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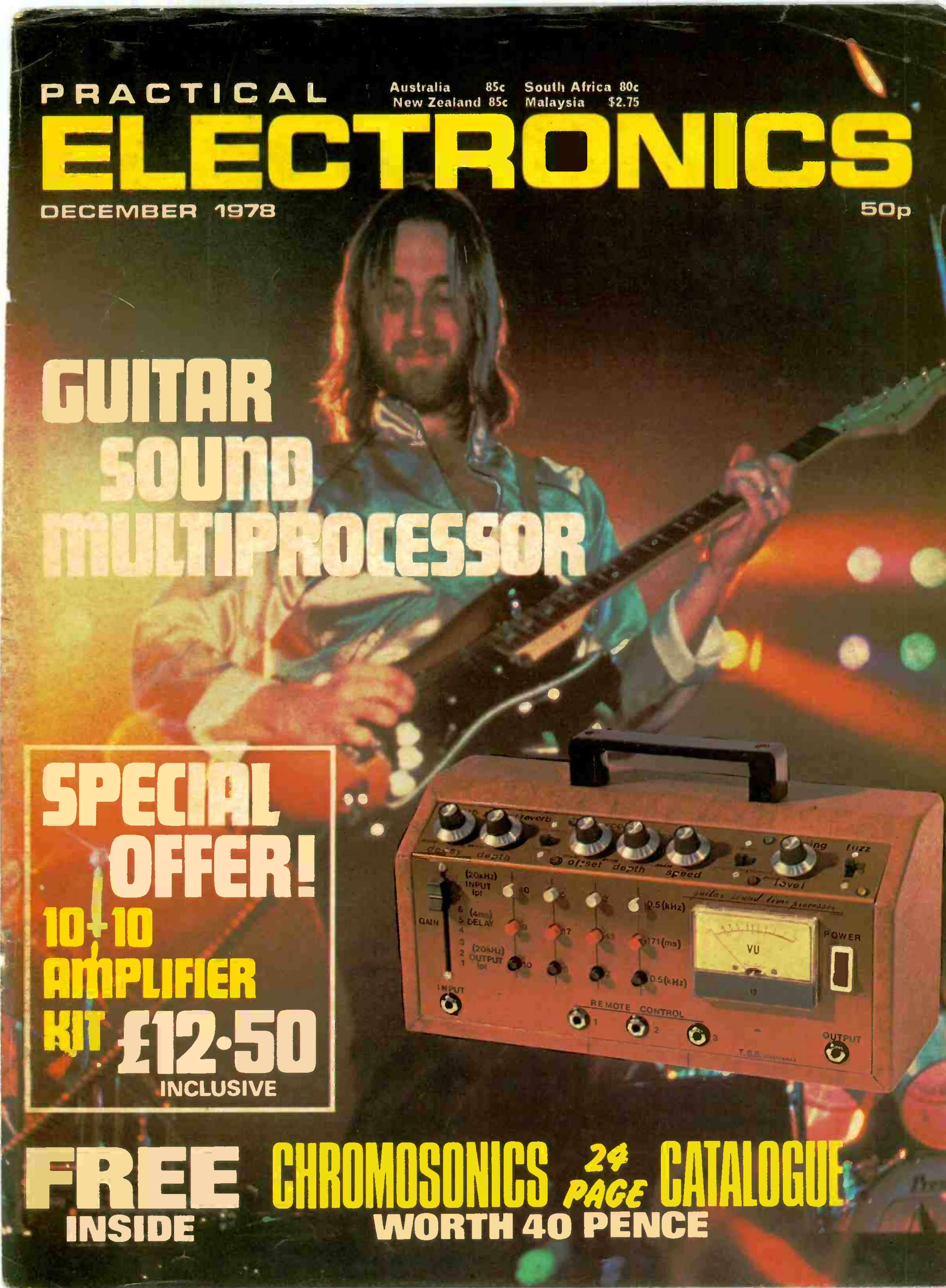

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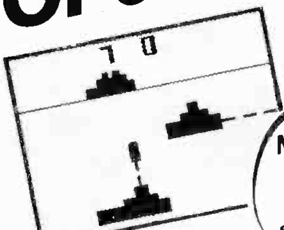
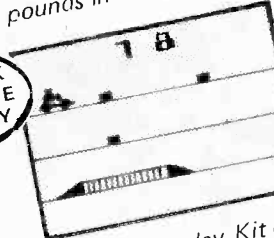
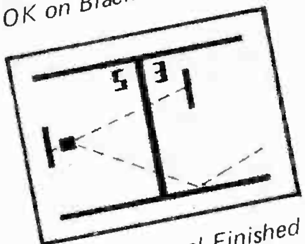


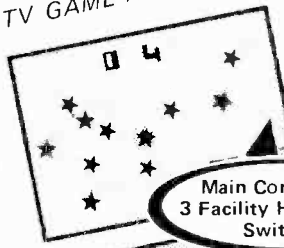
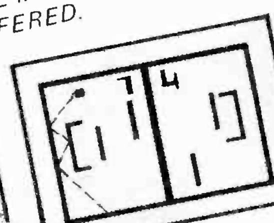



Money back if not satisfied

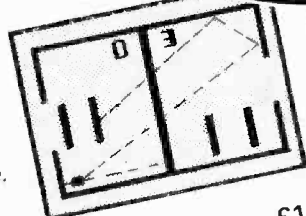
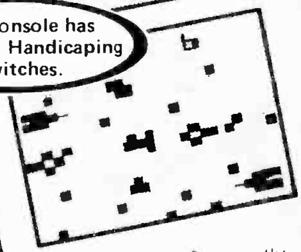
We offer all this to you for ONLY **£28·90** + £2.31 VAT

Fully Assembled £35.90

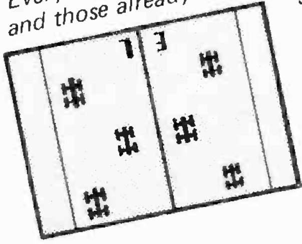
The Teleplay Kit consists of a Professional Finished Inject Moulded Box – Joystick Hand Controls – one cartridge which consists of 10 games – Football, Tennis, Solo Squash (1 & 2 players), Hockey, Basketball (1 & 2 players), Shoot etc. Mains Adaptor. All holes are pre-drilled – No Special equipment required. You'll be surprised how easy it is to assemble this professional kit! Instruction Manual supplied separately at 0.45p. TELEPLAY GIVES YOU TWICE THE FUN BUILDING AND PLAYING THE MOST PROFESSIONAL TV GAME KIT EVER OFFERED.

Main Console has 3 Facility Handicaping Switches.

Every 3 months a NEW game will become available to you and those already under production include Submarines, Space War, Wipe Out and many more. The price of these will vary from £12 to £19 depending upon the complexity of the game.



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PRACTICAL

ELECTRONICS

VOLUME 14 No. 16 DECEMBER 1978

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our January issue will be on sale Friday, 8 December 1978
(for details of contents see page 1259)

NOT EVERY CABLE HAS A LABEL

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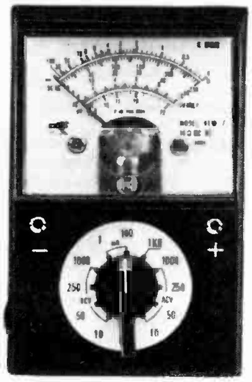

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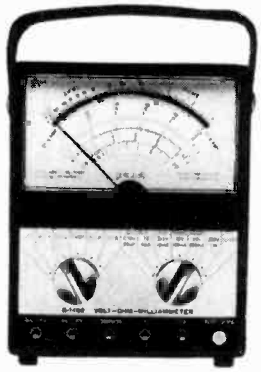

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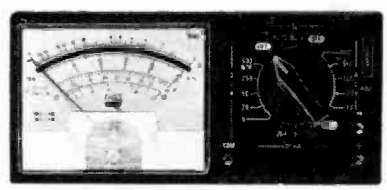

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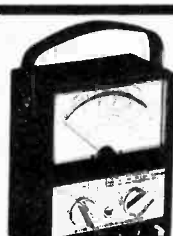

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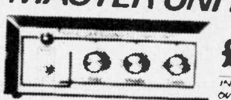

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1A DP c/over **15p**
½A DPDT **13p**
4 pole c/over **24p**
PUSH BUTTON
Spring loaded
SPST on/off **60p**
SPDT c/over **65p**
DPDT 6 Tag **85p**

JACK PLUGS / SOCKETS

	Screened chrome	Plastic body	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

	PLUGS	SOCKETS	In Line
DIN 2 PIN Loudspeaker	11p	7p	18p
3, 4, 5 Pin Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours	9p	5p single	15p
Metal Screened	12p	8p double / 10p 3-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	7p	7p	—
WANDER 3mm	8p	8p	—

SWITCHES ★ Miniature Non-Locking
Push to Make **15p** Push to Break **25p**
ROCKER (white) 10A 250V
SP changeover centre off **30p**
ROCKER: (black) on/off 10A 250V **23p**
ROCKER: Illuminated (white)
Lights when on: 3A 240V **52p**
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2-6W 3p/2-4W 4p/2-3W **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**; 20 pin **27p**; 24 pin **30p**; 28 pin **42p**; 40 pin **55p**.

DIGITAL MULTIMETER

Announcing DM900 – The Digital Multimeter with a difference – It measures Capacitance too. *(as published in E.T.I. August 1978)*

Throw away your analogue meters, here's digital accuracy at only half the price of an equivalent commercial Multimeter.

The DM900 is a 3½ digit multimeter with an 0.5in L.C.D. display incorporating:

5 AC & DC Voltage ranges; 6 Resistance ranges.
5 AC & DC Current ranges; 4 Capacitance ranges.

The prototype accuracy is better than 1%.

This is a unique design using the latest MOS ICs and due to the minimal current drain, is powered by only one PP3 battery. There is also a battery check facility.

DM900 is an attractive hand-held lightweight device, built into a high impact case with carrying handle and has been ingeniously designed to simplify assembly.

Never before have all these features been offered to the electronics enthusiast in a single unit.

Price: **£54.50*** only (p&p insured add 80p)
Send SAE for leaflet.
Ready Built and tested units **£78.50*** including probes and carrying case (P&P insured 80p)
(Demonstration on at our shop)

PE VDU SYSTEMS

parts now available
(send SAE for list)

Convert your TV into a VDU by using the new Thomson-CSF, TV-CRT controller chip SF.F 96364. 16 lines by 64 characters, text refreshment, cursor management on TV screen, line erasing, line end erasing. Compatible with any computing system.

SFF 96364E	£11.75*
AY-5-1013UART	£4.50*
71301 ROM SFC	£8.20*
SFS80102 RAM 1K	£2.05*
74LS163 RAM	£0.95*
MC1488	£0.85*
MC1489	£0.90*
SN75450	£1.20*
SN75451	£0.70*
SN75452	£0.70*
SN75454	£2.25*
2102 LF	£1.60*
2513	£5.95*
74LS132	£0.95*
81LS97	£1.09*
1 MHz crystal	£3.23*
14.31818MHz	£2.70*

TTL 74★

7400	13	7494	78	74194	105	4056	134
7401	13	7495	65	74195	95	4057	2570
7402	14	7496	57	74196	99	4059	480
7403	14	7497	189	74197	85	4060	115
7404	14	74100	119	74198	150	4061	2380
7405	18	74105	62	75150	110	4062	999
7406	38	74107	29	75491	75	4063	110
7407	38	74109	54	75492	80	4066	58
7408	17	74110	54			4067	380
7409	17	74111	68	**CMOS★**		4068	22
7410	15	74112	88	4000	15	4069BE	20
7411	20	74116	198	4001	17	4070	32
7412	17	74118	83	4002	17	4071	21
7413	30	74119	119	4006	105	4072	21
7414	51	74120	115	4007	18	4073	21
7416	30	74121	25	4008	87	4075	23
7417	30	74122	46	4009	50	4076	85
7420	16	74123	48	4010	50	4077	40
7421	29	74125	38	4011	18	4078	21
7422	24	74126	57	4012	18	4081	20
7423	27	74128	74	4013	42	4082	21
7425	27	74132	73	4014	86	4085	74
7426	36	74136	73	4015	89	4086	73
7427	27	74141	56	4016	45	4089	150
7428	35	74142	269	4017	89	4093	85
7430	17	74143	314	4018	89	4094	190
7432	25	74144	314	4019	48	4095	105
7433	40	74145	65	4020	99	4096	105
7437	30	74147	175	4021	91	4097	372
7438	33	74148	109	4022	88	4098	110
7440	17	74150	99	4023	20	4099	145
7441	74	74151	64	4024	66	4160	109
7442	68	74153	64	4025	19	4161	109
7443	115	74154	96	4026	180	4162	109
7444	112	74155	53	4027	45	4163	109
7445	94	74156	80	4028	81	4174	110
7446	94	74157	67	4029	99	4175	99
7447	82	74159	210	4030	50	4194	108
7448	56	74160	82	4031	205	4408	720
7450	17	74161	92	4032	100	4409	720
7451	17	74162	92	4033	145	4410	720
7453	17	74163	92	4034	196	4411	995
7454	17	74164	105	4035	111	4412F	1650
7460	17	74165	105	4036	325	4412F	1380
7470	28	74166	161	4037	100	4415F	795
7472	25	74167	198	4038	108	4415V	795
7473	32	74170	230	4039	320	4419	280
7474	27	74172	625	4040	105	4422	545
7475	38	74173	170	4041	80	4433	1180
7476	36	74174	87	4042	75	4435	825
7480	48	74175	87	4043	94	4440	1275
7481	86	74176	75	4044	88	4450	295
7482	69	74177	78	4045	145	4451	295
7483	72	74178	102	4046	128	4490F	695
7484	95	74180	85	4047	87	4490V	525
7485	106	74181	165	4048	58	4501	17
7486	31	74182	90	4049	48	4502	120
7489	210	74184	135	4050	48	4503	69
7490	33	74185	135	4051	72	4506	51
7491	75	74188	275	4052	72	4507	55
7492	38	74190	115	4053	72	4508	298
7493	32	74191	105	4054	110	4510	99
		74192	105	4055	128	4511	150
		74193	105			4512	98

LINEAR IC'S

702	75	MC1303	88
709C 14 pin	35	MC1304P	260
710★	48	MC1310	149
723★	45	MC1312P	195
733★	99	MC1488★	85
741C★ 8 pin	22	MC1489★	90
747C★	70	MC1495★	395
748C★	36	MC1496	92
753	150	MC1710★	79
810	159	MC3401	69
8038CC★	335	MC3340P★	150
AY-1-0212	580	MC3360P	120
AY-1-1313	660	MFC4000B	85
AY-1-1320	305	MFC6040★	97
AY-1-5050	208	MK50398★	635
AY-1-5051	145	MK50362★	650
AY-1-6721/6	195	MM2102-2★	170
AY-3-8500★	385	MM2112★	100
AY-3-8710★	850	MM2112-2★	295
AY-5-1224A★	260	MM57160★	620
AY-5-1230★	490	NE518A★	210
AY-5-1315	560	NE555★	29
AY-5-1317A	630	NE556DB★	60
CA3011★	82	NE560★	325
CA3020	170	NE561★	395
CA3023	170	NE562★	410
CA3028A★	80	NE565A★	120
CA3035	240	NE566★	160
CA3043	190	NE567★	170
CA3046	71	NE571★	450
CA3048	200	RAM2102-2★	170
CA3075	175	RC4136D★	120
CA3080E★	70	ROM2513★	595
CA3081	190	SG3402	295
CA3089E	210	SN76003N	175
CA3090AQ	375	SN76013N	140
CA3123E	200	SN76023N	140
CA3130★	85	SN76033N	175
CA3140★	70	SN76115N	215
ICL7106E★	752	SN76477★	225
ICM7205★	1150	SN76227	115
LD130★	452	TAA621AX1	228
LM301A	30	TAA960	300
LM304	240	TBA120S	70
LM308	110	TBA540Q	215
LM318	195	TBA550Q	330
LM324★	79	TBA641BX11	250
LM339★	80	TBA651	180
LM348★	95	TBA800	90
LM379★	375	TBA810S	99
LM380	95	TBA820	70
LM381	145	TBA920Q	260
LM381AN	248	TDA1022★	575
LM382	125	TDA2020	320
LM1458★	50	TL071CP★	70
LM3900★	60	TL081CP★	52
LM3909N★	70	TL082CP★	96
LM3911★	125	TL084CP★	130
M252AA★	750	UAA170	198
M253AA★	795	ZN414	90
MC724★	175	ZN424	130
		ZN425E★	375

