and vegetable production become less productive, smells become noticeable at repugnant levels. Simple procedures of water supply fail.

By the late 1700s, European communities were beginning to understand the reasons for medical epidemics and the need for water purification on a routine ordered basis. It is somewhat surprising to learn that one of the first sand filters was introduced as late as 1804. It was no wonder that London had an outbreak of typhoid disease (1831) that claimed 50 000 lives — the sewer outlets into the river entered the flow above the water supply inlets!

Gradually water supply design improved, due to the introduction of various Acts of Parliament. Addition of chemicals that sterilized just about all water-borne diseases began in 1897. Today we have things well under control, although there are still poisonous toxins that get through on the very rare occasion.

Electronic methods of measurement and control have provided the means to achieve this state of affairs with high reliability and at low cost. We begin by looking at water management on the extensive regional basis, progressing inward, via the filtration plant through to the pipe it flows from.

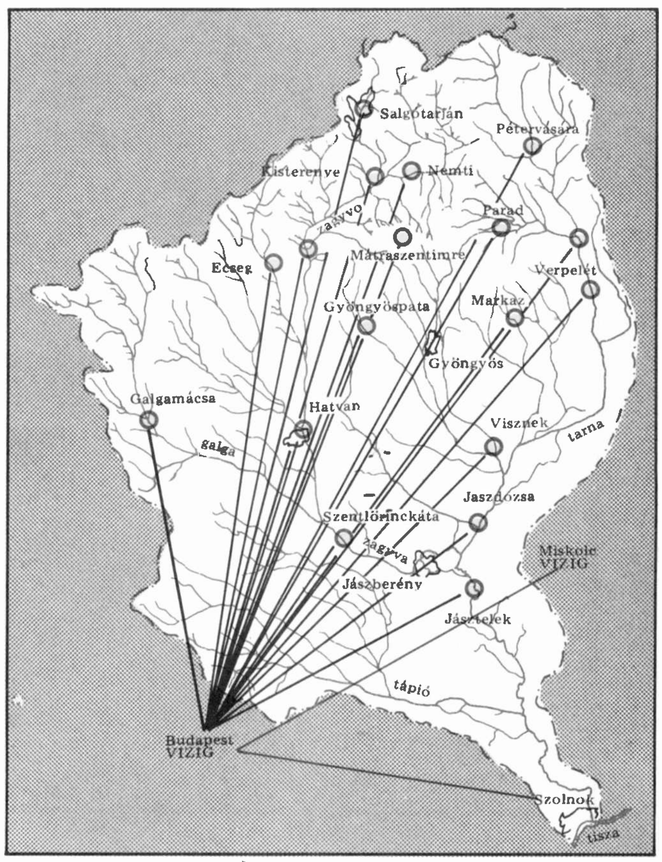
Regional Water Resource Management

Little new water is created by natural means — the bulk is recirculated by the various processes of evaporation and precipitation, and seepage through strata. Whichever way it comes, it ends up returning with a regional distribution that can vary widely. This is witnessed as extremes ranging from droughts to floods, terms which describe lack or excess of normal rainfall.

If the pattern of water renewal remained constant over time it would be an easy matter to design pipe and canal systems to take it to the places where it is needed. As the pattern varies widely in practice, it becomes necessary to use active methods of control operating floodgates and reservoirs to control flow across a region.

This requires a system of measurement that provides a central authority with the information required to take action to prevent flood or drought. As an example, let us take a brief look at a system designed for use in Hungary, in the Central Danube Valley District Water Authority area. There the Zagya and Tarna rivers catch rain and snow water for an area of 5676 km². The average run-off from the surface varies from 16-200 mm per year. Normal values can vary as much as eighteen times, so floods are commonplace. Figure 1 shows the location of the monitoring stations. ▶

Fig. 1. Location of monitoring stations for the Hungarian water resource management system. Such schemes aim to control the flow of water so as to establish safe and uniform conditions of supply.



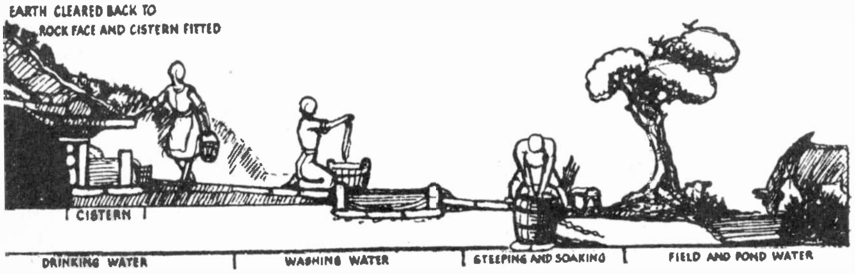
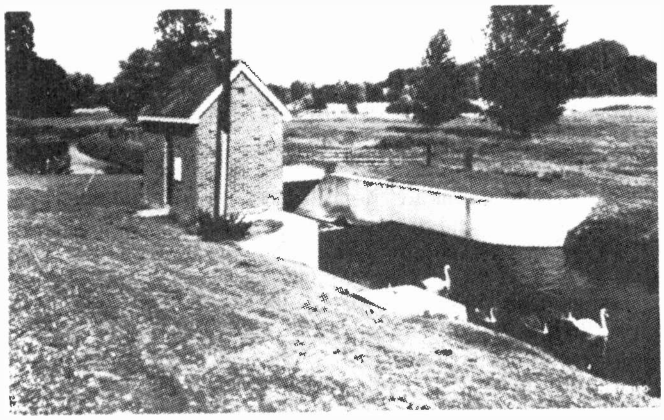


Fig. 2. Water is used in a sequence that gradually increases its impurities. When it is given too little time to be re-purified and enters the supply source troubles begin. Electronic measurements have provided us with the methods of controlling the quality of water.

Fig. 3. Gauging stations, such as this one on the River Lea in England, are a common sight today. In this hut are monitored flow, DO, temperature, pH, conductivity, suspended solids, ammonia and nitrate.



Telemetry will be used to transmit variables such as water level, rainfall, water content of snow, ground frost, soil moisture, and air and soil temperatures, from 18 gauging stations to a control centre in Budapest. A central memory unit will store five days of data which will be used to set the parameters of an analytical water flow model for purposes of predicting extremes early enough to allow reservoir capacities to be adjusted ready to accept larger or smaller water quantities. The Hungarian post office telex network will convey the data across the country. Additional dams will be built to give greater overall averaging and better control on a district-by-district basis.

The computer interprets the situation from around 100 000 data values spread over a flood period of five to eight days. The flood peaks will be followed as they descend the rivers, thus enabling more accurate prediction downstream. A number of control models have been developed for the different situations that are known to occur.

This example is not unique. Many water resource control schemes exist across the world in which the data are obtained by methods ranging from purely manual to automatic procedures. A completely supervised system is extremely expensive — but so is the cost of just one flood. In Hungary it is calculated that a bad flood causes a loss of 20 per cent of a year's economic product. The falling cost of data processing by electronic means has now made water resource management schemes economically viable at the national scale of size.

Fig. 4. Effect and limits of pollutants in Water (Sowry, Priory Press).

Type	Effect	Limit of concentration in mg/l
Organisms from human or animal excrement	Enteric fever, dysentery, cholera, typhoid, etc.	Should be none in 100 ml
Pesticides	Cumulatively toxic over lifespan of consumer	ADI† to ensure does not build up to toxic levels
Nitrates (and nitrites)	Methaemoglobinaemia in babies stops oxygen being carried in the blood, so they may die	45
Fluorides	Although less than given limits aids tooth decay, too much will damage teeth and bones	0.9-1.7 for cool climate 0.6-0.8 for hot climate
Arsenic	Poisonous in large quantities	0.05
Cyanide	Poisonous, ADI of 0.05 mg per kg of body weight	0.01
Lead	Poisonous, ADI of 0.05 mg per kg of body weight	0.05
Mercury	Cumulatively toxic	0.001

†ADI: Acceptable daily intake

Assessment Of Source Water Quality

It has become obvious in recent years that whilst water supply authorities were adequately monitoring and correcting the output quality of a supply system, the water entering it was being given too little attention. The result has been, in many places, a steady deterioration in the ability to cope with the rising pollution levels in the filtration plant processes.

Considerable interest has now developed in getting the sources clean again. The Thames River is now no longer at a state where the Parliament at Westminster in the 1850s had to adjourn because of the stench! Today controls are gradually restoring the river's ability to support water life, which means, in turn, that its natural processes of purification are again coming into operation (too much pollution destroys the process completely, removing all natural ability to purify itself).

Source water quality can range from reasonably clean rainwater run-off to river water polluted with industrial wastes and sewage.

The stream station pictured in Fig 3, regularly monitors dissolved oxygen (vital to bacterial processes),

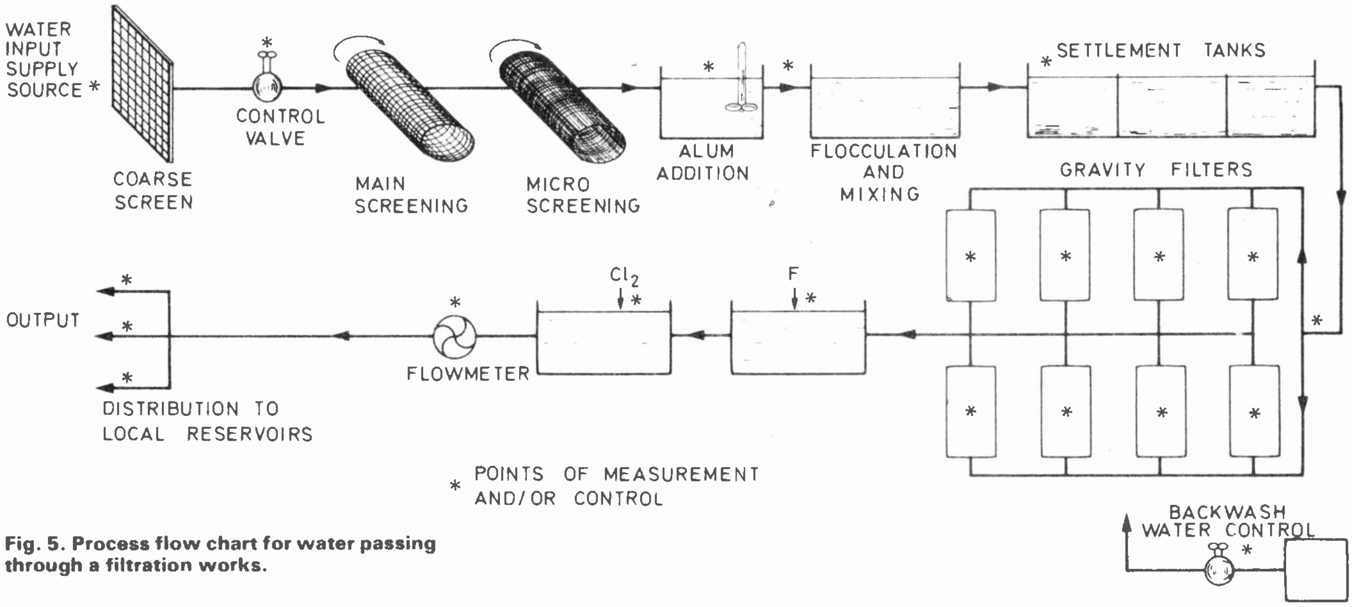


Fig. 5. Process flow chart for water passing through a filtration works.

temperature, conductivity, suspended solids, and ammonia and nitrate levels dissolved in the water. Flow rate is also gauged.

In large rivers it is customary to use instrumented barges to measure the profile of variables across and along the rivers — this helps detection of excessively polluted outfalls. Legislation reinforced by heavy penalties, is now in force to cause industry to clean up its discharges before release.

Dissolved oxygen is a key variable. Organic matter entering a river provides food for life in the water, but the micro-organisms digesting it use oxygen in the reaction. This oxygen is replaced in a balanced "healthy" system by dissolving more from the air — hence the reason for aerated water-ways being clean, when static ponds are not. Indeed, if the water is too static, an inversion layer situation results which allows dangerous toxins to generate in the bottom. Given no more pollutant, the situation will slowly recover. Biological oxygen demand (BOD) is another related variable often measured.

Figure 4 is a summary list of pollutant levels generally agreed as maxima that may occur in water considered as potable. The World Health Organisation, WHO, has developed standards for guidance, but each country must interpret these as its own experts see fit. Addition of chlorine is mandatory to all water so as to be absolutely sure that the water is disinfected before use. This procedure in itself can lead to filtration plant difficulties as the water entering the plant will already contain a background quantity which must not be increased beyond given levels.

In The Filtration Works

Although the actual appearances of water works vary widely, they all follow a similar basic design philosophy. The degree of electronic sophistication used ranges from just about complete manual measurement and control, to fully computer-based automated plants.

A schematic, Fig 5, gives the flow route for water. At the intake will be found coarse screens that prevent large debris, fish, cans and similar water-borne rubbish from entering the system. Following this, in cases of gravity feed, will be a large control valve that can regulate the inputs so that the plant will not flood if some part of the process clogs up. Level gauges exist throughout the plant. The water is then filtered to remove finer trash, and there may be a micro-filter to eliminate algae.

Removal of material small enough to remain in suspension requires some other process. Addition of aluminium sulphate causes these to join up — coagulate — forming large particles that will settle out as a spongy "floc". This flocculation stage usually alters the pH of the water, necessitating readjustment by other chemcial addition. (pH is a variable used to express the range from strong acidity pH = 0, to strong alkalinity pH = 14, through neutrality at pH = 7.)

The coagulated material is then settled out in large shallow sedimentation tanks ready for final filtration and chlorine dosing.

Filtration is done in either a slow sand, or rapid gravity filter. The first allows the water to filtrate through layers of sand with little pressure head. These need large areas and are cleaned a few times a year.

Gravity filters are smaller and need cleaning — called back-flushing — at about eight-hourly periods. Each filter tank has its own controls. These enable the pressure-head loss to be monitored as the sand clogs, and allow the various flow control valves to be sequenced to reverse the flow, flushing the unit with clean water held in reserve at a high-head.

After filtration the water is dosed with chlorine and, perhaps, fluoride, using automatic dosing units.

Addition of fluoride and chlorine requires very careful control, for too much can be injurious. Where the background quantities are practically zero, as in a system operating a great distance from any other water supplies or pollutants, the dosing is done on a basis of flow rate. When background exists it usually must be measured with chemical analytical instruments that monitor the existing level, causing addition of the balance needed to bring it into line with health regulations.

The water is then ready for distribution to holding reservoirs in towers or on hill tops. This stage requires control of pumping according to the demand of the remote reservoir levels. Overall throughput of the plant is also recorded routinely.

Water supply schemes all follow this pattern. However, as the size of throughput increases and the inter-

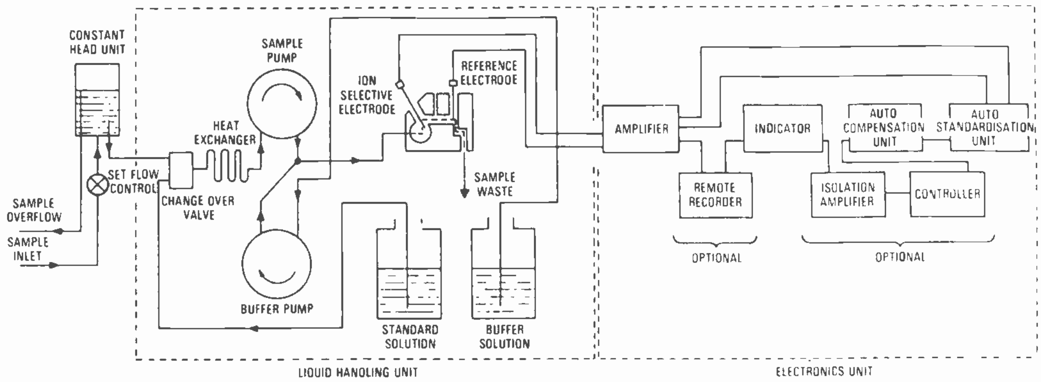


Fig. 6. Schematic flow diagram of console used to operate a chosen selective-ion probe under automatic conditions (EIL).

action between adjacent plants grows, it becomes necessary to introduce automated procedures. The first stage is to provide a central control centre where all variables and alarms are presented to the operator, who can then control the state of affairs without the need to walk all over the plant. The next stage of automation is to eliminate routine tasks from the operator's job by placing them under automatic control. Backwashing, distribution, chlorine predosing (that added at the input) and postdosing, and record-taking are examples.

Electronic Measurement Of Pollutant Levels

A number of different methods are commonly used in this field. Here we look at how ion-selective electrodes, galvanic cell, automatic titration and conductivity methods work

Ion-selective Electrodes: Operation of these uses basic principles, described as electro-chemistry. When electrons are transferred in a solution and ions occur, the solution is termed an electrolyte. Thus, combinations of such materials as metals and electrolytes produce electromotive force — emf.

If the electrolyte is known to possess only ions of specific classes, then electro-chemical methods can be used to measure the concentration of the substance of the ions as the signal level generated in millivolts. The pH electrode measures the level of hydrogen ions present — these decide the degree of acidity or alkalinity.

Specific-ion probes each comprise certain electro-chemical couples which are formed without flowing contact via a gas-permeable membrane. An SO_2 specific - ion probe uses a pH electrode to monitor the pH change produced by the magnitude of the partial pressure of the ammonia in the sample. It produces around 50 mV per decade change in SO_2 concentration. The response time of ion probes is slow — 10 minutes being required for low level detection.

The temperature and the general cleanliness of the sample entering the cell are vital for good performance, and ion-selective cells used in automated systems must be operated with great care. Figure 6 shows the schematic of a unit designed for continuous monitoring.

The reservoir levels have to be checked once a week and pump tubing is replaced at three-monthly intervals, otherwise such a unit is virtually maintenance-free.

Galvanic Cells For DO; The Mackereth cell, a cylindrical silver cathode surrounding a lead anode and using a polyethylene membrane filled with electrolyte, generates a current proportional to the partial pressure of oxygen in the test solution. As the output is temperature-sensitive, it must be corrected for solution temperature. Special techniques of use now enable maintenance-free service for as much as three-monthly intervals. The membrane is currently the key component and needs to be replaced regularly.

Automatic Titration: As the name implies the sampled solution has appropriate small metered quantities of chemical added. These will produce colour or turbidity changes, the magnitude of which is a measure of the concentration of such factors as alkalinity and hardness. The changes are then monitored by electronic sensors by methods which are more easily implemented with electronic principles.

Conductivity: The electrical resistance of a solution can provide a measure of the "purity". The method has little ability to discriminate between pollutants, but, nevertheless, has found wide use for monitoring such situations as acidity, saltiness, detergent strength, soda water manufacture and rinse water. Resistivities of solutions vary widely. The units are expressed in microsiemens per centimetre (which is 1 / Mohm per cm).

As the conductivity rises the cell plate and separation must be changed in order to produce usable signals.

Cell construction basically provides two well-insulated electrodes that contact the flow, producing two resistances that are coupled into a Wheatstone bridge for measurement.

Chemical analytical equipment is gradually incorporating more electronic procedures. There is still, however, much room for invention of methods that reduce the great amount of plumbing and cleaning needed today. It is worth remembering, however, that electronic methods were introduced into industry in the 1920-30 era, only fifty years ago!

Further Reading

"Water", by Jo Sowry, Priory Press, 1976, gives a general introduction to water supply.

"Water in England", by D. Hartley, Macdonald, 1964, provides fascinating reading about many aspects of water in historical times.

"Your Water Supply", National Water Council, London, is a useful booklet giving facts and figures and a bibliography. (The title is adapted from this.)

Much of the electronic information presented here was provided as the result of assistance given by Electronic Instruments, Ltd., EIL, of Chertsey, Surrey, England, and the staff of the municipal filtration plant of Armidale, N.S.W., Australia. ETI

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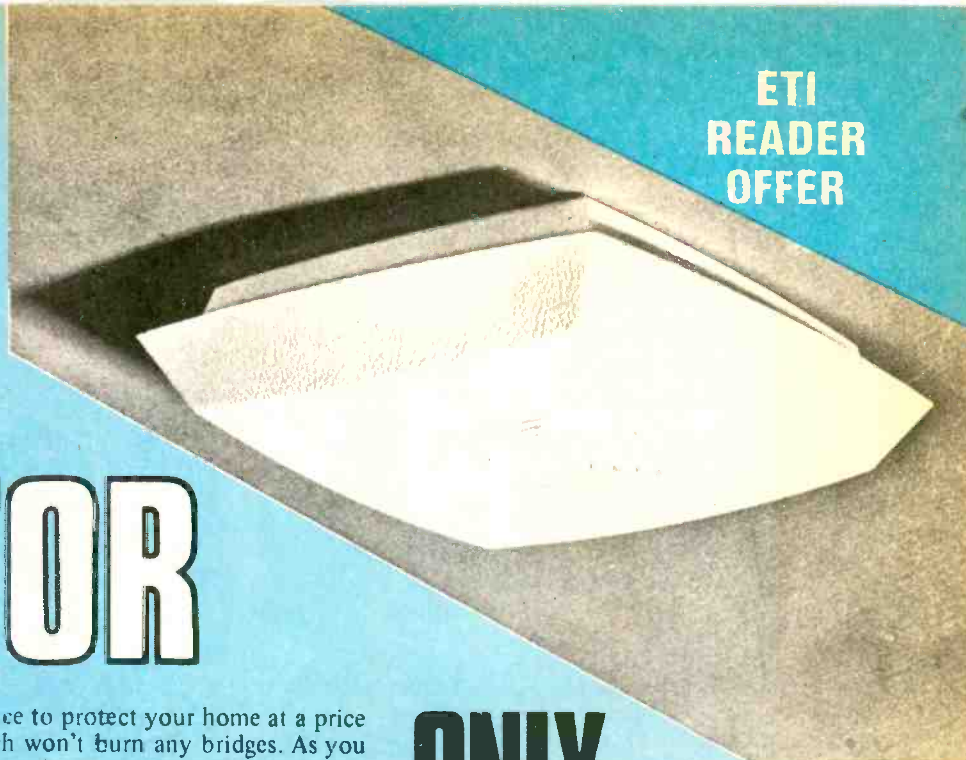

At the time of writing the firemans strike is still on. By the time you read this we sincerely hope it is over, whatever the political aspects of the dispute. One thing the strike has done is to focus peoples minds on the dangers of fire in the home.

Throughout large areas of North America smoke detectors are compulsory furniture in *all* new buildings, which is some measure of the impact these units have had over there. Here in Britain they are but starting to be recognised for their worth.

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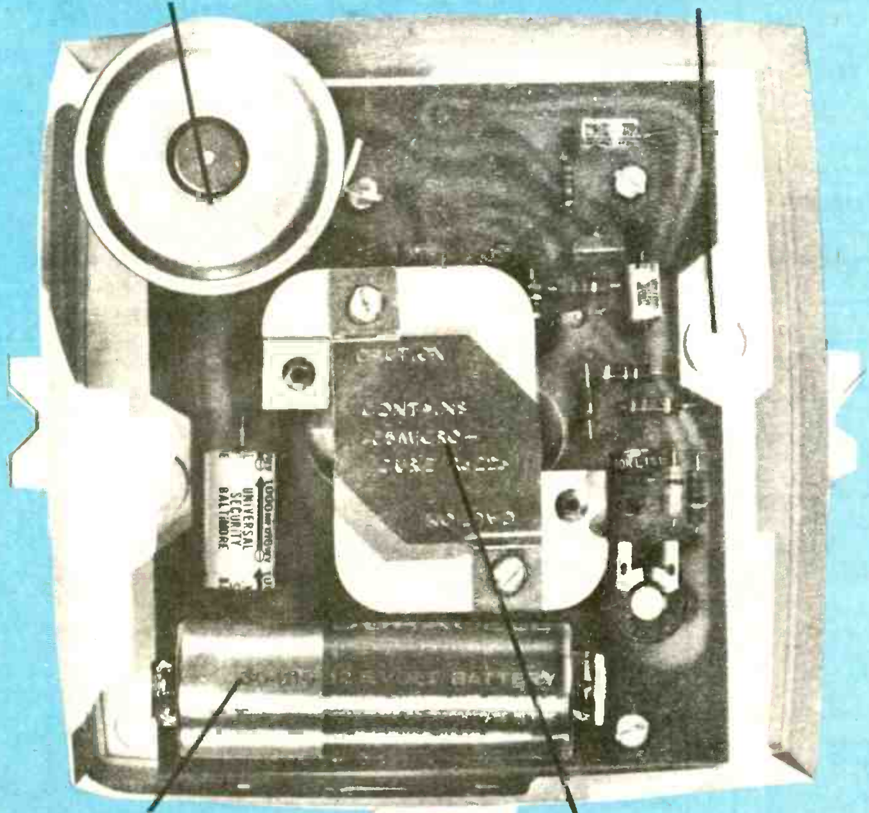

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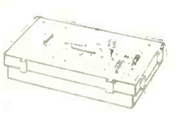

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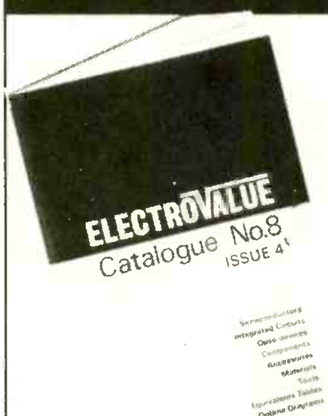

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CUTS CARD

Designed by John Miller-Kirkpatrick

THE SYSTEM 68 CUTS encoder/decoder PCB provides a home for the four ICs making up this circuit (see last month for circuit diagrams). The card also caters for the mounting of eight RAM ICs to provide expansion of the system memory by up to 4K. There is also space for memory decoding circuitry and an area for user breadboarding.

The assembly of the CUTS encoder/decoder is straightforward. Assemble all of the components according to the overlay shown in Fig 2 checking that all IC's are correctly orientated before soldering any of the pins.

The CUTS interface requires three signals from the UART—the 4800 Hz clock, SI and SO. These signals should be brought out from the TTY card via some of the uncommitted pins on that PCB. Note that the UART cannot drive both the TTY and CUTS encoders nor decode signals simultaneously. The UART PCB allows for two UARTs and both are required if TTY and CUTS interfaces are required.

Testing

Testing commences with the connection of +5 V and Ground supplies and the 4 800 Hz signal being input to connector pin 2. As the DATA INPUT pin is open circuit it will act as a logic 1 input to IC2/1, this should result in a 2 400 Hz signal, appearing at IC1/2s Q output. Similarly, if the DATA INPUT line is taken to ground then the output will be 1 200 Hz. At this stage the MIC and AUX outputs can be checked for 1 200 Hz or 2400 Hz approximate sinewave outputs at about 50 mV and 500 mV respectively.

Test Tape

At a later stage you will need a test tape to input to the decoder, this can be generated at this stage without the use of the UART or MPU. Connect the AUX (or MIC as appropriate) output to the input of your tape recorder, load a (preferably) new cassette and run about thirty seconds of tape without recording.

Leave the DATA INPUT open circuit or at logic 1 and start recording. If you can monitor the signal level at the recorder then the volume level should be set so that the signal on the tape is at a maximum without showing any signs of distortion. If your recorder is fitted with an AGC then this will handle this problem for you and the volume setting on RECORD can be ignored. In either case make a note of the volume setting used for future use, a couple of pointers cut from self adhesive paper can be used for showing best RECORD/PLAYBACK positions.

Leave the recorder recording 2 400 Hz for several minutes and then put DATA INPUT to logic 0 so that the recorder records 1 200 Hz for several minutes and then revert to 2 400 Hz. It is an idea to fill the whole of one side of a C60 cassette in this way with a note of the locations on the tape of 2 400, 1 200Hz or no tones, a tape counter is invaluable in a CUTS recorder.

The idea of filling one side of a cassette is that it can be left running whilst testing the decoder circuitry and thus a known input signal is available for thirty minutes at a time.

Cuts Decoder Testing

The decoder consists of two parts, the amplifier and the TTL decoder. To set up VR1 temporarily disconnect IC2/4 from the transistor and apply IC1/2 Q output to the input of IC2/4. With the DATA INPUT at logic 1 IC1/2 Q will produce 2400 Hz signals which are thus input at ICs 3/1 and 4/1. The B input at IC3/1 will trigger the monostable producing a variable width pulse, the width of which is controlled by VR1. Setting VR1 at midway will give output pulses of approximately the correct width. A DC voltmeter or dual-trace scope with the B input displayed on one trace and the Q output on the other trace, will make it possible to adjust VR1 more accurately with the logic 1, present at the UART's input, the Q output of IC3/1 should remain high (5V read from meter or as seen on the scope).

With DATA INPUT at logic 0 the Q output pulse width should be about 70% of the width of the 1 200 Hz pulses applied to the B input and thus will be at logic 1 for 70% of the pulse and logic 0 for 30% (3V5 read from meter or from scope's display). The Q output from IC4 should be at the same logic level as the DATA INPUT, this output is the DATA OUTPUT from CUTS card and is available at connector pin 3 for connection to the UART SI input.

Test Tape Again

The test tape can now be played into the EAR input of the card and the DATA OUTPUT signals checked, this should be the same as that originally used when recording the tape (ie only long periods of logic 1 or logic 0). The setting of the volume control on the recorder which gives the best results will vary from recorder to recorder and in some cases it may be necessary to vary the values of the components used in the amplifier part of the CUTS card to suit your recorder.