TRANSISTORS

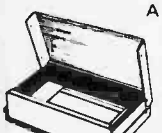
AC117★	35	BC170	17	BF184★	30	OC41★	48	ZTX311	17	2N3563	20
AC125★	20	BC171	11	BF194	10	OC42★	32	ZTX314	24	2N3614★	169
AC126★	20	BC172	10	BF195	10	OC43★	55	ZTX326	40	2N3615★	135
AC127★	20	BC177★	17	BF196	10	OC44★	31	ZTX341	20	2N3663	24
AC128★	20	BC178★	17	BF197	10	OC45★	20	ZTX500	13	2N3702	10
AC141★	24	BC179★	17	BF198	18	OC46★	28	ZTX501	14	2N3703	11
AC141K★	38	BC182	9	BF200★	28	OC70★	19	ZTX502	19	2N3704	10
AC142★	24	BC182L	10	BF224A	18	OC71★	25	ZTX503	15	2N3705	11
AC142K★	38	BC183	9	BF244	24	OC72★	30	ZTX504	25	2N3706	10
AC176★	18	BC183L	10	BF256★	50	OC76★	36	ZTX531	25	2N3707	10
AC187★	20	BC184	9	BF257★	26	OC77★	76	ZTX550	25	2N3708	10
AC188★	20	BC184L	10	BF258★	26	OC79★	76	2N526★	58	2N3709	10
ACY17★	35	BC186	21	BF259★	30	OC81★	28	2N696★	35	2N3710	16
ACY18★	40	BC187★	28	BF394	22	OC82★	45	2N697★	21	2N3711	10
ACY19★	40	BC212	9	BF594	40	OC83★	48	2N698★	39	2N3715★	250
ACY20★	40	BC212L	10	BF595	38	OC84★	44	2N699★	39	2N3772★	170
ACY21★	35	BC213	9	BFR39	25	OC122★	48	2N706A★	19	2N3773★	288
ACY22★	40	BC213L	11	BFR40	25	OC123★	48	2N707★	50	2N3819	22
ACY28★	40	BC214	9	BFR79	28	OC139★	85	2N708★	19	2N3820	32
ACY39★	78	BC214L	10	BFR80	28	OC140★	85	2N914★	32	2N3823★	65
ACY40★	48	BC307B	14	BFX29★	26	OC141★	85	2N916★	27	2N3824★	70
ACY44★	39	BC308	13	BFX81★	130	OC170★	40	2N918★	30	2N3866★	90
AD140★	69	BC328	13	BFX84★	24	OC171★	40	2N920★	51	2N3903	18
AD149★	70	BC338	12	BFX85★	24	OC201★	75	2N930★	18	2N3904	18
AD161★	42	BC441★	30	BFX86★	28	OC202★	85	2N961★	61	2N3905	18
AD162★	42	BC461★	30	BFX87★	23	OC203★	85	2N1131★	22	2N3906	17
AF114★	25	BC477★	18	BFX88★	24	OC204★	85	2N1132★	22	2N4037★	52
AF115★	25	BC547	11	BFY18★	50	TIP29	43	2N1302★	35	2N4058	17
AF116★	25	BC548	11	BFY50★	20	TIP29A	44	2N1303★	50	2N4061	17
AF117★	25	BC549	11	BFY51★	20	TIP29C	60	2N1304★	50	2N4064★	120
AF118★	55	BC557	13	BFY52★	20	TIP30	47	2N1305★	28	2N4236★	145
AF121★	48	BC558	12	BFY71★	20	TIP30A	47	2N1306★	35	2N4289	20
AF124★	55	BCY30★	57	BSX20★	18	TIP30B	64	2N1307★	50	2N4859	65
AF125★	35	BCY34★	75	BSY65★	30	TIP30C	65	2N1308★	46	2N5135	42
AF127★	35	BCY39★	80	BSY95★	25	TIP31★	40	2N1613★	23	2N5136	42
AF139★	35	BCY40★	78	BSY95A★	25	TIP31A★	40	2N1671★	190	2N5138	20
AF178★	70	BCY43	75	BU105	140	TIP31B★	40	2N1671B★	195	2N5179★	60
AF180★	70	BCY58★	22	BU205★	190	TIP31C★	66	2N1893★	28	2N5180★	60
AF186★	50	BCY59★	22	BU208★	225	TIP32★	45	2N1986★	60	2N5191★	65
AF239★	42	BCY70★	15	E5567	65	TIP32A★	49	2N2160★	105	2N5305★	24
ASY26★	40	BCY71★	17	MD8001★	158	TIP32B★	70	2N2217★	48	2N5457	32
ASY27★	45	BCY72★	17	ME4102	10	TIP32C★	70	2N2218A★	31	2N5458	32
BC107★	9	BCY78★	20	ME6002	14	TIP33★	80	2N2219A★	32	2N5459	32
BC107B★	10	BD115★	62	MJ400★	90	TIP33A★	80	2N2220A★	26	2N5485	32
BC108★	9	BD121★	95	MJ491★	160	TIP33B★	100	2N2221★	23	2N5777★	45
BC108B★	12	BD123★	98	MJ2955★	95	TIP33C★	105	2N2222★	20	2N6027	40
BC108C★	12	BD124★	115	MJE340★	45	TIP34★	85	2N2297	45	40311★	50
BC109★	9	BD131★	38	MJE370★	55	TIP34A★	85	2N2303★	45	40313★	125
BC109B★	12	BD132★	38	MJE371★	60	TIP34B★	110	2N2368★	21	40316★	85
BC109C★	12	BD133★	43	MJE520★	45	TIP34C★	110	2N2369★	15	40317★	52
BC113	17	BD135★	36	MJE521★	65	TIP35★	219	2N2476★	125	40324★	85
BC114	19	BD136★	37	MJE2955★	99	TIP35A★	225	2N2483★	28	40326★	52
BC115	19	BD137★	36	MJE3055★	70	TIP35C★	270	2N2484★	30	40327★	62
BC116	19	BD138★	36	MPF102	30	TIP36A★	265	2N2646★	48	40347★	80
BC117	15	BD139★	36	MPF103	36	TIP36C★	325	2N2784★	55	40348★	101
BC118	19	BD140★	36	MPF104	36	TIP41A★	63	2N2846★	140	40360★	43
BC119★	26	BD142★	59	MPF105	36	TIP41B★	73	2N2894★	30	40361★	45
BC134	19	BD145★	198	MPF106	50	TIP42A★	64	2N2904A★	22	40362★	48
BC135	20	BD222★	60	MPF107	50	TIP42B★	82	2N2905A★	20	40407★	50
BC136	18	BD695A★	75	MPSA05★	24	TIP2955★	63	2N2906★	18	40411★	289
BC137	20	BD696A★	75	MPSA06★	24	TIP3055★	60	2N2907★	20	40412★	63
BC140★	28	BDY17★	195	MPSA12	42	TIS43	36	2N2907A★	22	40467★	95
BC142★	25	BDY60★	110	MPSA55	24	TIS44	45	2N2926G	10	40576★	190
BC143★	25	BDY61★	165	MPSA56	24	TIS46	45	2N29260	8	40594★	80
BC147	7	BF115★	22	MPSA70	34	TIS50	47	2N2926R	8	40595★	90
BC148	7	BF154★	25	MPSU02★	58	TIS60	45	2N2926Y	8	40603★	65
BC149	8	BF156★	29	MPSU05	48	TIS62	45	2N3011★	24	40636★	125
BC153	14	BF167	25	MPSU06	54	TIS74	47	2N3053★	20	40673★	68
BC154	14	BF173★	25	MPSU52★	65	TIS90	18	2N3054★	49		
BC157	10	BF177★	24	MPSU55★	53	TIS91	22	2N3055★	55		
BC158	11	BF178★	25	MPSU56★	56	ZTX107	11	2N3108	39		
BC159	11	BF179★	30	MPU131★	39	ZTX108	11	2N3121	40		
BC160	27	BF180★	30	OC25★	120	ZTX109	11	2N3133	43		
BC167A	11	BF181★	30	OC26★	150	ZTX300	13	2N3135	33		
BC168C	12	BF182★	30	OC28★	99	ZTX301	16	2N3250	30		
BC169C	10	BF183★	30	OC29★	160	ZTX302	18	2N3252	36		
				OC35★	80	ZTX303	21	2N3302	35		
				OC36★	99	ZTX304	24	2N3442★	131		

Diodes

IN4148	4
CRO33★	148
Zeners 400mw 2.7-33v	9

YOUR COMPLETE RANGE OF ELECTRONIC HARDWARE....

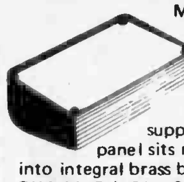
BIMENCLOSURES



ALL METAL BIMCASES

Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.

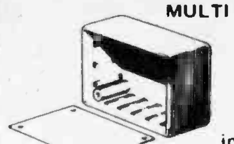
BIM 3000
(250x167.5x68.5mm)
£14.58



MINI DESK BIMCONSOLES

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.

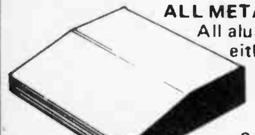
BIM 1005 (161 x 96 x 58mm) £2.18
BIM 1006 (215 x 130 x 75mm) £3.05



MULTI PURPOSE BIMBOXES

Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

BIM 4003	(85x56x28.5mm)	£1.18
BIM 4004	(111x71x41.5mm)	£1.62
BIM 4005	(161x96x52.5mm)	£2.19

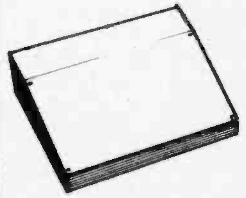


ALL METAL BIMCONSOLES

All aluminium, 2 piece desk consoles with either 15° or 30° sloping fronts, sit on 4 self-adhesive non-slip rubber feet. Ventilation slots in base and rear panel for excellent cooling.

Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold

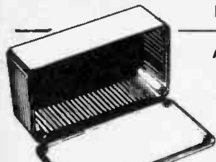
15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£10.67
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£11.44
BIM7153 (165x216x51[28] mm)	BIM7303 (165x183x102[28] mm)	£12.61
BIM7154 (165x211x76[33] mm)	BIM7304 (254x140x76[28] mm)	£13.82
BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£15.36
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£16.67
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£17.58
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£18.55



LOW PROFILE BIMCONSOLES

Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

BIM 6005	(143 x 105 x 55.5 [31.5] mm)	£2.37
BIM 6006	(143 x 170 x 55.5 [31.5] mm)	£3.08
BIM 6007	(214 x 170 x 82.0 [31.5] mm)	£4.12

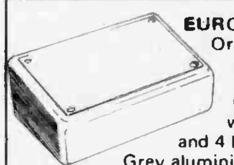


ABS & DIECAST BIMBOXES

6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x60x31mm)	N/A		BIM5001/11	TBA	TBA
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12	£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13	£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14	£2.24	£1.82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15	£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16	£3.94	£3.33

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.00

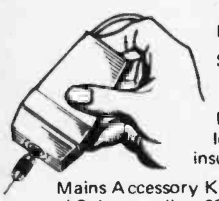


EUROCARD BIMCONSOLES

Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

BIM 8005 (169x127x70[45] mm) £4.12
BIM 8007 (to be announced shortly)

BIMTOOLS

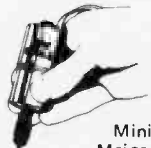


MAINS BIMDRILLS

Small, powerful 240V hand drill complete with 2 metres of cable and 2 pin DIN plug. Accepts all tools with 1mm, 2mm or .125" dia. shanks. Drills brass, steel, aluminium and pcb's. Under 250g, off load speed 7500 rpm. Orange ABS, high impact, fully insulated body with spring return on/off switch £10.53

Mains Accessory Kit 1 includes 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.48

Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £22.14



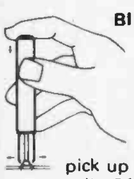
12 VOLT BIMDRILLS

2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.

Mini BIMDRILL with 3 collets up to 2.4mm dia £ 8.10
Major BIMDRILL with 4 collets up to 3mm dia £13.60

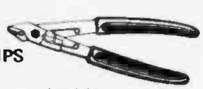
Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 – £15.12, Major Kit 1 – £19.44.
Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains 12V dc adaptor. Mini Kit 2 – £34.02, Major Kit 2 – £39.42.

Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 – £45.36, Major Kit 3 – £50.76.



BIMDIPS

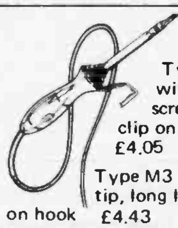
Rapidly inserts and withdraws any 4-18 pin, .3" pitch DIL package without beding the legs. Adjustable metal jaws for MOS type devices grip the bottom of the leg for minimum strain. Will pick up IC's from a bench, a carrier or a pcb. £13.77.



BIMSNIPS

Precision made side cutters, spring action, ground steel fine pointed blades for intricate work.

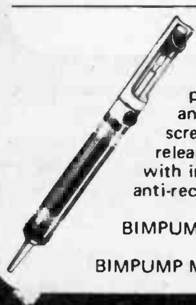
5¼" long £3.34



BIMIRONS

Type 30 General Purpose 27 watt iron with long life, rapid change element, screw on tip, stainless steel shaft and clip on hook. Styled handle with neon. £4.05

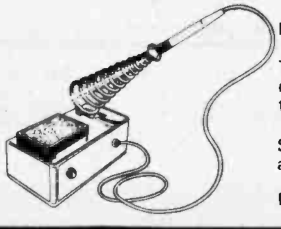
Type M3 Precision 17 watt iron, quick change tip, long life element, styled handle with clip on hook £4.43



BIMPUMPS

2 all metal desoldering tools provide high suction power and have easily replaceable screw in Teflon tips. Primed and released by thumb operation with in-built safety guard and anti-recoil system.

BIMPUMP Major (180mm long) £7.99
BIMPUMP Minor (150mm long) £6.80



BIMSTATION

Type PSU6 Soldering Iron Station complete with 6V, 6 Watt miniature iron having stainless steel shaft, quick change slide on tip and long life element.

Station contains 240V/6V transformer, neon, coiled iron support and sponge iron tip cleaning pad.

New product available shortly

BIMENCLOSURES (Bimboxes, Bimconsoles and Bimcases) BIMTOOLS (Bimirons, Bimdrills, Bimsnips, Bimpumps, Bimdips) BIMACCESSORIES (Bimfeet, Bimdaptors) BIMDICATORS BIMBOARDS

BIMDICATORS

.125" dia. lens .2" dia. lens

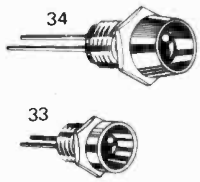
ECONOMY QUALITY LED's

Mixed bags of .125" and .2" dia. lens in various colours
50 for £5.67, 100 for £10.00

FULL SPECIFICATION LED's

.125" or .2" with mounting clips and data
Red – £1.67/pack of 5, Green – £2.48/pack of 5, Yellow/Amber – £3.18/pack of 5

34



33

33 and 34 SERIES

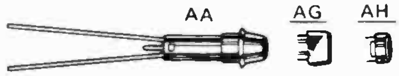
Front viewing (30° angle) LED indicators

BIM 33 is nickel plated, uses 3.2mm dia LED and needs 6.5mm dia. fixing hole.

BIM 34 is chromium plated, uses 5mm dia. LED and needs 8mm dia. fixing hole.

Red – £2.80/pack of 5, Green/Yellow – £3.24/pack of 5

AA AG AH



A SERIES

240V Neon with integral resistor. held in 8mm hole by plastic bezel.

Red, Amber, Clear or Opal lens £2/pack of 5, Green lens £3/pack of 5

Low Voltage equivalent of above with Red, Amber, Clear, Opal or Green Lens.
6V £0.54 each, 14V £0.58 each, 28V £0.65 each

State Voltage, lens style, colour and whether tags or flying leads.

A B

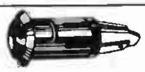
D SERIES

LES and Midget Flanged lampholder with 13mm dia. (A) and 18mm dia (B) lens. Solder tags. ½" dia. hole fixing (lamps not supplied) plus chrome bezel with A lens.

Red, Amber, Clear, Green, Opal £0.66 each

G SERIES

TI Midget Flanged lampholder. Lamps are available on request. 8mm fixing hole, solder tags. Front replaceable, 7.25mm dia. lens. Red, Amber, Clear, Green, Opal £0.43

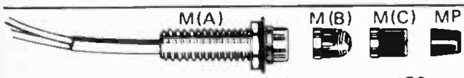


05 SERIES

240V Neon with integral resistor. Self retaining in 13mm hole, Solder/.25" push on blades. 13mm dia. lens with 19mm dia. chrome bezel.

Red and Amber £0.61 each, Green £0.78 each.

M(A) M(B) M(C) MP

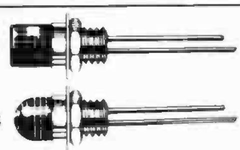


M & MP SERIES

Low voltage nickel plated brass (M) and Polycarbonate (MP) indicators, 150mm leads, 6.4mm fixing hole Red, Amber, Clear, Green, Opal

6.9mm dia. lens (M) 6V £0.65 each, 14V £0.68 each, 28V £0.79 each
7.5mm dia. lens (MP) 6V £0.55 each, 14V £0.59 each, 28V £0.68 each

A



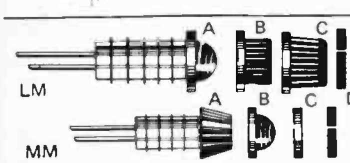
B

BIM M LED SERIES

Nickel plated brass bodied LES indicator, 21mm wire wrappable leads, 6.5mm fixing hole, 2 styles, 6,8mm dia lens.

Red £0.67 each, Green £0.83 each, Amber £1.00 each

A B C D



LM

A B C D

MM

Both lenses 'D' are square

BIM LM & MM LED SERIES

Subminiature nylon bodied LED indicators with 12mm wire wrappable leads

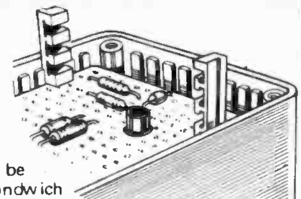
LM & MM push fit into 4.75mm & 4mm holes respectively. Each series has 4 lens styles in Red £0.67, Green £0.83, Yellow £1,00 each.

23 26 56

BIM 23, 26 & 56 LED SERIES

Black nylon bodied LED indicators. BIM 23 has 7mm flat face, BIM 26 & 56 utilise 4 & 5mm dia LED's. Push fit in 8mm hole. Red £0.46 each, Green £0.62 each, Yellow £0.77 each

BIMACCESSORIES



BIMDAPTORS

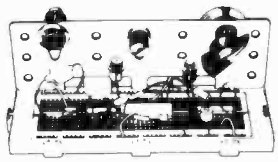
Allows pcb's to be flat mounted sandwich fashion in BIMBOXES, BIMCONSOLES, and all other enclosures having 1.5mm wide vertical guide slots. One plastic BIMDAPTOR on each corner of pcb(s) enables assembly to be simply slid into place. 54mm long, 10 slots on 5mm spacing and can be simply snipped off to length.

Packs of 25 £1.08 per pack

BIMFEET

11mm dia, 3mm high, grey rubber self adhesive enclosure feet.
Packs of 24 £0.77 per pack

BIMBOARDS



DIL COMPATIBLE BIMBOARDS

Accept all sizes (4-50 pin) of DIL IC packages as well as resistors, diodes, capacitors and LEDs. Integral Bus Strips up each side for power lines and Component Support Bracket for holding lamps, switches and fuses etc. Available as single or multiple units, the latter mounted on 1.5mm thick black aluminium back plate which stand on non slip rubber feet and have 4 screw terminals for incoming power.

BIMBOARD 1 has 550 sockets, multiple units utilising 2, 3 and 4 BIMBOARDS incorporate 1100, 1650 and 2200 sockets, all on 2.5mm (0.1") matrix.

BIMBOARD 1	£ 8.83
BIMBOARD 2	£21.01
BIMBOARD 3	£29.84
BIMBOARD 4	£38.79

DESIGNER PROTOTYPING SYSTEM

1, 2, or 3 BIMBOARDS mounted on BIM 6007 BIMCONSOLE with Integral Power Supply (±5 to ±15Vdc @ 100mA and fixed +5Vdc @ 1A) All O/P's fully isolated. Short circuit and fast fold back protection. Power rails brought out to cable clamps that accept stripped wire or 4mm plug.

DESIGNER 1	£55.62
DESIGNER 2	£61.02
DESIGNER 3	£66.42

...FROM BOSS

INDUSTRIAL MOULDINGS LIMITED

All quoted prices are 1 off and include Postage, Packing and VAT. Terms are strictly cash with order unless you have authorised BOSS account. For individual data sheets on all BOSS products send stamped, self addressed envelope.

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Cables & Telegrams: 'LITZEN LONDON SE24'

ELECTROVALUE Buying Guide

Section 4

HERE IS OUR NEXT SELECTION TO ADD TO THE PAGES YOU ALREADY HAVE SAVED.
If you have bought before from us, you know just how large and varied our stocks are and how good our service is. For those who have yet to know us, we are publishing a series of Ads. month by month to give up-to-date information and prices on much of the stocks we carry. These ads. are appearing in Practical Electronics, E.T.I., Elektor, Practical Wireless and Everyday Electronics so that a complete series will appear each month. So no matter which journals you read, BY DETACHING AND SAVING THESE PAGES YOU WILL ACQUIRE A VALUABLE AND COMPREHENSIVE MONEY SAVING CATALOGUE.

MEET US AT BREADBOARD 78, STAND D.8

Resistors

(Prices in pence)

Type	1+	10+	100+
CR25	●1Ω to 3Ω 9 5% *E12*		
.33W	3p	2p	1.76N
UPM033	●4Ω7 to 1M 5% *E24*		
.33W	2p	1.6	1.43N
CR25	●1M2 to 10M 10% *E12*		
.33W	3p	2p	1.76N
MR25	5Ω1 to 300K 2% *E24*		
.4W	5p	4p	3.60N
UPM050	●4Ω7 to 4M7 5% *E12*		
.5W	2p	1.6	1 43N
CR37	●1Ω to 3Ω9 5% *E12*		
.5W	3p	2p	1 87N
UPM075	●4Ω7 to 10M 5% *E24*		
.75W	2p	1.6	1.43N
UPM100	●4Ω7 to 4M7 5% *E12*		
1W	5p	4p	3.27N
UPM100	●5M6 to 10M 10% *E12*		
1W	5p	4p	3.27N
TR5	10Ω to 1M 2% *E24*		
.5W	5p	4p	3.20N
TW1	0.22Ω to 0.47Ω ± 0.05Ω *E12*		
1W	15p	13p	11.8N
TW1	0.56Ω to 3R9 10% *E12*		
1W	15p	13p	11.8N
GWS3	0.47Ω, 1Ω to 10Ω 10% *E12*		
3W	18p	14p	11.0N
GWS3	12Ω to 10K 5% *E12*		
3W	18p	14p	11.0N
GWS7	1Ω to 10Ω 10% *E12*		
7W	18p	14p	11.0N
GWS7	12Ω to 10K 5% *E12*		
7W	18p	14p	11.0N

Net prices apply for complete 100s only. Bulk prices available.
E12 values: 1.0, 1.2, 1 5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2.
E24 values: as *E12* plus 1.1, 1.3, 1.6, 2.0, 2.4, 3.0, 3.6, 4.3, 5.1, 6.2, 7.5, 9.1, *and their decades.*

NEW — ERG DUAL IN-LINE SWITCHES

One-pole change-over SDC.1	42p
Two-pole change-over SDC.2	78p
Three-pole change-over SDC.3	£1.08

On-off 2-pole SDS.2	**42p**	**On-off 6-pole SDS.6**	**£1.08**
On-off 4-pole SDS.4	**78p**	**On-off 8-pole SDS.8**	**£1.32**

(These types colour coded)

Multi-type one-pole 8-way Type DS16A-8	99p
Multi-type two-pole 4-way Type DS16A2-4	£1.08

For fuller range of switches, see section 5 in our current ads.

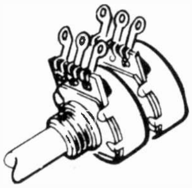
Pots.

CARBON TRACK, ROTARY●
Long spindle, without flat, 0.25 . 0.375 B.S. bush, nut and washer

P20 lin 1-gang	23p
P20 log 1-gang	23p
P20 lin +switch	67p
P20 log +switch	67
JP20 lin 2-gang	67p
JP20 log 2-gang	67p
JP20 lin +switch	1.11
JP20 log +switch	1.11
DP20 2-gang (separate spindles)	£1.17
DP20 +switch	£1.67

Resistance values stocked

P20 lin	100Ω to 4M7
P20 log	220Ω to 2M2
JP20 lin	1K, 4K7 to 2M2
JP20 log.	4K7 to 2M2



DP20 made to order in any values available in P20. State front (near bush) and rear tracks clearly.

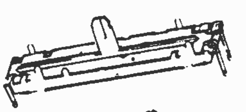
CARBON TRACK, SLIDER (58mm travel)●
For knobs, see JV-slider

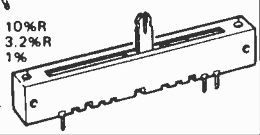
PG58 mono	35p
C1PG58 mono	63p
C1PG58ST stereo	£1.03

Resistance values stocked

PG58 lin	4K7 to 1M
PG58 log	10K to 1M
C1PG58 lin	4k7 to 1M
C1PG58 log	4K7 to 1M
C1PG58ST lin	4K7 to 1M
C1PG58ST log	4K7 to 1M

Log stereo matching ± 2dB @ 10%R
± 3dB @ 3.2%R
± 4dB @ 1%

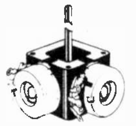




MINIATURE PRE-SETS
Type PR.10 Horizontal or Vertical – all values 100Ω to 4M7 –**9p** each

NEW — JOYSTICK TWIN POT. UNIT

Pan pot assembly comprising two carbon track pots mounted at right angles on rigid plastic box and operated individually by joystick control. 100K or 220K per section



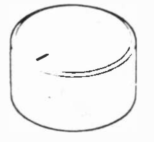
£2.25

Knobs

All screw fitting

ALUMINIUM (plastic inner)

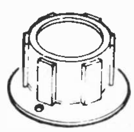
EV18A 18mm	56p
EV22A 22mm	64p
EV32A 32mm	73p
EV38A 35mm	78p



Type EV

BULGIN

K107 pointer 32mm black or white	22p
K108 pointer 57mm black only	35p
"Modern range"	
K491 29mm	46p
K492 37mm	46p
K493 32mm	46p
K382 dial 270 0-10	22p
K389 dial 300 0-10	22p



Type K/CK

SI FAM COLLET KNOBS
(Caps must be ordered separately)

15mm diameter	
S1508 short	27p
K1508	28p
W15088 winged	32p
22mm diameter	
S2108 short	35p
K2108	36p
W2108 winged	39p
Caps 15mm	
C150	3p
C151 with line	5p
C152 w spot	5p
Caps 21mm	
C210	3p
C211 with line	5p
C212 w spot	5p
Nut covers 15mm only	
N1508	5p
N1518 with line	10p
Dials 15mm	17p
Dials 21mm	18p

K5

Types available
D151, D211 0-11
D152, D212, 1-12
D158, D218 wedge
D159, D219 white arrow
Caps in black, red, yellow, green, blue and grey
All other items black only

K6

JV SERIES
Plastic cylindrical — black, red, yellow, green, blue, light or dark grey, white

JV18 18mm	27p
JV23 23mm	27p

NK

The following pair are designed for DP20 pots, and have 4mm and 6mm bores

JV18/4	40p
JV23/6T	40p

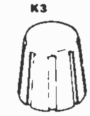
JV Slider knobs for Radiohm mono and stereo pots In eight colours as above

JVS + colour	8p

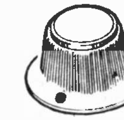
K3

BLACK PLASTIC

K1 25mm S	13p
CK1 25mm SM	18p
K2 35mm S	15p
CK2 35mm SM	20p
K3 27mm P	12p
K4 32mm P	12p
K5 19mm	20p
K6 25mm	25p
NK 36mm SK	37p
PK 36mm SP	37p
SK6 41mm SK	36p
K7 19mm B/W	20p
K8 25mm S	20p



Si Fam Collet



K8

S skirted
M metal insert
P pointer
Sk skirt, 0-10
B/W black or white

We are appointed National Distributors for

NASCOM 1

MICROCOMPUTER KITS

We give delivery from stock (Net price) **£197.50** + VAT

● Discounts for quantity buyers

MOTOROLA
Microprocessor Evaluation Kit Net **£175.87** +VAT

BOXES

ALUMINIUM				
AB7	133 x	70 x	38	60p
AB8	101 x	101 x	38	60p
AB9	101 x	70 x	38	60p
AB10	133 x	101 x	38	62p
AB11	101 x	64 x	51	60p
AB12	76 x	51 x	25	50p
AB13	152 x	101 x	51	77p
AB14/2	127 x	89 x	64	74p
DIECAST				
992	89 x	35 x	30	1.24
993	114 x	64 x	30	1.32
998	114 x	64 x	55	1.62
994	114 x	89 x	55	2.10
999	171 x	121 x	55	3.07
974	171 x	121 x	106	4.39
PLASTIC				
P81	116 x	77 x	36	48p
PB801	122 x	67 x	43	66p

(PB301 is "double U" type and has vent and various holes)

- GOODS SENT POST FREE C.W.O. ORDERS IN UK OVER £5 LIST VALUE. If under, add 27p for handling charges.
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400mw *(Bzy88) DO7 Glass encapsulated* range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v.
No. Z4 8p ea.

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POTENTIOMETERS

CARBON POTS (Linear Track)

Single gang with wire end terminations, 6mm × 50mm plastic shaft 10mm bushes supplied with shake proof washer & nut. Tolerance ± 20% of resistance.

1831 1k ohms £0·26* 1836 47kohms £0·26*
1832 2k2ohms £0·26* 1837 100kohms £0·26*
1833 4k7ohms £0·26* 1838 220kohms £0·26*
1834 10kohms £0·26* 1839 470kohms £0·26*
1835 22kohms £0·26* 1840 1Meg £0·26*
1841 2M2 £0·26*

CARBON POTS (Log Track)

1842 4k7ohms £0·26* 1846 100kohms £0·26*
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DUAL CARBON POTS (Lin Track)

These high quality dual gang pots are fitted with wire end terminations and 6mm × 50mm plastic shaft 10mm, bush and supplied with shake proof washer & nut track tolerance ± 20% but matched to within 2db of each other. VC3

1851 4k7 £0·78* 1855 100kohms £0·78*
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1853 22kohms £0·78* 1857 470kohms £0·78*
1854 100kohms £0·78* 1858 1Meg £0·78*
1859 2M2 £0·78*

DUAL CARBON POTS (Log Law)

1860 4k7ohms £0·78* 1864 100kohms £0·78*
1861 10kohms £0·78* 1865 220kohms £0·78*
1862 22kohms £0·78* 1866 470kohms £0·78*
1863 47kohms £0·78* 1867 Meg £0·78*
1868 2M2 £0·78*

SINGLE GANG SWITCHED (Lin Law)

These potentiometers are fitted with double pole on-off switches. The switch is incorporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1·5amps at 250v AC.

1870 4k7ohms £0·60* 1874 100kohms £0·60*
1871 10kohms £0·60* 1875 220kohms £0·60*
1872 22kohms £0·60* 1876 470kohms £0·60*
1873 47kohms £0·60* 1877 1Meg £0·60*
1878 2M2 £0·60*

SWITCHED POT (Log Track)

Specification as VC2 but track having (log) law.

1879 4k7ohms £0·60* 1833 100kohms £0·60*
1880 10kohms £0·60* 1884 220kohms £0·60*
1881 22kohms £0·60* 1885 470kohms £0·60*
1882 47kohms £0·60* 1886 1Meg £0·60*
1887 2M2 £0·60*

DUAL GANG LOG-ANTI-LOG POT

1888 Track specification as dual gang pots VC3 as above, but tracks mounted to log-anti log action. £0·75*

SPECIAL VOLUME CONTROLS

A miniature 16mm type replacement volume control incorporating single pole on-off switch. Resistance value 5kohms. Tolerance ± 20% 1/8watt rating.
1889 £0·27* VC8

MINIATURE ROTARY VOL CONTROL

5kohms log law with on/off switch. 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.
1890 £0·54* VC9

WIRE WOUND POTS

A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shake-proof washer and nut.
VC6

1891 10ohms £0·80 1895 220ohms £0·80
1892 22ohms £0·80 1896 470ohms £0·80
1893 47ohms £0·80 1897 1kohms £0·80
1894 2 0ohms £0·80 1898 2k2ohms £0·80
1899 4k7ohms £0·80

PRE-SET POTS HORIZONTAL MOUNTING

Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screw driver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2·54mm. All tracks are linear law.
VC7

1801 100ohms £0·08* 1808 22kohms £0·08*
1802 220ohms £0·08* 1809 47kohms £0·08*
1803 470ohms £0·08* 1810 100kohms £0·08*
1804 1kohms £0·08* 1811 220kohms £0·08*
1805 2k2ohms £0·08* 1812 470kohms £0·08*
1806 4k7ohms £0·08* 1813 1Mohms £0·08*
1807 10kohms £0·08* 1814 2M2ohms £0·08*
1815 4M7ohms £0·08*

PRE-SET POTS VERTICAL MOUNTING

Miniature type for transistor circuits. Wiper adjustment is made by a screw driver slot. Designed to fit 2·54mm pitch board. All tracks are linear law.
VC7

1816 100ohms £0·08* 1823 22kohms £0·08*
1817 220ohms £0·08* 1824 47kohms £0·08*
1818 470ohms £0·08* 1825 100kohms £0·08*
1819 1kohms £0·08* 1826 220kohms £0·08*
1820 2k2ohms £0·08* 1827 470kohms £0·08*
1821 4k7ohms £0·08* 1828 1Megohms £0·08
1822 10kohms £0·08* 1829 2M2ohms £0·08
1830 4M7ohms £0·08*

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O/No. 1934. Iron coated bit 3/32" for 1931 iron. £0·50

O/No. 1953. SK1 soldering kit—this kit contains 15 watt soldering iron fitted with a 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'how to solder'. In presentation display box. £5·30

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1505	FLV310 led	2	GREEN	£0·19
1506	FLV410 led	2	YELLOW	£0·19
1510	BDL707 display	3	RED	£0·80
1511	BDL747 display	3	RED	£1·50
1512	BDL727 display	3	RED	£1·80
1514	ORP12 Light dependent resistor			£0·55
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50V RMS	BR2/50	£0·45
100V RMS	BR2/100	£0·48
200V RMS	BR2/200	£0·52
400V RMS	BR2/400	£0·58
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50	THY600/50	£0·22
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200	THY600/200	£0·36
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Volts	No.	Price
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100	THY1A/100	£0·28
200	THY1A/200	£0·32
400	THY1A/400	£0·36
600	THY1A/600	£0·45
800	THY1A/800	£0·58

3 amp TO 66 Case

Volts	No.	Price
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100	THY3A/100	£0·30
200	THY3A/200	£0·33
400	THY3A/400	£0·42
600	THY3A/600	£0·50
800	THY3A/800	£0·65

5 Amp TO 66 Case

Volts	No.	Price
50	THY5A/50	£0·36
100	THY5A/100	£0·45
200	THY5A/200	£0·50
400	THY5A/400	£0·57
600	THY5A/600	£0·69
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Volts	No.	Price
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200	THY10A/200	£0·62
400	THY10A/400	£0·71
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Volts	No.	Price
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Volts	No.	Price
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AC137	£0·20
AC141	£0·22
AC141K	£0·30
AC142	£0·20
AC142K	£0·30
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AC153	£0·22
AC153K	£0·30
AC154	£0·20
AC155	£0·20
AC156	£0·20
AC157	£0·25
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AC179	£0·25
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AC180K	£0·28
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AC181K	£0·28
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ACY35	£0·25
ACY36	£0·35
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ACY41	£0·25
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ASY51	£0·30
ASY52	£0·30
ASY54	£0·30
ASY55	£0·30
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ASY57	£0·30
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BC548	£0·12*
BC549	£0·12*
BC550	£0·14*
BC556	£0·14*
BC557	£0·13*
BC558	£0·12*
BC559	£0·14*
BCY30	£0·55
BCY31	£0·55
BCY32	£0·60
BCY33	£0·55
BCY34	£0·60
BCY70	£0·15
BCY71	£0·15
BCY72	£0·14
BCZ10	£0·60
BCZ11	£0·60
BCZ12	£0·60
BD115	£0·50
BD116	£0·80
BD121	£0·65
BD123	£0·65
BD124	£0·70
BD131	£0·38
BD132	£0·40
BD131/132	£0·85
BD133	£0·40
BD135	£0·38
BD136	£0·35
BD137	£0·35
BD138	£0·40
BD139	£0·36
BD140	£0·36
BD139/140	£0·80
BD155	£0·80
BD175	£0·60
BD176	£0·60
BD177	£0·68
BD178	£0·68
BD179	£0·75
BD180	£0·75
BD181	£0·85
BD182	£0·90

Type	Price
BD183	£0·95
BD184	£1·10
BD185	£0·68
BD186	£0·68
BD187	£0·75
BD188	£0·75
BD189	£0·78
BD190	£0·78
BD195	£0·90
BD196	£0·90
BD197	£0·95
BD198	£0·95
BD199	£0·99
BD200	£0·99
BD201	£0·80
BD202	£0·80
BD201/202	£1·70
BD203	£0·80
BD204	£0·80
BD203/204	£1·70
BD205	£0·80
BD206	£0·80
BD207	£1·00
BD208	£1·00
BD222	£0·47
BD225	£0·47
BD232	£0·55
BD233	£0·48
BD234	£0·55
BD235	£0·55
BD236	£0·58
BD237	£0·55
BD238	£0·60
BDX32	£2·20
BDY11	£1·30
BDY17	£1·80
BDY20	£0·80
BDX77	£0·90
BF115	£0·22
BF117	£0·50
BF118	£0·75
BF119	£0·75
BF121	£0·50*
BF123	£0·60*
BF125	£0·50*
BF127	£0·60*
BF152	£0·25*
BF153	£0·25*
BF154	£0·22*
BF155	£0·35
BF156	£0·28
BF157	£0·28
BF158	£0·35*
BF159	£0·35*
BF160	£0·30*
BF162	£0·30*
BF163	£0·30*
BF164	£0·50*
BF165	£0·50*
BF167	£0·24
BF173	£0·20
BF176	£0·38*
BF177	£0·26
BF178	£0·28
BF179	£0·30
BF180	£0·30
BF181	£0·30
BF182	£0·30
BF183	£0·30
BF184	£0·20
BF185	£0·20
BF186	£0·26*
BF187	£0·26
BF188	£0·40
BF194	£0·10*
BF195	£0·10*
BF196	£0·10*
BF197	£0·12*
BF198	£0·14*
BF199	£0·14*
BF200	£0·30
BF202	£0·90*
BF222	£0·90
BF224	£0·17
BF240	£0·17*
BF241	£0·17*
BF244	£0·30*
BF257	£0·30
BF258	£0·30
BF259	£0·42
BF262	£0·60*
BF263	£0·60*
BF270	£0·36
BF271	£0·31
BF272	£0·80
BF273	£0·36*
BF274	£0·38*
BF324	£0·35*
BF336	£0·35
BF337	£0·30*
BF338	£0·38
BF457	£0·37
BF458	£0·37
BF459	£0·38
BF594	£0·30*
BF596	£0·28*
BFR39	£0·24
BFR40	£0·25*
BFR79	£0·28*
BFR80	£0·28*
BFX29	£0·22
BFX30	£0·30
BFX84	£0·22
BFX85	£0·24
BFX86	£0·25
BFX87	£0·22
BFX88	£0·22
BFX90	£0·55*
BFY50	£0·16
BFY51	£0·16
BFY52	£0·16
BFY53	£0·16
BIP19	£0·38
BIP20	£0·38
BIP19/20	£0·80
BPX25	£1·45
BSX19	£0·18

Type	Price
BSX20	£0·18
BSY25	£0·16
BSY26	£0·16
BSY27	£0·16
BSY28	£0·16
BSY29	£0·16
BSY38	£0·19
BSY39	£0·19
BSY40	£0·29
BSY41	£0·29
BSY51	£0·25
BSY95	£0·13
BSY95A	£0·13
BRY39	£0·45
BU105	£1·40
BU105/02	£1·95
BU204	£1·70
BU205	£1·70
BU208	£2·25
BU208/02	£2·95
E1222	£0·38
MAT100	£0·19
MAT101	£0·20
MAT120	£0·19
MAT121	£0·20
MJ480	£0·95
MJ481	£1·05
MJ490	£0·95
MJ491	£1·15
MJE340	£0·45
MJE370	£0·68
MJE371	£0·80
MJE520	£0·65
MJE521	£0·72
MJE2955	£0·98
MJE3055	£0·60
MJE3440	£0·52
MP8113	£0·52
MPF102	£0·35
MPF104	£0·38
MPF105	£0·38
MPSA05	£0·30*
MPSA06	£0·30*
MPSA55	£0·28*
MPSA56	£0·28*
ND120	£0·18
OC19	£0·85
OC20	£1·85
OC22	£1·50
OC23	£1·50
OC24	£1·35
OC25	£1·00
OC26	£1·00
OC28	£0·80
OC29	£0·95
OC35	£0·90
OC36	£0·90
OC41	£0·20
OC42	£0·22
OC44	£0·24
OC45	£0·20
OC70	£0·24
OC71	£0·15
OC72	£0·24
OC74	£0·26
OC75	£0·30
OC76	£0·35
OC77	£0·50
OC81	£0·22
OC81D	£0·24
OC82	£0·24
OC82D	£0·30
OC83	£0·26
OC84	£0·38
OC139	£1·20
OC140	£1·15
OC169	£0·35
OC170	£0·35
OC171	£0·35
OC200	£0·38
OC201	£0·95
OC202	£1·20
OC203	£0·85
OC204	£0·90
OC205	£1·15
P346A	£0·35
P397	£0·45
R20008B	£2·50
R2010B	£2·60
ST140	£0·15
ST141	£0·20
TIC44	£0·29*
TIC45	£0·35*
TIP29A	£0·40
TIP29B	£0·52
TIP29C	£0·50
TIP30A	£0·50
TIP30B	£0·60
TIP30C	£0·60
TIP31A	£0·45
TIP31B	£0·47
TIP31C	£0·49
TIP32A	£0·49
TIP32B	£0·51
TIP32C	£0·53
TIP41A	£0·49