And AGAIN

Turn your cassette over and prepare to record on the other side. You will need your MPU and UART to generate this test tape. Write a simple program to output Hex '00's continuously to the UART (not forgetting to test the TBMT flag in the UART). When the program has been tested record thirty seconds of blank tape (get over the leader, etc)

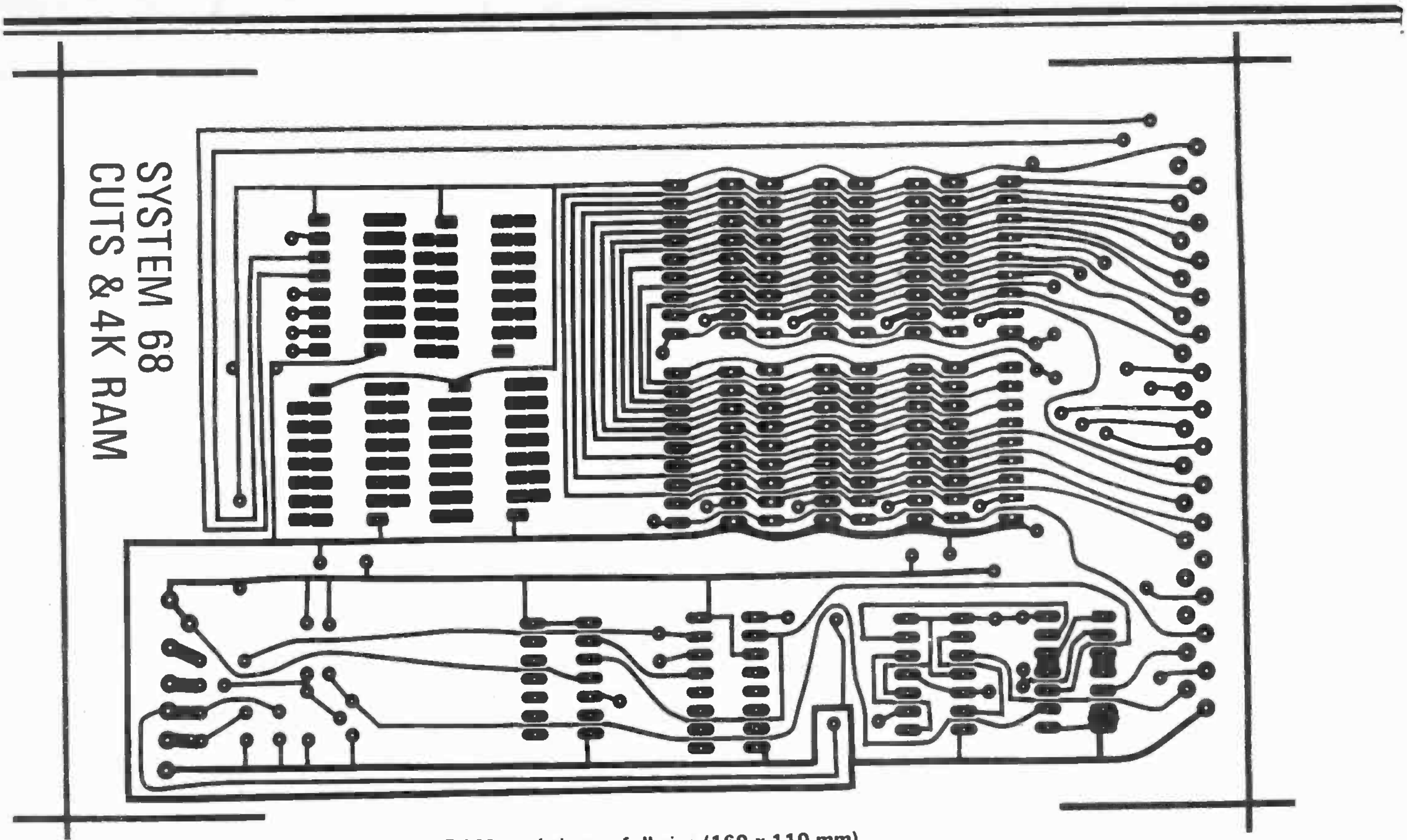

Fig. 1. Foil pattern for CUTS and RAM card shown full size (160 x 110 mm)

and then about thirty seconds of logic 1 before executing the program to output the Hex '00's for about five minutes. As the UART outputs logic 1 when not being used it is only necessary to set up the program, start the recorder, wait for thirty seconds and then press 'G' or whatever command starts execution.

Repeat the above exercise (thirty seconds blank tape, thirty seconds '1', data for five minutes) but using Hex 'FF' as the continuous data. This should follow the first exercise on this side of the tape, thus using about twelve minutes of tape so far. Again, make a note of the approximate location of each record on the cassette.

Repeat the exercise again but this time use a single byte in RAM or a spare accumulator and increment the value by one each time so that the output to the tape is a Hex '00' followed by '01', '02', . . . 'FF', '00', '01', etc. Thus all possible ASCII characters are output in sequence.

The fourth part of this side of the test tape can be used with a program to accept data from the keyboard and output it to the UART. Unless you can type at thirty characters per second the data on the tape will be 2 400 Hz for most of the time with character data occurring at about once per second (or however fast you can type). You have about ten to fifteen minutes of tape left to fill up with test messages, etc from the keyboard.

Each of these programs can be tested before outputting to the UART by using a UART output routine and temporarily replacing the call to this routine with a call to the VDU output routine. The first program should print '@', the second '?', the third the ASCII character set, and the fourth will repeat the keyboard entered characters.

As soon as you feel confident that the test tape is correct remove the 'FILE PROTECT' tabs so that you cannot accidentally overwrite the tape, the test tape may well come in useful in the future for calibration purposes.

And Finally

Before you file your test tape away it should be used to calibrate your present system. In theory all you have to do is to rewind the tape, set up your recorder and CUTS decoder for playback and then write a simple CUTS (or UART) to VDU program. This should allow you to playback the tape for half an hour whilst watching the VDU print lots of '@'s, '?'s, ASCII strings and messages.

NB. It is best not to stop the playback halfway through a record (noun, not verb) as with some machines the tape could be damaged with spikes, wait for an inter-record gap of 2 400 Hz or no tone before stopping the machine.

Four down, twelve to go . . .

With only four ICs and not many discretes making up the CUTS unit we decided to use up the spare space on the PCB as usefully as possible. Whereas most people who are building System 68 will probably have most, if not all, of the PCBs published so far in their system, now is the time that individuality will take over and each system will be modified as the user requires. If you have modifications to make you may be interested in a VERO DIL card which takes several ICs from eight pin to forty pin types and has been used several times in making the first prototypes of the PCBs used in this series, the card takes the standard 31 way connector.

For simple additional hardware circuits the CUTS card has half of ICs 3 and 4 unused plus IC locations at IC13, IC15 and IC16. These can be used for any 14 or 16 pin ICs to generate simple hardware add-ons, an example might be a STOP/START control for your recorder.

The IC location at IC14 has been laid out to take a 74LS139, half of which is again unused and could be

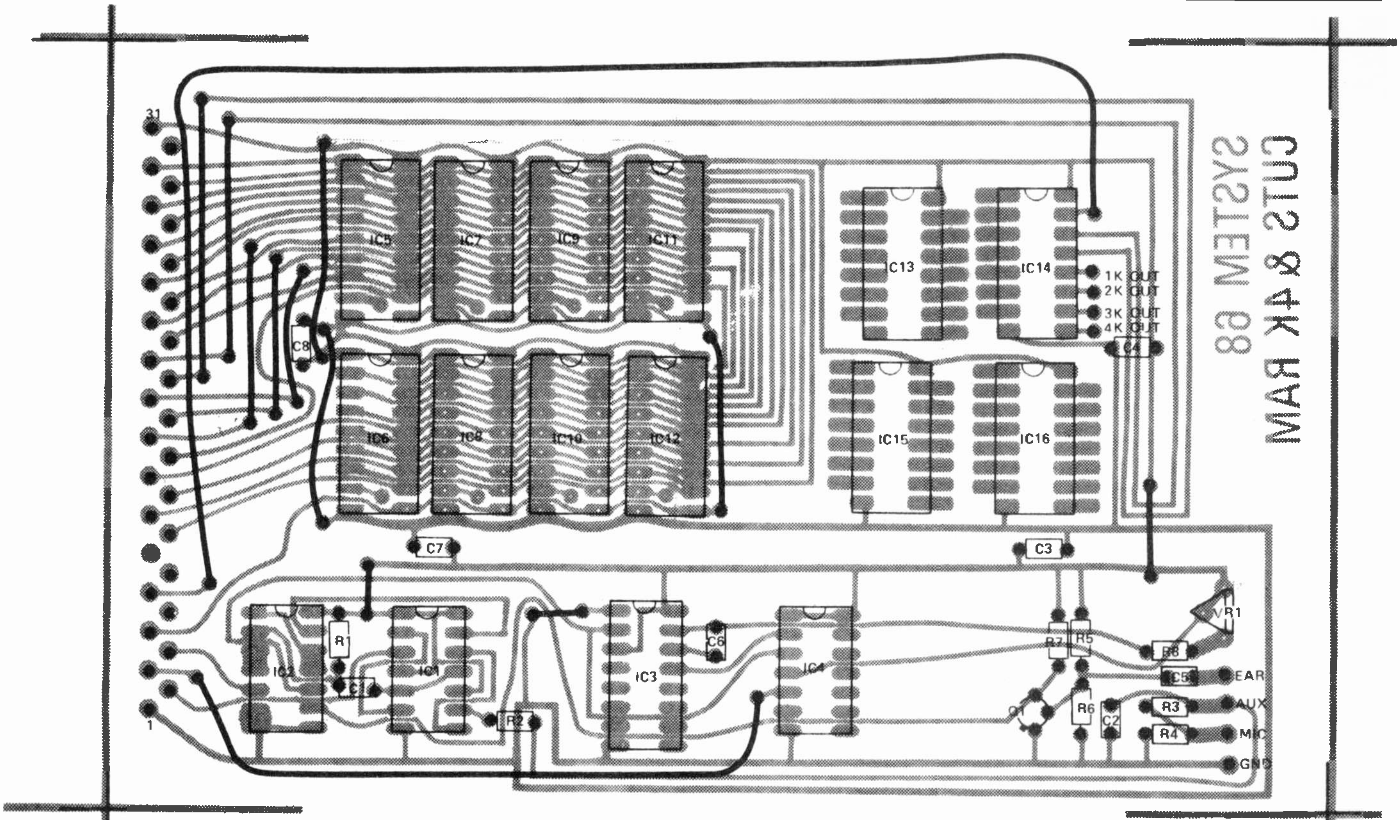

Fig. 2. Overlay for CUTS and RAM card.

used with the other IC locations for prototyping. The other half of IC14 is intended to act as a device address decoder to split up a 4K page or block of addresses into 4 x 1K blocks, these outputs could be used to activate external devices such as a STOP/START flip-flop, relay, etc. but are intended to enable the RAM chips at locations IC5-IC12.

Minus another four leaves eight.

The last eight IC locations IC5-12 are intended to allow expansion of up to 4K bytes of static RAM. Pin 8 of the 31 way connector will accept an enable signal from the MPU card or elsewhere for a RAM ENABLE strobe. The MPU card has a RAM output which can be used to drive 1K of RAM, if a 4K RAM enable is required it will have to be decoded from the upper 4 address bits (A12-A15) externally. In the present layout this 4K enable is used to enable half of the 74LS139 which is additionally addressed by A10 and A11 to give one of four output enables. As an example let us assume that we wish to use address bit 12 as a system expander. With the EXTERNAL ENABLE pin of the MPU card connected to ground or to VMA. 02 then all address accesses will be decoded by the MPU card with the upper 4 address bit being ignored, thus we are able to references X' Exxx' X'Axxx', X'8xxx are to the same location. We effectively ignore the first character of any address. When we add our 4K RAM ENABLE we want it to access a unit not on the MPU card and not already decoded. One way to do this (but not necessarily the best) is to use the lowest of the unused address bus, A12. If A12 is buffered and inverted to give tlo enable strobes one of which is low when A12 is low (call it EVEN) and the other of which is low when A12 is high (ODD), we now have one enable for whenever an even 'senior' address is selected (X'0xxx', X'Exxx', X'Axxx' etc) and another for whenever an odd 'senior' address is selected (X'1xxx', X'3xxx', etc).

If we feed EVEN back as the MPU card enable then the only oddball is the UARTs at X'7xxx' which could become X'8xxx' without much software changes. If we then use ODD to enable a 4K RAM then valid addresses for this RAM would be X'1xxx', X'xxx', etc.

The correct way to decode these 4K blocks is to use a 7442 or 7 4154 type of device fed with the upper 4 address bits and thus producing 8 or 16 4K enable strobes. Some of these strobes are ANDed to give the MPU card enable, others can be used to drive external

PARTS LIST

RESISTORS

R1	47k
R2,5	100k
R3,6,7	10k
R4	1k
R8	3k3

POTENTIOMETERS

VR1	10k min. vert.

CAPACITORS

C1	1n
C2	4n7
C3,4,7,8	100n
C5	47n
C6	200n

SEMICONDUCTORS

Q1	BC109
IC1	74C74
IC2	74C02
IC3	74123
IC4	74C74
IC5–16	see text

MISCELLANEOUS

PCB as pattern, IC sockets as required.

NOTE: Capacitors C3,4,7 and 8, not shown on circuit diagram, are for de-coupling purposes. C5, not referred to on circuit diagram, couples the output of the recorder to the base of Q1.

memory blocks. Using this method it would be possible to have a 4K ROM card enabled at X'Exxx', 4K RAMS at X'Fxxx, X'Oxxx and X'1xxx', peripheral hardware such as printer or Floppy at X'Cxxx' and X'Dxxx' and the MPU card at all other locations.

The idea of putting 4K ram on the CUTS PCB is that if you are using CUTS then you will need some RAM to read your blocks of data or programs into or out of, as your system becomes more sophisticated so you will probably want more RAM and thus better tape facilities and thus a second recorder. When you get to the stage of the third and fourth recorders, you willl need another CUTS card, more RAM, etc, etc.

The PCB is laid out to take the new industry standard 2114 type of 1K x 4 static RAM chip. Two of these chips will give 1K bytes of RAM, and thus eight chips will give 4K bytes, the alternative is to use 2112 (256 x 4) or 2102 (1K x 1) chips but this solution requires thirty-two RAM chips plus decoding chips and it is a little difficult to lay out a Eurocard to take forty-odd pin packages — not impossible, just eye-popping.

The 2114 is packaged in an eighteen pin package with a layout which is very similar to that of the 2112 inasmuch as the address lines and data lines are in the same pin locations. The IC locations on the CUTS card could be easily modified to take eight 2112s in place of eight 2114s.

At present these chips are very new and very expensive at about £45 per 1K bytes compared with about £25 per K using 2112s, similarly, the availability of these chips is at present unpredictable. Within the next two to three months we should see a drop in prices and easier availability thus making the memory part of the CUTS card a useful expander card.

As the 2114 is a 1K x 4 device they must be mounted in pairs to give 8 bit byte storage. On the CUTS card the pairs are ICs 5 & 6, 7 & 8, 9 & 10, and 11 & 12. Under each of the IC locations is a connecting pad, each pad must be connected to its pair and also to one of the enable outputs of IC 14. Apart from these connections all of the other pins are already connected to the appropriate pins on the 31 way connector, plug in the 2114s and you're ready to run.

System 68 So Far . . .

The system we have presented as SYSTEM 68 contains some of the most advanced ideas and technology available as most of you who have built it will know because of component availability of some of the very new devices. At the time of writing there is not any commercial equipment of this type on the market using the DM8678 character generator, the 81LS series buffers, the 2114 RAMs and other devices which appear in SYSTEM 68.

The System was designed with cost and simplicity as major factors with suitability of both hardware and software expebdability and interchangeability also high in priority. The system so far has an attractive case and efficient power supply to cover more than most requirements. The 64 x 16 VDU interface outputs a video signal suitable for interfacing to any commercial monochrome portable TV (see 'Electronics Tomorrow' Special). The ASCII keyboard inputs to the VDU interface card and thus onto the main MPU bus connectors. The 6800 CPU card contains space for 256 bytes of RAM and 1K bytes of PROM which can contain the ETIBUG plus additional firmware monitor programs. The serial interfaces allow use of two TTY type devices with separate baud rate control, typical serial devices might be a printed and a cassette recorder using the CUTS interface described above. There is still enough room in the case and capacity in the power supply for about four more Eurocards and it would be a simple matter to extend the system into a second case or onto a S100 or other bus structure.

Exchangability

System 68 is not limited to the 6800 MPU, there are already two SC/MP MPU cards which are suitable but as one of them came from another magazine perhaps we should not mention it except to point out that the 100 x 160mm card and connector is supported by other MPUs.

We heard of someone doing a Z80 based System 68 and we expect to see a 6502 based System 68 around soon. Thus there is the ability to change from one MPU to another in a matter of seconds.

Software

Obviously with a system capable of supporting several MPU types software support is a nightmare from the magazines point of view. We have ETIBUG which is a simple VDU based version of MIKBUG and ETIBUG2 (next month) which can be added to ETIBUG to increase the facilities available. As an example of software exchange, ETIBUG2 is based on software commands which were found to be useful on other systems and were translated and modified for the 6800. ETIBUG was based on MIKBUG as supplied with most MOTOROLA based systems, ETIBUG does an automatic check for the presence of an ETIBUG2 chip and thus as a result of thoughtful software the ETIBUG2 PROM could be used with very little change by MIKBUG users.

Some of the BASIC compilers available are also based on the MIKBUG ROM and thus it should be possible to modify one of these compilers to run on ETIBUG with System 68. If any System 68 users evolve such a program or if you have any ideas on the subject please write to me at ETI.

NEXT MONTH ETIBUG2 which includes the software associated with the TTY and CUTS I/O cards.

ETI

Corrections

1 VDU A. In some cases the master oscillator (ICl) output does not have the ability to drive two TTL loads (IC2 and the character generator). This results in 'dots' in place of '?' on the screen. The output of IC1 can be buffered by using the spare 7408 gate on the board.

2. CPU. The clock phases on the PCB are reversed. Also, for correct operation two 22R resistors should be placed in the line between the driver and the MPU. The resistors can be used to exchange the clock phases at the MPU by breaking the PCB tracks to pins 3 and 37 and swapping the connections using the resistors.

3. CPU. The NRDS signal causes the data input buffer to be enabled at the same time as the oncard PROM or RAM. Two cures are possible — a, the driver can be removed and the MPU pins connected to the connector by inserting wire links into the sockets, this solution is only suitable for a 'minimum' System.

b. By disabling the NRDS signal during a PROM or RAM access. This can be achieved by modifying IC5b. The condition we require is that VMA.02 must be low, the enables to both RAM and PROM must be high and R/W must be high. If the spare gate on the driver chip is used to NAND the RAM enable and R/W signals we get a low output only when both inputs are high. If we use this output and the PROM enable signal as inputs to IC5b with VMA.02 as enable then output Y2 will be a valid NRDS signal to external devices and to the data input buffer. The R/W signal can be used direct to most memory devices as internal decoding will take place inside the device. All of this assumes that the external enable input is connected to VMA.02., if external decoding is done then the fact that this enable should only be valid during VMA.02 time should be taken into consideration, if a 7442 type of decoder is used as a 4K decoder then its D input should be VMA.02.

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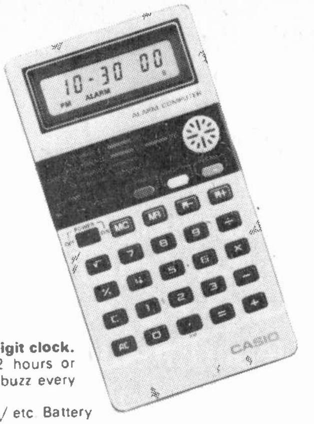

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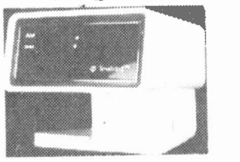

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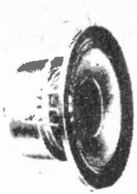

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7416 40p	7451 18p	74128 82p	74184 260p
7417 40p	7453 18p	74132 81p	74185 190p
7420 18p	7454 18p	74136 81p	74186 990p
7421 43p	7460 18p	74141 85p	74190 160p
7422 28p	7470 36p	74142 300p	74191 160p
7423 36p	7472 32p	74145 95p	74192 160p
7425 33p	7473 36p	74147 205p	74193 160p
7426 43p	7474 37p	74148 160p	74194 160p
7427 40p	7475 48p	74150 130p	74195 110p
7428 40p	7476 37p	74151 61p	74196 130p
	7480 54p	74153 81p	74197 130p
	7481 108p	74154 160p	74198 270p
	7482 90p	74155 97p	74199 216p
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BC108/8 10p	BF244B 34p	OC71 35p		2N3706/7 14p	40595 97p
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BC169C 15p	BFR40/1 34p	TIP31A 56p		2N3903/4 22p	
BC172 11p	BFR79 34p	TIP31C 68p		2N3905/6 22p	
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BC213 12p	BFX88 30p	TIP35C 290p		2N5179 75p	
BC214 16p	BFY50 22p	TIP36A 297p		2N5245 40p	
BC461 40p	BFY51 22p	TIP36C 360p		2N5296 58p	
BC478 32p	BFY52 22p	TIP41A 70p		2N5401 62p	
BCY70 20p	BFY90 90p	TIP41C 84p		2N5457/8 40p	
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4A	100V	90p
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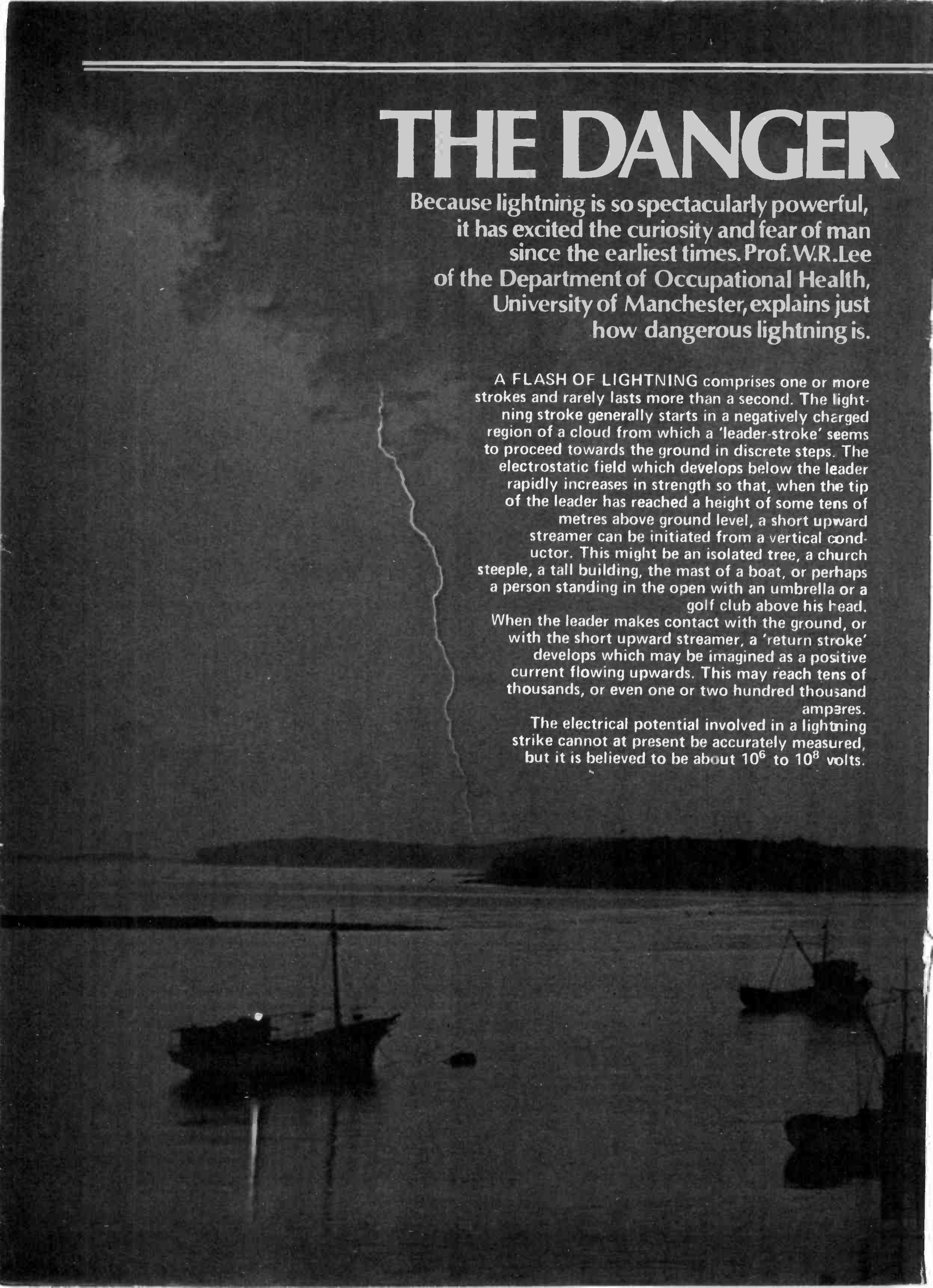


THE DANGER

Because lightning is so spectacularly powerful, it has excited the curiosity and fear of man since the earliest times. Prof. W.R. Lee of the Department of Occupational Health, University of Manchester, explains just how dangerous lightning is.

A FLASH OF LIGHTNING comprises one or more strokes and rarely lasts more than a second. The lightning stroke generally starts in a negatively charged region of a cloud from which a 'leader-stroke' seems to proceed towards the ground in discrete steps. The electrostatic field which develops below the leader rapidly increases in strength so that, when the tip of the leader has reached a height of some tens of metres above ground level, a short upward streamer can be initiated from a vertical conductor. This might be an isolated tree, a church steeple, a tall building, the mast of a boat, or perhaps a person standing in the open with an umbrella or a golf club above his head.

When the leader makes contact with the ground, or with the short upward streamer, a 'return stroke' develops which may be imagined as a positive current flowing upwards. This may reach tens of thousands, or even one or two hundred thousand amperes.

The electrical potential involved in a lightning strike cannot at present be accurately measured, but it is believed to be about 10^6 to 10^8 volts.

OF LIGHTNING

Whatever the actual voltage, a lightning stroke can immediately puncture the skin of a victim.

More is known about the characteristics of the lightning current, at least at the point of strike. This is fortunate for physiological responses depend on the current rather than the applied voltage. Characteristic waveshapes of lightning current are unidirectional with a fast rising front and a slower tail usually lasting several tens of microseconds.

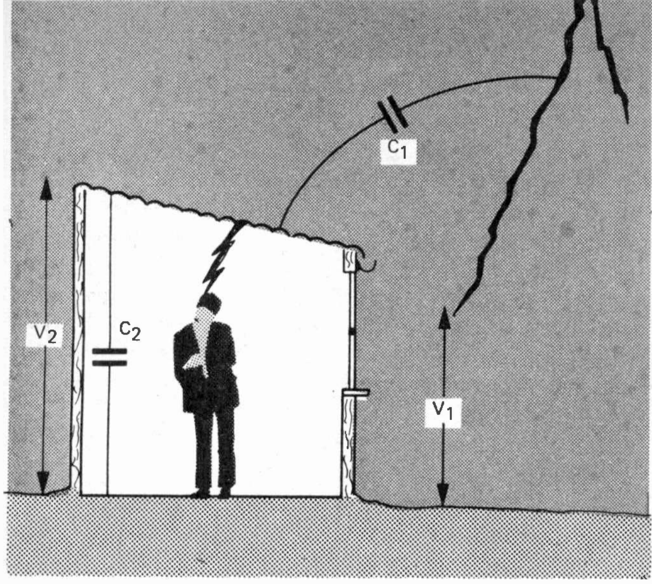
In mountainous regions conditions may be different. The bottom of a thundercloud may lie only a short distance above conducting objects, such as human beings from whom arise, as point or brush discharge, currents of several micro-amperes. These may be felt as a slight tingling, perhaps raising the hair on a bared head. At night they may appear as a luminous glow. In the past this glow, appearing at the tops of ships' masts during stormy conditions, was called St. Elmo's fire — after the patron saint of Mediterranean sailors. Such point discharges can develop into an upward-directed leader stroke which may last several tenths of a second and involve a current of some hundreds of amperes.

Four Types

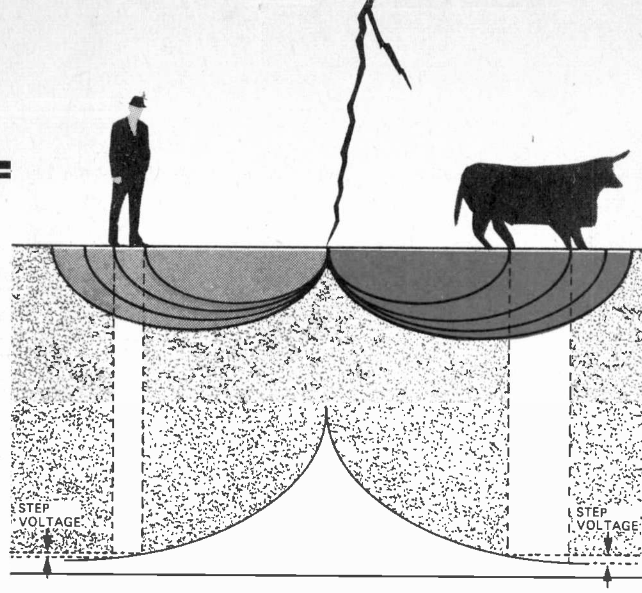
When accidents are considered, lightning strokes may be grouped in four types. A direct stroke occurs when the person or something he is holding is struck. The lightning current enters the head or upper part of the trunk, passing through the body and into the ground through the feet. If several persons are standing close together more than one may be struck.

It has been calculated that the current rises rapidly to a peak of 1 000 A (amperes), immediately falling so that about 10 microseconds from the start it reaches 4 A and remains at that value for the duration of the strike. The occurrence of an external flashover is confirmed by ample evidence from accident reports. If it occurs outside the body and through or outside the clothing, the hair and beard may be singed, there may be burn marks on the soles of the feet and burn marks are found on the clothes, which may catch fire. Metals carried on the body may melt, causing burns. If the flashover is between the body and the clothing, current flowing over the body surface may convert the sweat and skin moisture into steam so that the resulting pressure causes clothes or boots to be torn off.