Type	Price
TIP41B	£0·51
TIP41C	£0·53
TIP42A	£0·53
TIP42B	£0·55
TIP42C	£0·57
TIP2955	£0·65
TIP3055	£0·50
TIS43	£0·24
TIS90	£0·22*
UT46	£0·22
ZTX107	£0·10*
ZTX108	£0·10*
ZTX109	£0·10*
ZTX300	£0·12*
ZTX301	£0·12*
ZTX302	£0·16*
ZTX303	£0·16*
ZTX304	£0·20*
ZTX330	£0·15*
ZTX500	£0·14*
ZTX501	£0·12*
ZTX502	£0·16*
ZTX503	£0·12*
ZTX504	£0·45*
ZTX531	£0·26*
ZTX550	£0·16*
2G301	£0·22
2G302	£0·22
2G303	£0·22
2G304	£0·30
2G306	£0·40
2G308	£0·36
2G309	£0·36
2G339	£0·20
2G339A	£0·18
2G344	£0·20
2G345	£0·18
2G371	£0·18
2G371B	£0·12
2G373	£0·18
2G374	£0·18
2G377	£0·32
2G378	£0·18
2G381	£0·18
2G382	£0·18
2G401	£0·32
2G414	£0·32
2G417	£0·26
2N388	£0·36
2N388A	£0·56
2N404	£0·20
2N524	£0·40
2N527	£0·50
2N598	£0·40
2N599	£0·46
2N696	£0·13
2N697	£0·12
2N698	£0·12
2N699	£0·32
2N706	£0·10
2N706A	£0·12
2N707	£0·48
2N708	£0·14
2N711	£0·30
2N717	£0·30
2N718	£0·25
2N718A	£0·50
2N726	£0·29
2N727	£0·29
2N743	£0·20
2N744	£0·20
2N914	£0·15
2N918	£0·30
2N929	£0·20
2N930	£0·18
2N946	£0·40
2N1131	£0·18
2N1132	£0·18
2N1302	£0·15
2N1303	£0·18
2N1304	£0·18
2N1305	£0·18
2N1306	£0·25
2N1307	£0·25
2N1306	£0·30
2N1309	£0·30
2N1599	£0·35
2N1613	£0·20
2N1711	£0·20
2N1889	£0·45
2N1890	£0·45
2N1893	£0·30
2N2147	£0·75
2N2148	£0·70
2N2160	£1·00
2N2192	£0·38
2N2193	£0·38
2N2194	£0·38
2N2217	£0·22
2N2218	£0·22
2N2218A	£0·20
2N2219	£0·20
2N2219A	£0·24
2N2220	£0·20
2N2221	£0·20
2N2221A	£0·22
2N2222	£0·20
2N2222A	£0·20
2N2368	£0·18
2N2369	£0·14
2N2369A	£0·14
2N2411	£0·25
2N2412	£0·25
2N2646	£0·47
2N2711	£0·22

Type	Price
2N2712	£0·22
2N2714	£0·22
2N2904	£0·18
2N2904A	£0·21
2N2905	£0·18
2N2905A	£0·20
2N2906	£0·16
2N2906A	£0·19
2N2907	£0·20
2N2907A	£0·22
2N2923	£0·15*
2N2924	£0·15*
2N2925	£0·15*
2N2926G	£0·09*
2N2926Y	£0·08*
2N2926O	£0·08*
2N2926R	£0·08*
2N2926B	£0·08*
2N3010	£0·65
2N3011	£0·15
2N3053	£0·16
2N3054	£0·40
2N3055	£0·40
2N3391	£0·20*
2N3391A	£0·22*
2N3392	£0·20*
2N3393	£0·20*
2N3394	£0·20*
2N3395	£0·22*
2N3402	£0·21*
2N3403	£0·21*
2N3404	£0·29*
2N3405	£0·42*
2N3414	£0·16*
2N3415	£0·16*
2N3416	£0·29*
2N3417	£0·29*
2N3614	£1·00
2N3615	£1·05
2N3616	£1·05
2N3646	£0·09*
2N3702	£0·08*
2N3703	£0·08*
2N3704	£0·07*
2N3705	£0·07*
2N3706	£0·08*
2N3707	£0·08*
2N3708	£0·07*
2N3708A	£0·07*
2N3709	£0·07*
2N3710	£0·07*
2N3711	£0·07*
2N3772	£1·60
2N3773	£2·50
2N3819	£0·20
2N3820	£0·35
2N3821	£0·60
2N3823	£0·60
2N3903	£0·15**
2N3904	£0·15*
2N3905	£0·15*
2N3906	£0·15*
2N4058	£0·12*
2N4059	£0·14*
2N4060	£0·14*
2N4061	£0·12*
2N4062	£0·12*
2N4284	£0·18*
2N4285	£0·18*
2N4286	£0·18*
2N4287	£0·18*
2N4288	£0·18*
2N4289	£0·18*
2N4290	£0·18*
2N4291	£0·18*
2N4292	£0·18*
2N4292	£0·18*
2N4921	£0·55*
2N4923	£0·65*
2N5135	£0·10*
2N5136	£0·10*
2N5138	£0·10*
2N5172	£0·14*
2N5194	£0·56
2N5245	£0·40
2N5294	£0·34
2N5296	£0·36
2N5257	£0·32
2N5458	£0·32
2N5459	£0·35
2N5551	£0·36*
2N6027	£0·34
2N6121	£0·70
2N6122	£0·70
2S 301	£0·50
2S 302	£0·43
2S 302A	£0·43
2S 303	£0·56
2S 304	£0·71
2S 305	£0·80
2S 306	£0·80
2S 307	£0·80
2S 321	£0·57
2S 322	£0·43
2S 322A	£0·43
2S 323	£0·57
2S 324	£0·71
2S 325	£0·71
2S 326	£0·71
2S 327	£0·71
40360	£0·36
40361	£0·36
40362	£0·38
40406	£0·45
40407	£0·35
40408	£0·52
40409	£0·75
40410	£0·75
40411	£2·70

74 SERIES TTL IC'S

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0·10	7427	£0·24	7472	£0·20	74105	£0·38	74163	£0·78
7401	£0·11	7428	£0·33	7473	£0·25	74107	£0·27	74164	£0·85
7402	£0·11	7430	£0·12	7474	£0·25	74110	£0·45	74165	£0·85
7403	£0·11	7432	£0·22	7475	£0·29	74111	£0·67	74166	£0·95
7404	£0·11	7433	£0·30	7476	£0·25	74118	£0·80	74174	£0·86
7405	£0·11	7437	£0·23	7480	£0·44	74119	£1·18	74175	£0·66
7406	£0·26	7438	£0·23	7481	£0·85	74121	£0·24	74176	£0·74
7407	£0·26	7440	£0·12	7482	£0·68	74122	£0·39	74177	£0·75
7408	£0·13	7441	£0·50	7483	£0·70	74123	£0·46	74180	£0·84
7409	£0·13	7442	£0·54	7484	£0·88	74136	£0·74	74181	£1·60
7410	£0·12	7443	£0·88	7485	£0·88	74141	£0·55	74182	£0·74
7411	£0·17	7444	£0·88	7486	£0·25	74145	£0·62	74184	£1·18
7412	£0·20	7445	£0·65	7489	£1·95	74150	£0·95	74190	£1·00
7413	£0·24	7446	£0·65	7490	£0·32	74151	£0·58	74191	£1·00
7414	£0·50	7447	£0·60	7491	£0·64	74153	£0·58	74192	£0·95
7416	£0·26	7448	£0·56	7492	£0·37	74154	£0·95	74193	£1·00
7417	£0·26	7450	£0·12	7493	£0·30	74155	£0·60	74194	£0·89
7420	£0·12	7451	£0·12	7494	£0·75	74156	£0·60	74195	£0·82
7421	£0·20	7453	£0·12	7495	£0·50	74157	£0·60	74196	£0·88
7422	£0·16	7454	£0·12	7496	£0·62	74160	£0·78	74197	£0·85
7423	£0·23	7460	£0·12	74100	£0·92	74161	£0·78	74198	£1·45
7425	£0·19	7470	£0·25	74104	£0·39	74162	£0·78	74199	£1·45
7426	£0·23								

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·15	CD4015	£0·98	CD4026	£1·70	CD4043	£0·98	CD4070	£0·40
CD4001	£0·18	CD4016	£0·50	CD4027	£0·60	CD4044	£0·94	CD4071	£0·23
CD4002	£0·18	CD4017	£0·98	CD4028	£0·98	CD4045	£1·40	CD4072	£0·23
CD4006	£0·98	CD4018	£1·00	CD4029	£1·15	CD4046	£1·30	CD4081	£0·20
CD4007	£0·18	CD4019	£0·55	CD4030	£0·55	CD4047	£1·10	CD4082	£0·23
CD4008	£0·98	CD4020	£1·10	CD4031	£2·20	CD4049	£0·55	CD4510	£1·30
CD4009	£0·58	CD4021	£0·98	CD4035	£1·30	CD4050	£0·55	CD4511	£1·60
CD4010	£0·58	CD4022	£0·90	CD4037	£0·95	CD4054	£1·10	CD4516	£1·40
CD4011	£0·20	CD4023	£0·20	CD4040	£0·95	CD4055	£1·40	CD4518	£1·25
CD4012	£0·20	CD4024	£0·80	CD4041	£0·82	CC4056	£1·35	CD4520	£1·25
CD4013	£0·52	CD4025	£0·20	CD4042	£0·82	CD4069	£0·40		

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£1·05*	CA3130	£0·93	MC1350	£1·20*	UA710C	£0·40*	SN76115	£1·90*
CA3014	£1·70*	CA3140	£0·90	MC1352	£1·40*	74710	£0·30*	SN76660	£0·75*
CA3018	£0·75*	LM301	£0·39*	MC1469	£2·95	UA711C	£0·32*	SL414A	£1·95*
CA3020	£1·70*	LM304	£1·60	MC1496	£0·98*	72711	£0·32*	TAA550B	£0·35
CA3028	£1·02*	LM308	£1·40*	NE536	£3·50*	UA723C	£0·45	TAA621A	£2·00*
CA3035	£1·70*	LM309	£1·50	NE550	£0·95	72723	£0·45	TAA621B	£2·50*
CA3036	£1·35*	LM320-5v	£1·50	NE555	£0·32	UA741C	£0·24*	TAA661	£1·65*
CA3042	£1·50*	LM320-12v	£1·50	NE556	£0·82	72741	£0·24*	TAD100	£1·30*
CA3043	£1·85*	LM320-15v	£1·50	NE565	£1·75*	741P	£0·20*	TBA540	£2·20*
CA3046	£0·80*	LM320-24v	£1·50	NE566	£1·50*	UA747C	£0·70*	TBA800	£0·80*
CA3052	£1·60*	LM380	£0·85*	NE567	£1·80*	72747	£0·79*	TBA810	£1·05*
CA3054	£1·35*	LM381	£1·55*	UA702C	£0·46*	UA748	£0·35*	TBA820	£0·80*
CA3075	£1·50*	LM3900	£0·65*	72702	£0·46*	72748	£0·35*	TBA9200	£3·40*
CA3081	£1·50*	MC1303L	£1·48*	UA703	£0·25*	748P	£0·35*	TCA270S	£2·20*
CA3089	£2·10*	MC1304	£1·90*	UA709	£0·25*	SN76013N	£1·75*		
CA3090	£4·25*	MC1310	£0·95*	72709	£0·46*	SN76023	£1·75*		
CA3123	£1·90*	MC1312	£1·90*	709P	£0·25*	SN76110	£1·50*		
		MC1330	£1·20*						

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	£0·08	BB104	£0·15	BY130	£0·17*	BYZ19	£0·36	OA200	£0·08
AA120	£0·08	BAX13	£0·07	BY133	£0·21*	OA5	£0·60	OA202	£0·08
AA129	£0·08	BAX16	£0·08	BY164	£0·51	OA10	£0·35	SD10	£0·06
AAY30	£0·09	BY100	£0·22	BY176	£0·75*	OA47	£0·08	SD19	£0·06
AAZ13	£0·15	BY101	£0·22	BY206	£0·30	OA70	£0·08	IN34	£0·07
BA100	£0·10	BY105	£0·22	BYZ10	£0·45	OA79	£0·13	IN34A	£0·07
BA102	£0·32	BY114	£0·22	BYZ11	£0·45	OA81	£0·13	IN914	£0·06
BA148	£0·15	BY124	£0·22*	BYZ12	£0·45	OA85	£0·13	IN916	£0·06
BA154	£0·12	BY126	£0·15*	BYZ13	£0·40	OA90	£0·07	IN4148	£0·06
BA155	£0·14	BY127	£0·16*	BYZ16	£0·41	OA91	£0·07	IS44	£0·05
BA173	£0·15	BY128	£0·16	BYZ17	£0·36	OA95	£0·07	IS920	£0·06
				BYZ18	£0·36	OA182	£0·13		

TRIACS

2 amp Volts	TO5 Case No.	Price	10 Amp Volts	TO48 Case No.	Price
100	TR12a/100	£0·31	100	TR110a/100	£0·77
200	TR12a/200	£0·51	200	TR100a/200	£0·92
400	TR12a/400	£0·71	400	TR100a/400	£1·12

6 Amp Volts	TO66 Case No.	Price	10 Amp Volts	TO220 Plastic Case No.	Price
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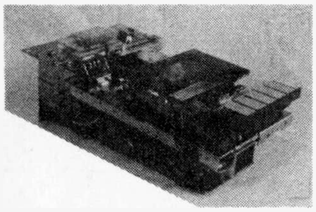

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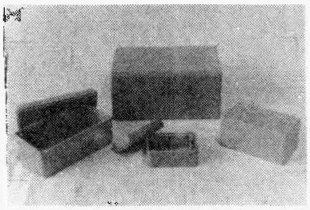

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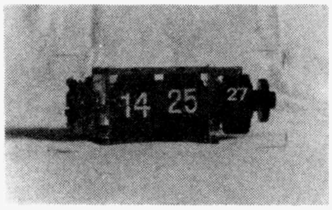

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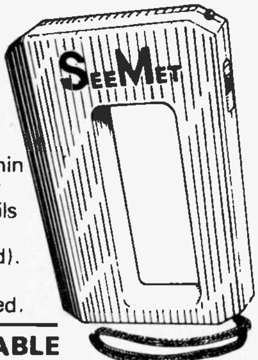

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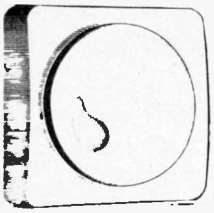

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PE VOLUME 14 No. 16 DECEMBER 1978

INVENTIVE

ELSEWHERE in this issue you will find the brief results of our inventors' competition. This competition which carried £490 worth of Scopex 'scopes as prizes was run in the June and July issues of P.E. and attracted a large range of entries, from simple applications for flashing l.e.d.s to complex systems for aircraft guidance. We were amazed by the sheer range of ideas and by the incredible ingenuity of a number of readers.

Apart from simply giving the results, some comments may prove interesting and helpful to other readers: The entries which have been awarded prizes have been partly selected because they had been built and proven; it was surprising to find the number of excellent ideas which were put forward by people without either the time or ability to develop that idea. These suggestions have not been overlooked, although we did not feel we could award any of them a prize, they were considered none-the-less and, in fact, it is likely that a fair amount of money will be spent on the development and testing of one of these ideas as the first step in its ultimate production.

Another large group of entries received described the design of a new component or mechanical assembly for use in consumer equipment already on the market. Unfortunately there is little we can do with such ideas except advise the inventor to patent his system or component and then sell it to one of the manufacturers.

A third group of ideas were for equipment which could be produced and marketed on a small scale but which were not considered to be economically viable to put into quantity production. A number of these ideas were for use in schools and colleges and their designers might do well to approach local authorities to assess a demand and then try to interest a small equipment manufacturer in the idea as a side line.

EXHIBITIONISM

P.E. is not renowned for its exhibitionism—nor are any members of staff we are glad to say. However from November 21 to 25 we will have a stand at the Breadboard Exhibition in London (see page 1278 for further details) and will be exhibiting and demonstrating a number of projects.

One project we are sure will be of interest is the *P.E. Microprinter* which will form our cover feature next month. We believe this will be the first time a d.i.y. printer has been published in the U.K. and this design will enable the computer fanatics to make a 40 column printer for approximately £100. So don't miss us at Breadboard—**we will also be giving out free gifts; £3,000's worth of them!**

PRICES

The price of many components—particularly in MPU related areas—continue to fall almost weekly. Because of these reductions readers are advised to check with suppliers before buying. The Chromasonics catalogue given away inside this issue contains a page of memories. The catalogue was printed before this page was written and in the meantime Chromasonics have been able to reduce the price of many memories. For instance the 2112A-2 quoted at £3·24 was available at the time of going to press for £2·14. The 2111A-1 has been reduced from £3·51 to £2·46 and the more expensive 2114 from £16·20 to £8·10.

These are not the only reductions and, as suggested above, a phone call or two before any purchase could save a few pence or even pounds.

Mike Kenward

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We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only.**

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p & p.

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Binders for PE are available from the same address as back numbers at £2·85 each to UK addresses, £3·45 overseas, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

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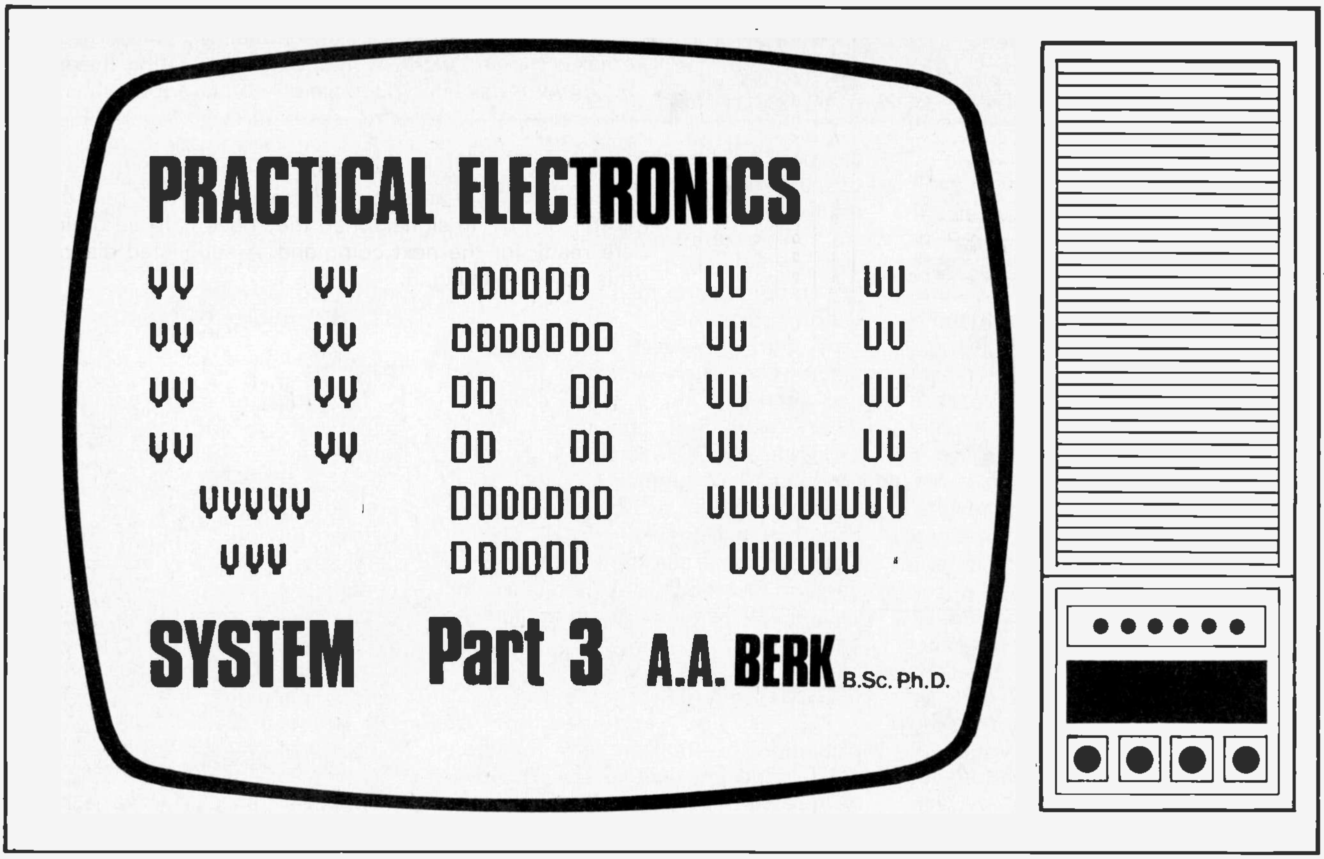
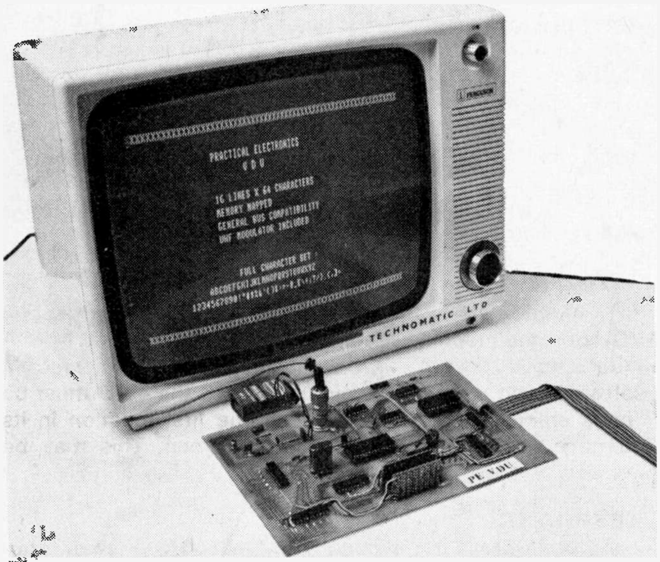


★ *Interfacing the VDU to an MPU system*
★ *Some cursor management suggestions*
★ *Simple keyboard interface*
★ *Addition of lower case characters*
★ *Further advice on the use of the UHF modulator.*



THE "PE VDU" is a complete output peripheral for MPU systems, and will interface easily to any data bus and address bus, including the 6800, Z80, 8080, and SC/MP systems such as the Science of Cambridge MK14.