The second type of lightning stroke is the side flash. This is most clearly understood by considering what happens when someone is sheltering under a tree that is struck. Standing on the ground he is initially at earth potential. However, as the lightning current discharged down the tree trunk increases, the voltage drop down the lower part of the trunk, which might have a resistance of a few kilohms, may become greater than the electrical breakdown strength of the air gap between the trunk and the person. A side flash then occurs through the victim.



Side flash from a corrugated iron roof insulated from earth by a dry wooden structure. When a lightning stroke develops nearby, the effect of the electrical capacitances represented by C_1 and C_2 is to raise the roof to a potential V_2, with respect to earth, equal to $V_1C_1/(C_1\text{-}C_2)$. The potential difference between the roof and the head of the occupant of the shed can become high enough to cause a flashover without the shed being struck.



Regular pattern (a) of current in uniformly constituted soil, set up by a direct lightning strike to open ground. The potential distribution curve (b) shows how a 'step' voltage develops between the legs of humans or animals standing nearby.

There is more than one report of persons struck while cycling past a tree. One victim who was unconscious for 15 minutes, and did not need resuscitation, subsequently recalled a 'blow' and that he saw 'fire' coming to him from the tree and that the handlebars of his bicycle 'became electric'. He sustained no burn marks. Quite a number of accidents are on record of death or injury occurring in persons sheltering in a tent, and the descriptions of the circumstances and of the injuries strongly suggest side flashes from the tent pole or perhaps from the wet fabric.

One of the most dramatic and serious accidents involving side flashes in recent times occurred in the Japanese Alps in 1967. A party of forty-one schoolchildren with five teachers was overtaken by a sudden thunderstorm when they were strung out along a steep ridge immediately below a mountain peak 1 660 metres above sea level. Lightning killed eleven of the boys instantly and most of the remainder were temporarily paralysed, burned or blinded.

The third type of lightning stroke is the step voltage. If lightning strikes open ground, either directly or through a tall object such as a tree or post, the current is discharged into the mass of the earth. On non-uniform ground the current distribution produces differing voltages according to the distance from the site of the strike. A person, or animal, walking along a radius from the site of the strike will be subject to a potential difference between the legs. It will be seen later that quadrupeds are more likely than humans to die from this because the current, flowing between the forelegs and hindlegs, traverses the heart, whereas in the human the pathway is from leg to leg and the heart escapes. When a church in France was struck during a service all the persons standing on the damp flagstones in the nave fell and could not get up for several minutes, as though their lower limbs were paralysed. But people standing in the oak choir stalls at the sides were spared, clearly because they were insulated from the ground.

The fourth type of stroke is the contact voltage, sometimes called a touch potential. It may be regarded as a particular instance of the side flash, in which the victim is actually making contact at the time of the lightning stroke. A case history from Russia about ten years ago gives a clear account of such an accident.

Two women were sheltering under a tall spruce tree which was struck during a thunderstorm. One of them, who was killed, stood with her back against the tree. Her clothing was not damaged but at the back of her head, on the right hand side, the hair was singed and ash grey in colour over an area 40 mm by 40 mm. In the centre of this the skin damage was like a small abrasion. On the tree trunk there was a longitudinal strip of damage to the bark about 40 to 60 mm wide starting near the top of the tree and stopping about 1.58 m from the ground, that is, on a level with the height of the victim. The other woman was holding on to the tree with her right hand. She lost consciousness for about 10 to 15 minutes and was unable to move or to feel her lower limbs for about two to three hours. She sustained some burning of the body down to the foot, but was discharged from hospital after two days and resumed work after ten days.

An intriguing theoretical study has concluded that anyone touching a lightning conductor when it is struck would not risk death because the current discharged through the body would be too weak. This is not an invitation to test the hypothesis by personal experiment!

How does lightning current produce death? Our knowledge comes from three main sources. Firstly, since the end of the last century, there has been a steady increase in our knowledge of how direct and alternating currents at mains frequency cause death. This is based, in a large part, on animal experiments. Secondly, there have been a few studies of the effects of impulse currents on animals. Thirdly, we have accounts of accidents ranging in quality from the anecdotal to the investigation which is fully and carefully documented from both the electrical and medical viewpoints. However, the accounts suffer from two main drawbacks. The obvious one is the absence of any quantitative electrical data and the other is that it is often difficult after an electrical accident to determine exactly why someone died.

Pathway

Lightning may be considered to produce direct effects in one of three ways: its action on the heart and respiration, and by heat. There are other indirect effects such as injuries from falls but they are not peculiar to lightning. For currents greater than a few milliamperes, the body behaves as a structureless gel or, for the electrical engineer, as a volume conductor. There is no 'preferred' pathway along which the current flows. It is believed that the body resistance along the path taken by the current in most direct lightning strokes, many side flashes and many contact voltage accidents, is about 500 to 1 000 ohms, possibly falling to the first value after the skin has been punctured. Generally, the effects are produced by direct action on the organs concerned, so it is important to trace the current's pathway through the body.

Careful examination of burn marks usually provides information on the points of entry and exit. Sometimes these may be surprisingly small. The lightning return stroke has a central core with a diameter of a centimetre or so, which may reach a temperature of about 30 000° K, but only for the first tens of microseconds. This may save a person from extensive burning, although small metal objects on the clothing may melt. Because the skin has the highest resistance to the current, heat tends to be developed there, often causing relatively small skin burns. But if the lightning current has a long 'tail' it may have a value of several hundred amperes during that period. This so-called 'hot' lightning can cause more severe burning of the body and clothing. Examination of victims frequently reveals 'tree-like' or aborescent markings that are not true burns. They disappear after a few hours.

Lightning current causes death by affecting either the heart or the nervous mechanism controlling respiration. The heart has two main pumping chambers — one to pump blood around the body and the other to pump it through the lungs. The thick walls of these ventricles consist almost entirely of muscle, and the simultaneous contraction of all the individual muscle fibres provides the necessary pumping pressure. An electrical current passing through the heart may disturb the concerted action of the fibres so that they contract individually and fail to establish enough pressure. When seen in this state the ventricles, instead of showing forceful regular contractions, are flaccid, with irregular twitchings (fibrillation) of the individual fibres.

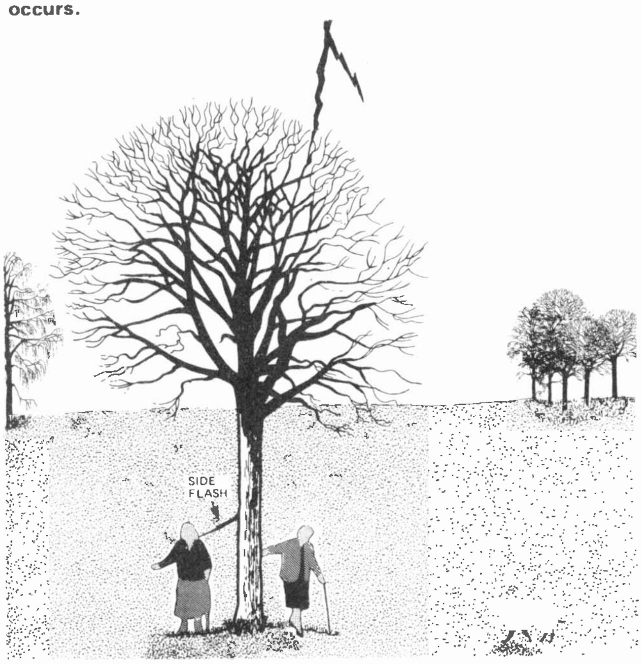
Relationships

Nearly all the investigations to establish the relationships between some electrical factor and time have been carried out using alternating current at mains frequency. The shortest duration studied in such investigations is about eight milliseconds, corresponding to a half wave at 60 Hz. This approaches that of a lightning current with a long tail.

A number of relationships have been suggested. They all accept that current, or a derivative, is important. One of the most widely published relationships suggests that within certain time limits the ventricular fibrillation threshold depends on energy. Another suggestion is that it depends on charge. One theory is that the threshold is a function simply of current but that there are in fact two thresholds, one when the current lasts for less than a heart cycle and another, much lower, if it is more (about 400 to 1 000 milliseconds).

Lightning currents do not last longer than a heart cycle. However, an electrical current will cause fibrillation only if it falls at a certain time in the cycle, the 'T' wave, which occupies about 20 to 25 per cent of the full cycle. Once fibrillation has become established, blood circulation ceases and death follows. Finally, it has recently been stated that in many victims of lightning stroke the heart simply stops altogether — ventricular asystole. First-aid treatment for both is the same.

Side flash from a tree struck by lightning. At first the current flows through the trunk. The electrical resistance of the trunk, between ground and a point level with the head of anyone standing nearby, may be a few kilohms. Build-up of current through it may cause the potential drop across the lower part of the trunk to exceed the electrical break-down strength of the air between the trunk and the victim. At that stage a side flash occurs.



Nervous System

The centre for the control of respiration by the nervous system is in the lower part of the brain. There is strong evidence that the current has to go through it to stop respiration. Indeed, in so-called electric shock treatment for certain mental disorders it is extremely uncommon for respiration to remain stopped once the current has ceased to flow. There are a number of carefully reported cases in which high voltage or lightning currents passing through the respiratory centre have caused breathing to stop. Some victims have responded to prompt artificial respiration. A current pathway through the head and trunk seems to be more common in lightning than in electric shock accidents.

Using our knowledge of how death is caused by lightning, we can attempt to establish a rational basis for first aid. Simply stated, the victim's breathing or circulation — or both — might have stopped. No first-aid manoeuvre is likely to start either again, though fortunately respiration often starts spontaneously after an interval of anything from a few seconds to several hours. Obviously, except in cases of very short arrest, it is necessary to provide artificial respiration, by first-aid and later perhaps in hospital, until breathing starts again. First-aid treatment for arrested circulation is, according to many authorities, not without serious dangers and should not be lightly undertaken. It would be prudent to learn from national first-aid organizations how these conditions may be diagnosed and treated.

Several simple precautions would reduce lightning accidents. An upright person acts like a lightning conductor and thus attracts a lightning strike over a distance which, as a first approximation, is proportional to the square of his height above the ground. It is, therefore, much safer to squat down than to stand up or, worse still, to stand on the top of a vehicle or structure. To increase one's effective height by carrying an umbrella or golf clubs, held upright, is foolish: better to get wet than killed. The risk of side flashes can be minimized by keeping at a distance of a few metres from other people when in a group, by *not* standing near the trunk of an isolated tree and by keeping away from large metallic objects both indoors and outdoors. Tents can be readily protected but it is a wise precaution to keep the greatest possible distance away from the tent pole or the wet fabric.

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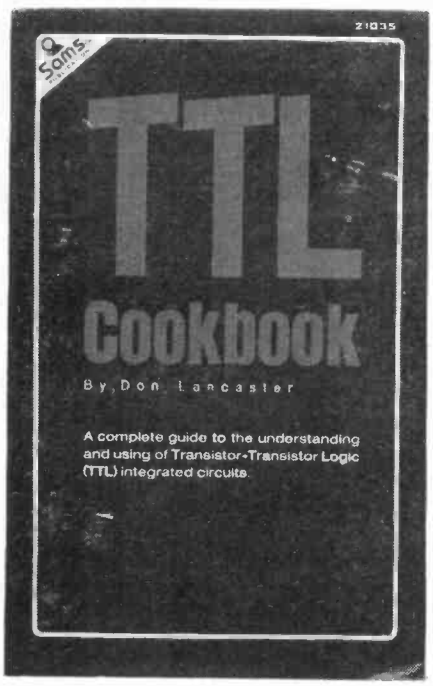

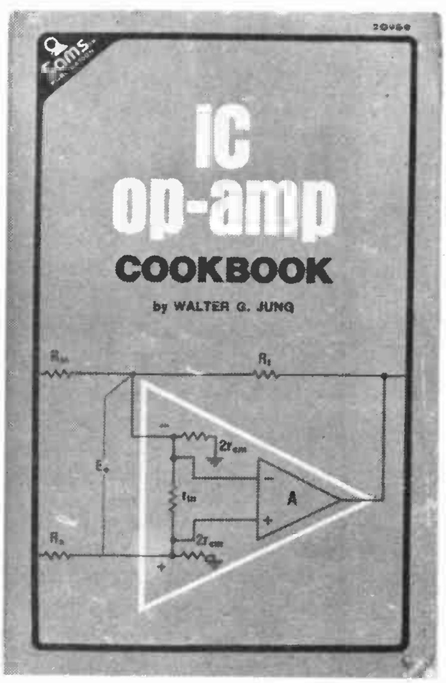

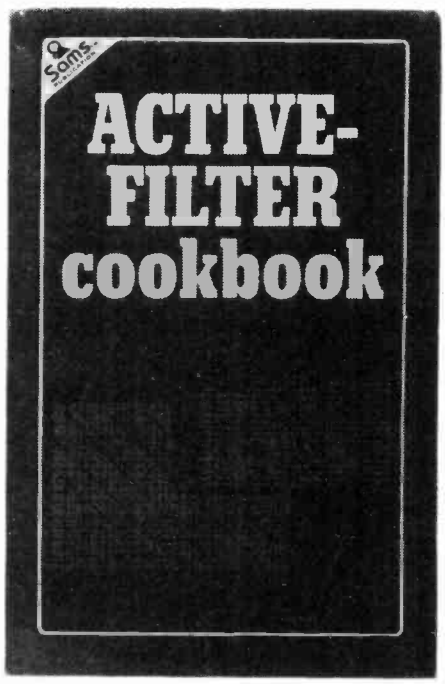

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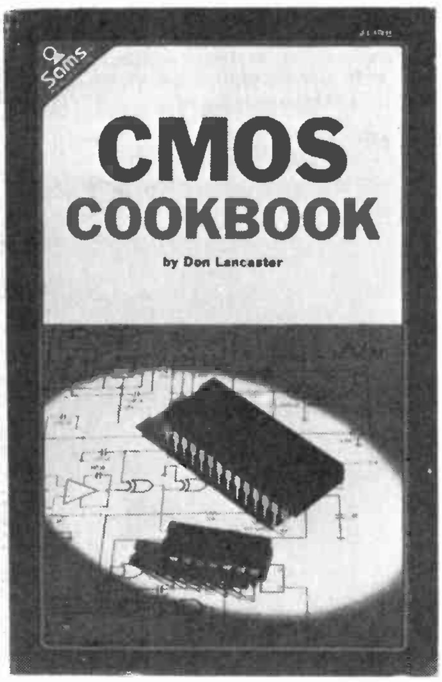
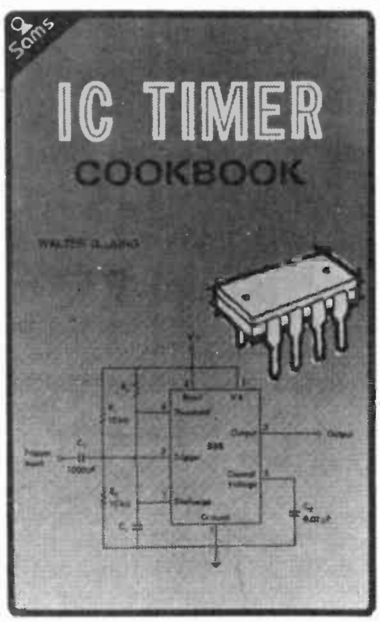
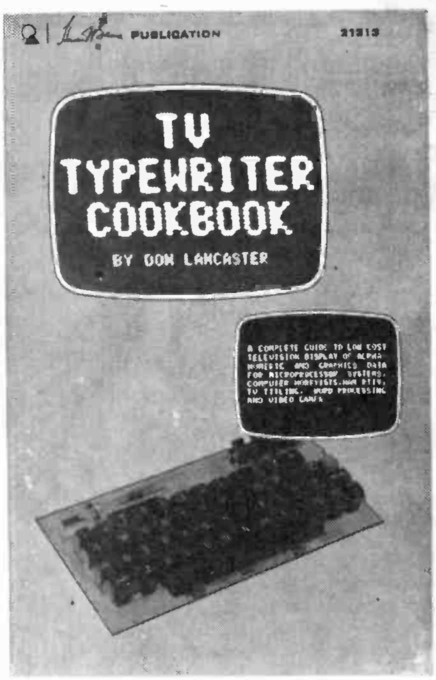






What to look for in the March issue: On sale February 3rd

OVERCOMING FEEDBACK

Frequency Shifter: Wanna hear a howler? You don't really, and neither does anyone else. Howlround, feedback or whatever you call it is the gremlin most likely to in any PA System. Next month we are presenting a project to overcome the problem once and for all. By shifting upwards in frequency (by 5Hz) everything presented to it, our suppressor allows extra gain to be applied, cleans up sounds and generally makes life that much nicer.

MODEL CONTROL

White line Follower: Well it's like this. There's this member of our staff who enjoys models of a type other than female, and can be very vociferous (i.e. loud) in making a point. He gently reminded us all that we have never done a project for the model constructor, and further discussion led to a circuit which bequiles a model car, tank, train or whatever into following a simple white line wherever it leads. Sounds interesting? It is! Can be easily adapted to fit any suitably sized vehicle, with the emphasis on ease of construction and flexibility.

VCT4U2

VCT UPDATE: We brought you the news of its existence first, and now we take a longer look at how this revolutionary device does what it does — and why VCT is all set to start making news in a big way. So make sure you don't get left behind.

REMEMBER REMEMBER

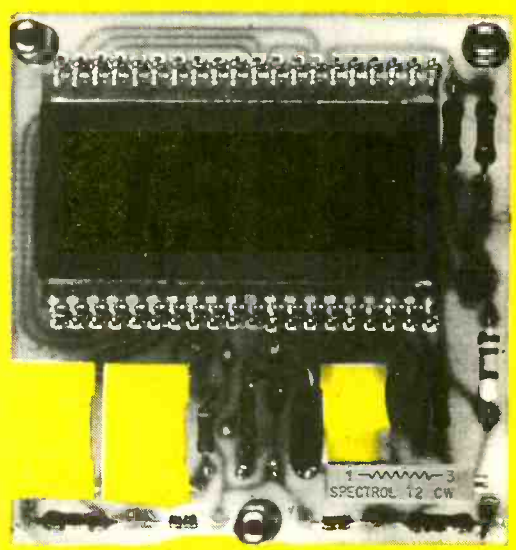
MEMORIES: A Data Sheet Special which will prove invaluable to all those involved in storing a bit on the side now and then. Find out whats available, and what it'll do. Memories are definitely made of this.

ELECTRONICS AND THE AUTOMOBILE

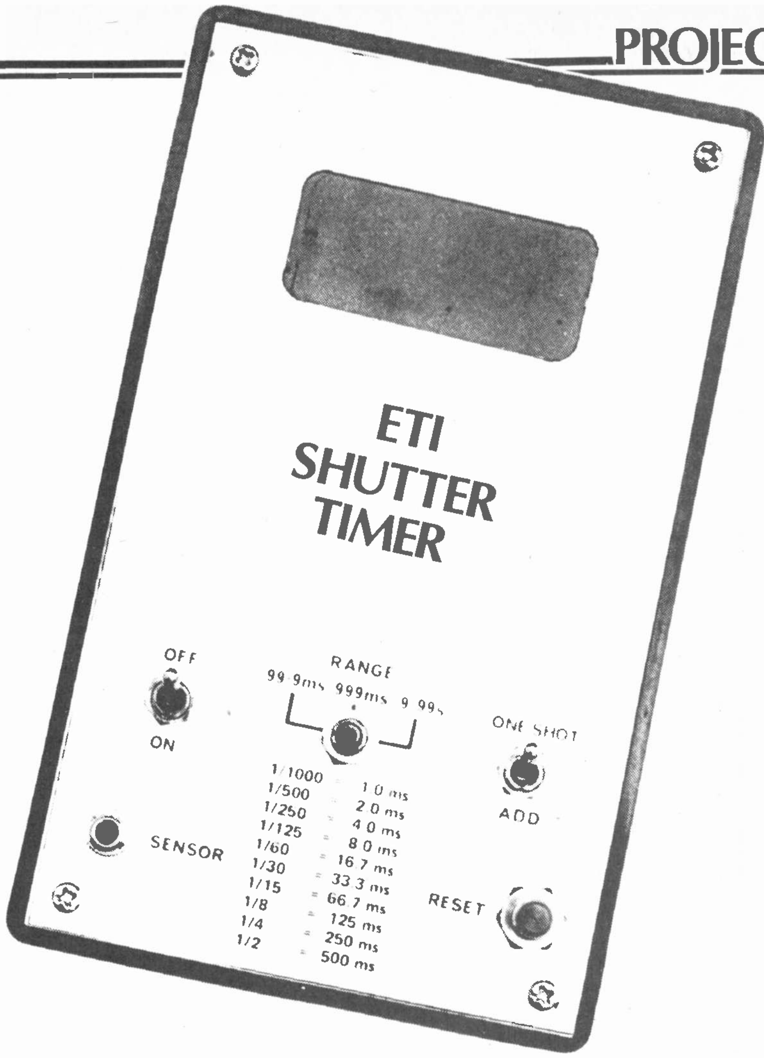
AUTO ELECTRONICS: The electron and the internal combustion engine may not sound a good pairing, but it's definitely a developing relationship with electronics encroaching ever further into the family saloon, and having a meaningful relationship with the fastback! Next month Dr Sydenham spares us no detail in the full story of just how far things have gone . . . wheels within wheels. . . .

LCD METER MODULE

Panel Meter: LED displays are becoming almost compulsory in equipment these days, everything from ovens to overload indicators. Whisper it quietly though, their days are numbered! LCD has always the edge with its low power consumption, and greater legibility, and next month ETI goes LCD with our 3½ digit panel meter. Don't be mis-LED into missing it."



SHUTTER SPEED TIMER



A project from the amateur photographer from ETIs project team to enable accurate checking of the mechanical bits!

THE NUCLEUS of good photography is correct exposure. This is a combination of shutter speed and lens aperture as determined by an exposure meter. If either speed or aperture is not as indicated on the camera the results will be less than perfect.

While the lens aperture is a simple mechanical operation and unlikely to be in error the same cannot be said about the shutter with its springs and things. *(Typical electronic engineer's attitude!— Ed.)* Not only may the speed not be exactly as indicated on the dial, it may (probably) change as the camera gets older. Therefore it is desirable that a simple method of determining the actual speed should be available.

This project describes the design and construction of a unit which is capable of measuring times from 1 / 10 000 s to 10 s. This allows the actual speed to be measured and then used to calculate the correct aperture when taking those important photos.

SPECIFICATION

Timing range	0.1 ms to 9.99 sec.
Sensor	Photo transistor
Display	3 digit LED
Power supply	9 volt batteries 65 – 160 mA LEDs on 20 mA LEDs off
Battery life	≈6 hours – normal ≈20 hours – alkaline

It is suitable for checking cameras with a hinged or removable back so that the sensor can be placed in the film plane. For cameras where the film fits into a slot this unit cannot be used.

Construction

Commence construction with the PCB adding initially the nine links required. Next add the resistors and capacitors in the appropriate locations as shown in the component overlay. Note that capacitor C5 is polarised and must be inserted the correct way round.

The transistors and the displays can now be soldered in place taking care with orientation of the transistors.

The ICs are the last components to be installed and these must be in the correct location and orientation. As they are all CMOS devices (except IC2) the pins should not be handled if possible to minimise the danger of static electricity damaging them. When soldering them in, solder the corner pins (the power supplies), pins 7 and 14 or 8 and 16 first as this allows the internal protection diodes to work while you solder the other pins.

The front panel can now be drilled and cut. A piece of polarised plastic helps as a display window. The switches, pushbutton and phone jack can now be fitted and connected to the PCB as shown in the component overlay. The only point which could cause problems here is that the phone jack connections sometimes vary, and you should check yours before connection.

The PCB can now be mounted onto the support bracket with 6 mm spacers and the bracket into the box with two screws. When positioned correctly, the display will be visible through the window and the battery holders will be held in position at the other end.

Sensortive

The sensor plate which contains Q1 and R1 can now be made. We used a piece of PCB material, although any non-conductive material which is opaque or translucent may be used. Start by cutting the plate to size and drilling a 6 mm hole in the centre. The photo-transistor Q1 should be mounted with the curved surface (which is the active side) into the hole and R1 soldered to the leads, the whole assembly then being glued onto the plate with quick dry epoxy. Ensure that all conductive parts are covered with epoxy to prevent touching when in use.

HOW IT WORKS

To measure the time the shutter is open we use a phototransistor, Q1, positioned in the film plane in the camera. When the shutter is operated and if the camera is focusing a bright light on to the transistor, the voltage across R4 will rise to about 7 V for the duration of the shutter being open. The transistor used is a Darlington type and is normally too slow for measuring times shorter than 1 ms. The addition of R1 increases the speed at the expense of sensitivity – hence the need for a bright light.

The output across R4 is squared up by the Schmitt trigger formed by IC1/1,2. The output of this controls the input to the 10 kHz oscillator IC2. This is an ordinary 555 oscillator where the frequency is set by C1, R2, R3 and RV1. The output of IC2 is divided by 10 in IC3/1 and again by 10 in IC3/2. We use the enable inputs of IC3 as they give clocking on the negative edges, which is what we need. We now have three outputs of 10 kHz, 1 kHz and 100 Hz. One of these outputs is selected by SW2/1 which is a centre off toggle switch. When it is in the off position, 1 kHz is selected via R8, while in the other positions the 1 kHz signal is swamped by the low output impedance of the other dividers.

Whichever frequency is selected clocks IC4 which is a 3 decade counter-latch-multiplexer. We are not using the latch in this application. This IC simply counts the number of pulses it receives and with the help of IC5 (7 segment decoder-driver) and Q2 – Q4 displays the result on the LED displays. During the counting period the display is blanked to prevent ripple on the supply rail upsetting the 555 timer. The ripple would occur as the current changes with different digits displayed. The decimal point is controlled by SW2/2.

Two modes, single-shot and add, are provided. In the single-shot mode when light hits Q1 operating the Schmitt trigger the monostable formed by IC1/3 gives a pulse about 50 µs long which resets the main counter IC4 and the /10 dividers, IC3. Pins 1 and 9 on IC3 which have to be low to allow clocking are taken high during the reset pulse only because it made the PCB easier and does not affect the operation. In the 'add' mode the reset pulse does not occur and unless the reset button is pressed the second and successive counts will simply add on to the previous count. This allows say ten tests to be made and the total divided by ten to find the average.

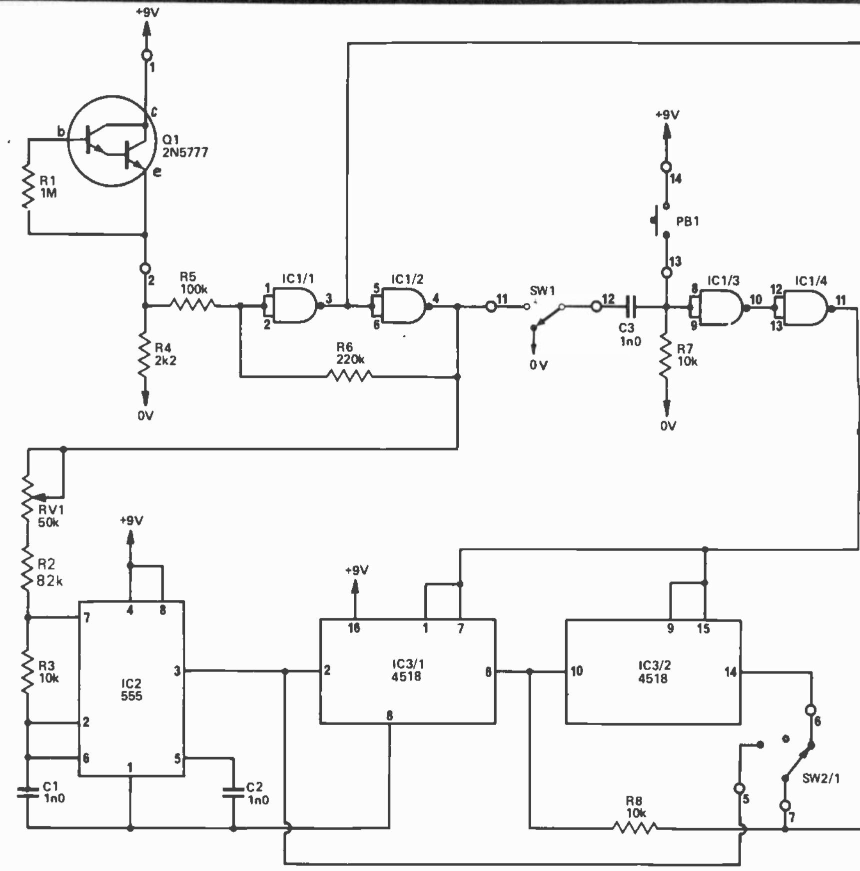
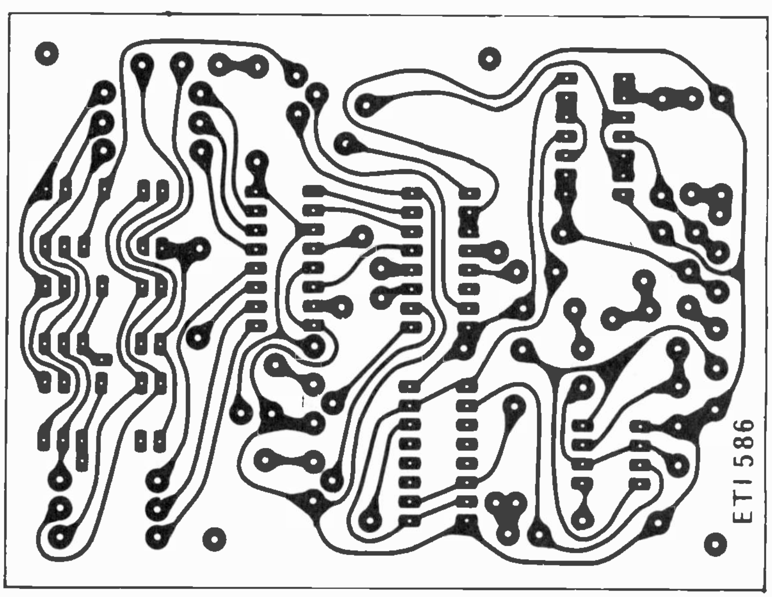
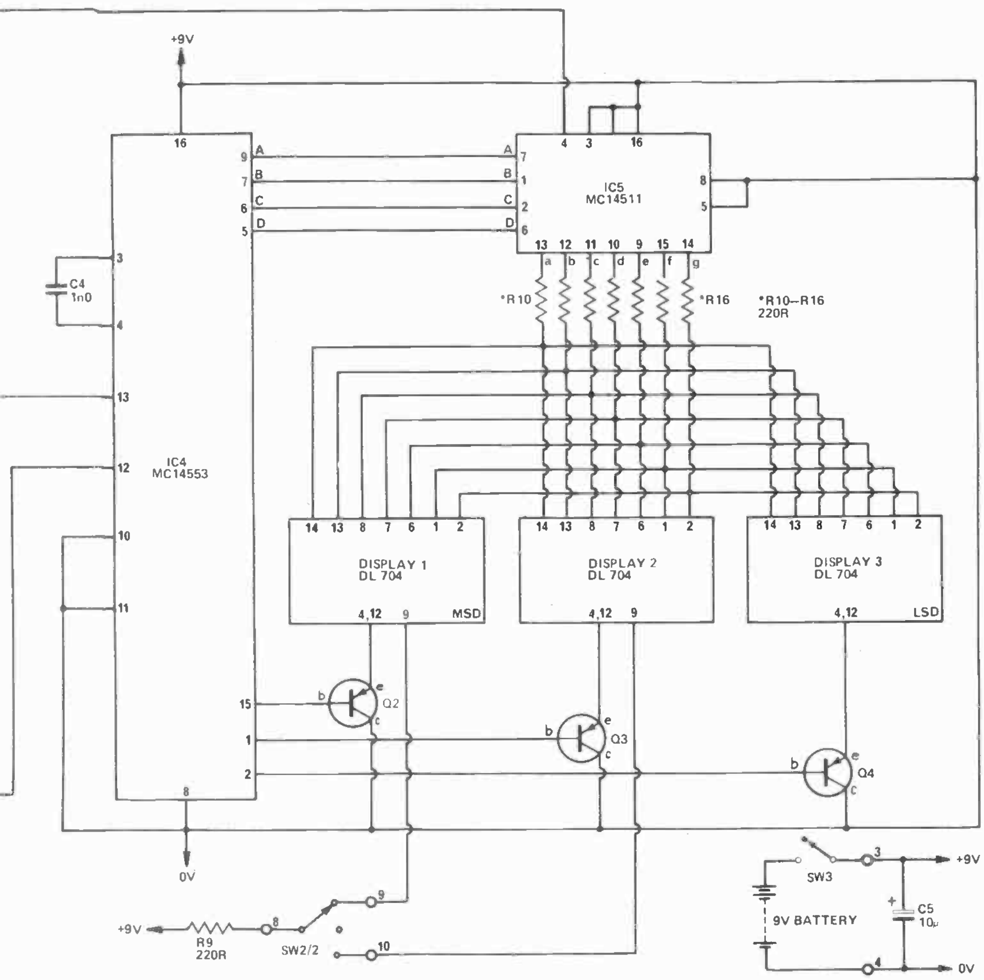


Fig. 1. Circuit diagram of the timer.

BUYLINES

All the components here are readily available. The only thing the home constructor might not have come across is the 2N5777 photo-darlington. This is not a rare device at all, however, and is stocked by Marshalls, Watford etc. etc. If you use an equivalent type of display, make sure of the pin outs with respect to the PCB. If your type does not match up, the best thing would be to fix the displays to the front panel, and wire up from the PCB mounting holes.





PARTS LIST

RESISTORS all ½ W 5%

R1	1M
R2	82k
R3	10k
R4	2k2
R5	100k
R6	220k
R7,8	10k
R9–R16	220R

POTENTIOMETER

RV1	50k

CAPACITORS

C1–C4	1n0 polyester
C5	10u 16 V electrolytic

SEMICONDUCTORS

IC1	4011
IC2	555
IC3	4518
IC4	14553
IC5	4511
DISPLAY 1–3	DL704
Q1	2N5777
Q2–Q4	BC559

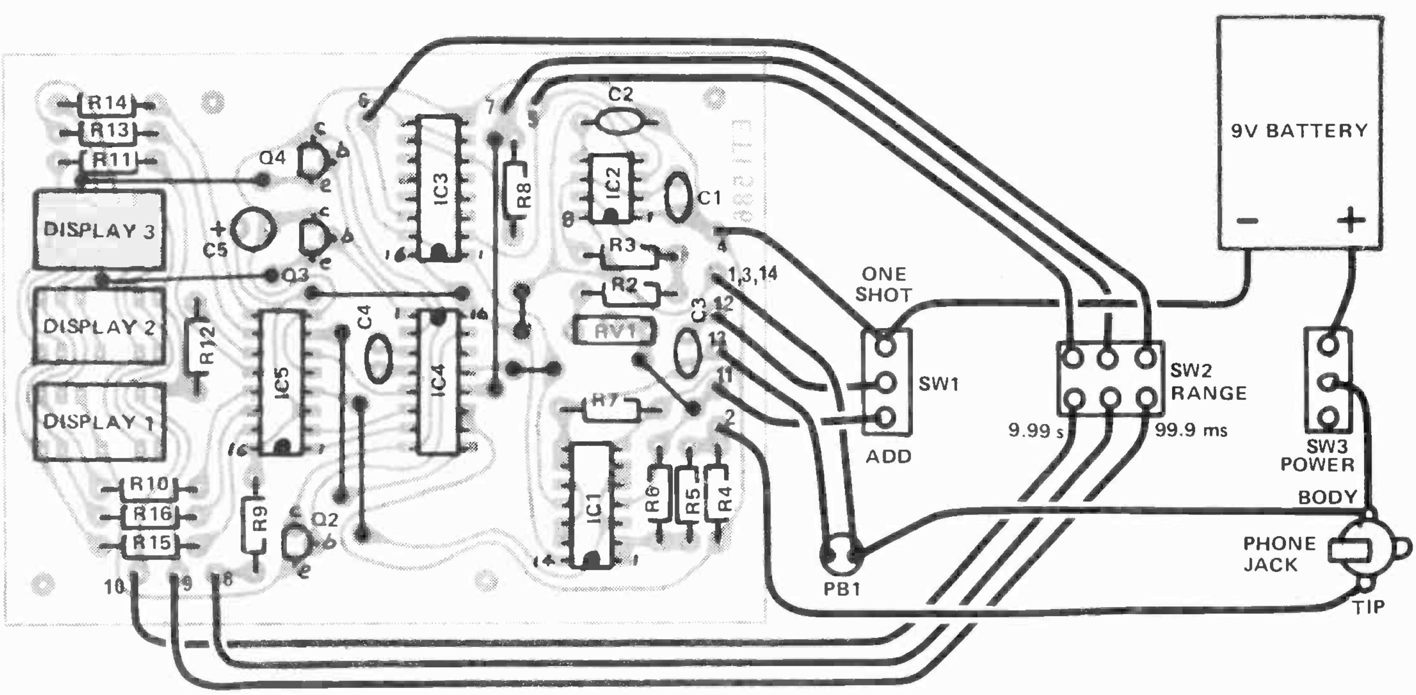
SWITCHES

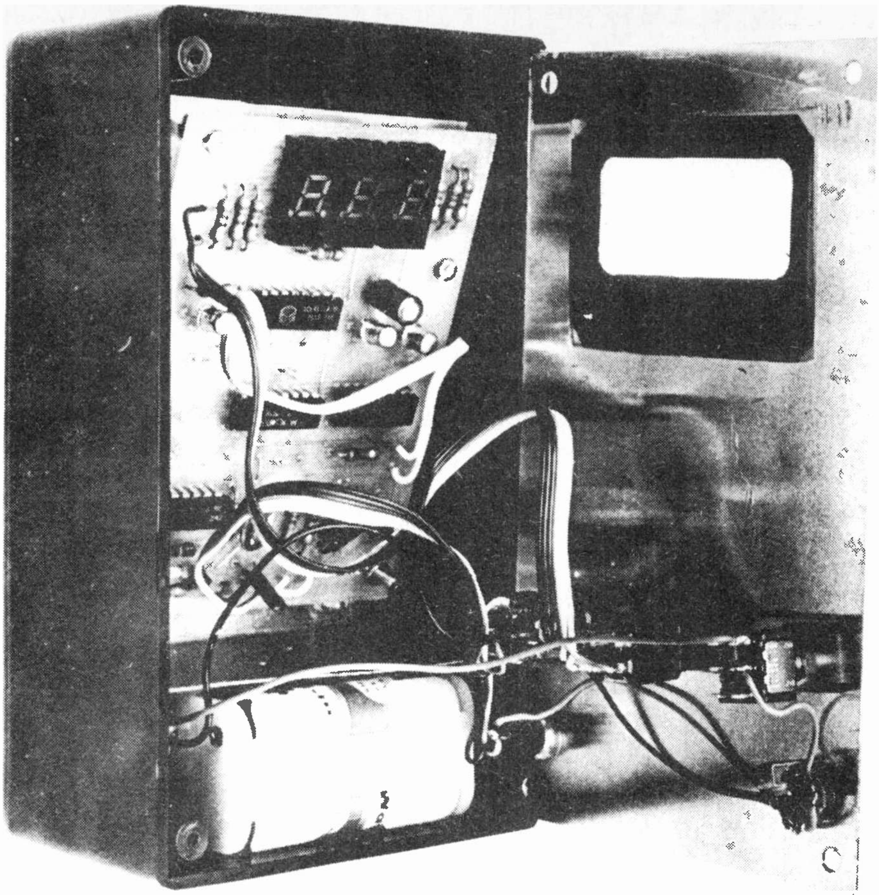
SW1,3	toggle switch SPDT
SW2	toggle switch DPDT centre off

MISCELLANEOUS

PCB ETI 586, plastic box, push button, phone jack and plug, battery holder, battery clip, support bracket, spacers, nuts, bolts, wire etc.

Fig. 2. Component overlay and wiring diagram.





Calibration

The unit can be calibrated accurately enough with the aid of a stopwatch with a second hand. Set the camera up as detailed in the operational notes and using the single-shot mode, open the lens for five seconds. By adjusting RV1 get the reading close to 5s.

Now use a longer time, say 20 s, noting that the first digit will be missing. (i.e. a reading of 8.52 represents 18.52 s while 2.31 would be 22.31 s) and finally adjust RV1.

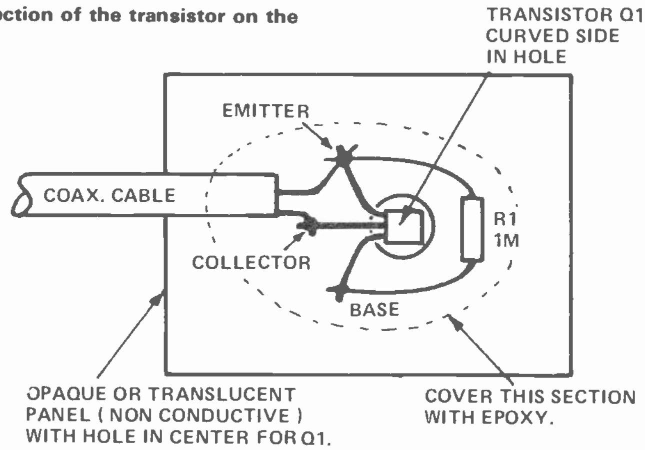
To aid setting up a push button can be substituted for the phototransistor but the 'add' position should be used and the timer manually reset as contact bounce can cause the display to reset on release of the button.

Operation

While the camera can be hand-held it is recommended that a tripod be used. Mount the camera on the tripod pointing at a light of 100 – 500 Watts about 2 – 3 feet away. Open the back of the camera and position the sensor plate so that the light is focused on the sensor. Initially, have the lens wide open; if enough light is hitting the sensor, the display will be blanked. Stop the lens down until the display comes on then go back one stop.

This sets the sensitivity and by selecting the appropriate range the shutter speed can be checked. ETI

Fig. 3. Connection of the transistor on the sensor plate.



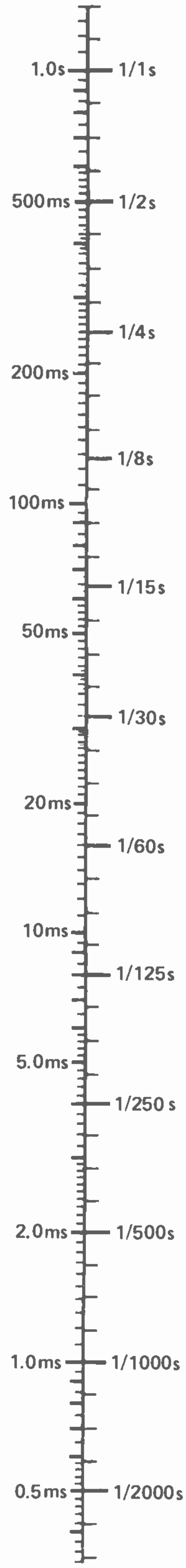


Fig. 4. Graph showing the relationship between time and shutter speed. Each of the small divisions on the right hand side corresponds with a ¼ stop.

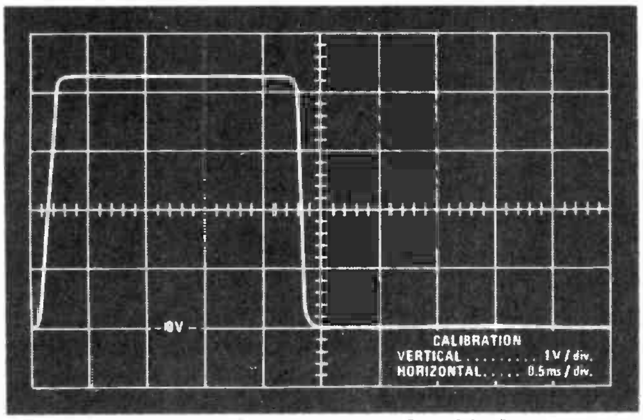


Fig. 5. Waveform on the input (point 2) with the camera on 1/500 sec. The actual time was 2.1ms.

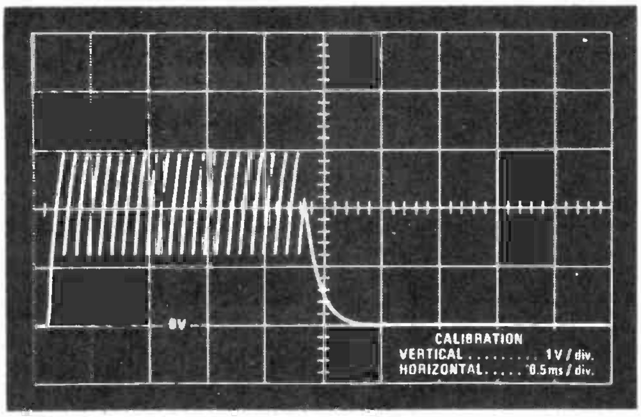


Fig 6. Voltage across C1 during operation

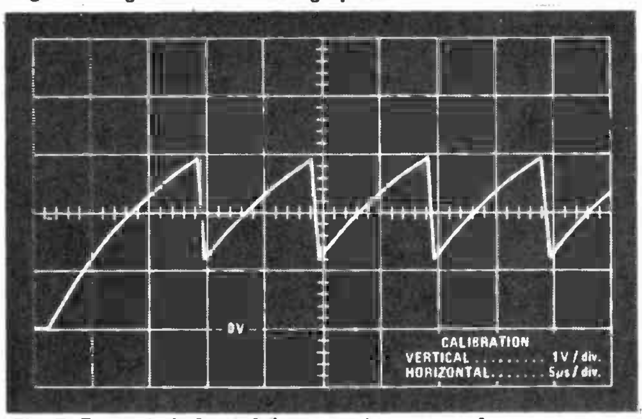


Fig. 7. Expanded view of the start above waveform.

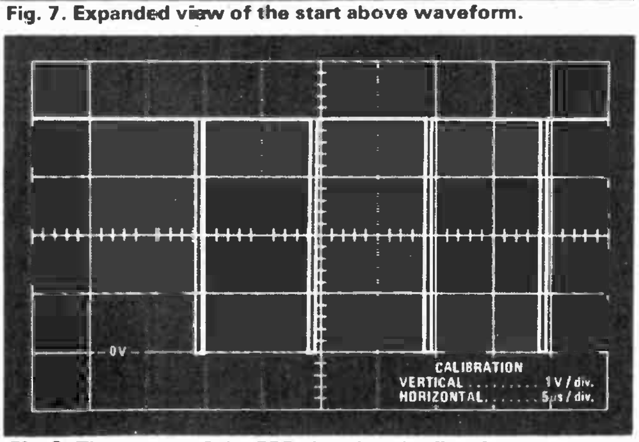


Fig. 8. The output of the 555 showing the first four pulses.

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BC116 17p | BC548 22p | BD609 70p | 1N5404 20p
BC147/8/9 9p | BC558 29p | ZTX109 12p | 2N3053 17p
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ULTRASONIC SWITCH

Two-board design forms basis for a wide range of applications from door-bells to data transmission!

THE USE OF an invisible beam to transmit information or to act as an alarm system has always been fascinating. We have described light operated systems of the infra-red (invisible), normal light and laser beam types. We have also published a radar alarm system. This unit uses a high frequency acoustical beam, well above the range of human hearing, which can be used simply as a door monitor, i.e. to give an alarm if the beam is broken, or can be modulated at up to several hundred Hz. This will allow information to be transmitted – details of how to do this will be given in future issues.

Construction

The construction of the units is not

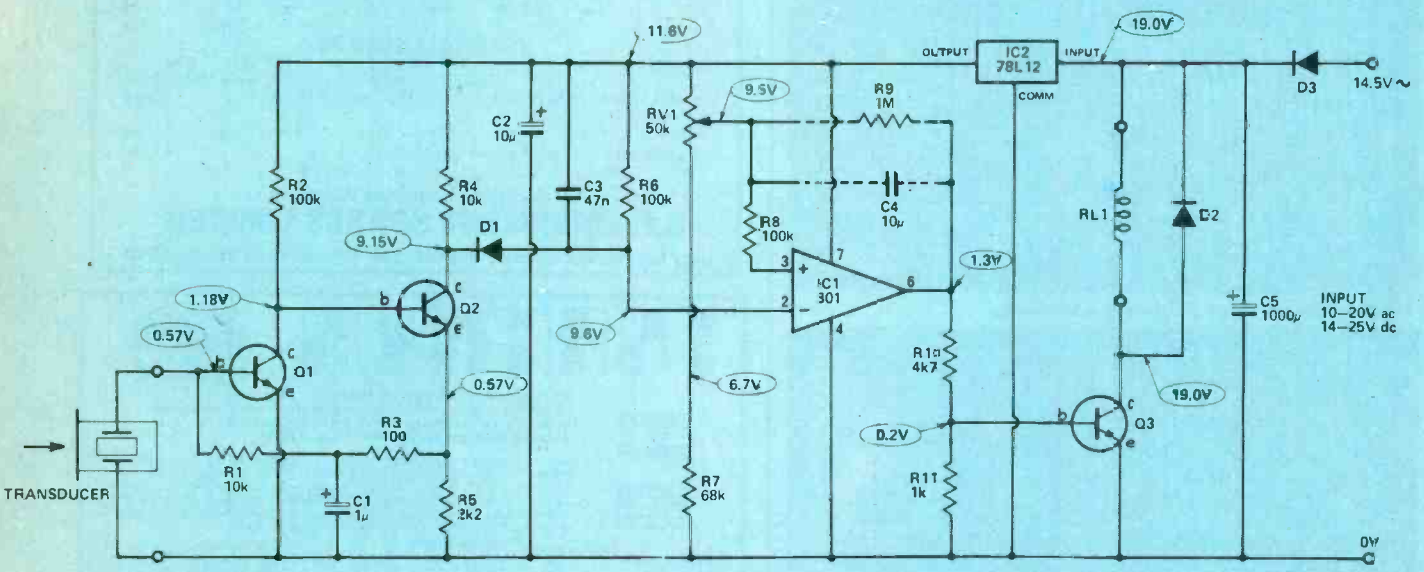


Fig. 1. Circuit diagram of the receiver.

NOTES:
VOLTAGES MEASURED WITH NO INPUT SIGNAL USING A VOLTMETER WITH 10 MEG OHM INPUT IMPEDANCE.
Q1–Q3 ARE BC548
D1 IS 1N914
D2,D3 ARE 1N4001
C4 IS USED INSTEAD OF R9 IF A MONOSTABLE ACTION IS REQUIRED.

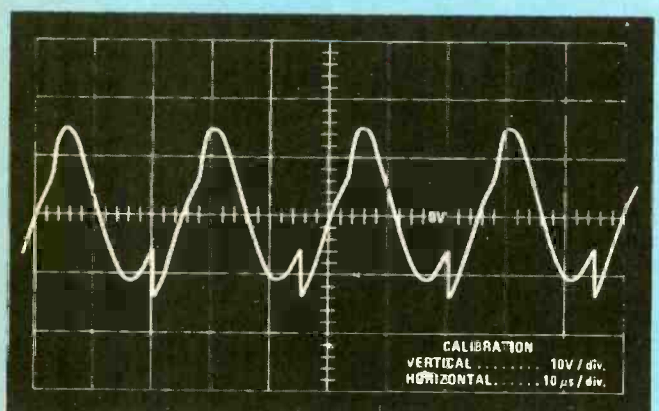


Fig. 3a. Waveform across the transducer on the transmitter.

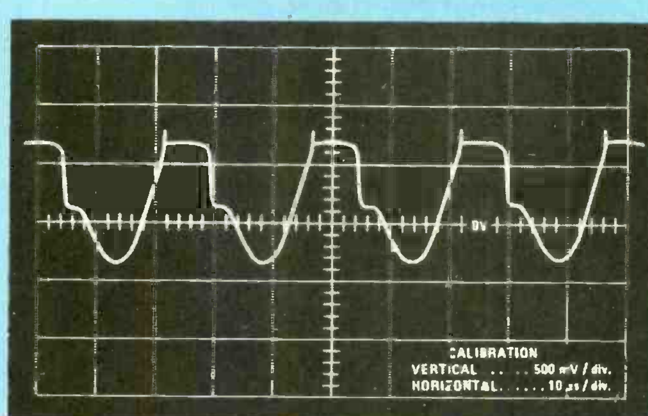


Fig. 3b. Voltage on the base of Q2 in the transmitter.

critical — any method may be used although the PC boards are recommended. We didn't mount the relay on the PCB as it can vary in size and if the unit is later used with a modulated beam, the relay will not be needed.

The only adjustment on the unit is the sensitivity control and this should be set to give reliable operation. The transmitter needs a supply voltage of 8 V to 20 V at about 5 mA. This could come from the regulated supply on the receiver board.

If it is required to extend the effect of a quick break in the beam or a quick burst from the transmitter, the resistor R9 can be replaced by C4 and this will give a minimum operation time of about 1 second.

ETI

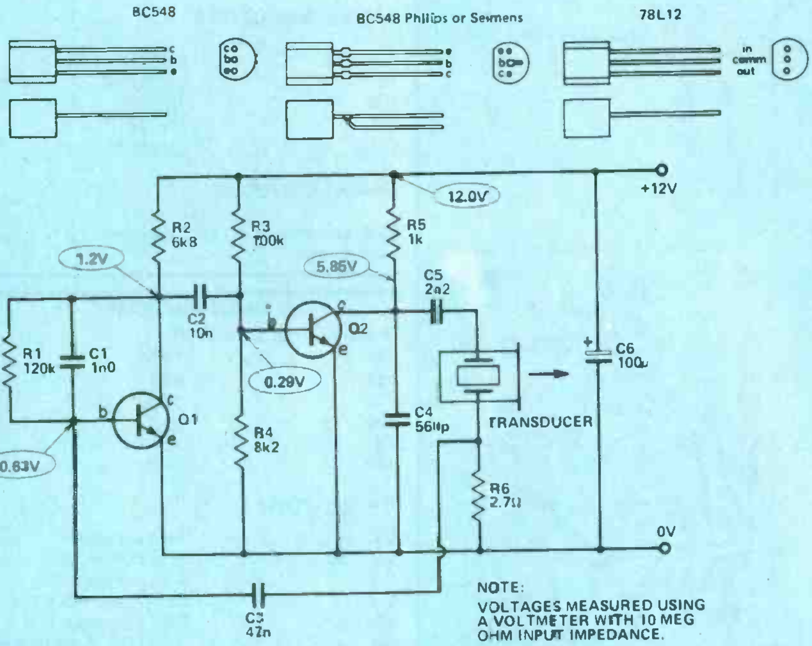


Fig. 2. Circuit diagram of the transmitter.

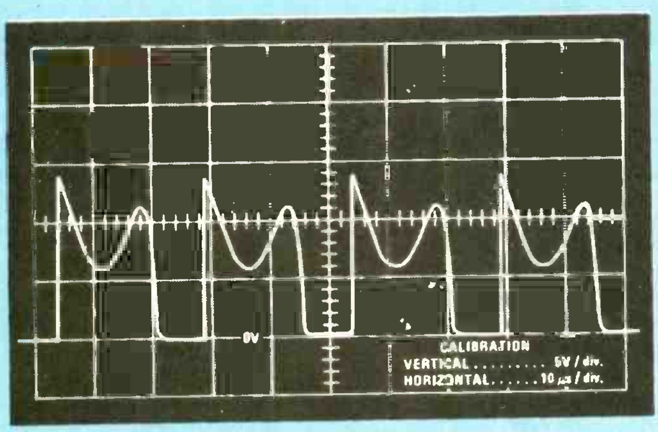


Fig. 3c. Voltage on the collector of Q2.

HOW IT WORKS

Transmitter

This is an oscillator the frequency of which is determined by the transducer characteristics. The impedance curve of the transducer is similar to that of a crystal with a minimum (series resonance) at 39.8 kHz followed by a maximum (parallel resonance) just above it at 41.5 kHz.

In the circuit the two transistors are used to form a non-inverting amplifier and positive feedback is supplied via the transducer, R6 and C3. At the series resonant frequency this feedback is strong enough to cause oscillation.

Capacitors C1 and C4 are used to prevent the circuit oscillating at the third harmonic or similar overtones while C5 is used to shift the series resonant point up about 500 Hz to better match the receiver.

Receiver

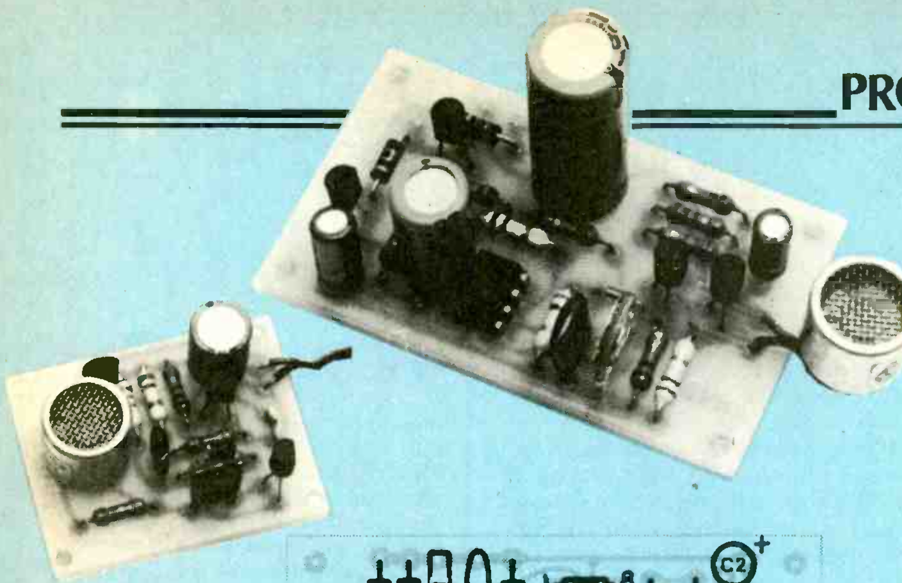
The output from the transducer is an a.c. voltage proportional to the signal being detected (40 kHz only). As it is only a very small level it is amplified by about 70 dB in Q1 and Q2. D C stabilization of this stage is set by R1 and R3 while C1 closes this feedback path to the 40 kHz A C signal.

The output of Q2 is rectified by D1 and the voltage on pin 2 of IC1 will go more negative as the input signal increases. If the input signal is strong the amplifier will simply clip the output, which on very strong signals will be a square wave swinging between the supply rails.

IC1 is used as a comparator and checks the voltage on pin 2, i.e. the sound level, to that on pin 3 which is the reference level. If pin 2 is at a lower voltage than pin 3, i.e. a signal is present, the output of IC1 will be high (about 10.5 volts) and this will turn on Q3 which will close the relay. The converse occurs if pin 2 is at a higher voltage than pin 3.

A small amount of positive feedback is provided by R9 to give some hysteresis to prevent relay chatter. If R9 is replaced by the capacitor C4 the IC becomes a monostable and if the signal is lost for only a short time the relay will drop out for about 1 second. If the signal is lost for more than 1 s the relay will be open for the duration of the loss of signal.