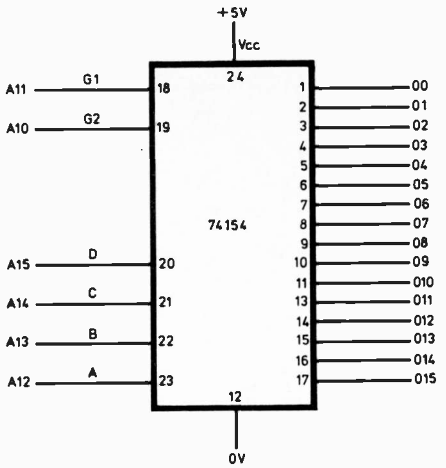
However, an appreciation of address decoding is necessary for successful interfacing.

ADDRESS DECODING

When an MPU places an address upon the address bus, it is usually either looking for a *reply* from that address location (to appear on the data bus) or is in the process of *sending* a word of data to change that location. It is thus of utmost importance that any address location be uniquely identifiable. In order to ensure this, each memory device has, in addition to a minimal number of address lines, one or more chip selects (CS) lines (or more usually $\overline{CS}$ lines). It is up to the designer to ensure that a given memory device receives a $\overline{CS}$ pulse only when it is supposed to be selected. For example, the 1K memory in the VDU has ten address lines A0 to A9 because $2^{10} = 1024$ (or 1K for short). These are to be connected to the address bus of the MPU.

To select this block of memory when required, the upper six address lines (A10 to A15) must be decoded to send a $\overline{CS}$ pulse to the memory for exactly the right bit pattern on these address lines. The 74154 is an excellent device for this type of function and a possible arrangement for connections is shown in the diagram of Fig. 1.

Operation of the device is as follows. Any bit pattern on A12 to A15 selects one of the outputs (normally high) and forces a zero to appear there. The zero outputs on 0_0 to 0_{15} occur as D, C, B and A take up the binary numbers as shown in the right-hand table. Thus the binary number 0010, for instance, forces 0_2 low. This may be connected to the $\overline{CS}$ input of a memory device which will then be selected.



D	C	B	A
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

Fig. 1. Using a 74154 to decode the address lines thus generating the necessary $\overline{CS}$ signals

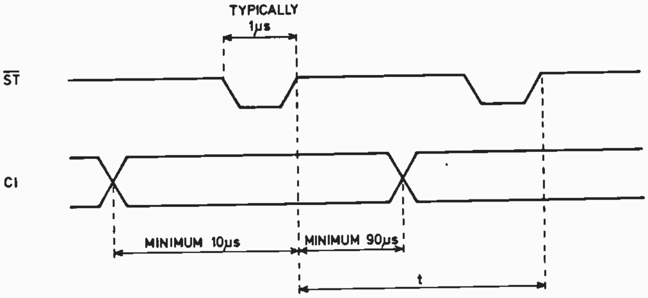


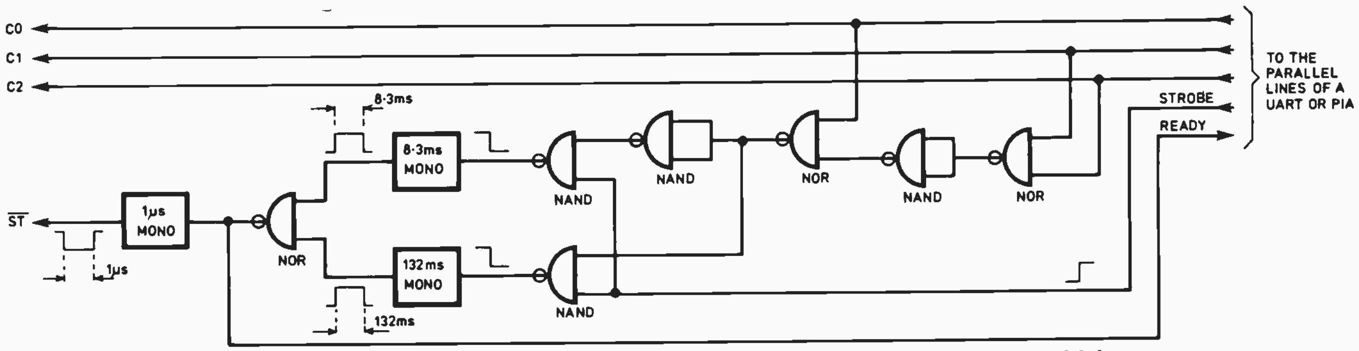
Fig. 2. Timing diagram for CO, C1, C2 and $\overline{ST}$ lines

Time "t" is a minimum of 132ms for C_0 C_1 C_2 = 0 0 0 (Cursor home and page erase command); and 8·3ms for any other command word. A method of generating these times in software has been discussed. Another approach is to use monostables to generate them directly. A UART or PIA (MC6820) may be used to interface to the control lines in either method. For the monostable generation of the timing pulses, a ready line from the mono's must also be fed to the UART or PIA, to signal when they have finished timing and are ready for the next command. A suggested diagram for this is shown in Fig. 3.

The 8·3ms and 132ms mono's are set to give a "high" for the required time on a negative excursion input. The 74123 is fitted to provide all the monostable functions required. The 1μs mono is set to give a zero pulse on the $\overline{ST}$ line when it receives a rising edge from the appropriate mono at the end of its timing pulse. In Fig. 3, the MPU sets up a control word on C_0 C_1 C_2 and then sends a start pulse to the monostables. The correct mono is automatically selected by the logic shown. While one of the mono's is timing, the ready line is low. The MPU detects a ready signal (high) at the end of this period for the next command. The PIA or UART used to access this piece of hardware will have $\overline{CS}$ lines, or their equivalent, and may thus be treated as a memory location as described above in address decoding.

If software cursor delays are used, the author has found that the UART or PIA may be conveniently replaced by a simple TTL latch such as the 74174. C_0 C_1 C_2 and $\overline{ST}$ are connected to the outputs of this device and the inputs con-

Fig. 3 (below). Using monostables to generate the timing pulses, instead of software. A suggested circuit.



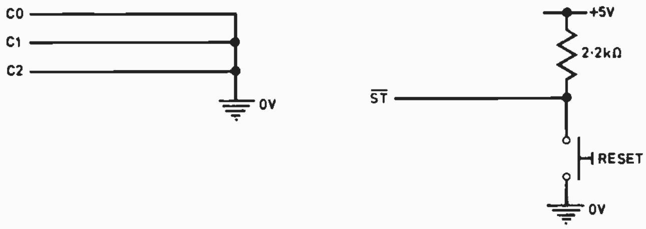


Fig. 4 (left). Reset circuit for initial page erase, necessary when the cursor is generated by software

nected directly to the data bus. This is a purely 'output' device and does not affect the information on the Bus. To prevent Bus loading, the LS version is recommended. The Clock input to the latch is to be treated as the Chip Select line. Hence the C_0 C_1 C_2 word should be set up first followed by the pulsing of the $\overline{ST}$ line and a suitable delay before any repetition.

All this depends upon G1 and G2 being low. Thus only for zeros on A11 and A10 will the 74154 select any of its outputs. This causes 0_0 to 0_{15} to select sixteen 1K pages, *one of which could be the VDU.*

In order to simplify address decoding two $\overline{CS}$ inputs are included on the VDU; these are labelled $\overline{\text{VDU select and enable}}$. Both must be low for the VDU RAM to be selected.

CURSOR CONTROL

Part One explained how to use the cursor control lines C_0, C_1, C_2 and $\overline{ST}$. Fig. 2 illustrates the timing diagram to be followed when using these lines.

OTHER CURSOR GENERATION METHODS

There are several monitor programs for memory mapped VDUs on the market—these should all work admirably with the PE VDU. Most of them, however, generate the cursor in software, and under these circumstances the VDU must be "page erased" at the start so that the first location in its memory appears at top left of the screen. This may be assured by a reset button on the $\overline{ST}$ line as shown in Fig. 4.

KEYBOARD

As this VDU is not a videowriter, a keyboard is not interfaced to it directly. There are many ways to add a keyboard to a MPU system. One of the simplest, *and fastest,* is illustrated in Fig. 5.

D0 to D6 are the seven lines of character information given out by the keyboard. These must be latched before entering the buffer. Most keyboards perform this function automatically. This information is only allowed through and onto the data bus if the CS line is low. The keyboard may thus be thought of as a memory location and accessed via memory decoding. The strobe pulse from the keyboard informs the MPU when a new piece of information is available. This line may be connected up in several ways.

The strobe may simply be connected to D7 of the data bus through the buffer. A service routine in the monitor checks D7 continually for a strobe and D0 to D6 are then read and acted upon. Alternatively, the strobe may be connected to an interrupt line of the MPU. The monitor program must then contain an interrupt service routine to accept data from the keyboard, act upon it and return to the program which was interrupted.

A more sophisticated method is to latch the strobe pulse and clear the latch when the data is read. This allows the MPU to use the keyboard information at its leisure.

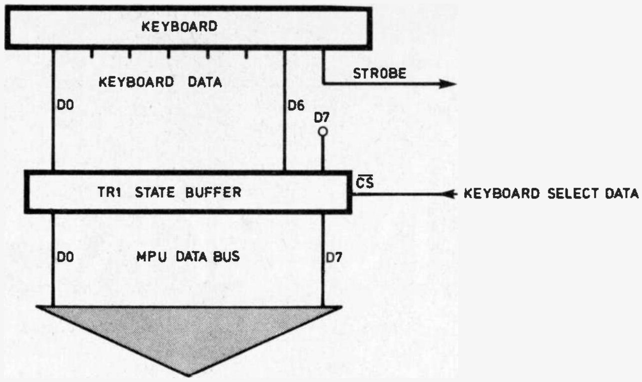
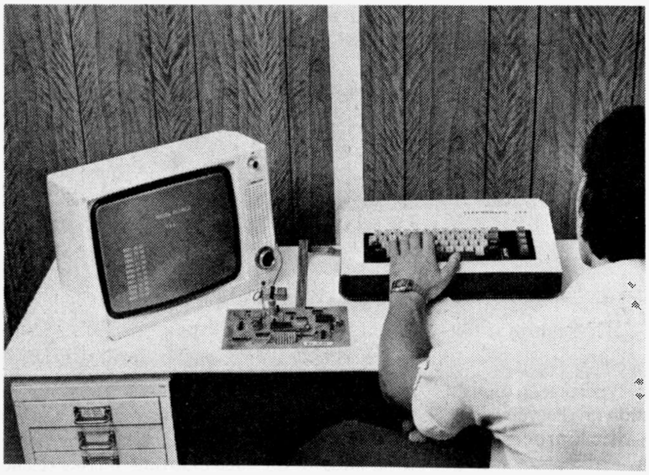


Fig. 5. Simple method of interfacing a keyboard to an MPU system

ADDING LOWER CASE CHARACTERS

Adding other characters to the VDU is very simple indeed. The easiest method is to use the lower case version of the 2513. This may be wired in parallel with the upper case 2513 (except for their $\overline{CS}$ lines). These character generators are simply Read Only Memories (ROMs). They have $\overline{CS}$ inputs which are used to enable them (pin 11). In order to address either ROM, its pin 11 must be low. The data in the ROM is accessed by six address lines fed from RAM through IC11 (six bit latch). Two lines from the RAM (DO6 and DO7) are unused as six bits are enough for 64 characters. Lower case characters occur when DO5 and DO6 are both ones. This may be seen from the ASCII code. A little logic decoding is necessary to turn the upper case 2513 off ($\overline{CS}$ high) and the lower case on ($\overline{CS}$ low) for this occurrence.

This only uses half the lower case ROM and a little more logic decoding will access the other half which contains a varied collection of special symbols. By this method, most other character generators may also be added with the appropriate decoding.



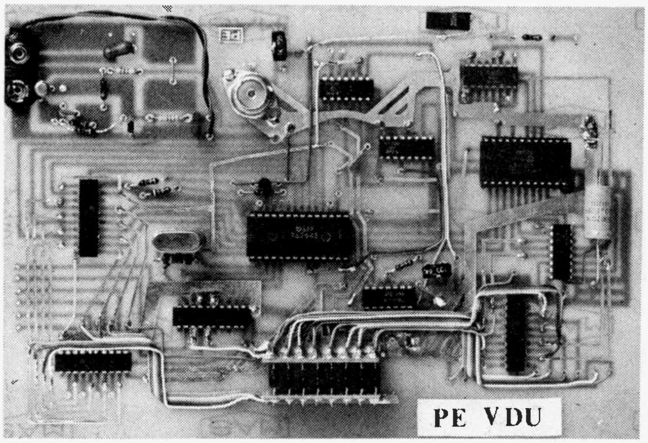
The photographs in Part 1 showed the VDU displaying reverse field characters. In this part the position of switch S1 is set so that the more common white characters on a dark background are generated

FURTHER HINTS ON UHF MODULATOR

The stripline modulator, mounted on the p.c.b., has given good results by following the suggestions given below.

The value of VR1 should be changed to 1kΩ. This matches impedances more accurately for the UHF modulator, though may be found a little low for straight video. The p.c.b. track taking the +9V from the battery to the modulator should be cut, and about 5mm removed from it. This gap should then be bridged by a 2·2kΩ resistor. C6 is at one end of this resistor, and a further 10nF capacitor can be placed between the other end and the 0V track nearby. It will also be found that the 33pF tuning capacitor, C4, may be ommitted to tune to most TV sets. Finally, a 12pF capacitor may be placed in the UHF feed line. Printed circuit track should be removed to accommodate this component, and care must be taken to remove tracking as near to the output end as possible—to prevent damage to that part of the p.c.b. track which forms L3.

The kits and boards available from Technomatic include the above modifications.



LIGHT-PEN?

As a final note, the CRTC chip data sheet informs the reader that a light-pen facility is available. Unfortunately, this is not really so at present. It is still possible to add a light-pen to the PE VDU and its addition conjures up all sorts of dazzling features. Instant editing of the screen's contents would be a most elegant process. Games would be beautifully interactive. Even the demise of the keyboard can be envisaged, with the top right-hand corner of the screen containing a full ASCII character set which may be "typed" in to the MPU system simply by holding a light-pen up to the appropriate character.

Ah well, perhaps next Christmas! ★

Market Place

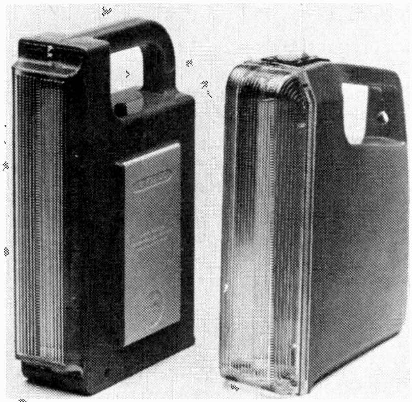
Items mentioned are usually available from electronic equipment and component retailers. However, where a full address is given, general enquiries may be made direct to the firm concerned. All quoted prices are correct at time of going to press.

by Alan Turpin and David Shortland

LET THERE BE FLUORESCENT

Christmas is coming and the nights are getting dark. Use fluorescent lanterns and give batteries more spark.

These Sterling lanterns from Dixons have a built-in carrying handle and a spring clip for wall fixing. A ribbed tube cover maximises illumination although the diffusion of fluorescents makes them no good for burglars.



The XP500 costs £5·95 and runs off eight 1·5V HP2's or equivalent. The XP1000 at £7·95 is similar but can also be used off a 12V car battery (a 15ft lead for use with a cigar lighter socket is supplied).

CATALOGUES

Home Radio's new catalogue has an interesting Barbara Hepworth design on the cover. The index mentions several hundred items. Home Radio say they have over 3,000 components. Price is £1 plus 25p p&p. **Home Radio Ltd., 240 London Road, Mitcham, Surrey, CR4 3HD. (01-648 8422)**

A stamped, self addressed envelope, 9 × 6½, is all you need to send for the latest TUAC catalogue—30 pages of technical specs. on their pre-amps, power supplies, disco mixers, sound to light sequencers, trannies, high power loud speakers, musician and p.a. combination amps, slave amps, components and hardware.

Transistor Universal Amplification Co. Ltd., 119 Charlmont Road, London, SW17 9AB.

Magenta Electronics have a 31 page catalogue with everything for the hobbyist.

Send a 12 × 9 SAE to **Magenta Electronics Ltd., Newton Leys, Burton-on-Trent, Staffs., DE15 0DW. (0283 65435)**

PRODUCT GUIDES

A new guide to Mullard "preferred" power transistors is available. Categories included are complementary power transistors, complementary Darlingtons, *npn* high-voltage transistors, *npn* switching power transistors, and transistors for switched-mode power supplies. Also included in the guide are recommended power transistor line-ups and an equivalents list.

Central Enquiry Handling Unit, Mullard Ltd., New Road, Mitcham, Surrey. (01-580 6633)

General Instrument Microelectronics product guide has information on their devices under the headings—Microprocessor, Microcomputer, Memory, Telecommunications, Home Information Centre, Entertainment, TV Games, Consumer, Industrial/Mosfet.

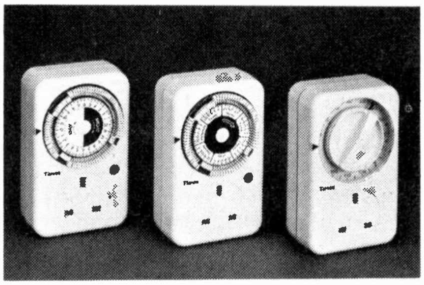
General Instrument Microelectronics Ltd., Regency House, 1–4 Warwick Street, London, W1R 5WB. (01-439 1891)

PLUG-IN TIMERS

Superswitch have extended their TIMAC Range of timers by introducing three new models with automatic controls.

The new 24-hour TIMAC (Cat No. T1301) has 96 built-in quarter hour time selectors for easy setting. "ON" sequences are clearly indicated by red segments which are exposed when the time selectors are operated.

The new 7-day TIMAC (Cat No. T1307) uses a similar built-in time selector system. In this model the 84 time selectors give 12 two-hour "ON" sequences per day. These sequences are indicated by blue segments



which are exposed when the time selectors are operated.