We used a voltage regulator to prevent supply voltage fluctuations triggering the unit. The relay was not included on the regulated supply, allowing a cheaper regulator to be used.



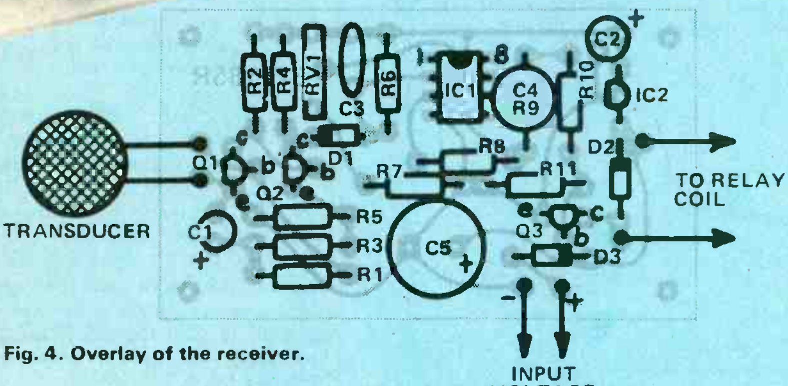


Fig. 4. Overlay of the receiver.

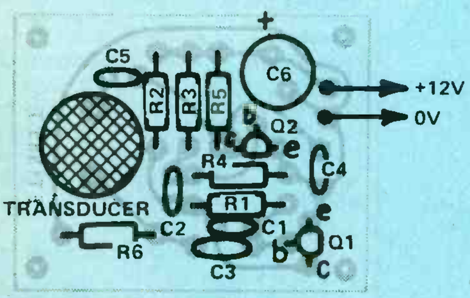


Fig. 5. Overlay of the transmitter.

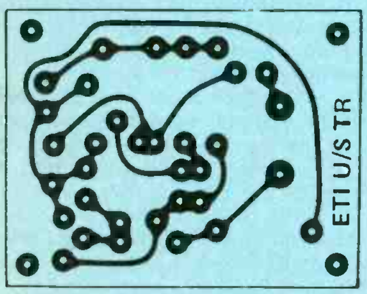


Fig. 7. Printed circuit board of transmitter. Full size 46 x 36mm.

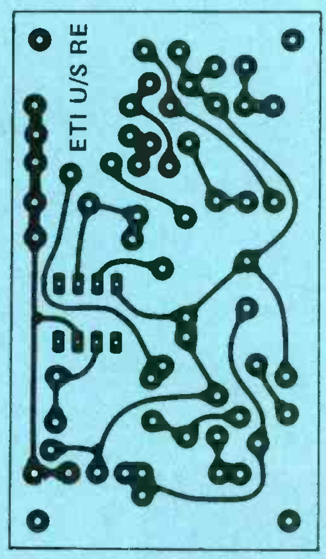


Fig. 6. Printed circuit board of receiver. Full size 70 x 40mm.

PARTS LIST

RECEIVER

RESISTORS all ½ W 5%

R1,4	10k
R2,6,8	100k
R3	100R
R5	2k2
R7	68k
R9	1M
R10	4k7
R11	1k

POTENTIOMETER

RV1	50k preset

CAPACITORS

C1	1u 25 V electrolytic
C2	10u 25 V electrolytic
C3	47n polyester
C4	10u non polarised electrolytic
C5	1000u 16 V electrolytic

SEMICONDUCTORS

Q1–Q3	BC548
IC1	LM301A
IC2	78L12
D1	1N914
D2,3	1N4001

MISCELLANEOUS

PCB as pattern, 40 kHz receiver, 12 V relay, case to suit

TRANSMITTER

RESISTORS all ½ W 5%

R1	120k
R2	6k8
R3	100k
R4	8k2
R5	1k
R6	2R7

CAPACITORS

C1	1n polyester
C2	10n polyester
C3	47n polyester
C4	560p cetamic
C5	2n2 polyester
C6	100u 25 V electrolytic

TRANSISTORS

Q1,2	BC548

MISCELLANEOUS

PCB as pattern, 40 kHz transmitter, case to suit.

BUYLINES

This project was designed with simplicity in mind and as a result uses components that should be available from most suppliers of electronic components. The only items likely to be difficult to obtain are the transmitter and receiver. In case of difficulty however these can be purchased from Audio Electronics at 301 Edgware Road, London.

SPECIFICATION

FREQUENCY	40 kHz
RANGE	5 metres
MAXIMUM MODULATION FREQUENCY (NOT WITH RELAY OUTPUT)	250 Hz
OUTPUT	relay, closed when beam is made
POWER SUPPLY	
TRANSMITTER	14–25 V DC 10–20 V DC
RECEIVER	8–20 V DC, 4 mA

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9-0-9	100	13	**1.85**	40
0 9 0 9	330 330	235	**1.95**	40
0-8-9,0-8 9	500 500	207	**2.35**	55
0-8-9 0-8 9	1A 1A	208	**3.50**	55
0-15 0-15	200 200	236	**1.95**	40
0-20 0-20	300 300	214	**2.35**	70
20-12-0-12-20	700(DC)	221	**3.10**	70
0-15-20 0-15-20	1A 1A	206	**4.20**	85
0-15-27 0-15-27	500 500	203	**3.65**	70
0-15-27,0-15-27	1A 1A	204	**4.75**	85

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Pri 220-240 Volts

Amps 12V	Amps 24V	Ref.	Price £	P&P
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1 0	0 5	213	**2.30**	70
2	1	71	**2.90**	70
4	2	18	**3.75**	70
6	3	70	**5.35**	85
8	4	108	**6.25**	1 00
10	5	72	**6.95**	1 00
12	6	116	**7.85**	1 00
16	8	17	**9.25**	1 10
20	10	115	**12.75**	1 30
30	15	187	**16.60**	1 30
60	30	226	**22.90**	1 60

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Sec 0-12-15-20-24 30V

Amps	Ref No.	Price £	P&P
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1.0	79	**3.05**	70
2 0	3	**4.80**	85
3 0	20	**5.80**	1 00
4 0	21	**6.85**	1 00
5 0	51	**7.75**	1 00
6 0	117	**9.50**	1 00
8 00	88	**11.35**	1 30
10 0	89	**12.00**	1 30

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Sec 0-19-25-33-40-50V

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1 0	103	**4.20**	85
2 0	104	**6.10**	1 00
3 0	105	**7.85**	1 00
4 0	106	**9.80**	1.10
6 0	107	**14.95**	1 30
8 0	118	**15.75**	1 50
10 0	119	**20.50**	2.00

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1 0	126	**4.65**	85
2 0	127	**6.50**	1 00
3 0	125	**9.15**	1 10
4 0	123	**11.25**	1 30
5 0	40	**11.80**	1 30
6 0	120	**14.75**	1 40

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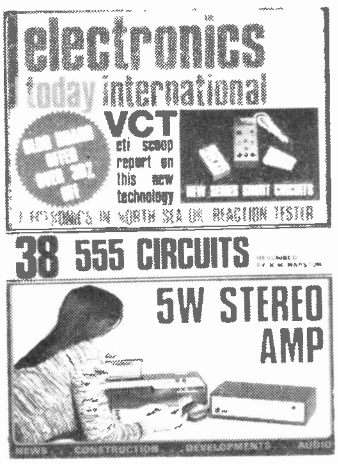

Gaps?

It can be a nuisance can't it, going from newsagent to newsagent? "Sorry squire, don't have it - next one should be out soon."

Although ETI is monthly, it's very rare to find it available after the first week. If it is available, the newsagent's going to be sure to cut his order for the next issue - but we're glad to say it doesn't happen very often.

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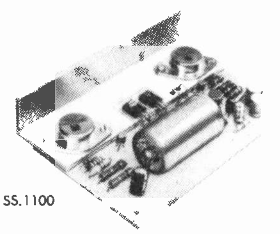

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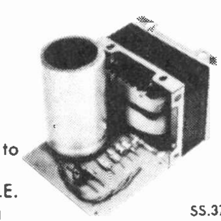
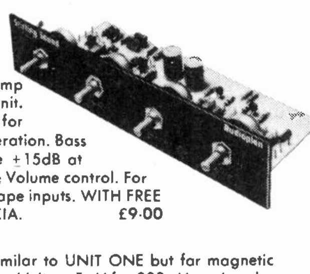


SS.370



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microfile.......

Gary Evans takes a detailed look at two new personal computing systems.

I SUSPECT THAT this year will be the one during which personal computing ''takes off'' in the UK. This seems likely because until now, although the micros we all know and love have been available, together with a multitude of development kits, bought by many in the mistaken belief that they were all the manufacturer's advertising claimed they were, there have been few, if any, low-cost micro-computers on sale in this country. All this will change in the next few months.

The Research Machine's 380Z, described in December's Microfile, was, perhaps, the first system that could rightly qualify as a home-computer to come onto the market over here. This month we look at two new additions to the range of home systems in detail, together with two further products, that will contribute to the broad range of computers for the home, likely to be available before 1978 is out.

Lynx With NASCO

The first machine we shall examine is the NASCOM 1. This is described as a complete microcomputer kit and sells for £197.50 plus VAT. Now a phrase like complete computer kit when appended to a product selling for less than a good few hundred pounds is generally a euphemism for what most of us would refer to as a development kit, something with Hex Keyboard Input, LED displays a very basic monitor plus small amount of RAM. Not so with the NASCOM 1.

The specification for this piece of equipment includes full alphanumeric keyboard for data input, 1 Ks worth of powerful monitor, 2K of RAM, full character generating logic for display of output on a TV screen, easy expansion plus, one might say, many more attractive features.

In short the NASCOM 1 does provide what most of us would agree are the minimum requirements of a home computer at a price that until now would buy little more than a development kit. In order to find out more about the NASCOM 1 I went up to Chesham to meet the people responsible for this little goodie.

The NASCOM 1 is manufactured by NASCO (that stands for North American Semiconductor Company). While many of us will not have heard of NASCO before, many of us will be familiar with Lynx Electronics which is the part of the NASCO group that deals with the amateur electronic market. The NASCOM 1 was designed with the amateur in mind, and because of Lynx's strong base in this area the NASCOM 1 will be marketed via Lynx. If all this sounds a bit complicated, don't worry, all that counts is that we can get our hands on a cheap home computer.

Unlike other companies that have produced micro based systems, NASCO decided not to undertake the development work themselves, but to employ the services of a consultant. This facility was in the form of

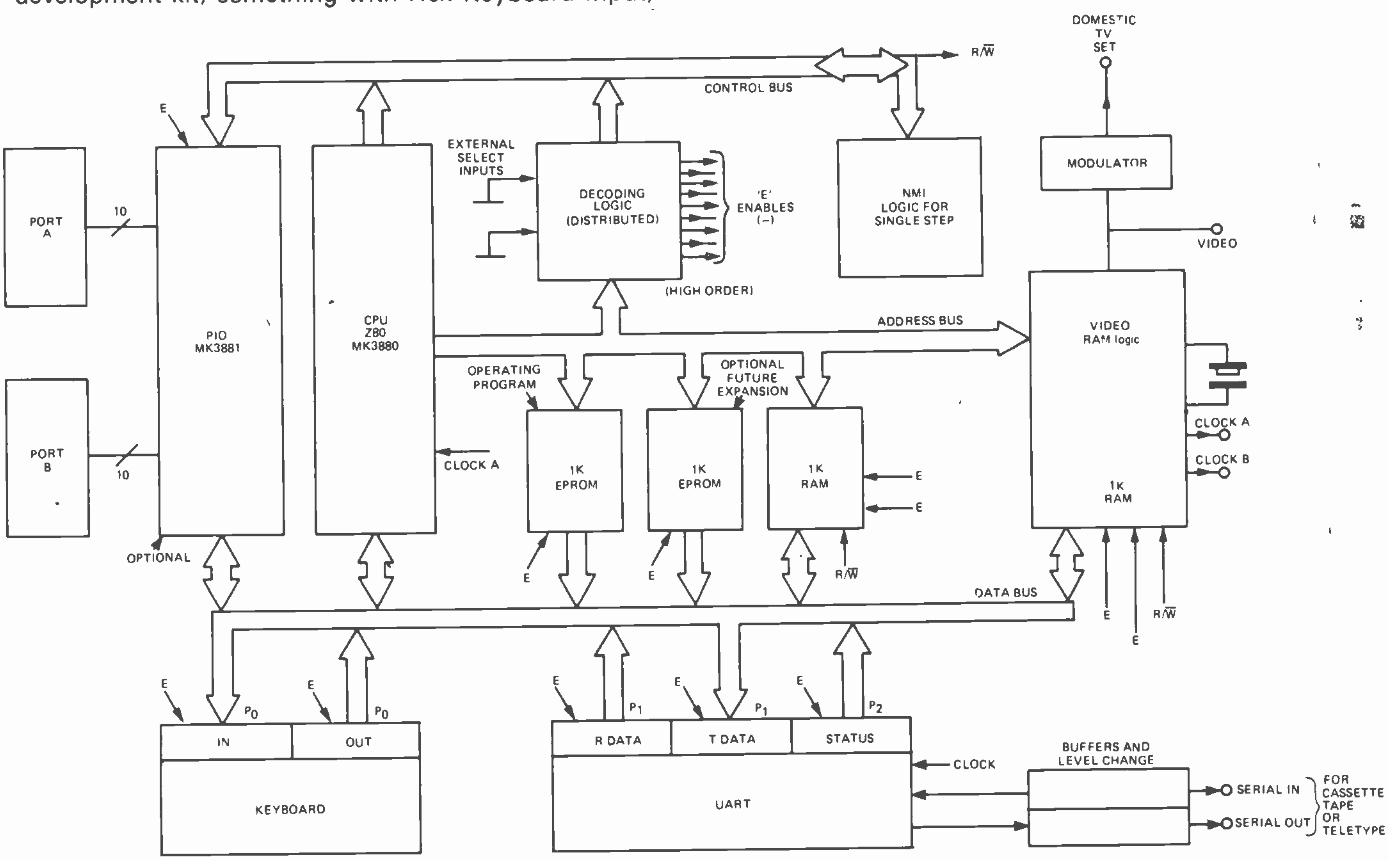

Fig. 1. A block diagram of the NASCOM 1 system.

The photograph on the left shows the NASCOM 1 single board computer. The user requires only a standard TV receiver and a cassette recorder to complete a powerful and versatile home computer system.

Shelton Instruments Ltd or, more simply, Dr Shelton.

NASCO provided Dr Shelton with a number of design aims that were to be realised in the final product — these included producing the system for around £200, using the best available products (not just those from one favoured manufacturer), to design for maximum control by software (always a good idea — well nearly always) and to design the basic system so that it might easily be expanded to incorporate extra facilities.

These aims, together with a few more, were formulated after considerable discussion amongst the NASCO staff and some five months later the design was finalised. Easy to say but no doubt those five months included many late nights and salt pills (all that sweat).

Five months may not seem a long time in which to develop a complex project of this nature, but it is necessary to work on this sort of time scale because otherwise there is a danger that the system will be out of date by the time of its launch (a fate that has befallen many an electronics entrepreneur).

The general form of the NASCOM 1 can be seen in the block diagram shown in Fig. 1. It can be seen that the Z80 MPU has been chosen for the system. This MPU with its efficient machine language, speed, simple hardware support plus other sophisticated features (automatic dynamic RAM refresh, easy 16 bit arithmetic, etc), seems to be the automatic choice for many systems being designed at the moment.

All the systems components are mounted on a single PCB card. Care has been taken to ensure that the kit is easy to assemble, for example by plating through all the through board links on the PCB, so that most people should have no trouble constructing the kit.

The monitor will allow easy development of software and provides the following commands:

1 EXECUTE
2 SET BREAKPOINT
3 SINGLE STEP
4 TABULATE on screen
5 EXAMINE/MODIFY memory
6 DUMP memory to serial I/O.
7 LOAD from serial I/O
8 COPY memory from one block to another.

System Support

In any system it is important that additional support, both hardware and software, is available to the purchaser of any system. Lynx are aware of hardware add-ons, CUTS interfaces, 4K RAM cards, S100 interfaces, etc, as well as giving thought to such things as a TINY BASIC. They are also expanding their staff to enable the technical back-up that is all so important to be available to those who need it.

I do not have enough space to mention all the details of the NASCOM 1 and if, as I suspect, you would like to know as much about it as possible, get in touch with Lynx at the address shown below and they should be able to help: Lynx Electronics, 92 Broad Street, Chesham, Bucks.

Incidently if you would be interested in attending any future symposia held by Lynx, they are considering a Manchester venue for the next, please get in touch with them at the above address.

TRS—80

The second system I should like to look at this month is the Tandy TRS-80. Now to most of you the name Tandy will be associated with a shop in the High Street that sells some audio gear and a few components. This, to say the least, is the tip of a vast iceberg. The Tandy Corporation owns the Radio Shack chain of shops which

Heathkit's H8 should be available during the spring of 1978 and will be one of a range of home computers available at that time.

comprises over 6 000 outlets across the USA and Canada plus about 500 more operating world-wide. The British chain represents about one half of one per cent of the group's turnover. To say the TRS-80 has resources to back it up is an understatement.

There is only one TRS-80 in this country at the moment. Since its launch in the States Tandy have not been able to make enough of them, hence the shortage of supplies. The machine was in Birmingham (a place of many a mis-spent youth — including your correspondent's) so I travelled up there to see the machine in action.

The TRS-80, unlike the NASCOM 1, is not a kit, but is supplied fully built. It comprises four main units — a case containing the MPU (again the Z80) plus ROM, RAM and a 53 station keyboard, a 12" monitor, a cassette recorder and, finally, a power supply.

The basic TRS-80 is supplied with 4K of ROM containing the system's BASIC interpreter. This is a fairly powerful floating point basic package, which also takes care of keyboard input, output to the monitor and cassette I/O and file handling.

The minimum system is provided with 4K of user RAM implemented with dynamic devices. The memory may, by using simple jumpers, be expanded to 16K and to 64K with an external memory card.

The monitor displays the system's output as 16 lines of 64 characters displayed as a 5x7 dot matrix in a 6x12 cell. The system is also capable of providing a versatile graphics display capability.

The cassette interface runs at 300 baud but is *NOT* CUTS. In this system a logic 1 is stored as a pair of pulses while a logic 0 is stored as one pulse. In use, however, the system appeared to give no problems.

It was nice to see that the instructions provided were excellent. The set I saw was a proof copy but I am told the final item will be much the same. The instructions started off with a description of the machine and then, with the help of a question and answer format encouraging the use of the TRS-80, dealt with the use of BASIC finishing with quite sophisticated programs.

There is also a range of software available on tape, from games programs to Kitchen Menus and a handy Personal Finance package. Tandy plan to add to the range of this software as a continuing program.

It is also nice to note that plans for additional items of hardware to make the systems forty way bus connector are well advanced — line printers, floppies, MODEMS and additional memory are a few of the products in the pipeline.

Tandy expect supplies of the TRS-80 to begin arriving in March and in the meantime if you want more information of this very attractive system contact Tandy at the address below. Oh, I almost forgot, the price. Not finally fixed yet but about £500 — and a bargain at that.

Tandy Corporation, TRS-80, Bilston Road, Holyhead Road, Wednesbury, Staffs, SW10 7JN.

More To The Fore

The three systems described so far will be joined by at least two others, the Heathkit H8 and Commodore's PET, provide a wide range of price and performance to choose from when buying a microcomputer.

We shall probably see other organisations developing products to exploit this area of consumer interest and I for one will not be surprised if 1978 sees the launch of many more systems to compete with the five mentioned above.

ETI

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200V	0·64	0·64	0·75	0·75	0·87	0·87	0·97	1·01	1·17	1·17
400V	0·77	0·78	0·80	0·83	0·97	1·01	1·13	1·18	1·70	1·74
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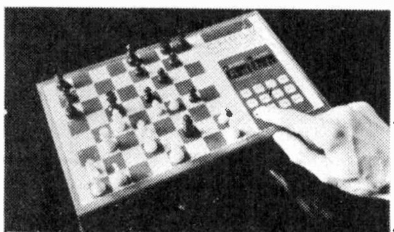

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DATA SHEET

MM5837 NATIONAL **NOISE SOURCE**

General description

The MM5837 digital noise source is an MOS/MSI pseudo-random sequence generator, designed to produce a broadband white noise signal for audio applications. Unlike traditional semiconductor junction noise sources, the MM5837 provides very uniform noise quality and output amplitude. The circuit is packaged in an 8-lead Epoxy-B mini-DIP.

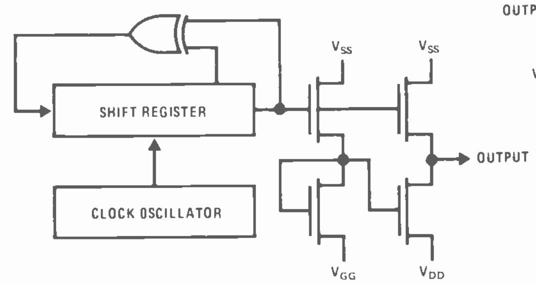
Features

- Uniform noise quality
- Uniform noise amplitude

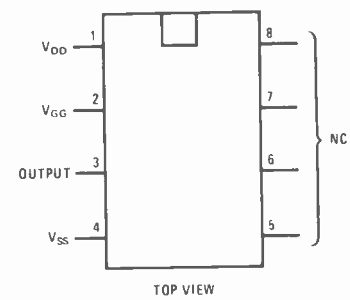
Applications

- Electronic music rhythm instrument sound generators
- Music synthesizer white and pink noise generators
- Room acoustics testing/equalisation

Logic And Connection Diagrams



Dual-In-Line Package



Electrical Characteristics

T_A within operating range, V_{SS} = 0V, V_{DD} = −14V ±1.0V, V_{GG} = −27V ±2V, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output (Loaded 20 kΩ to V_{SS} and 20 kΩ to V_{DD}	T_A = 25°C				
Logical "1" Level		V_{SS}−1.5		V_{SS}	V
Logical "0" Level		V_{DD}		V_{DD}+1.5	V
Logical "0" Level	V_{GG} = V_{DD}	V_{DD}		V_{DD}+3.5	V
Supply Currents					
I_{DD}	No Output Load	3		8	mA
I_{GG}				7	mA

Absolute Maximum Ratings At Ta = 25° C (Unless Otherwise Specified)

Supply voltage, Vcc (1), pin 15 . . . . 6.0V

Supply voltage, Vcc (2), pin 14 . . . . 12.0V

Input voltage applied to any device terminal 6.0V

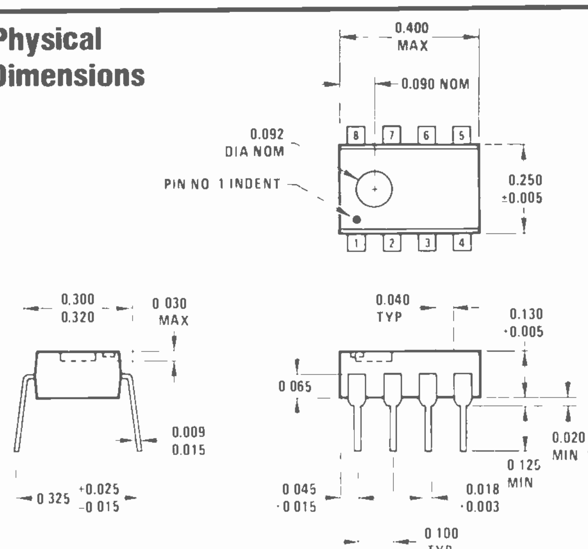
Storage temperature . . . . −65° C to +150° C

Operating temperature range . . . . −55° C to +120° C

Lead temperature inch from case for 10 seconds . . . . +260° C

Recommended operating conditions	MIN	TYP	MAX	UNITS
Supply voltage, Vcc_1, pin 15	4.5	5.0	5.5	V
Supply voltage, Vcc_2, pin 14	5.7		9.0	V
Operating free-air temperature	0	25	70	°C

Physical Dimensions



Moulded Dual-In-Line Package (N)
Order Number MM5837N

THE SN76477 is a bipolar/I^2L device that provides a noise source, VCO, low frequency oscillator, envelope generator, plus various mixing and control logic on a single 28 pin DIL package. By the connection of appropriate external components and application of logic level control signals a wide variety of complex sounds can be synthesized. The design of the SN76477 allows for maximum user flexibility and the device should prove useful in applications requiring audio feedback to an operator (home video games, toys, timers, alarms, etc.).

The block diagram in Fig. 1 shows the main circuit blocks, each of which is described in detail below.

SLF (Super Low Frequency Oscillator)

The SLF can be operated in the range 0.1-30 Hz, the specific frequency is determined by a control resistor connected to pin 20, and a capacitor connected to pin 21. The frequency being given by the following equation:

$$F_{SLF}=\frac{0.64}{R_{SLF}\,C_{SLF}}\text{Hz}$$

VCO (Voltage Controlled Oscillator)

The VCO provides an output whose frequency is dependent upon a voltage fed to its input, the higher the voltage the lower the frequency. The control voltage may be either the SLF output, or an external voltage applied to pin 16, the SLF output being selected when the voltage applied to pin 22 is a logic '1', and the external source when pin 22 is at logic '0'.

The "range" of the VCO is internally set at a ratio of 10:1. The minimum VCO frequency is determined by a control resistor connected to pin 18 and a capacitor to pin 17. This minimum frequency is given by the equation:

$$F_{MIN\ VCO}=\frac{0.64}{R_{VCO}\,C_{VCO}}\text{Hz}$$

The "pitch" of the VCO's output is changed by varying the duty cycle of the output. This is achieved by adjusting the ratio of the voltages at pins 16 and 19. The duty cycle is given by the following equation:

$$\text{VCO Duty Cycle}=0.5\left[\frac{\text{V pin 16}}{\text{V pin 19}}\right]\%$$

leaving pin 19 high produces an output with 50% duty cycle.

Noise Oscillator

The "noise oscillator" supplies random frequencies for the "noise generator". The noise oscillator requires a 43 k resistor to ground at pin 4. The "noise oscillator" controls the rate of the "noise generator". An external noise oscillator may be used to provide this control. The external source is applied to pin 3 and provides an automatic override of pin 4.

MIXER SELECT C	MIXER SELECT B	MIXER SELECT A	MIXER OUTPUT
PIN 27	PIN 25	PIN 26	
0	0	0	VCO
0	0	1	SLF
0	1	0	NOISE
0	1	1	VCO/NOISE
1	0	0	SLF/NOISE
1	0	1	SLF/VCO/NOISE
1	1	0	SLF/VCO
1	1	1	INHIBIT

TABLE 1

Noise Generator/Filter

The output of the "noise generator" feeds an internal noise filter. This "rounds off" the generator's output, reducing the HF content of the noise. The upper 3 dB point is given by

$$F_{UPPER}=\frac{1.28}{R_{NF}\,C_{NF}}$$

where R_{NF} and C_{NF} are external components connected to pins 5 and 6 respectively

ABSOLUTE MAXIMUM RATINGS AT TA = 25°C (Unless otherwise specified)

SUPPLY VOLTAGE, Vcc (1), PIN 15 .... 6.0V
SUPPLY VOLTAGE, Vcc (2), PIN 14 .... 12.0V
INPUT VOLTAGE APPLIED TO ANY DEVICE TERMINAL 6.0V
STORAGE TEMPERATURE .... −65°C to +150°C
OPERATING TEMPERATURE RANGE . −55°C to +120°C
LEAD TEMPERATURE 1/16 INCH FROM CASE FOR 10 SECONDS . +260°C

RECOMMENDED OPERATING CONDITIONS

	MIN	TYP	MAX	UNITS
SUPPLY VOLTAGE, Vcc1, PIN 15	4.5	5.0	5.5	V
SUPPLY VOLTAGE, Vcc2, PIN 14	5.7		9.0	V
OPERATING FREE-AIR TEMPERATURE	0	25	70	°C

OPERATING CHARACTERISTICS AT TA=25°C AND Vcc1=5.0V

Mixer

The "mixer" logic selects one, or a combination, of the inputs from the SLF, VCO, and noise generator. Selection is according to Table X.

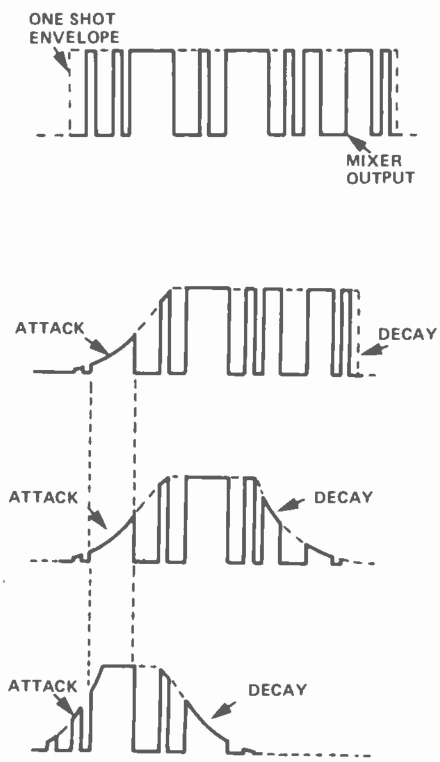
System Enable Logic

The "system enable" input provides an enable/inhibit for the system output. The output is inhibited when the voltage at pin 9 is a logic '1', and enabled when logic '0'.

One Shot Logic

The "one shot" logic can be used to provide sounds of a short duration. The duration of the "one-shot" is given by the following equation:

Fig. 2. Showing the various envelopes that the SN 76477 circuitry can produce.