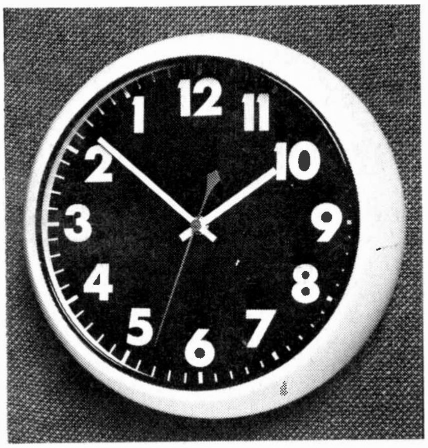
The new 2 hour TIMAC (Cat No. T1300) incorporates a mechanical timer to give control when shorter periods are required. The large dial allows very accurate settings for both domestic and industrial use.

All three units plug into standard 13 amp outlet sockets and have 3,000W ratings.

The recommended prices of the three units are: T1301, £13·50; T1307, £15·75; T1300, £12·50.

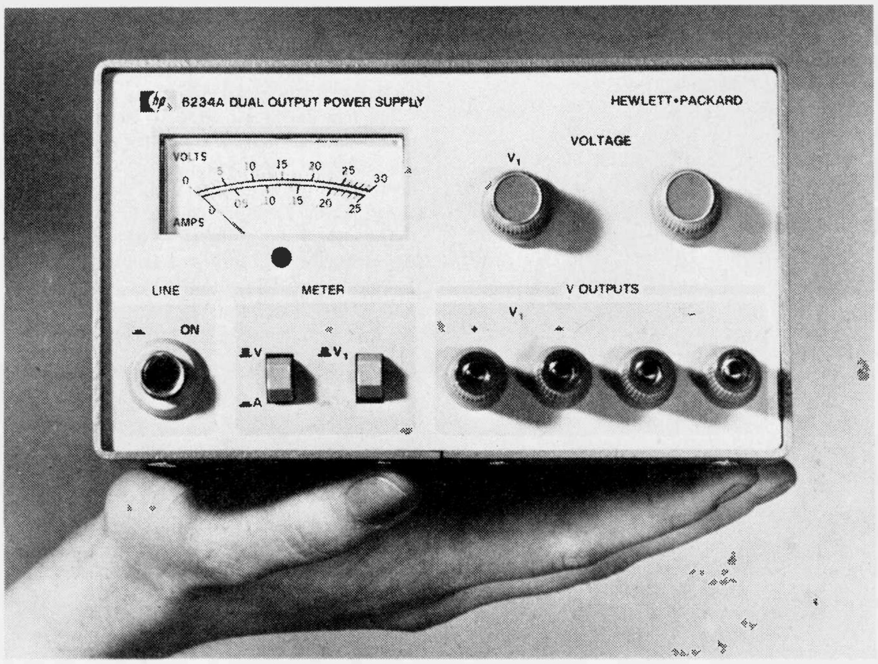
ANTI-CLOCK

More of a conversation piece than a device to get you to work on time, this clock does tell the time—eight minutes past ten in the photograph. It has a black face, white hands and numerals, and a high frequency, 400 day, battery operated, electronic, torsional pendulum movement.



The face does not show real time going backwards but at least makes for more awareness of the fact that time passes relentlessly on, however it is displayed.

The "Backward" clock is available at £13·95 (inc. VAT and p&p) from designers and manufacturers **Accutec Designs Ltd., 121a Strathville Road, London, SW18. (01-874 4641)**



DUAL POWER SUPPLY UNIT

The dual-output bench power supply from Hewlett-Packard offers two independently adjustable and isolated power sources in one compact unit. Both of the d.c. power sources are of the constant voltage/current limit type with each output voltage being adjustable continuously over a 0 to 25V range. The maximum current available per output is 0·2A and is limited to prevent overloading.

The HP-6234A offers considerable flexibility to the user with output voltages that can be arranged to provide identical or different voltages in any polarity combination with respect to zero or other common positive or negative voltage points. The outputs can also be connected in series to provide up to 50V at 0·2A. Both sources are fully isolated to permit either of the output terminals to be grounded.

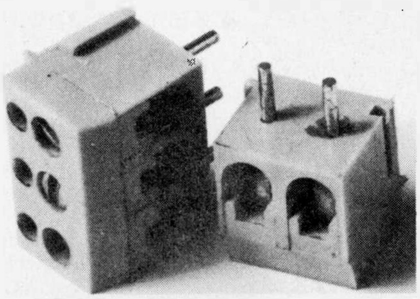
With pushbutton switches users can select either voltage or current for each output to be monitored on the unit's meter. Other features include two multiple-turn controls for precise voltage setting, regulation to 0·01 per cent and ripple and noise of less than 200 µV rms.

The 6234A is priced at £112. For further information contact **Hewlett Packard Limited, King Street Lane, Winnersh, Wokingham, Berkshire.**

TIDY TERMINATIONS

Flying leads to circuit boards can be a nuisance to terminate neatly. Also, to enable future access to the underside of the board, several inches of lead may have to be left spare.

These Verospeed terminal blocks fit across two pitches of 0·1 inch matrix board. They come in 2-way or 3-way units and the mouldings are designed to mechanically interlock, allowing any number of terminations to be built up. Each termination



incorporates a test socket for 2mm plugs. A captive screw contact takes up to 1·5mm² wire. The contact is made from tin plated brass and has a phosphor bronze leaf wire protector. Nominal voltage, 380V. Nominal current, 16A.

2-way, pack of three, 78p. 3-way, pack of three, 98p. Verospeed catalogue free. Prices include p & p but add VAT at eight per cent.

Verospeed, Barton Park Industrial Estate, Eastleigh, Hants SO5 5RR. Telephone: 0703 618525/6.

CHOOSE A CARD

There are now two other versions of the Casio Mini Card calculator mentioned in the June Market Place, a Scientific Card, fx-48, and a Timer Card, ST-24. Full details of all three are available from suppliers Tempus.

If you ever found the old Westminster chiming clocks a useful aid to slumber breaking then the Timer Card may be of interest. As well as the usual sports timing functions there is a repeater timing function. This enables any period of time up to 24 hours (minus one second) to be repeatedly alarmed.

Thus by setting to a repeat of, say, one hour or 30 minutes, one can have a gentle Westminster system sounding out all night (if too loud put it in a drawer). When you have slumbered enough, one of these signals will lightly pull you out at the top of one of your alternating deep/light sleep cycles. Far more civilised than a nerve jarring, sudden awakening from a deep sleep trough by a sergeant-major type of alarm clock.

Prices (batteries supplied) from Tempus are: Mini Card, LC-78, £16·95; Scientific Card, fx-48, £19·95; Timer Card, ST-24, £19·95.

All prices include VAT and p&p, and each 91 × 55 × 6mm calculator is complete with a leatherette case and 30 booklet pages of user information.

Tempus, Talk of the Town, 19–21 Fitzroy Street, Cambridge CB1 1EH.

NEW MUSIC CENTRE

For £139·50 (inc. VAT and p&p) you get—Amps. 2 × 14W r.m.s. into 4Ω, t.h.d. 0·5 per cent typical, push buttons for all functions; Deck—BSR P182 semi-automatic single player, 3 speeds, SC12M cartridge, sapphire stylus, 10·5in turntable; Speakers—8 × 5in rated 15W r.m.s.; Radio—VHF, MW, LW, AFC, Stereo Beacon; Cassette—Auto CRO2 (chrome), 6 piano keys inc. pause, automatic record level, auto stop on play, digital turns counter, cassette storage rack; Two mikes; Cabinet—teak, walnut or black veneers, hinged tinted dust cover; 12 month guarantee.

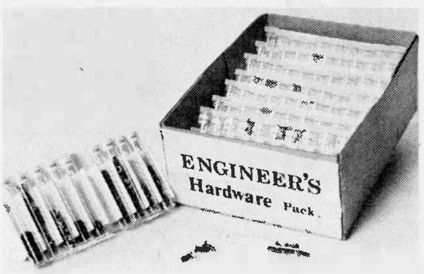
Will it fit—width 610, depth 460, height 108mm; Speakers—206 × 152 × 352mm.

For a colour illustration send SAE.

Delivery ex-stock from **Readers' PCB Services Ltd., Fleet House, Welbeck Street, Whitwell, Worksop, Notts. (0909 720695)**

NUTS FOR CHRISTMAS

The next time the wife tells you a nut or bolt has dropped out of the hairdryer, food mixer, kids' toy, etc., get this hint in for a Christmas present. Spend a quarter of an hour digging around your cake tin of mixed nuts, screws, washers and bolts, and then in exasperation say, "If only I had an Engineer's Hardware Pack". "A what?," she'll say. Then you can explain Home Radio's kit of 2 to 8BA nuts—brass and nylon; screws—brass, self tapping, chrome, nylon, grub; washers—brass,

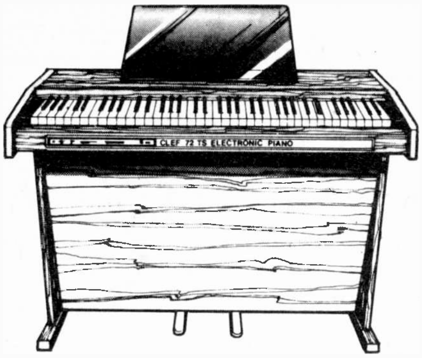


shakeproof and nylon; solder tags; and metric screws and nuts. Finally dig once more into your tin of allsorts and sit her down with a large glass of cheap sherry in case she moans at the price.

£21 plus 8 per cent VAT from **Home Radio (Components) Ltd., 240 London Road, Mitcham, Surrey, CR4 3HD. (01-648 8422)**

JOANNAS

The latest six and $7\frac{1}{4}$ octave touch sensitive electronic piano kits from Clef Products will be demonstrated for the first time at the Breadboard '78 Exhibition.



The Joanna 72 and 88 have been developed from the P.E. Joanna and are designed by A. J. Boothman. The Joanna 88 is a full size 88 note piano. The new design has a greater degree of precision in the damper action, and adopts layout techniques to eliminate beehive breakthrough, which has been a problem in pianos due to the requirement of maximum system gain to cope with the instant wide dynamic range.

For further information contact **Clef Products, 16 Mayfield Road, Bramhall, Cheshire.**

NICE MEDICINE

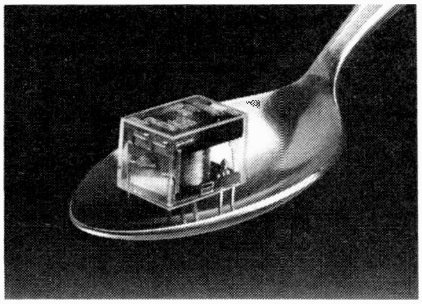
One of the world's smallest relays, the G2E, is available with coil ratings from 1·5V to 24V at currents of 18·8mA to 300mA.

Relay contacts are rated at 0·5A (100V a.c. PF = 1) or 1A (24V d.c.), while the carry current is 2A for both versions.

This subminiature component measures only 16 × 11 × 10·5mm and weighs just 3·5gm. Termination pins are arranged on 2·5mm pitch.

Life is in excess of 5×10^6 operations, and switching frequency is 1,800/hr max. Coil resistances range from 5Ω to 1,280Ω and only 290mW of pull-in power is needed.

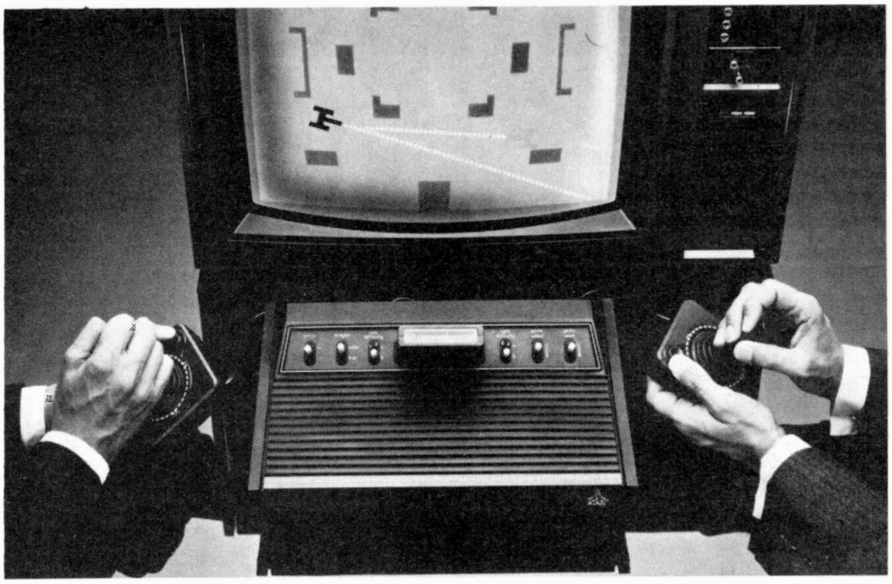
Both operate and release times are $\ngtr$5ms, and insulation resistance is $\nless$100MΩ (measured with a d.c. 500V megger).



A transparent case protects the component from dust. Operating ambient temperature range is −25°C to +55°C.

Available at £1·15 each from outlets in major cities. Contact IMO for distributors. Further distribution enquiries welcome.

IMO Precision Controls Limited, 349 Edgware Road, London W2 1BS. Telephone 01-723 2231/4.



PLAY, PLAY, PLAY

If you are a player of pub video games machines and would like one of your own, no not a pub but a programmable video games centre, then this system may be for you.

In the beginning, Atari, in Sunnyvale, California, invented a coin-operated game called Pong. This was popular so they invented more games, like Breakout and Indy 500.

These games were introduced into pubs in Great Britain by a Swedish video and vending machine group. Now the games are available on cartridges, 192 games on nine cartridges so far.

The progammable system consists of a control panel, mains unit, aerial switch box, a pair of paddle controllers and a pair of joystick controllers, plus a 27 game Combat cartridge.

A further eight cartridges are available with from four to fifty games variations on each. Other titles are Air-Sea Battle (27 variations), Star Ship (17), Street Racer (27), Video Olympics (50), Surround (14), Black Jack, and Basic Maths (8). Breakout has 48 variations and Indy 500 (14).

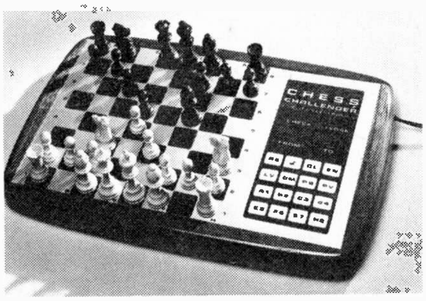
Other titles in progress are: Space War (17), Home Run (Baseball), Outlaw (16), Hunt and Score (8), Codebreaker (20), Hangman (9), Football (American) and Basketball.

The distributors, Cherry Leisure, also announce that cartridges which encompass junior and middle school spelling and vocabulary are being prepared, with over 10,000 words in the program.

System complete, plus Combat, £169.95 (inc. VAT). Additional games cartridges, £14.95. Should be available in all major cities. Trade enquiries to **Cherry Leisure, 387 High Road, Willesden, London NW10 2JR. Telephone 01-459 2236.**

GRAND MASTER TRAINER

The basic and three level models of the very popular microprocessor controlled Chess Challenger range have now been joined by their very latest and most sophisticated version, the Chess Challenger 10.



This latest addition to the range is capable of playing at ten levels: beginner, intermediate, experienced, advanced, superior, expert and excellent. The three other levels cover: two move puzzles, tournament practice and postal chess (with a response time of up to 24 hours). The level of play is changeable at any time during the game and an override switch enables you to make multiple moves before the computer responds or *even* add or subtract pieces from the board!

The problem mode allows you to establish your own chess problems and see how the computer reacts. Each time you press a key the Challenger emits a single tone and when it has responded it gives a double tone. The Challenger 10 is priced at £199·95 including VAT and delivery. It is available by mail order from **Gemini Electronics, Newton Buildings, 50 Newton Street, Manchester. (061-236 3083)**

ANTEX

The latest shortform catalogue from Antex includes three of their very popular models:

The model C (15W), which is available in six voltage ranges and has seven suitable bits.

The model CX (17W), which is only slightly larger than the model C, but has a greatly improved breakdown voltage rating and is available in two voltage ranges (220, 240V–100, 120V).

The model X25 (25W) is no longer a miniature iron but is more suited for general purpose work around the home or garage. Of the five different types of bit available, two are dual in line blocks for desoldering i.c.s.

The MLX is a 25W iron, ideal for car, boat and caravan owners because it is fitted with a 12V element.

Antex Ltd., Mayflower House, Armada Way, Plymouth, Devon.

Farnborough

A review of some of the latest developments in civil and tactical avionics by Peter Preston

THE 1978 Farnborough International Air Fair afforded the opportunity to view some of the latest developments in civil and tactical avionics from 450 companies, representing 16 participating nations. Crawley-based MEL announced that, following a contract from Mobil North Sea Ltd., trials with MADGE (Microwave Aircraft Digital Guidance Equipment) **(1)** were planned within the next six months on the Beryl "A" platform.

This marks the first commercial order of a British MLS (microwave landing system), and MEL are set for an all-out assault on the North Sea market, said to be worth £10M between now and 1986. Particular emphasis is placed on the portability and cost-effectiveness of the system, which was originally developed for military use. It can be transported in a Land Rover, rigged by two men in less than 20 minutes (11 mins is the record!) and handle up to 240 aircraft simultaneously.

Clear accurate glideslope, localiser and distance-to-go information over a range of some 20 nautical miles enables day or night operations to be maintained in conditions which would otherwise inhibit offshore supply services. The estimated cost of closing down a platform such as Beryl "A" is put in excess of £1M per day, and as the quest for black gold extends even further from coastal bases, the requirement for a high-integrity helicopter guidance system will become even more pressing. MEL must be considered to be in an enviable position with regard to their offshore MLS experience; MADGE should receive C.A.A. certification within the next 12 months.

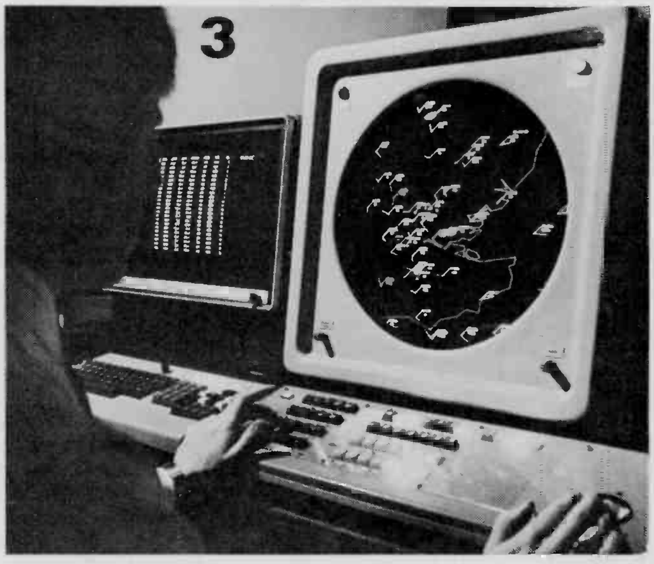
Marconi showed their new Lynx A.D.F. which enables pilots to obtain bearings from a ground beacon by merely pressing a button. The version designated AD 380S also incorporates the 2182kHz maritime radiotelephone distress frequency. Search-and-rescue helicopters can home on a vessel transmitting on this frequency without having prior information relating to its position.

2

SATELLITE COMMUNICATIONS

Satellite communications equipment from many sources was in abundance at the show and amongst the more interesting systems was Marconi's Compack miniature ground terminal. This self-contained unit weighing 50kg can be carried by three men and assembled in about 10 minutes. The system can be erected in mountains or jungle to provide

1



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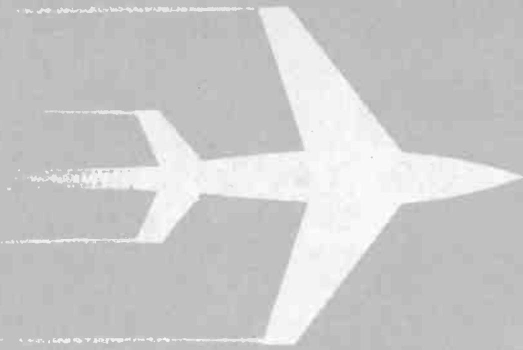


reliable, fade-free communication over thousands of miles, and is constructed to withstand severe climatical conditions.