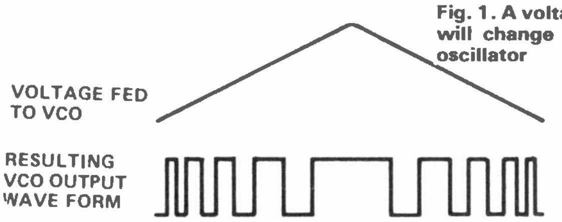


Fig. 1. A voltage fed to the input of the VCO will change the output frequency of this oscillator

Fig. 3. Block diagram

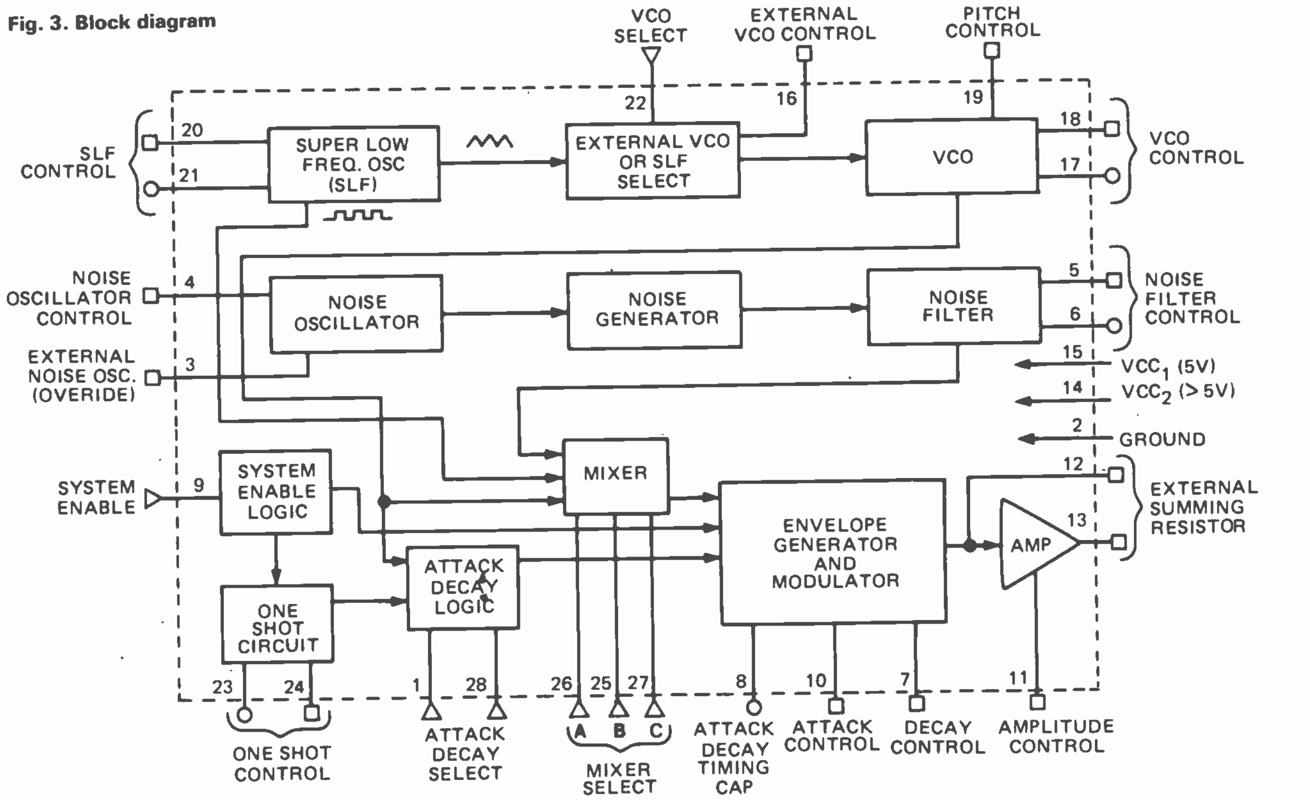


TABLE 2

ADL SELECT 1 PIN 1	ADL SELECT 2 PIN 28	OUTPUT
0	0	VCO
0	1	MIXER ONLY
1	0	ONE–SHOT
1	1	VCO WITH FLIP–FLOP

$T_{OS} = 0.8\ R_{OS}\ C_{OS}$

where R_{OS} and C_{OS} are external components connected to pins 24 and 23 respectively. The maximum duration of the "one-shot" is about two seconds.

The "one-shot" logic is triggered by the trailing edge of the system enable logic control signal.

ADL (Attack/Decay Logic)

The ADL determines the envelope for the mixer's output. The envelope selected is determined by the ADL control inputs to pins 1 and 28, the output selected being shown in Table 2.

Envelope Generator and Modulator

The attack/delay characteristics of the output are determined by the components connected to pins 7, 8 and 10.

The attack and delay times are given by the following:

$T_{ATTACK} = R_A\ C_{A/D}$ secs

$T_{DELAY} = R_D\ C_{A/D}$ secs

where $C_{A/D}$ is the attack delay capacitor connected to pin 8, and R_A and R_D are resistors connected to pins 7 and 10.

Output Amplifier

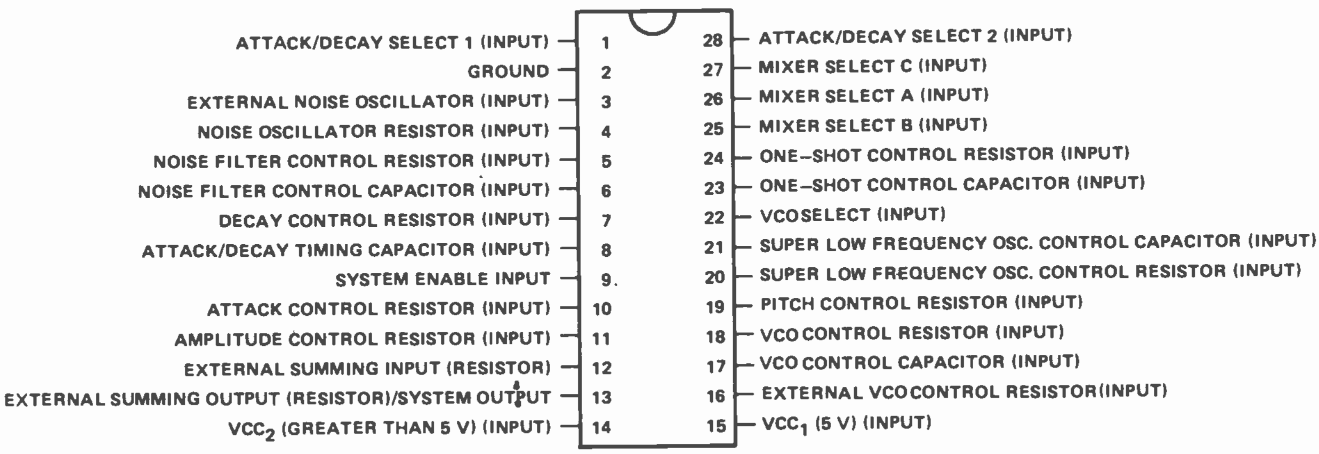
The output amplifier provides a low impedance output. The peak output voltage is determined by the following equation:

$$V_{OUT} = \frac{3.4\ R_S}{R_G}$$

where R_S is a summing resistor connected to pins 12 and 13 (set equal to 10 k) and R_G is a gain resistor connected to pin 11.

Notes:

1. Supplies greater than 5VO may be used, in which case they should be connected to pin 14 to allow the internal regulator to supply the internal circuit requirements.
2. For dedicated sound logic inputs (pins 1, 9, 22, 25, 26, 27 and 28) may be hard-wired to high or low logic levels.



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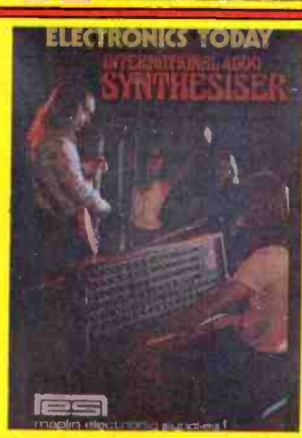

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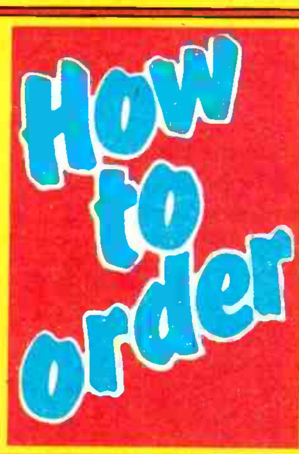

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audiophile......

.... This month Ron Harris offers up a report from the Australian ETI on the Heil (air motion transformer) Bass Driver, which has had a long and chequered development. ESS now seem to be moving into production, however, so ....

It appears as though a production version of the Heil bass driver is finally on the way. At a consumer show in Chicago recently, a thing called the Transar was on view, and behind the name lurks the long awaited woofer. The principle has been with Heil for some time. They showed what is now the basis behind Transar at the Sydney (Australia) Electronics show last year.

From the time of the air motion transformer's introduction ESS have planned to produce a bass unit using similar principles. The fundamental difference between the Heil driver and conventional drive units is the rapid acceleration of large volumes of air from the drive radiating surface; air being squeezed out from between the Heil drive units' pleats.

Time to produce

With the production bass unit now looking a reality, we thought it timely to examine the principle behind the unit, as Heil showed their hand at the Sydney exhibition.

At this demonstration a specially modified ESS power amplifier was used. The amplifier was modified to reduce damping factor, because the drive unit itself is largely self-damped (to be discussed shortly) and additional damping from the amplifier was found to degrade performance. The prototype used a fairly conventional moving coil driver, but the coil former was not attached directly to the diaphragm, but was linked to four vertical rigid rods. These rods were in turn bonded to a number of relatively small individually suspended diaphragms made of a specially-developed formed-plastic material with integral suspension giving very long throw. Angled 'baffles' separated each diaphragm and these were so designed as to isolate front and rear outputs (of opposing phase) from the diaphragms.

The motor system operated in a vertical plane, thus causing the diaphragms to move up and down also. As the upper surfaces of the diaphragms move upwards,the volume of the cavities created by the diaphragm/baffles is reduced and so air is squeezed outwards from the cavities. At the same time, at the rear of the drive unit, the concurrent upward movement of the lower surface of the diaphragm increases the volume of the diaphragm/baffle cavity, drawing air inwards. Thus there is the same inhale/exhale characteristic of air movement as featured in the Heil high frequency drive unit.

Coupling to advantage

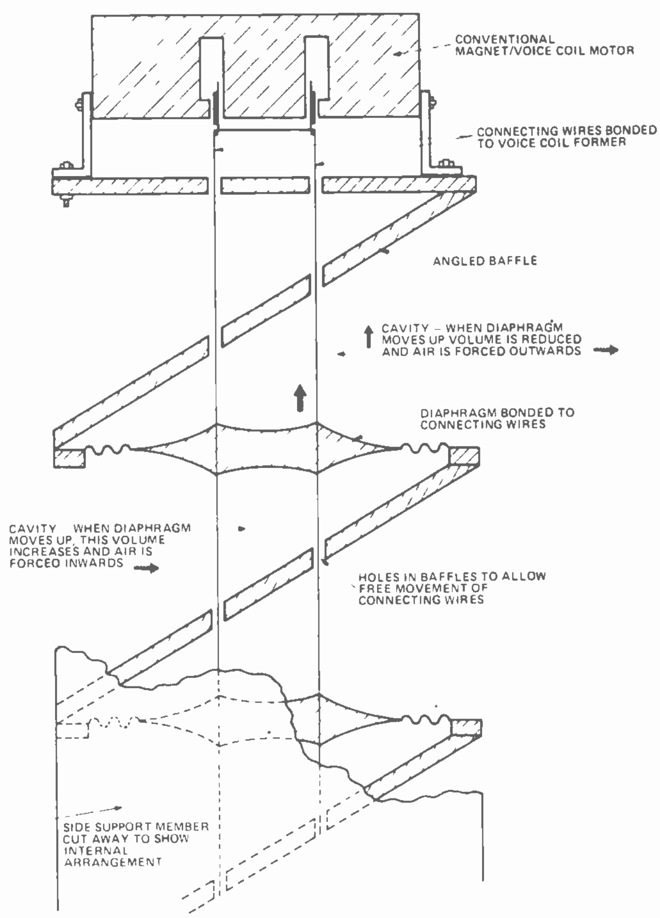
A great advantage of this concept is excellent coupling of the diaphragm to the air. The radiating surface area is far greater than conventional speakers in which air is merely pushed or pulled by the diaphragm.

The moving mass of the Heil system relative to the amount of air displaced is far lower than in the vast majority of other speaker systems and as a consequence the air will damp the diaphragm to a greater extent than with conventional high mass dynamic cone systems.

Thus amplifier damping — which in effect shorts out the back-EMF caused by the coil's continuing movement after the signal has ceased — apparently modifies the natural motion of the Heil system sufficiently to prevent it from responding correctly to wanted output from the amplifier.

Possibly this need for an 'undamped' amplifier could be the main reason for delay in the appearance of the Heil woofer. It also seems likely that the amt-2 (which designation has been set aside for the full-range Heil system) will be a bi-amped or possibly tri-amped speaker, using suitable electronics at the bass end, fully integrated with the drive unit and its somewhat curious load demands, and a more conventional electronic arrangement for higher frequencies.

Only one Heil bass air motion transformer was available for the 1976 CES. Thus the demonstration was strictly mono, and imperfect matching between the HF system comprising a standard Heil unit, was used in the existing amt-1A, and the low frequency system did little to help matters. Nor did the crowded exhibition conditions. Nevertheless, the Heil woofer, mounted on a large open baffle, spoke more than adequately for itself, delivering the kind of bass quality expected only from the better transmission lines (and without their efficiency penalty) or uncompromised custom built systems.



This ETI-prepared drawing shows the most probable form of construction.

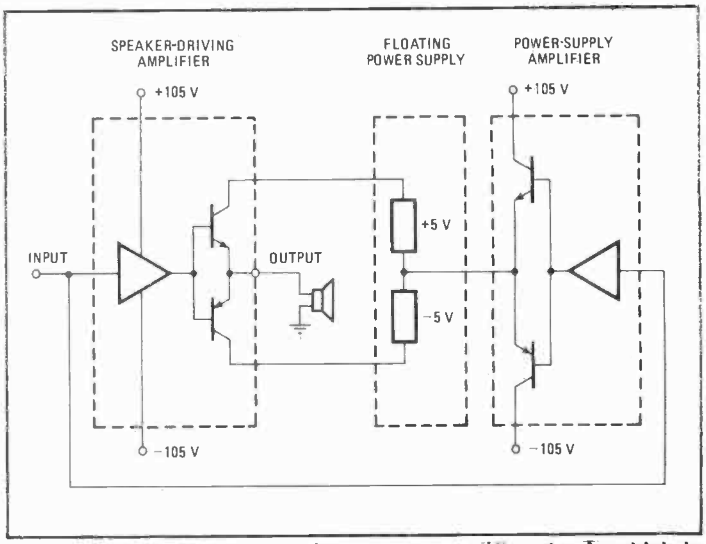
Wafting in on the sea breeze from Japan comes news of another 'Rock Folly'. Would you believe a 350 W class A amplifier' Matsushita INCs designers have surfaced from the labs bearing a beasty with talents claimed to be class As low distortion and class Bs efficiency.

Class A designs have always received the audiophiles nod of approval for their fidelity, and the thumbs down from the power station for a lack of efficiency. (≈25%). This is due to the output stage never being off. Class B on the other hand has a much higher efficiency, circa 75%, but suffers from a rash of nasties-not least of which is crossover distortion.

Those cunning Matsushita people have attempted to get around the gremlins by driving the output stage from a different power supply to that which pushes watts into the speaker! The circuit works by virtue of having two amplifiers, one signal (load driving) and the other dubbed 'power supply'. The output of the latter is connected to the centre point of a ± 5 V supply, which thus floats at load voltage. This then powers the output pair.

Input signals are fed to both amps simultaneously, and both are made to have identical voltage gain, by generous use of negative feedback amongst other things.(Nobody mention TID or Ricochet *please)* All this means the output is only powered when there is something to power it for, hence lowering dissapation and raising efficiency.

The unit needs 1 kW power requirement to push out its rated watts, and can deliver into either four or eight ohms quite happily. Distortion is less than 0.003% at 350 W right across the audio band. Only limited production is at present going on, and the price in America is a dissapating $4000.



Block diagram of the Matsushita 350W amplifier circuit which is designated A+.

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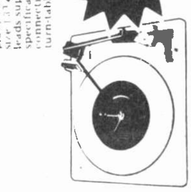

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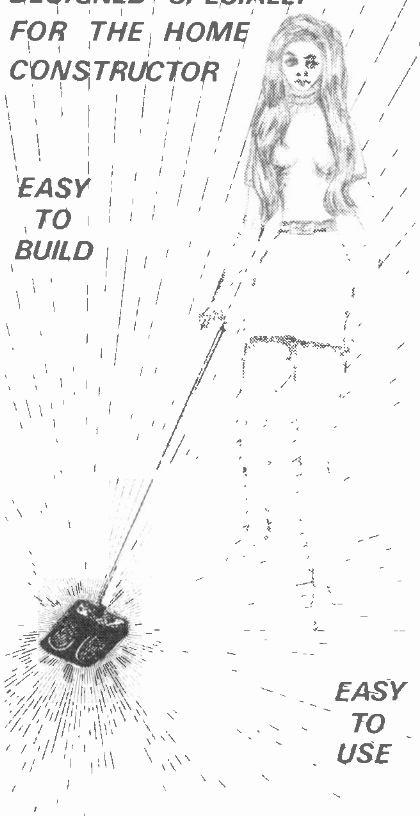

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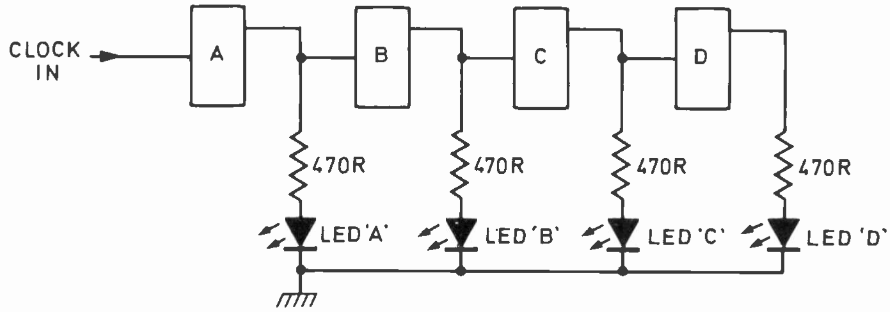


Frequency Divider

With power to the board switched off, set up the first flip-flop as before with J=1, K=1. Connect a wire link from pin 15 (Q1) to pin 6 (CK 2), and attach a resistor and LED in the usual way to pin 11 (Q2) and a spare pad. This LED will indicate the state of the output of the second flip-flop whose J and K pins can be left floating.

With power applied, the output pulses from Q2 should now be at one quarter of the frequency of the oscillator so that this complete circuit is a divide-by-four, producing one complete pulse at the output for each group of four complete clock pulses into pin 1. This is shown in the clock pulse diagram of Fig. 1(b).

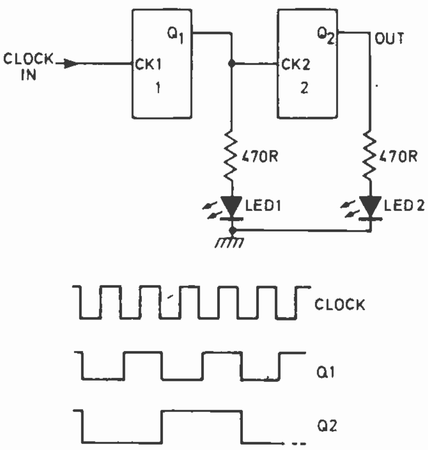


Fig. 1. Cascading 7476 J-K flip-flops.
(a) Circuit.
(b) Pulse diagram.

With the supply disconnected again, connect up both halves of the second 7476 as shown in Fig. 2, so that we now have four toggling flip-flops in sequence. Connect a resistor and LED in the usual way onto the final Q output.

Can you predict what the count number of this circuit will be? (The count of a circuit is the number of complete pulses in to give one complete pulse out.) Using the slow clock pulse from the 7414 oscillator, count input pulses for one complete output pulse (0 to 1 to 0), and draw a clock pulse diagram.

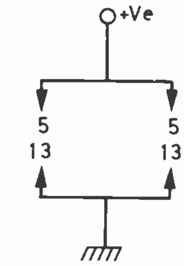


Fig. 2. Four cascaded flip-flops formed from the two 7476s.

Asynchronous Counters

The type of circuit described above is a frequency divider, with each stage dividing the clock frequency by two. It can also be thought of as a scale-of-two counter, with a serial input and a parallel binary output.

Let us explain this.

The pulses into the first clock input need not be at a steady rate, so long as each is separated from the next. This is a serial input — meaning one after the other. The output of each flip-flop can be read, by means of an LED attached to each Q output, for example, and since all can be read together, this is a parallel set of outputs. Our counter, therefore, has serial input and parallel output.

More important, if we started putting the pulses into the input when the output of each flip-flop was zero (the counter cleared, or reset), we could tell how many pulses had appeared at the input if we stopped counting at some stage.

If we label our flip-flops A, B, C, and D (Fig. 2), with A the flip-flop at the input and D at the other end of the line, then we could also label B as 2, C as 4, and D as 8. We are able to do this because, starting at zero, QB will go to 1 after two input pulses (and back to zero on pulse number four), QC will go to 1 after four input pulses (and back to zero at eight), and QD will go to 1 after eight pulses, returning to zero at the sixteenth pulse. We would expect, for example, that after seven pulses QD=0, QC=1, QB=1, and QA=1 because 4+2+1=7.

This circuit is a binary asynchronous counter — binary because the counting is carried out in the scale of two instead of the more familiar ten, and asynchronous because the flip-flops are being clocked at different rates. The truth table of Fig. 3 shows the relation between the binary figures (the outputs from the Q terminals) and the number of pulses in (using decimal figures). Note that this arrangement counts to 15, and that all the flip-flops reset to zero on the sixteenth pulse.

PULSES	QA	QB	QC	QD
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1
11	1	1	0	1
12	0	0	1	1
13	1	0	1	1
14	0	1	1	1
15	1	1	1	1
16	0	0	0	0

Fig. 3. Truth table for four cascaded flip-flops.

BY EXPERIMENT PART 5

Four-Stage Counter

Set up a four stage asynchronous counter on your board with a resistor and LED to indicate the state of each Q output. Label the LEDs to avoid confusion — QD furthest from the pulse input should be labelled 8, QC labelled 4, QB labelled 2, and QA labelled 1. Take the oscillator output through a gate which can be controlled by a switch, and connect the reset terminals (pins 3 and 8 of each 7476) to another switch so that all the outputs can be reset to zero by pressing the switch to connect the reset pins to the 0 V line.

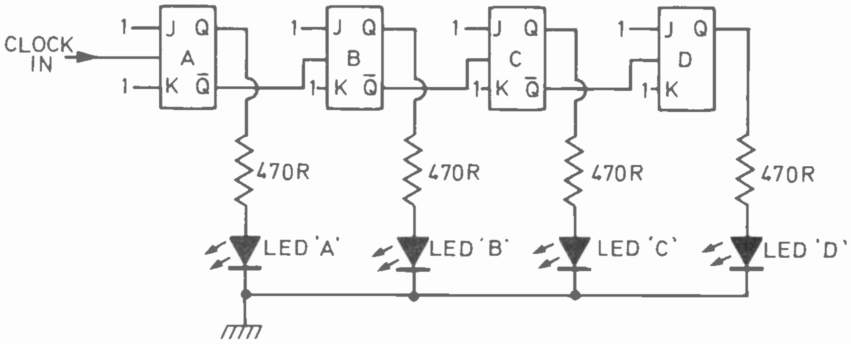
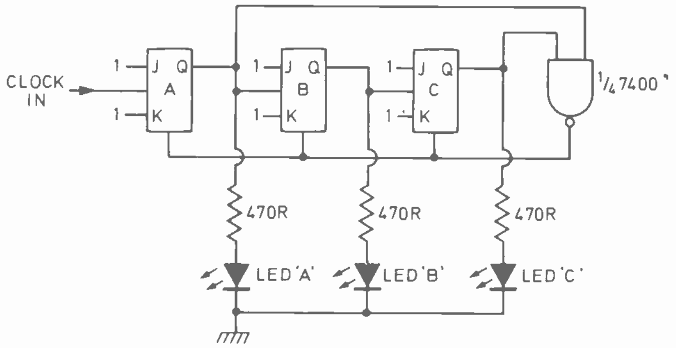


Fig. 4. Cascading from the $\overline{Q}$ terminals — what does this counter do?

Fig. 5. A scale-of-five counter.



Now apply power and check that the count sequence is as shown in the truth table of Fig. 3 when the gating switch is ON. Try switching the gate off and resetting.

Switch off the power and alter the connections between flip-flops A, B, C and D so that $\overline{Q}$A is connected to clock B, $\overline{Q}$B to clock C, and $\overline{Q}$C to clock D. Leave the LED indicators connected to the Q outputs as before (Fig. 4). Now switch on, and start the count. What is happening now?

Could you, not necessarily using only the ICs on the board, design a counter using two 7476s which would count either up to 15 and reset, or down to zero (resetting) according to the position of a single switch, or the voltage on a gate? The number of gates needed makes this impossible on our board..

Interrupted Counts

We seldom want a counter which counts up to 15 and then resets to zero. We may want a decimal counter (0 to 9 and then reset to zero), or a counter which stops at some definite count, or which counts to some number, resets to zero and then stops. These operations can be achieved by using the J and K terminals of the flip-flops together with gates.

Suppose, for example, that we want to count up to four, reset to zero at the fifth pulse, and then start again. What we need is some way of detecting the output at a count of five and using this to operate a reset. Detecting a count of five is easy enough since it is when QD=0, QC=1, QB=0, and QA=1. We can detect this by taking the Q outputs from C and A and connecting them to the inputs of a NAND gate, as shown in Fig. 5. When QC=1 and QA=1, the output of the NAND gate will be zero. The simplest and most obvious way to use this is to connect the output of the NAND gate directly to the reset line of the flip-flops, replacing the reset switch we used previously.

Set up this circuit on your board. Use wire connections from QC and QA to the inputs of one of the 7400 NAND gates, and disconnect the switch from the reset line. Now switch on, with the slow oscillator input to the flip-flop first clock, and observe the count.

Can you now design a counter using four flip-flops which would reset at the tenth inward pulse? This will be a scale-of-ten (decimal) counter. Remember that ten in the binary scale is when QD=1, QC=0, QB=1, and QA=0. If, for any reason we want to use a separate switch-operated reset with this counter, we shall have to arrange an input through either an OR gate or a NOR gate as shown in Fig. 6.

Fig. 6. Using a push-button reset with the circuit of Fig. 5. This could be implemented in several other ways.

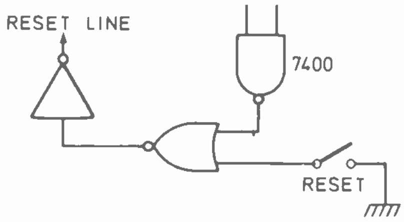
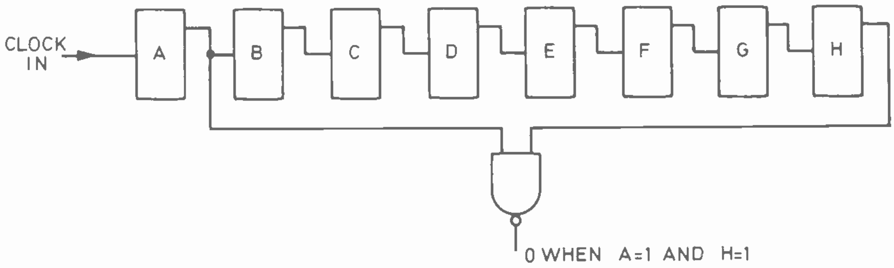


Fig. 7. A "ripple counter". This type of counter can suffer from "race hazards".



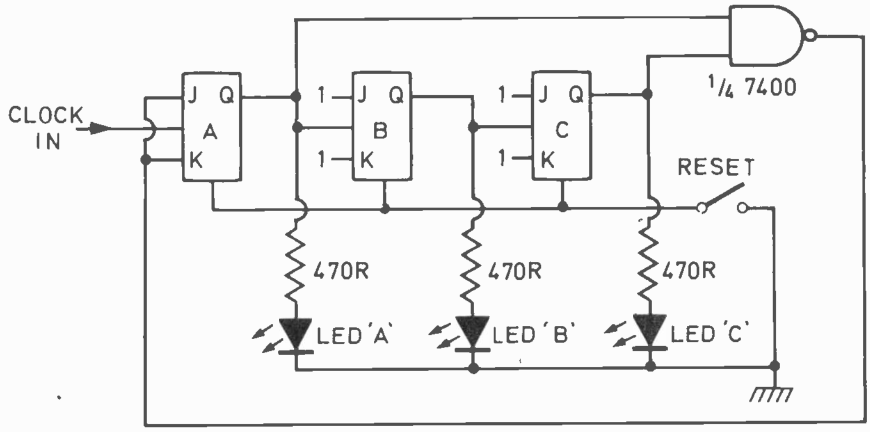


Fig. 8. What does this counter do? Build the circuit on your blob-board and draw up a truth table.

Ruined By Ripple

We can use this gating system to construct asynchronous counters which reset at the highest designed count number, but the system runs into problems with large count numbers and with high speed operation. For example, the first stage counter runs at the speed of the input pulses, and if these pulses are fast, then we may find "Race Hazards" — problems caused by the time delay in each flip-flop.

To take an example, we may be detecting the state 10000001. Now the 1 on the flip-flop H (Fig. 7), called "The Most Significant Figure", appeared just after the count had been 01111111, and if there is a time delay in the system flip-flop A may have gone to zero, to 1 and back to zero again before the clock pulse to flip-flop H has had time to work its way through all the stages in the counter. This time delay, caused by the need for a change to *ripple* through all the flip-flops, gives us the name "Ripple Counter", and can cause miscounting at high speeds.