As always, radar was in great prominence at Farnborough, and Plessey used the opportunity to give their new GF75 **(2)** multi-role defence radar an airing. Designed to meet the tactical warfare needs of the 1980's this highly-mobile helicopter transportable unit incorporates the most sophisticated ECCM (Electronic-Counter-Counter-Measures) and data-processing facilities. Pulse compression and an advanced DMTI (Digital Moving Target Indicator) provide a degree of clutter rejection comparable with pulse doppler systems.

The GF75 has applications in gap-filling, low cover, forward area alert, coastal defence and missile acquisition sector control and reporting.

Yet another British airport has chosen the Cossor Compass 9000 system **(4)** for their Secondary Surveillance Radar display and processing requirements. The order, from East Midlands Airport near Derby, follows similar announcements from Newcastle, Gatwick and RAE Farnborough.

Compass 9000 is a complete ATC radar display system, including refresh and controller units. Character/Vector generators will provide a raw/synthetic or mixed display, and code/callsign correlation may be added. Up to 24 display units can be accommodated and training simulation, self-generated map and a "hand over" facility are made available. Another important development from the same stable is a new monopulse technique for processing aircraft transponder signals, which dramatically improves the integrity of SSR (Secondary Surveillance Radar) information received by air traffic controllers.

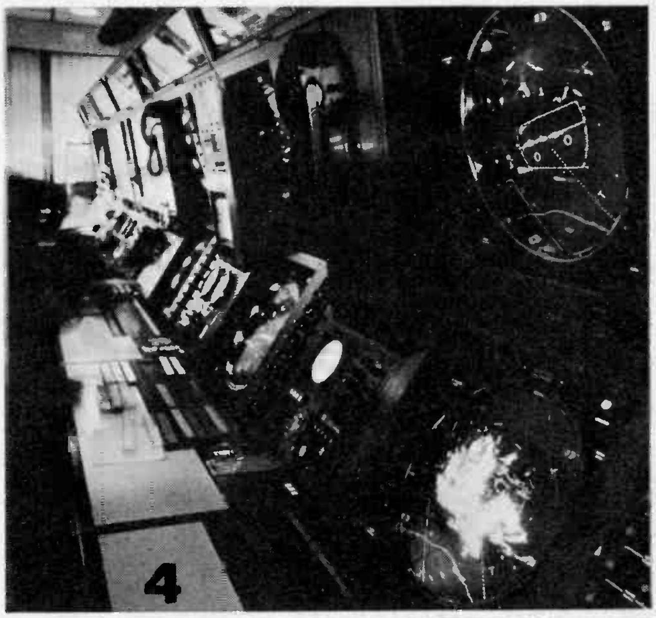
Although available independently, this technique is an essential part of the ASDEL system **(3)**, the first to be able to interrogate and identify selectively each aircraft within its range—bringing major benefits to aircraft operation and safety.

TRANSCEIVERS

Some VHF and UHF multi-facility transceivers were shown by the French T.R.T. company alongside a digital radio altimeter **(6)** and an interesting portable MF radio beacon **(5)**. Aimed at the military and oil field markets the beacon, designated the RBM 200 series, is available with the option of 8, 15 or 8 (selectable) and 100W outputs. It is lightweight and can be rapidly tuned to an assigned frequency by means of a synthesiser.

The Farnborough show was the largest and most important exhibition of its kind to be presented anywhere in the world in 1978. A biennial event, it is the podium from which the world's aviation industry shows its capabilities and can be relied upon to provide a vast array of state-of-the-art technology.

Readers are encouraged to give their support to future venues, which reflect strongly our own expertise in the highly-competitive aerospace industry.



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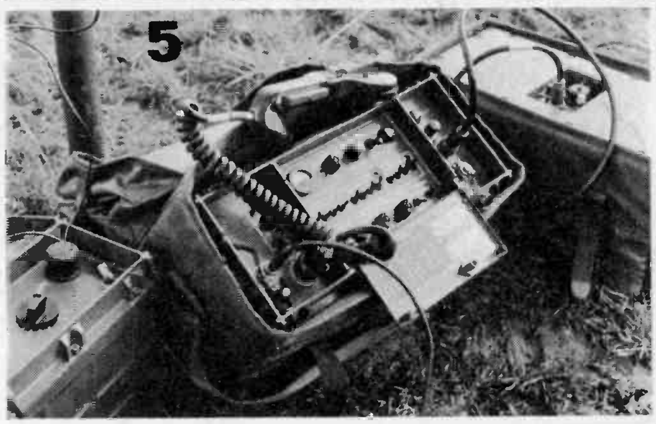

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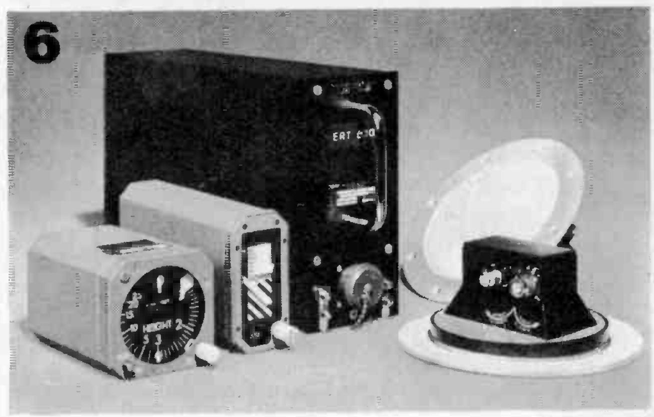

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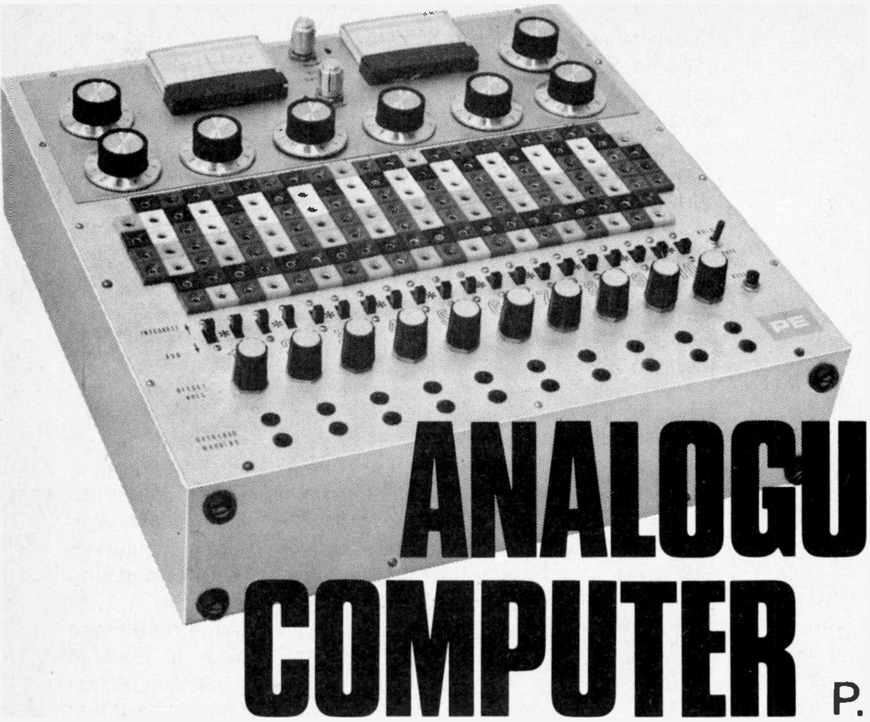


★ Lissajous Figures

★ Flight Simulation

★ Special Circuits

ANALOGUE COMPUTER

P. J. KRONIS B.Sc.

PART 4

IT was mentioned last month that damping is caused by air resistance or electrical resistance. This form of damping is called "viscous damping" in mechanical vibrations and is proportional to the velocity. Viscous damping is something that in many cases we wish did not exist. For example, it forces us to burn fuel continuously to propel an aeroplane through the air. Spaceships travelling in vacuum do not have to do this, although they have to burn fuel to decelerate. In other cases we find damping very useful. Mechanical vibration is one of these cases, where damping helps to reduce unwanted and dangerous vibrations. Without it motor cars would provide a very rough ride. The mechanical and electrical damped systems are shown in Fig. 4.1.

Fig. 4.1. The mechanical and electrical equivalent circuits for damping.

In the mechanical system damping is provided by a dashpot which is full of viscous oil. This system very closely resembles the suspension unit of a motor car.

The equations describing the response of these systems are:

Mechanical

$$M\ddot{x} + c\dot{x} + Kx = F$$

Electrical

$$L\ddot{q} + R\dot{q} + 1/Cq = E$$

c = damping constant — q = charge, therefore $\dot{q}$ = current

F = a forcing function — E = voltage (function of time)

Table 1 shows the equivalent mechanical and electrical quantities.

Mechanical		Electrical	
Mass	M	Inductance	L
Spring stiffness	K	1/Capacitance	1/C
Force	F	Voltage	E
Velocity	$\dot{x}$	Current	i or $\dot{q}$
Displacement	x	Charge	q
Viscous Damping	c	Resistance	R

TABLE 1

Rearranging the mechanical equation we obtain:

$$\ddot{x} = -\frac{c}{M}\dot{x} - \frac{K}{M}x + F$$

The flow diagram and the patch panel connections are shown in Fig. 4.2.

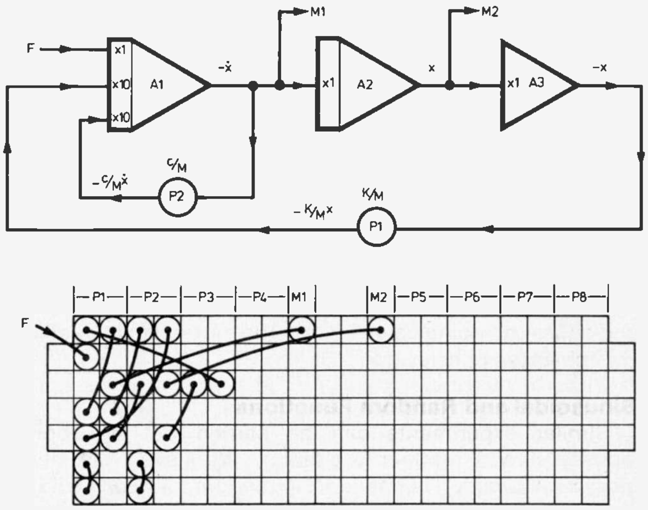


Fig. 4.2. Flow diagram and patch panel layout for investigating a damping system.

To run the program:
(1) Check A1 and A2 are integrating, and A3 adding.
(2) Switch power on and set potentiometer values.
(3) Computer mode: Hold.
(4) Press "reset" for a few seconds and release. Switch to compute.
(5) Apply a forcing function to A1 input.

Several functions can be tried, for example "step", "ramp", "impulse", "sinusoidal", or "random".

Impulse Function

An impulse function is a force of a relatively large value and short duration. It can be simulated by momentarily applying a voltage to the input of A1. The application of this function produces the results shown in Fig. 4.3. Repeat this experiment with several settings of P2.

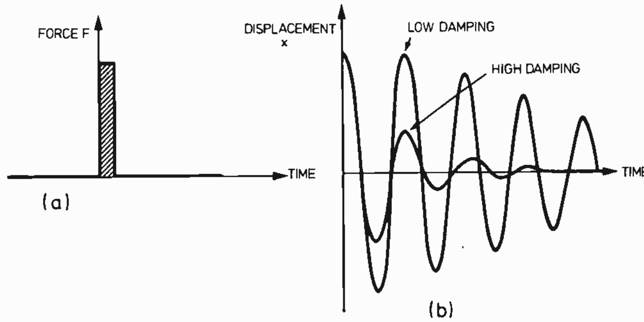


Fig. 4.3. The graphic representation of an impulse function is shown in (a). Graph (b) shows its effect on the circuit in Fig. 4.2.

Step Function

A step function of about 10V should be applied and a similar procedure followed as with the impulse function. At low damping settings the needle will overshoot the 10V level and oscillate about this value. As more damping is applied the overshoot will become less until at a certain value there will be no overshoot and the needle will take the shortest time to settle at the value of 10V. This is called critical damping. If more damping is applied the needle will take longer to reach the value of 10V. These results are shown in Fig. 4.4.

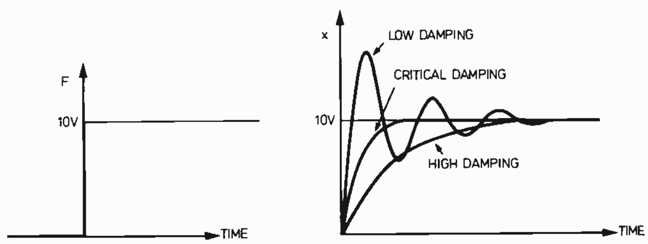


Fig. 4.4. Graph showing the effects of damping after a step function has been applied to Fig. 4.2.

One application of the above is in analogue measuring instruments, like moving coil meters. The input is usually a step function and the needle is damped to a value very near the critical damping value so that the meter can be read with the minimum of delay.

Sinusoidal and Random Functions

Similar experiments can be carried out by applying sinusoidal and random excitation. We have seen how a sinusoidal function is obtained. A random function is difficult to produce but it can be simulated by adding together two sinusoidal functions of different frequency and amplitude. Three amplifiers are required per sinusoidal function and therefore nine amplifiers will be needed to experiment with random excitation. One application of this is the problem of the suspension unit of a motor car. Here we have a mass sitting on springs and dampers with the wheels following the uneven contour of the road. The requirement is that as little vibration as possible is transmitted through the suspension unit to the car body. In this case a perfectly satisfactory solution is impossible to obtain and the values of spring stiffness and damping constant are compromises. The best possible values can, however, be worked out using the analogue computer and this saves the designer the expensive and time consuming task of testing many different models of the unit.

Lissajous Figures

These figures are produced by the combination of two curves, applied at right angles to each other. For example, two sinusoidal functions applied to the X and Y inputs of an X-Y plotter will produce a circle, if they are in phase with each other and have the same frequency. Where the curves are out of phase and differing in frequency, intricate meshing figures are formed, similar to the one shown in Fig. 1.1, at the beginning of this article. In these figures damping was used to vary the amplitude of the oscillation. In real life damping can only be positive, i.e. it can only act to suppress oscillation. However, mathematics, and therefore computers also, allow us to apply negative damping. To do this the flow diagram of Fig. 4.2 is altered by adding an inverting amplifier in the feedback loop containing P2, to change the sign of the damping term in the equation. In this case there is no need to apply a forcing function F. When compute is selected, the oscillation will begin with the amplitude growing progressively until the amplifiers saturate. To produce good figures, very little damping should be applied and the difference in frequency between the X and Y functions should be small.

Flight simulation

The flight of a rocket can be described by simple mathematical equations involving no more than Newton's law of motion. We can start with a program to simulate the flight of a lunar craft. The diagram with all the forces acting on the spacecraft is shown in Fig. 4.5. The equation of motion according to Newton is:

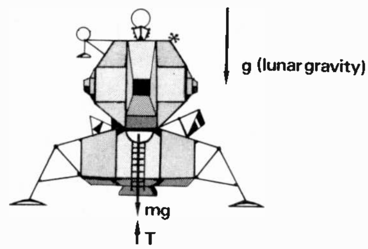


Fig. 4.5. Forces acting on the spacecraft.

$$T - mg = m\ddot{x}$$

To practice lunar landings, we need to have a thrust control and information about the speed and the altitude of the craft. The flow diagram shown in Fig. 4.6 satisfies these requirements, with potentiometer P1 providing the thrust control and M1 and M2 displaying velocity and altitude respectively. Notice the use of A3 as a sign inverter.

These experiments are of course very simple and the limitations will become very obvious to the programmer. To start with, the equation above assumes that motion can only take place vertically up or down. In reality, movement is in three dimensions and although we can still describe this

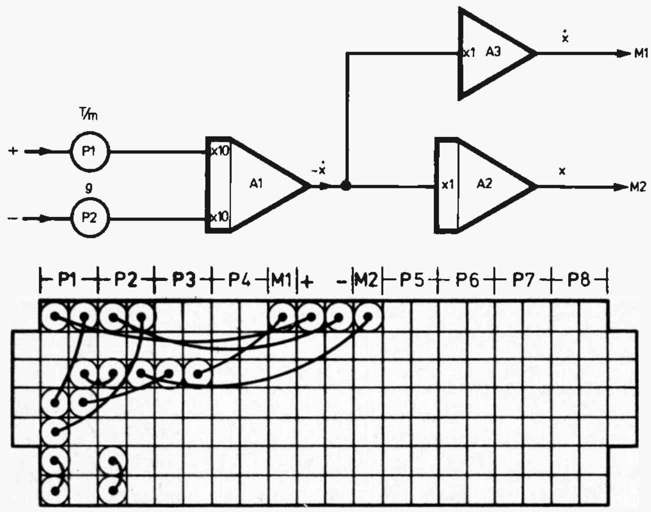


Fig. 4.6. Flow diagram and patch panel layout for amplitude scaling example.

motion mathematically, the equations become more complicated and require more computing elements if it is to be solved.

The other limitation which becomes very apparent when trying to run these programs, is the problem of the limited voltage range over which results can be obtained.

With the equations as they stand, one volt represents 1 unit of the relevant dimension. For example if SI units are used, one volt will represent 1 metre (distance), or 1m/sec (velocity), or $1 m/sec^2$ (acceleration), or 1 Newton (force). Therefore our flight will be limited to a height of about 26m (if −13m is taken as ground level) and the velocity to ±13 m/sec. Suppose that the following data apply to the lunar craft.

mass m = 1,000kg.
max. engine thrust T = 10,000N
lunar gravity = 1·6m/sec.

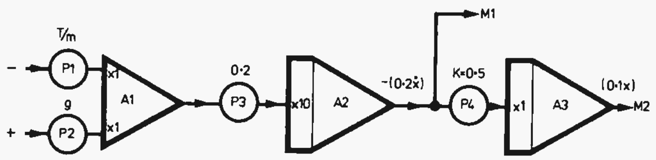
Using these values, it will be found that all three amplifiers will saturate very quickly. In fact, with full thrust applied, A1 will saturate in seconds. This is obviously unsatisfactory. Fortunately, we can get round this problem by scaling the various quantities.

Amplitude scaling

To do this we have to estimate the maximum likely values of the variables and their derivatives. Let us assume for convenience that we may work in the range ±10V and that, in the lunar lander example, we wanted to investigate the flight up to a height of 100m. Hence we may represent 100m by 10V. We therefore apply a scale factor of 10/100 = 0·1. We also estimate that the speed will not exceed 50m/sec. Hence we apply a factor for the velocity of 10/50 = 0·2. So the velocity will be represented by the computer variable $0{\cdot}2\ \dot{x}$ and the height by $0{\cdot}1\ x$ both measured in volts. We are also going to scale the acceleration by 0·2 to give a computer variable of $0{\cdot}2\ \ddot{x}$. We can now rewrite the equation as:

$$0{\cdot}2\ \ddot{x} = 0{\cdot}2\ (T/m - g)$$

The modified flow diagram in Fig. 4.7 shows the new machine variables in square brackets.



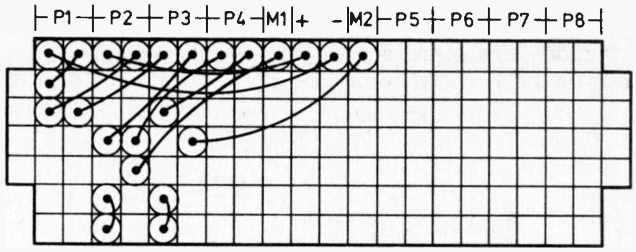


Fig. 4.7. Modified flow diagram and patchpanel layout.