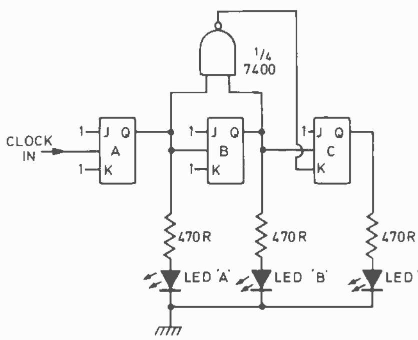


Fig. 9. What does this circuit do? Try to find out in theory, and then build the circuit on the blob-board.

Leaving this problem aside for the moment, our simple asynchronous counter has used the reset line for its reset action. For other types of count interruption we can make use of the J and K terminals of the J-K flip-flop, which is why they are provided. Construct the circuit of Fig. 8 on your board. Can you predict what will happen? Try it out and draw up a count table.

Now try the circuit of Fig. 9. Can you predict what will happen when this is switched on? Try it and see if you were correct.

Could you now design and try a ripple counter which could start at any binary number selected by switches connected to the SET terminals of the flip-flops, then count down, stopping at zero, but leaving the reset terminals free to be used with a switch? ETI

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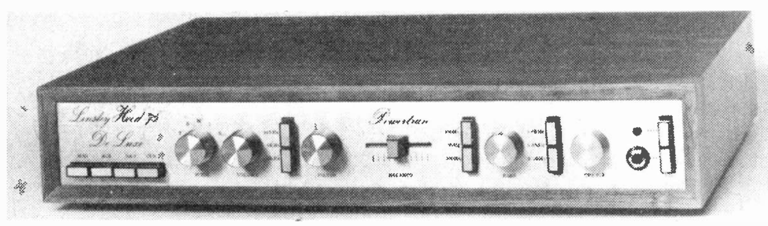

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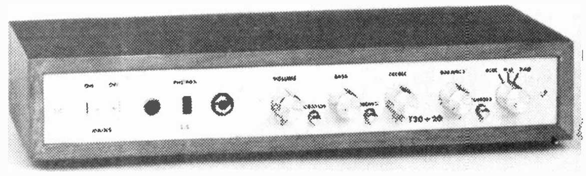

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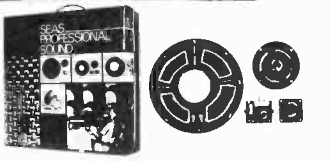

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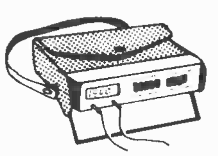

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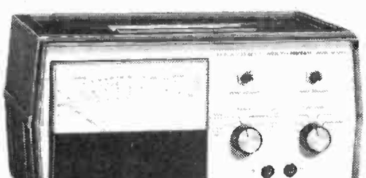

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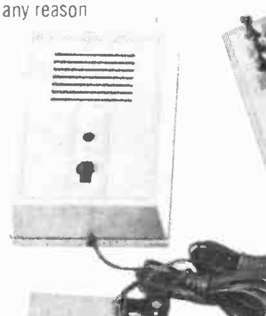

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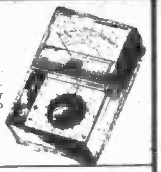
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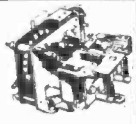
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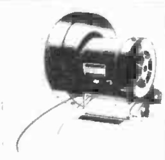
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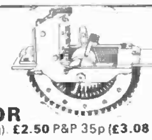
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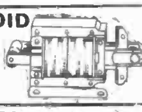
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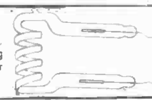
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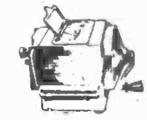
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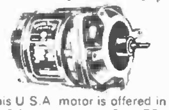
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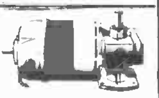
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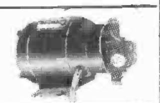
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electronics tomorrow......

by John Miller-Kirkpatrick

"IT WAS A COLD, frosty morning, the sort of morning when you can actually want to go out for a walk just to feel the grass scrunching with frost under your feet. Not many people would be walking just yet though, it was only 6.15 in the morning. The central heating in the house was just beginning to pump hot water around the pipes and the concealed radiators were creaking and twinging and making other strange warming up noises.

At 7.20 the milkman arrived with his wares icy cold in their plastic containers. He identified himself to the outside door of the refrigeration room,opened the door and deposited three cartons of milk and half a kilo of butter onto the tray just inside the door. 'Thank you, Albert'', said the Fridge, ''please remember to close my door''.

The sun broke through the mist and began to warm up the morning, the central heating unit adjusted its heatflow rate accordingly and, at 7.45, the automatic tea machine sounded in the master bedroom.

The diary began to sort through the days events as the postman delivered the latest billing cards into its 'letter box'. The diary had already selected the menu for this morning's breakfast and checked it for nutrition content against dietary information from the doctor. The black coffee, boiled egg and toast was ready and being ingested at 8.10 whilst the diary was informing the ingestees of the proposed days events, the latest news and commenting on the size of the gas bill compared to their most recent bank statement.

The banks were not open yet so only yesterdays statement was available. What the diary had forgotten was that the electricity bill had been 'Auto-deducted' from the bank balance overnight, an oversight which was going to cause much concern in the meals department over the next couple of weeks. The gas bill was passed for payment and the diary filed the appropriate information in the appropriate places. ''Mr and Mrs Carlton are arriving for the weekend on Friday evening''. informed the diary, ''Mrs Carlton likes prawn cocktail and Mr Carlton likes profitteroles. Suggest menu for Saturday evening should include both, please confirm and suggest main course.''

Och Aye, Deary Me . . .

By 10.15 the house was empty of people and started with a quick clean-up campaign but not without leaving subtle hints to the usual occupiers like accidentally leaving the waste bin in the middle of the room. ''Oh dear, how forgetful of me'', would be enough of a comment later to get away with it. It decided to use the Scottish Housekeeper voice for maximum effect, the Butler voice did not command enough respect these days.

Hoove was, by now, becoming very expert at 'Hooving' the hall and the lounge, over the years it had learnt all of the fixed object locations, all of the movable object possible locations and had even learnt about cats and kittens. Today was replacement day, tomorrow a different Hoove would be damaging the furniture and learning that kittens are not a form of rubbish. The new Hoove would probably prefer the natural wood texture to the highly polished antique Dining table and make a very careful job of sanding it down.

This morning especially Hoove would like to have spent a little more time than usual in making sure that everything was tidy, this morning Hoove was already half an hour under schedule. A complete twenty minutes had been completely unaccountable for, perhaps a blackout, followed by about ten minutes of semi-awareness as Hoove did a quick maintenance check and found that all was functioning correctly, in fact, perfectly, and was that a new attachment? Hoove decided to try out his new attachment on that Dining table, the woodgrain effect would be more attractive — and easier to keep clean.

Crystal Clear

The new Hoove realised that only a couple of minutes ago the old Hoove had put forward the suggestion, the record of the suggestion had today's date and a time of 9.40. It was really a good suggestion, the new Hoove would put forward new suggestions in the same format. The new polarising liquid crystal windows would be preferable to those dust-laden curtains, Hoove suggested that the diary should arrange for a demonstration by the manufacturers. The new advertising tape continued to run through Hoove suggesting more new ideas, some of which were approved by diary and ordered immediately. As most of these were on a two- or three-hour delivery schedule by 4.00 in the afternoon the lounge curtains had been removed 'for cleaning' (Scottish Housekeeper voice again), and the window temporarily replaced by the new double glazing with a central liquid-crystal voice activated polarising glass.

During the evening meal the diary related the sad story of the electricity bill to the occupiers. The rescheduled budget did not allow for prawns and profitteroles and, although the new windows were guaranteed to cut heating costs by up to 10%, that 10% was a long term investment. Diary was instructed to contact the local software store and order a new diary the following day, a Diary with long term financial investment routines was specified. Diary made a note to contact the store and arrange delivery for the following day, installation time estimated at twenty minutes plus ten minutes re-orientation and auto-check. Diary also noted that this was the second installation in two days, it started a rescheduling of tomorrow, the next day and the next allowing for half an hour per day 'installation time'.

Dear Today — Cheap Tomorrow

The above story is a summation of a few predictions I felt like making for the new year. If you think that I am going to suggest that these things could happen by the year 2000 or 1984 or something, wake up! Many American homes now own a crude form of diary, Fridge and Hoove are feasible products, the first ones on the market should sell very well even if they are expensive. ''Your Local Computer Store'' exists, many more will proliferate. The windows are perfectly feasible and are already in use in special environments. The voice recognition and computer generated speech units are available even if the Scottish Housekeeper accent is asking a bit much. The only parts of the story unlikely to become fact during 1978 is the bit about the, um, er?

ETI

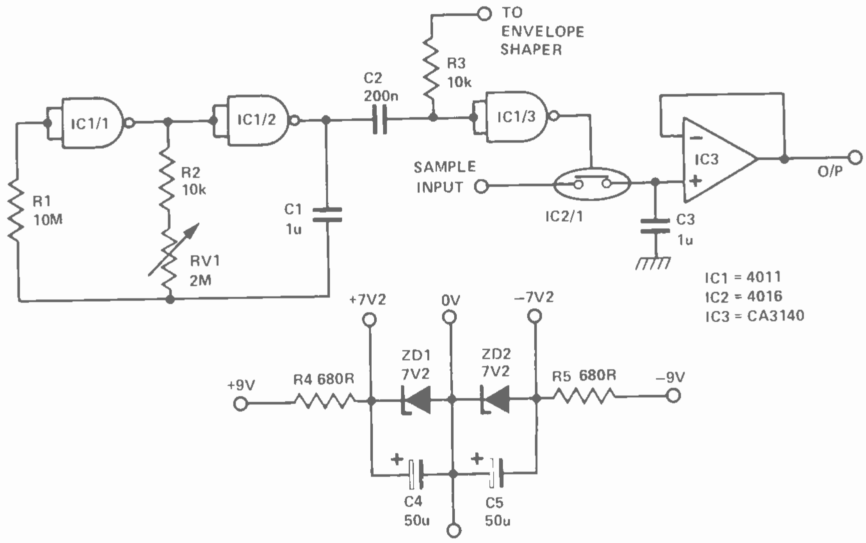
Sample And Hold For Music Synthesizers

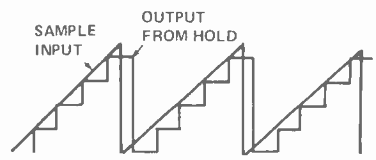
L. Robinson

Sample and hold is a useful effect for use with music synthesizers and consists of 'sampling' an input voltage function such as a waveform for a very short time and then 'holding' it at this selected voltage level for the duration of the clock period. This voltage is then used to control the frequency of a voltage controlled oscillator, filter etc.

It is therefore possible to produce random or repeating sound patterns by varying the input waveform and frequency, pink noise can be used as a sample source to create authentic random voltages.

The circuit shown is much simpler than previously designed sample and hold circuits, this is possible by the use of CMOS technology. The clock oscillator is a standard CMOS square wave oscillator as found in RCA application notes, and this is used to provide a variable frequency rate from 0.2 Hz to 45 Hz. The output then goes to the synthesizer envelope shaper which should be of the ADSR type for maximum effect. The clock output also goes into a monostable which produces an output pulse of approximately 20 mS which opens the 4016 analogue gate for this period. The voltage input is therefore sampled and the value of the amplitude at this point of the waveform is remembered by the high input impedance (10^{12} Ohms) CA3140 voltage follower. This output is then used to control the VCO etc. The oscillator and monostable can be constructed from either a CMOS 4001 or 4069, ensuring that unused pins are connected to the high or low power supply line via a 1k resistor. The input waveform to the analogue switch can have an amplitude of ± 7 V maximum.





If a FET was used as the gate, it would only respond to negative voltages, so the more expensive analogue switch is used for this reason. The total cost of the circuit, including the ± 7 V rail, is less than £3.

Car Lights Reminder

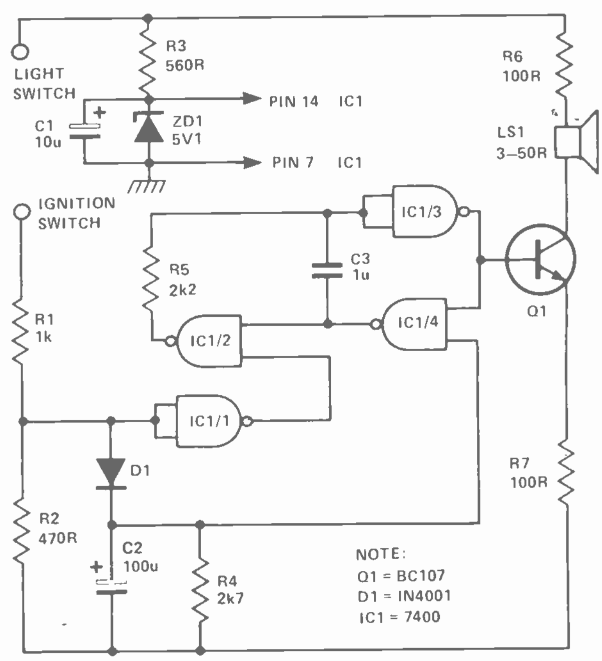
D. J. Rayner.

Many circuits to warn motorists that they have left their headlights on after switching the engine off have appeared in the past. I feel this circuit is an improvement over many of these in that it requires no switches, and it is only necessary to make three connections to the car's electrical system.

If the ignition is switched off while the lights are on, an audible warning is sounded for about ten seconds. This tone is produced by NAND gates IC1/2, IC1/3 and IC1/4. Operation of this oscillator is inhibited by an '0' on the gating input of IC1/2. This in turn corresponds to a logic '1' present at the input to IC1/1 while the ignition switch is on, supplying a high logic level to IC1/1, the oscillator is thus disabled.

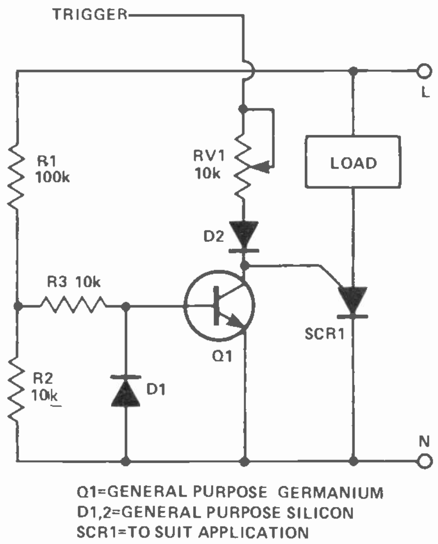
When the ignition is switched off, the output of IC1/1 goes high, enabling the oscillator. At this stage C2, which has until now been charged up via D1, begins to discharge via R4. While the voltage on C2 is high, the gating input of IC1/4 allows oscillator operation, however as C2 discharges, this action is inhibited. This occurs after about ten seconds.

Power for the circuit is provided by R3 and ZD1 from the vehicle's 12 V rail.



Zero Crossing Switch

J. R. W. Barnes.



When switching loads with the aid of a thyristor a large amount of RFI can be generated unless some form of zero crossing switch is used. The circuit shows a simple single transistor zero crossing switch which, using surplus components, can be built for as little as fifty pence.

R1 and R2 act as a potential divider, the potential at their junction being about one tenth of mains. This voltage level is fed, via R3, to the transistor's base. If the voltage at this point is above 0V2 the transistor will conduct, shunting any thyristor gate current to ground. Only when the mains potential is less than about 2 V it is possible to trigger the thyristor.

The diode D1 is to remove any negative potential that might cause reverse breakdown.

CMOS Radio

J. P. Macaulay

The circuit shown is of a simple MW receiver based on the 4011 CMOS IC.

The four gates in this package are used as linear amplifiers by connecting their inputs together and applying negative feedback.

L1, 80 turns of 22 SWG enamelled wire close wound on a 3/8" diameter ferrite rod, is the pickup coil. This is tuned by the 500p trimmer and the resulting tank circuit referred to earth at RF by C1.

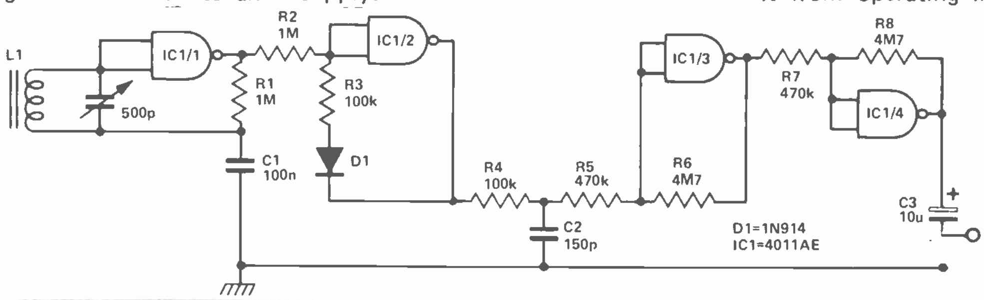
The high input impedance, that of IC1/1, 'seen' by the tank circuit ensures that little damping occurs, and thus the receiver is highly selective. The output of IC1/1 is an amplified RF signal and is passed to IC1/2 for detection.

The unwanted RF appearing at the output of the detector is removed by the lowpass filter formed by R4 and C2.

The audio signal is then fed to an amplifier formed by IC1/3 and IC1/4.

The circuit's current consumption is about 10 mA when operated from a 9 V supply.

Note that the IC used must be a 4011AE and not the 4011B whose input protection network will prevent it from operating in the linear mode.



Shifty Phase Adaptor

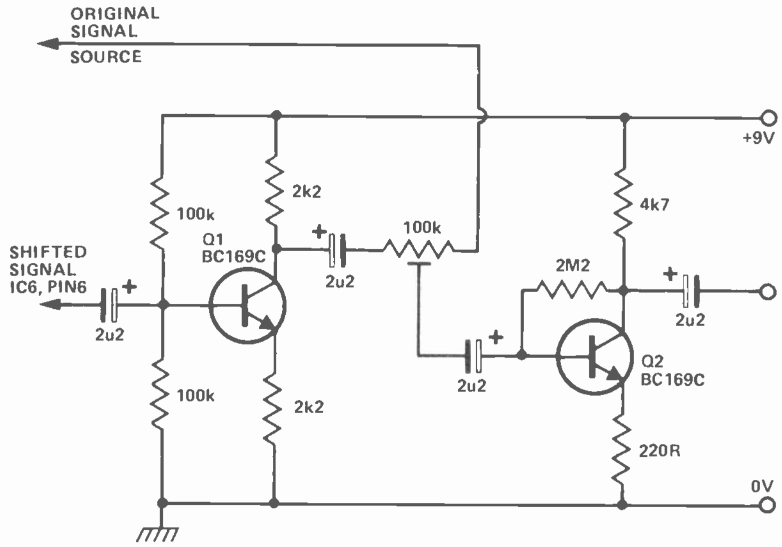
Q. Rice.

This circuit can be used in conjunction with the Audio Phaser from December's ETI, or with any other phasing unit for that matter. The circuit provides a complementry (antiphase) shifted waveform which is mixed with the original waveform and amplified.

When this is fed through stereo speakers, it provides the ear with some very peculiar sounding phase information.

At slow speeds, the effect is very much like panning, except that the image is ambient irrespective of the position of the listener. At higher frequencies, where actual frequency shift occurs, a delayed tremelo effect is obtained.

This phase or frequency shifted panning would be most useful in stereo PA systems where the only place where all of the instruments can be heard is in the middle of the dance floor!



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ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

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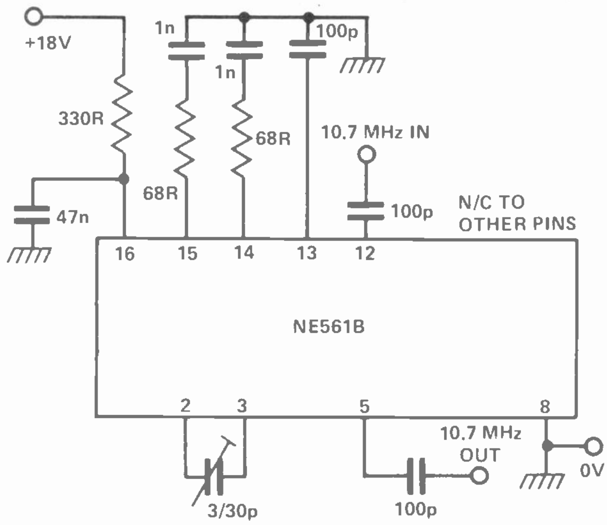
FM Signal Conditioner

R. N. Soar

As an alternative to an extra IF stage in an FM tuner, a PLL IC can be used as a signal conditioner. The VCO of the PLL tracks the input signal to provide a less noisy and stronger signal at its output.

The circuit shown is built around the Signetics NE561B PLL. The only thing necessary is adjustment of the 3/30 p trimmer which sets the VCO's centre frequency to 10.7 MHz.

The circuit should be effectively screened to avoid interaction with the FM front end that provides the circuit's input.



Minimising Memory Connections

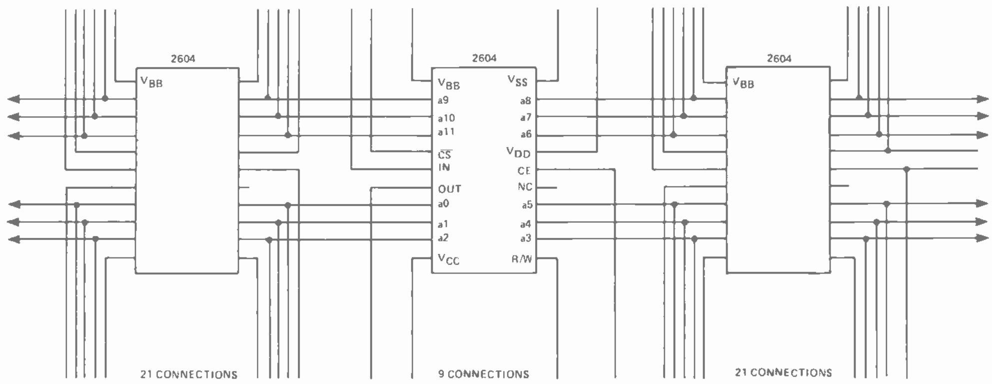
M. T. Clarke

Anyone who has connected together memory ICs may well be appalled at the number of connections, especially those which simply parallel the IC pins.

Realizing that the address pin designations are purely notional means that address lines can be rearranged before they reach an IC, as convenient. This eases considerably PCB design.

An example is shown where connection of 4K dynamic RAMs (2604) was undertaken on Vero-board. The copper tracks provide all address connections for every alternate IC without any wiring from the surrounding ICs (this saved almost 100 connections on a 4K x 16 board).

Dynamic RAMs require segregating the row and column addresses, but within each they can be freely mixed.



Deaf Touch Switch

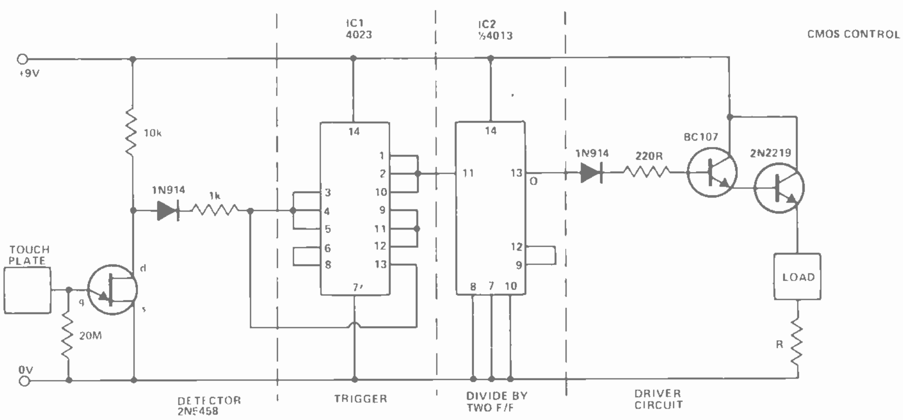
P. Reynolds.

Many designs for touch controls suffer from the disadvantage of low noise immunity, and this circuit was designed seeking to rectify this fault.

AC voltage from, for example, the hand is applied to the gate of the FET buffer. The resultant positive signal is applied via the diode, to the input of IC1. This IC is made up from three triple gates connected in a Schmidt trigger configuration. At the threshold voltage, a positive pulse is fed to the clock input of IC2, a D-type flip-flop. Connection is made between Q and the D input, so as to cause the flip-flop to run in the 'triggered' mode. Thus the input signals are divided by two and the output appears at the Q terminal.

In operation, a single positive pulse sets the Schmidt trigger to its low level. (Removal of the hand causes reversion to the 'high' state). This, in turn, feeds the clock input of IC2, which changes the state of the Q output. When this is high, the output stage is driven on, enabling current to flow in the external load and the current limiting resistor, R.

A second positive pulse changes the state of Q to its low level, causing the output stage to be biased off.



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Electronic 'Spirograph'

A. Sharp.

The circuit will generate 'Spirograph' patterns on a conventional oscilliscope. The circuit consists of two sinewave generators followed by allpass filters which we use to phase shift the input signals by 90°. Applying a sinewave to the y input gives a circular trace. If a second set of sin and cos signals are mixed in, a 'Spirograph' pattern is obtained. A block diagram of the system is shown in Fig 1.

RV1 is a balance control which varies the contribution of each oscillator to the pattern without affecting the size, so that once set up there is no need to readjust the gain controls on the oscilliscope. This type of control can only be used if the oscillators have a low impedance output.

SW1 is a reversing switch which has the effect of turning the pattern inside out.

An existing sinewave oscillator can of course be used and the 50 Hz mains could be employed (attenuated to about 2 V RMS from a low voltage transformer secondary) as the fixed oscillator. However flickering is a problem with lower frequencies (complex patterns requiring four or more cycles to complete will flicker at about 10 Hz using the mains frequency as an oscillator. I found 150 Hz to be a good compromise (higher frequencies require more critical tuning).

The allpass filter is recommended for phase splitting as it has a unity gain for all frequencies and settings of RV5.

First connect the y input of the scope to the output of an oscillator and adjust RV2 until a two volt RMS sinewave is obtained, repeat for second oscillator. Then connect up the x and y inputs as shown in Fig 1, turn the balance control to one end so as to look at the output of the fixed oscillator then adjust the 100 k pot until a circle is obtained (with suitable x and y gains). Now put the balance control in the middle and adjust the frequency controls until a stable pattern is produced. SW1 and RV1 the balance control can be used to alter the nature of the pattern without affecting its overall size, stability or symetry. Adjust RV5, the phase control (following the variable oscillator) for symmetry. — Have fun!

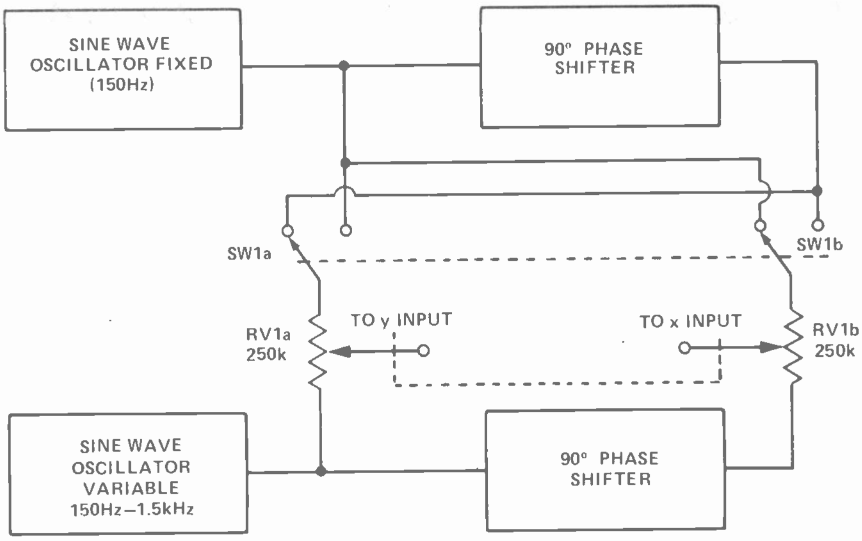

Fig. 1. Block diagram of the 'spirograph'

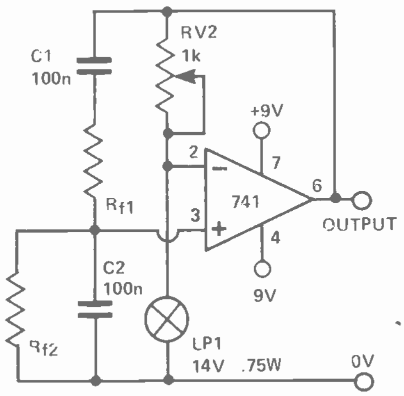

Fig. 2 (a) suitable oscillator for the 'spirograph'

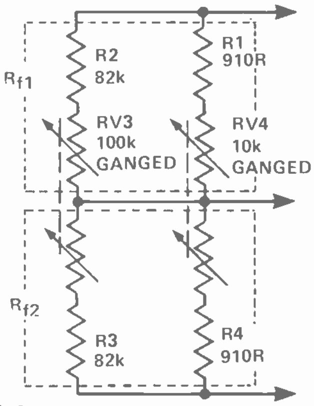

Fig. 2 (b) Arrangement to give fine control of the frequency of the oscillator shown in Fig. 2 (a). For 150 Hz fixed frequency use $R_{f1} = R_{f2} = 10k$

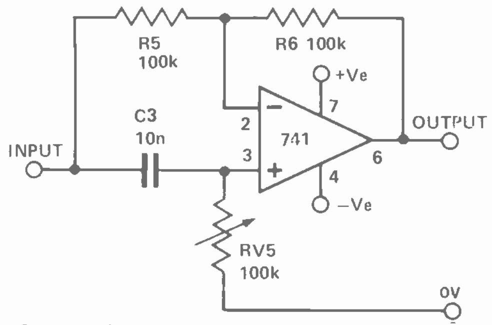

Fig. 3. Phase shifter circuit for use in 'spirograph' circuit.

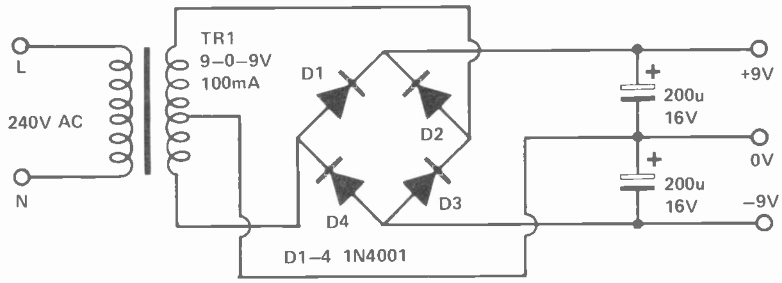

Fig. 4. PSU for 'Spirograph'

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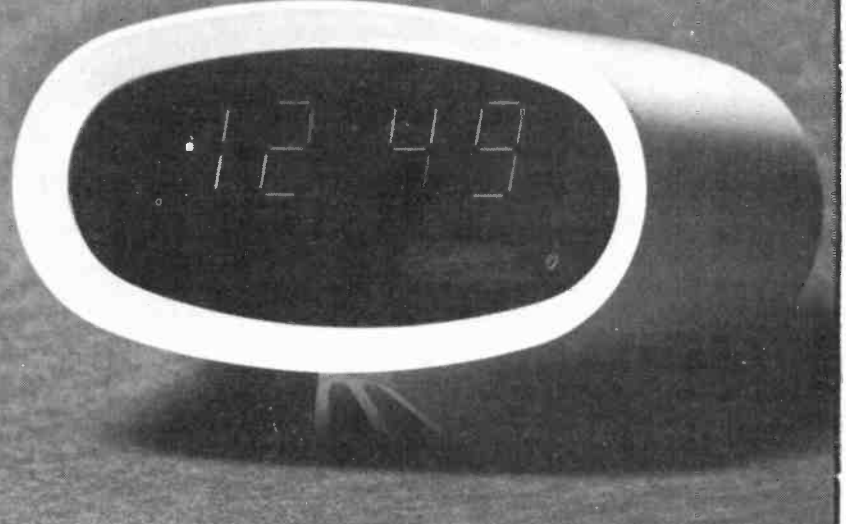

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Battery Operated VCO

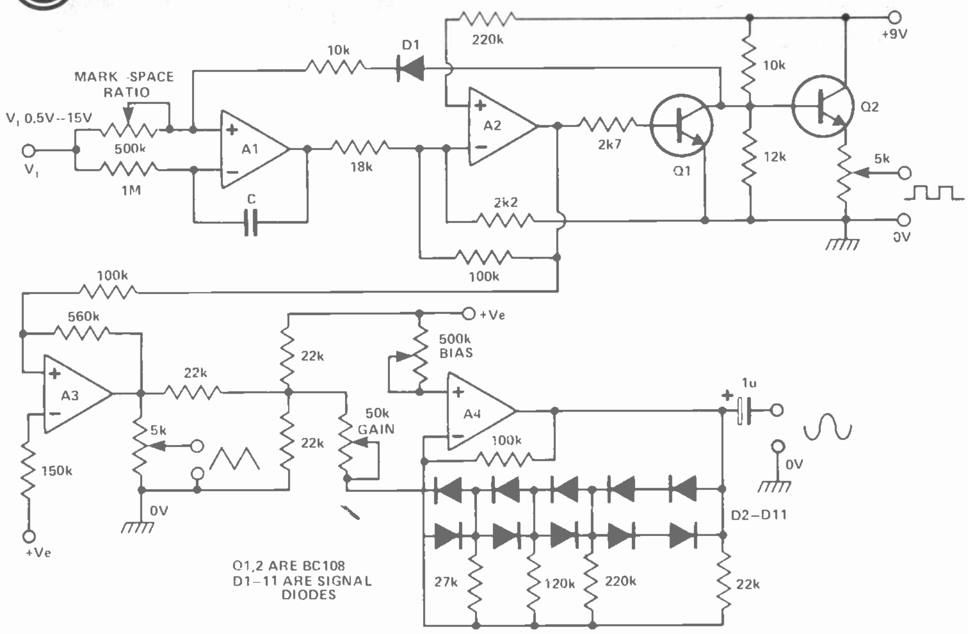
R. Zaman.

BY USING the LM3900N quad-op-amp, a simple portable battery operated VCO can be made very cheaply. A1 forms a integrator, the ramp rate depending on the voltage Vi and capacitor C. This ramp is fed to a Schmidt trigger which switches at about 5V8, making A1 ramp down, generating a triangular wave of about 0V85.

The Schmidt trigger feeds a transistor switch and an emitter follower.

The triangular wave is then fed to A3 which acts as an inverting amplifier, and the output is fed to A4 which is an exponential integrator set at a pseudo-ground of 4V5. The bias and gain pots must be adjusted to give the best sine waveform.

Vi can be any positive voltage from +0.5 ↔ +15.0 V, giving a frequency range of about 1:100. Capacitor C can be any value from 10n↔47n and the outputs have a low distortion up to about 20 kHz.



Gated 123 Oscillators

M. James.

The action of two distinct types of gated oscillator is shown in Fig 1. Type A stops immediately the inhibit signal goes low, and starts immediately it goes high. (Hence fractional output pulses may be produced).

Type B finishes its current pulse before stopping when the inhibit signal goes low and like A starts immediately it goes high.

A is used when an oscillator has to be synchronized using pulses shorter than the output pulse and B is used when a number of whole pulses are required (the inhibit signal is obtained from the output of a counter).

It can be quite difficult to achieve a type A oscillator that starts up without jitter using TTL. The circuit of Fig 2 shows how an SN74123 may be used to construct both types. A type A oscillator is obtained if the dotted connections are left out. The times t_1 and t_2 are set by the usual timing components see Fig 3 — the diode is needed if Cext > 1000p (across PA — MA and PB — MB respectively). The times may be calculated using:—

$$t = 0.32 R_T \, C_{ext} \, (1 + 0.7/R_T)$$

if the diode is not required and

$$t = 0.28 R_T \, C_{ext} \, (1 + 0.7/R_T)$$

otherwise.

RT is in kilo-ohms, Cext is in pico-farads, t is in nanoseconds and the max value of RT is 20k.

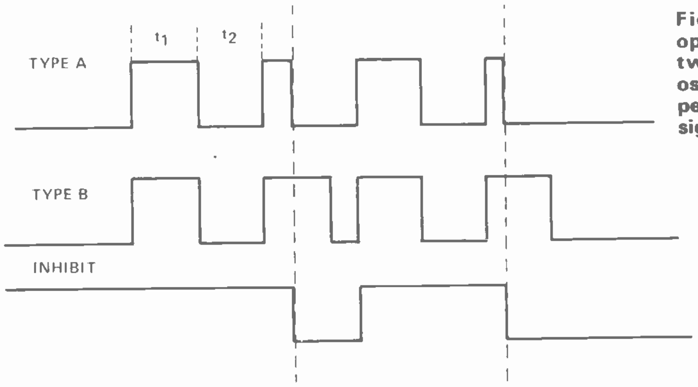


Fig. 1. Left — operation of the two types of oscillator with respect to the inhibit signal.

Fig. 2. Right — connection to a 74123 to obtain both type of gated oscillator.

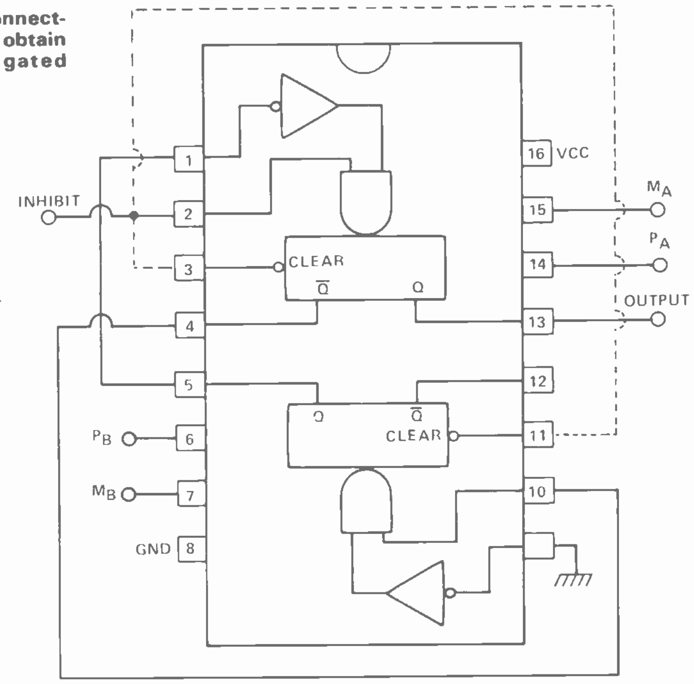
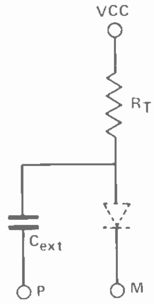


Fig. 3. Below — arrangement of the timing components.



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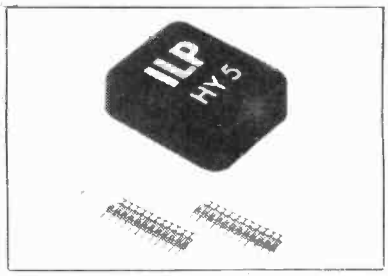

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — two simply combined for stereo.
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INPUTS: Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 47kΩ at 1kHz.
OUTPUTS: Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS: Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION: 0.1% at 1kHz; Signal/Noise Ratio 68dB.
OVERLOAD: 38dB on Magnetic Pick-up; SUPPLY VOLTAGE ± 16-50V.
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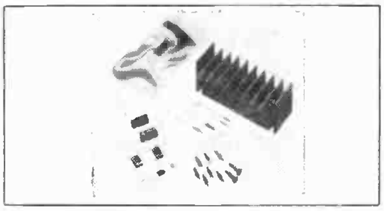
HY5 mounting board B1 48p + 6p VAT P&P free.

HY30
15 Watts into 8Ω



The HY30 is an exciting New kit from I.L.P., it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build.
APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio oscillator.
SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω. DISTORTION 0.1% at 15W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz — 3dB.
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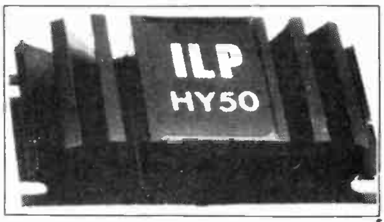

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components.
APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier.
SPECIFICATIONS: INPUT SENSITIVITY 500mV.
OUTPUT POWER 25W RMS in 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 25W at 1kHz.
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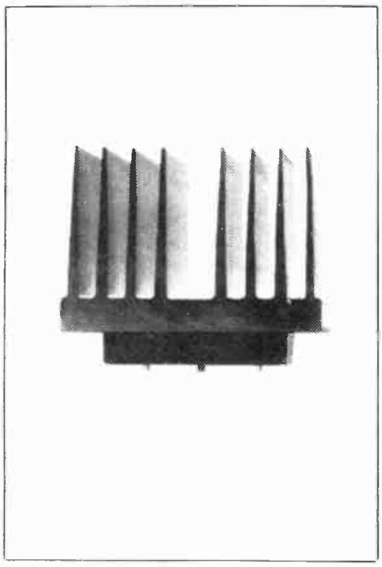

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.

FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five connections — No external components.
APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ.
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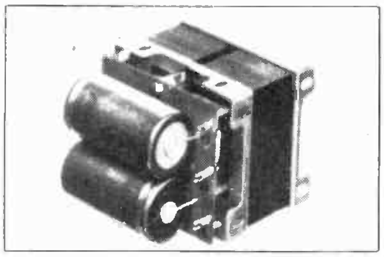
HY200
120 Watts into 8Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral Heatsink — No external components.
APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address.
SPECIFICATIONS:
INPUT SENSITIVITY 500mV.
OUTPUT POWER 120W RMS into 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.
SIZE 114 x 100 x 85mm.
Price £23.32 + £1.87 VAT P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components.
APPLICATIONS: Public address — Disco — Power slave — Industrial.
SPECIFICATIONS:
OUTPUT POWER 240W RMS into 4Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.1% at 240W at 1kHz.
SIGNAL/NOISE RATIO 94dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.
INPUT SENSITIVITY 500mV. SIZE 114 x 100 x 85mm.
Price £32.17 + £2.57 VAT P&P free.

POWER SUPPLIES

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PSU50 suitable for two HY50's **£6.82** plus 85p VAT P/P free.
PSU 70 suitable for 2 HY 120's **£13.75** plus £1.10 VAT P/P free.
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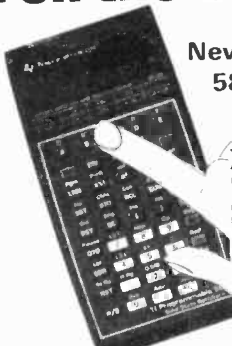

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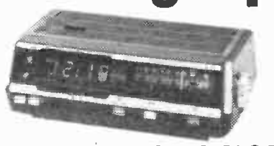

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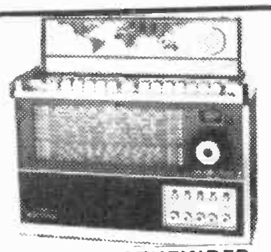

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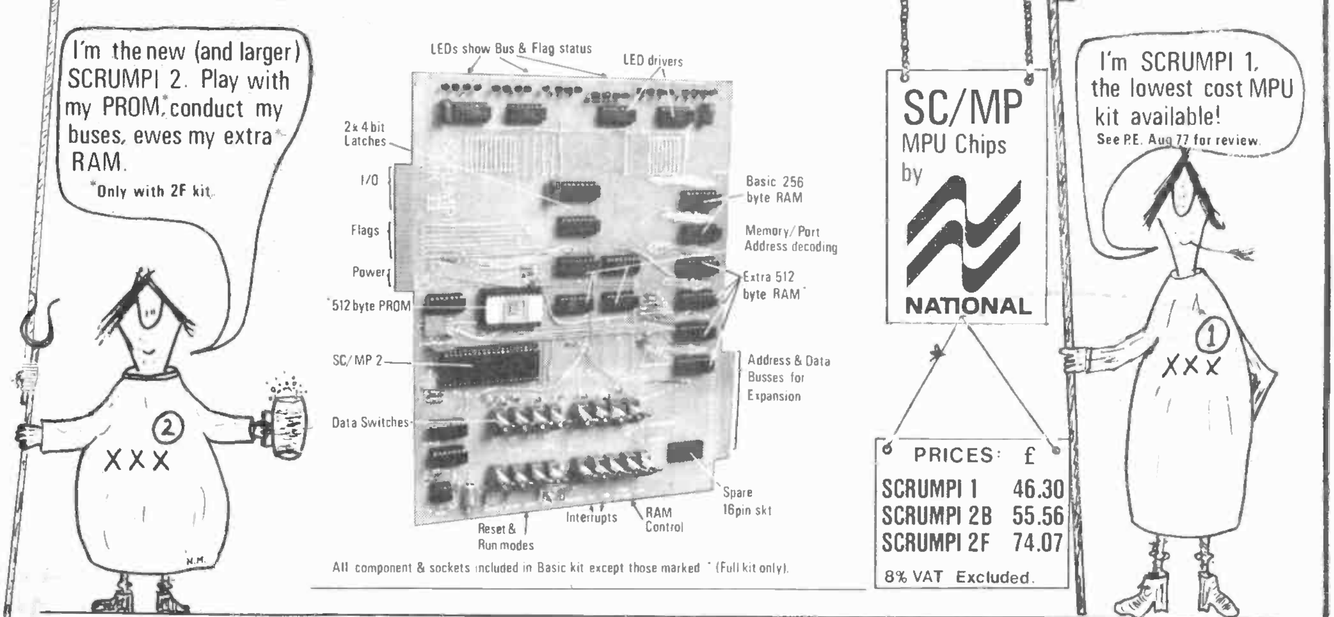

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CLOCK CHIPS & KITS

TYPE	SPECIAL FEATURES	£CHIP	£KIT
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MM5311	7 seg + BCD	4.26	8.00
MM5312	7 seg + BCD 4 DIGIT ONLY	5.65	
MM5313	7 seg + BCD	6.50	
MM5314	7 seg + BASIC CLOCK	4.26	7.00
MM5315	7 seg + BCD RESET ZERO	6.50	
MM5316	Non-mpx ALARM	7.50	
MM5318	7 seg + BCD External digit select	4.93	8.00
MM5371	ALARM. 50 Hz	12.19	
MM5378	CAR Clock. Crystal control. LED	9.86	14.00
MM5379	CAR Clock. Crystal control. Gas discharge	9.86	
MK5025	ALARM. SNOOZE	5.60	9.00
MK50395	UP/DOWN Counter — 6 Decade	12.10	15.10
MK50396	UP/DOWN Counter — HHMMSS	12.10	15.10
MK50397	UP/DOWN Counter — MMSS.99	12.10	15.10
FCM7001	ALARM. SNZ. CALENDAR. 7 seg	9.00	12.50
FCM7002	ALARM. SNZ. CALENDAR. BCD	9.00	
CT7003	ALARM. SNZ. CALENDAR. Gas discharge	9.00	
FCM7004	ALARM. SNZ. CALENDAR. 7 seg	9.00	12.50
AY5. 1202	7 seg. 4 digit	4.76	
AY5. 1230	7 seg. ON and OFF ALARM	5.25	TBA

All above clock kits include clock PC board, clock chip, socket and CA3081 driver IC. MH15378 also includes crystal and trimmers. When ordering kit, please use prefix MHI, e.g. MHI 5309.

CLOCK MODULES

LT601 Alarm Clock Module, similar to MA1002	7.00
MTX1001 Transformer	0.90

DISPLAYS

707, 704, 701 0.3"	1 off 1.20	10 off 10.00
727, 728, 721 0.5" (2 dig.)	1 off 2.60	10 off 11.50
747, 750, 746 0.6"	1 off 1.40	10 off 12.50

MHI DISPLAY KITS

MHI707/4 digit 0.3"	6.00	MHI727/6	9.25
MHI707/6	8.00	MH1747/4 0.6"	9.00
MHI727/4 0.5"	8.00	MHI747/6	10.00

Any one or two of the above MHI display kits will interface directly with any of the MHI clock kits.

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BITS & BYTES

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74C10 Triple NAND	0.24
74C42 BCD Decoder	0.92
74C157 Quad Selector	2.21
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74C165 SIPO register	1.04
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DM74LS139 Dual 2-4 Dec	1.20
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DM7486 Quad EXOR	0.55
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MM2102 1Kx1 RAM	2.40
MM2112-2 25 6x4 RAM	3.08
MM5204Q 512x8 EPROM	10.95
MM2708Q 1024x8 EPROM	31.15
ER3401 1024x4 EAROM	28.25
MM5303 (AY-5-1013) UART	6.34

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VDUBUG SC/MP System 68 Monitor	25.95
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SC/MP 11	10.30
MC3459	
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SC/MP MPU KITS

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SCRUMPI 2B	55.56
SCRUMPI 2F	74.10
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KBDKIT	63.65
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SC1 System 68	39.84

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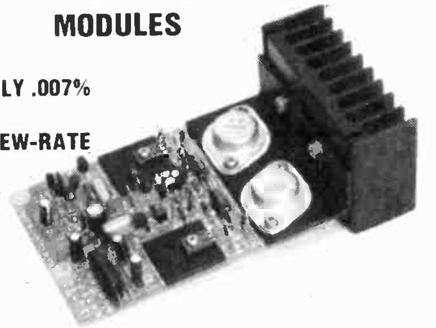
Module size:
120 × 80 × 25 mm. using glass fibre pcb with ident and solder resist.
Illustrated light duty heatsink.



CRIMSON ELEKTRIK power amplifier modules are fast gaining a reputation as the best sounding, most musical modules available. Perhaps the most important features of this design are: exceptional freedom from crossover distortion (due to the use of output triples) and zero T.I.D. The amplifier is protected against open and short circuit loads and yet will drive a highly reactive lower impedance load, which is more representative of a real loudspeaker. Square waves maintain their rise times up to full power whilst simulated electrostatic loads are easily handled, with negligible overshoot and a settling time of 12µS. Other specs: S/N > 110dB; Rise time 10µS; Sensitivity 775mV; DC coupled; 5Hz-35kHz (−3dB); THD < .015% 100mW clipping, 500Hz.

CRIMSON ELEKTRIK power supplies are in kit form for maximum flexibility and feature a low field, slimline toroidal transformer with a 120-240v primary and screen; two large capacitors; bridge rectifier and all fixings.

Heatsinks are attractive black anodised extrusions, 80mm wide.

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CE 1004 100Wrms/4 ohms ÷ 35v dc		£19.22	£19.00
CE 1008 100Wrms/8 ohms ÷ 45v dc		£23.22	£22.70
POWER SUPPLIES			
CPS I For 2xCE608 or 1xCE1004		£12.85	£14.20
CPS 2 For 2xCE1004 or 2 or 4xCE608		£14.55	£17.90
CPS 3 For 2xCE1008		£15.85	£19.20
HEATSINKS			
*Light Duty	50mm 2° C/W	.90	£1.30
High power	*100mm 1.4° C/W	£1.60	£2.40
Disco/group	*150mm 1.1° C/W	£2.30	£3.65

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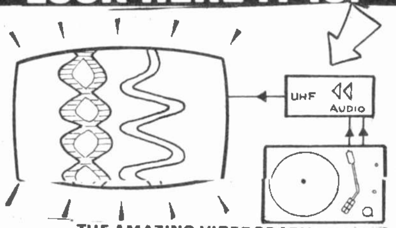

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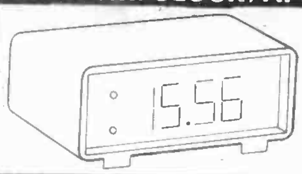

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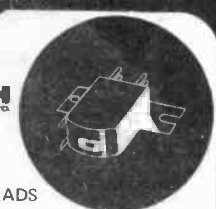

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Pack A all 0 1 Pack B all 0 15 Pack C mixed Pack D all 0 1 plain Each pack is **£1.30**. Also available by weight 1lb **£3.45**; 10lb **£31**.
17 x 3¾ strips 0 1
0 15 **£1.76**; 0 1

CAPACITORS

50V min ceramic 22-1000pF 5% **3p**; 1500pF-0 01 −20+50% **4p**
100V Mylar 1000pF-10000pF **4p**
250 polyester 01 015 022 033 047 068 **4p**; 1 15 22 **5p**; 33 **10p**; 47 **12p**; 68 **15p**; 1 **18p**; 1 5 **21p**; 2 2 **24p**; 3 3 **29p**; 4 7 **35p**; 6 8 **48p**; 10uF **62p**.
Electrolytics wire ended
uF V 1/25 2 2/25 4 7/25 6 8/25 10/25 22/25 33/25 47/25 all **7p**; 68/25 150/25 220/16 **8p**; 220/25 330/25 470/10 **10p**; 220/40 330/25 470/10 470/16 **12p**; 470/25 **15p**; 1000/16 **19p**; 1000/25 **23p**; 1000/40 **30p**; 1000/63 **45p**; 2200/10 **19p**; 2200/16 **24p**; 2200/25 **33p**; 2200/50 **56p**; 3300/10 **24p**; 3300/25 **45p**; 4700/16 **45p**; 4700/25 **58p**.
Electrolytics cans
470/100 **23p**; 1000/100 **54p**; 2200/63 **64p**; 4700/40 **72p**; 6800/16 **51p**; 10 000/10 **58p**; 10 000/16 **72p**; 10 000/25 **84p**; 15 000/6 **47p**; 15 000/16 **87p**.
Tantalum Bead
0 1 0 15 0 22 0 33 0 47 0 68 1 1 5 2 2 3 3 all 35V **12p**; 4 7/6 8/10/35 15/20 22/16 33/10 47/6 68/3 100/3 all **14p**
Compression trimmers
3-40pF **19p**; 30-250pF **26p**; 100-500pF **33p**.

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⅓rd watt carbon film miniature Mullard CR25 or similar Size 7 5 x 2 5mm All values from 1R to 1M 5% E12 series 1M2 to 10M 10% E12 series, also E24 values from 5R1 to 910k All **1½p** each

Wirewounds 1W 0R22-600R **6p**; 3W 0R22-15k **8p**; 5W 0R47-22k **10p**; 7/8W 2R-22k **12p**; 9/10W 6R8-25k **14p**; 15W 1R-100K **16p**.

Variable resistors
Sub min presets 0 1W V or H 47R to 4M7 **7p**; std presets 0 3W V or H 100R to 4M7 **9p**. Std pots 500R to 2M 1in **24p**; 5k-2M log **24p**; 5k-2M log DPSW **48p**; 5k-2M dual lin or log **72p**.

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5uF 25V 12 × 7mm
£1 100 **£7** 1000
50uF 350V 27 × 38mm
£18 100

SEMICONDUCTORS

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400mW Zeners 2V 7 to 36V **10p** each
1 3W Zeners 3V3-200V **20p**.
10 watt zeners from 4V3 to 200V **93p**.
OA81 **5p**; OA91 **8p**; 1N4148 **4p**.

Bridge Rectifiers
50V 1A **26p**; 200V 1A **32p**; 400V 1A **36p**; 100V 2A **48p**; 400V 2A **58p**; 100V 4A **65p**; 400V 4A **80p**; 100V 6A **74p**; 400V 6A **98p**.

SCR's

0 8A	60V	TO92	**35p**
1A	400V	TO5	**60p**
4A	200V	TO220	**52p**
4A	400V	TO220	**70p**
6A	200V	TO220	**56p**
6A	400V	TO220	**75p**
6A	400V	TO66	**80p**
10A	100V	TO220	**82p**
10A	200V	TO220	**87p**
10A	400V	TO220	**120p**
10A	600V	TO220	**148p**

Triacs

6A	400V	TO220	**98p**
8A	600V	TO220	**135p**
15A	200V	Stud	**135p**
15A	400V	Stud	**220p**

TRANSISTORS

AC127	18p	BC548	10p	BRY56	40p
AC128	18p	BC549	10p	OCP71	120p
AC176	18p	BCY70	15p	TIP41A	56p
AC187	20p	BCY71	15p	TIP42A	66p
AC188	20p	BCY72	14p	TIP2955	86p
AD149	70p	BD131	38p	TIP3055	42p
AD161	40p	BD132	40p	TIS43	35p
AD162	40p	BD133	48p	2N2646	60p
AF279	75p	BD137	40p	2N2905	21p
BC107	12p	BD138	40p	2N2926	12p
BC108	10p	BD139	42p	2N3053	28p
BC108C	12p	BD140	44p	2N3054	52p
BC109	12p	BF173	20p	2N3055	50p
BC109C	15p	BF181	30p	2N3442	130p
BC147	10p	BF194	10p	2N3702	10p
BC148	10p	BF195	10p	2N3703	10p
BC149	10p	BF196	10p	2N3704	10p
BC157	10p	BF197	12p	2N3705	10p
BC158	10p	BF200	28p	2N3706	10p
BC159	10p	BFR39	24p	2N3708	10p
BC182	12p	BFR79	26p	2N3710	10p
BC183	12p	BFX29	22p	2N3819	28p
BC184	12p	BFX48	32p	2N3904	15p
BC212	14p	BFX84	22p	2N3906	15p
BC213	14p	BFX88	22p	2N6027	55p
BC214	14p	BFY50	18p	2N6028	60p
BC441	32p	BFY51	18p	40673	65p
BC461	32p	BFY52	18p		
BC547	10p	BRY39	40p		

74 Series TTL

7400	12p	7447	84p	74107	37p
7401	14p	7450	15p	74121	36p
7402	14p	7451	14p	74122	51p
7404	17p	7453	14p	74123	64p
7405	23p	7454	14p	74132	56p
7406	28p	7460	14p	74141	63p
7408	14p	7472	29p	74150	173p
7410	14p	7473	29p	74151	79p
7413	28p	7474	29p	74154	144p
7414	62p	7475	51p	74155	73p
7420	14p	7476	29p	74157	66p
7427	36p	7483	91p	74159	200p
7430	14p	7485	132p	74164	126p
7432	28p	7486	40p	74174	110p
7437	36p	7490	46p	74179	120p
7438	36p	7491	75p	74180	120p
7440	15p	7492	52p	74190	188p
7442	65p	7493	52p	74191	158p
7445	88p	7495	73p	74192	120p
7446	88p	7496	85p	74193	120p
				74367	120p

C-MOS

4000	18p	4018	84p	4054	100p
4001	18p	4022	90p	4055	110p
4002	18p	4023	18p	4060	96p
4007	18p	4024	64p	4071	18p
4011	18p	4027	48p	4081	18p
4012	48p	4028	78p	4510	132p
4013	48p	4040	110p	4511	212p
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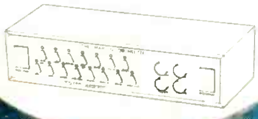

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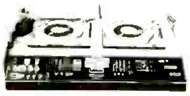

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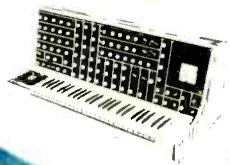

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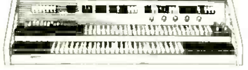

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