To find the value of P4, we have to examine the process of integration carried out by A3.

$$K \int (0{\cdot}2\ \dot{x})\ dt = 0{\cdot}1\ x$$

From this we can see that K = 0·1/0·2 = 0·5. Now if the sensitivity of M1 is adjusted so that it shows 10V at full scale deflection (f.s.d.) then 1 volt will represent 1/0·2 = 5m/sec, and f.s.d. will represent 50m/sec. Similarly 1V on M2 will represent 1/0·1 = 10m. By using P1 as a thrust control, take offs and landings can be practised. To carry out a gentle landing the velocity should be very near zero when the altitude is zero. You should practice doing this with the minimum of hovering, since this is fuel consuming!

The lunar lander can be converted to a vertical take-off aeroplane by the addition of air resistance or drag. The equation and flow diagram is shown in Fig. 4.8.

$$T - mg - D = m\ddot{x}$$
$$\text{or } T - mg - Cd\,\dot{x}^2 = m\ddot{x}$$
$$\text{if D is proportional to } \dot{x}^2$$

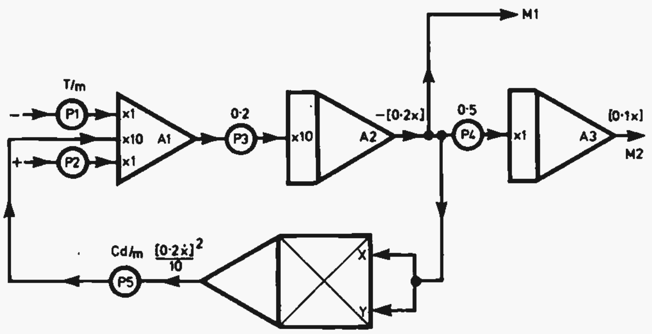


Fig. 4.8. Modified flow diagram to convert the lunar lander to a vertical take-off aeroplane.

Time Scaling

The solutions to different problems may extend over periods of time ranging from microseconds to many hours. It is not convenient to record results that occur within a split second or results that take many hours to produce. This is not the only reason, however, that we want to avoid both high speed and low speed computer operation. At high speed (e.g. at high frequencies) phase shifts in computing elements and recording instruments produce time lags and therefore errors in the results. At slow speed error voltages tend to build up when integrated. Fortunately we can use time scaling to get round these problems. This we can do by simply reducing or increasing the gain of integrators only. Time is not involved in the operation of adders. Forcing functions should also have their frequencies adjusted by the same factors as the integrators.

To summarize, voltages must be neither too big, nor too small, and the time scale must be neither too fast nor too slow.

Special Circuits

Many special circuits and techniques are used with analogue computers. Some of these involve the use of diode shaping circuits to produce non-linear functions. In physical systems we often find such effects as backlash, Coulomb or dry friction, dead space, and we may need to simulate these effects on the analogue computer.

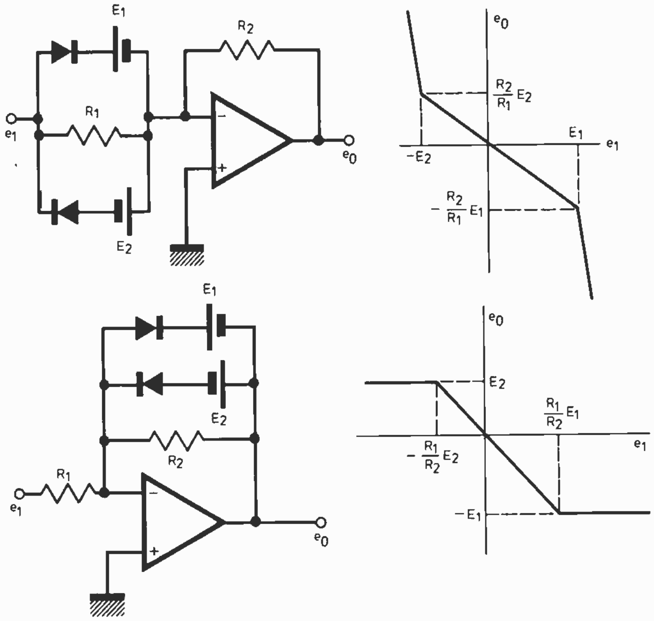


Fig. 4.9. Diode Limiter Circuit.

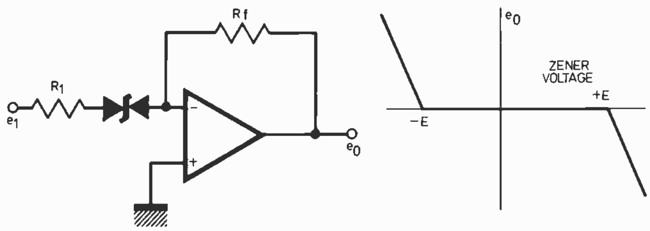


Fig. 4.10. Dead Zone Circuit.

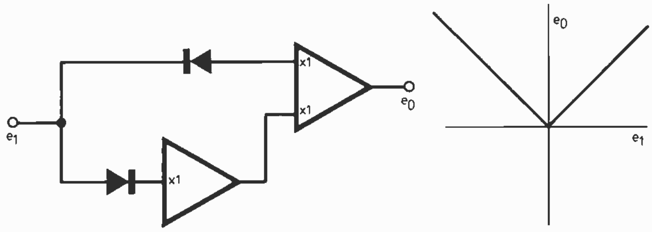


Fig. 4.11. Absolute Value Circuit.

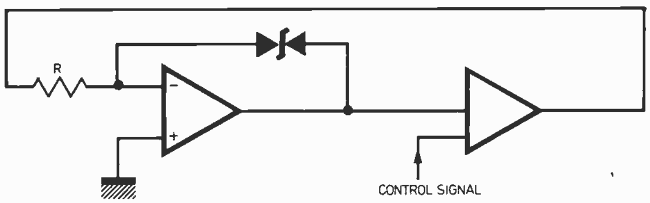
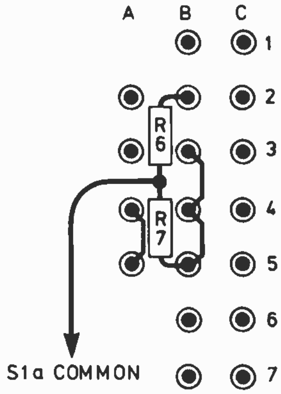


Fig. 4.12. Flip-Flop Circuit.

In this relatively short article, it has not been possible to touch on every subject in the field of analogue computation. Nevertheless it is hoped that the reader has been given a good introduction to the subject and that the constructor will be able to write his own programs and run them on the computer. ★



A2, A3	**X and Y inputs**
A4, A5	**Common outputs**
C1	**Coefficient multiplier input**
B1	**Coefficient multiplier output**
B2	**Initial conditions**
B3, B4, B5	**Amplifier outputs**
C2, C3	**Amplifier inputs (X1)**
C4, C5	**Amplifier inputs (X10)**
C7	**Spare socket**
B6, B7 (link)	**Integrate with nose gain of one**
B7, C6 (link)	**Integrate with nose gain of ten**

Fig. 3.2. This figure was incorrectly printed in Part 3 of the series.

News Briefs

MERSEY MICRO CLUB

A NEW group, called the Merseyside Mini/Micro Computer Club, has got off the ground under the guidance of Science and Technology Education on Merseyside (STEM). Local distributors have promised to help, in giving talks and demonstrating their products, as well as offering publicity.

Anyone who is interested in microprocessors and small computer systems are very welcome to join, whether new to the world of computing or with many years' experience.

A varied programme is expected to include such subjects as kit building, system configuration, games programs, programming in high level language, business and operating systems.

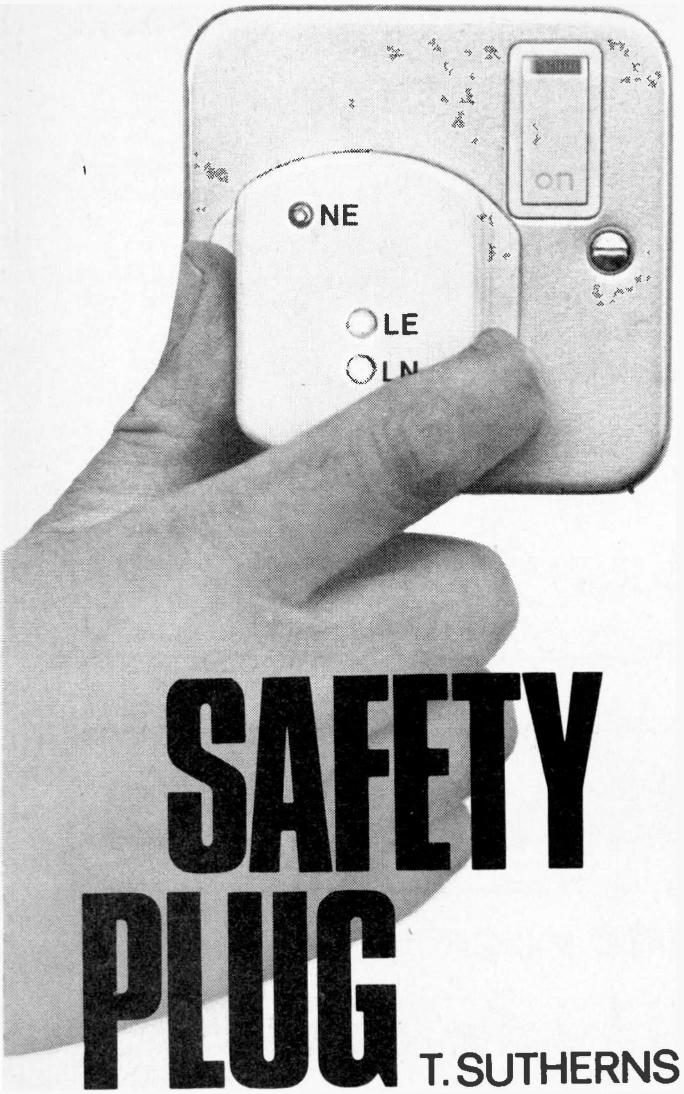
For further details, contact: Martin Beer (Chairman), Merseyside Mini/Micro Computer Club, 19 Abercromby Square, P.O. Box 147, Liverpool University, Liverpool L69 3BX.

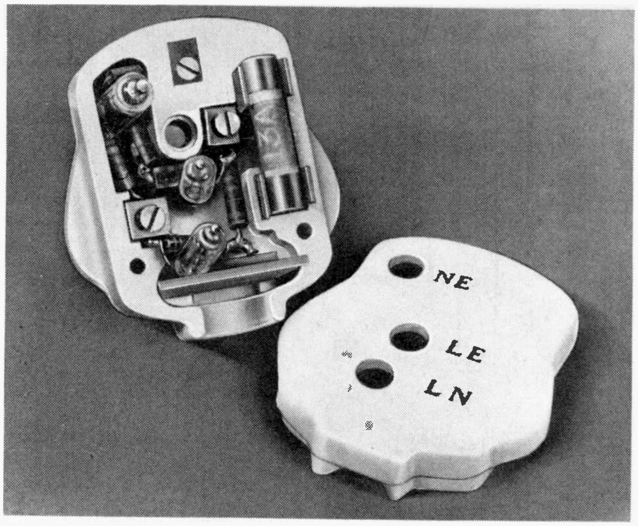
LATE NIGHT VIEWING

FOLLOWING extensive equipment trials and evaluations, Marconi Avionics Limited (a GEC-Marconi Electronics company) has won an important contract from the Ministry of Defence Procurement Executive for the development of a Visual Augmentation System for RAF Tornado aircraft. The system, which is to be fitted to the Tornado Air Defence Variant, will enable the crew to see a television picture of the scene ahead, taken with a highly-sensitive low light camera system.

The Visual Augmentation System is being developed by the company's Electro-Optical Surveillance Division at Basildon, England. It will show details, to both the pilot and the navigator, of targets at ranges well in excess of those which can be achieved with the unaided human eye and at ambient light levels ranging from daylight to starlight.

The new airborne system is an extension of the company's highly successful low light television systems which are widely used for industrial, commercial and naval applications including surveillance, target tracking and weapon aiming.





SAFETY PLUG

T. SUTHERNS

IT is a regrettable fact that in these days of high labour costs more and more people with no electrical knowledge consider themselves competent enough to wire up plugs, extension leads and the like. Many are incorrectly wired and are, or may become, potentially lethal. Consequently, people who use these sockets, e.g. anybody running a disco or mending a friend's TV are placed at risk. There is little point in carefully "earthing" all the exposed metal if the socket has no earth wire.

To check connections before touching anything is obviously desirable but usually not possible as it is time consuming and not very polite. One can quite easily check a plug's wiring by pretence of checking the fuse, but eyebrows would be raised if you started removing the wall socket!

In disco work the problem is even more serious since most discos contain much exposed metal. This will be connected to the earth pin of the mains plug and hopefully to a true earth. Any insulation breakdown or broken wire in the equipment arising from vibration, damp or misuse—all very likely—that connects a high voltage to a part of a chassis will make the whole disco "live". The first person to touch a metal part will thus receive a considerable shock. Since his hands are likely to be sweaty and hence conductive the shock may well be fatal. However, despite the importance of correct earthing there is rarely time to remove sockets and even if time is available the results may be misleading. Just because a socket is connected to an earth wire does not mean that the earth wire is connected to earth!

In a recent case brought to the author's attention a professionally wired school science laboratory lacked an earth connection. Had a piece of equipment with a live to chassis short been plugged in, then every metal case in the laboratory would have become live. Fortunately the fault was discovered before this happened and it was speedily corrected. Furthermore, earths are subject to corrosion and a socket known to be safe may become dangerous after a few years.

Faced with this problem it was decided to design a tester that would be small, simple, robust and above all quick to use. The unit devised has been in constant use ever since.

THE CIRCUIT

As can be seen from Fig. 1 the circuit contains three identical neon indicators. Each is designed to draw about 3·5mA from the mains, which ensures that floating earths will be identified as such providing the live/earth cable capacitance is less than about 50nF, which corresponds to several kilometres of cable.

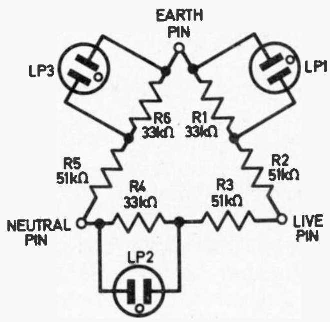
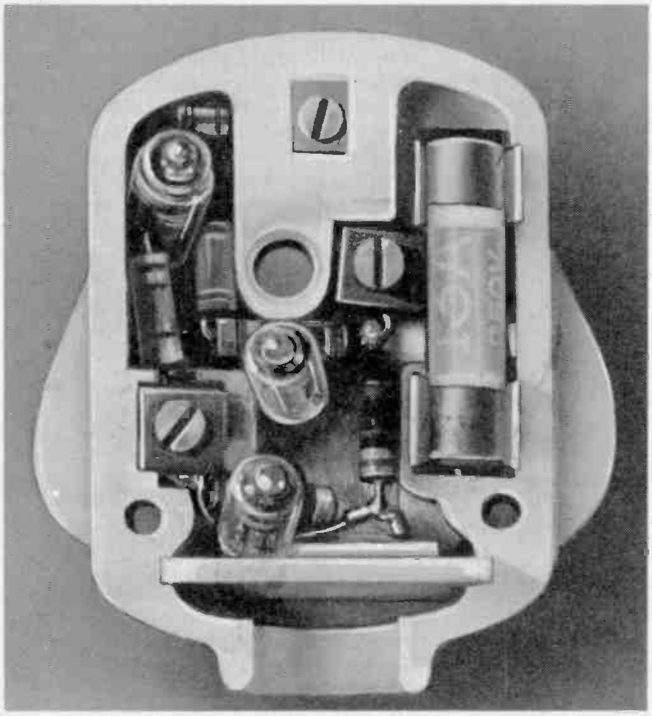


Fig. 1. Circuit diagram

CONSTRUCTION

The unit is built into a standard 13A mains plug as shown below. This requires careful construction and removal of some of the internal partitioning. When built and checked a thin smear of epoxy resin should be applied to prevent components moving.

It is necessary to shield LP3 from light generated by the other neons. This may be achieved by paint or a small piece of black pvc tape.



COMPONENTS . . .

R1, R4, R6 33kΩ (3 off)
R2, R3, R5 51kΩ (3 off)
LP1–3 90V neon (3 off)
All resistors ¼W 5% carbon
13A mains plug

USE

The plug is inserted into a socket for a few seconds and the pattern of neons noted. The plug should then be removed since it is not considered good practice to pass a current between live and earth. It is permissible in this case because of the short duration of the current and the safety orientated use. A number of neon patterns may be obtained and they are explained in Fig. 2. It should be emphasised, however, that only one pattern is safe and that any glow whatsoever in LP3 means the socket is dangerous.

The tester's simplicity makes it an aid that no DJ or constructor could safely do without. ★

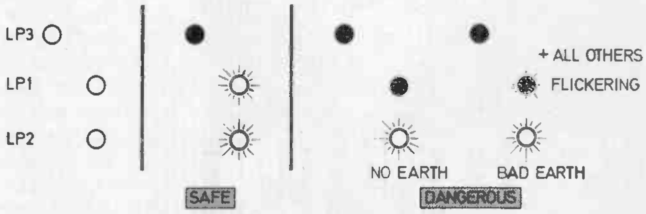
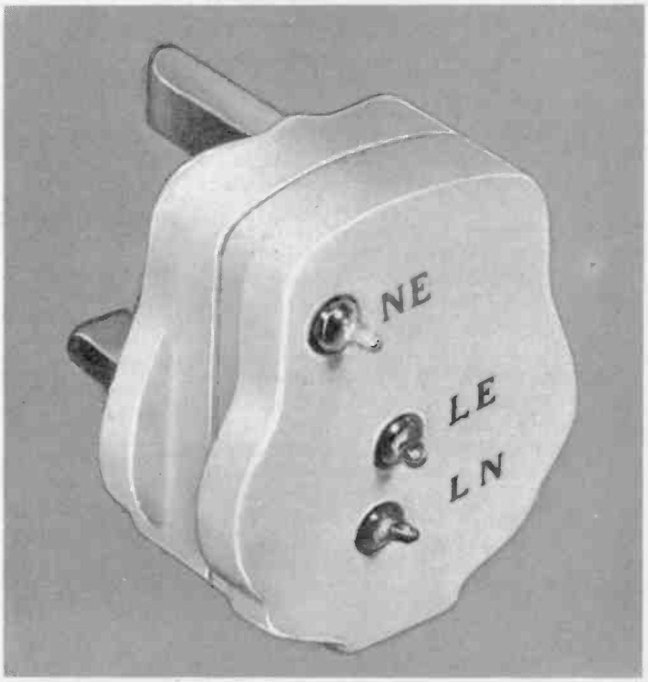


Fig. 2. Neon patterns and indications



POINTS ARISING

CHROMASONICS CATALOGUE *(this issue)*

Under regulators on page 5 the pin connections of the TO220 devices should be altered to the following:

Positive—1 in, 2 out, 3 common.
Negative—1 common, 2 out, 3 in.

SOUND TRACK MONITOR *(September 1978)*

In Fig. 2 there should be a break between C2 negative and TR1 emitter.

TV GAME CENTRE *(July–August 1978)*

In Fig. 2.1, S5 is shown incorrectly wired. It should connect between Boundaries O/P and SEL B, and S1 between SEL A and Boundaries O/P. D11 is 7·5V. Resistor R33 is 8·2kΩ.

In Fig. 2.2, the lower pad on the p.c.b. for R36 is missing, and so the component lead will have to be carefully soldered directly to the track.

In Fig. 1, IC4(a) should be Input—pin 6, and output—pin 7. Also S18 connects to IC1 pin 21, S17 connects to pin 20, and S9 connects to pin 18. IC1 pin 1 goes to 0V.

FRANK W. HYDE

THE USSR AND VENUS

In December there will be two nations in operation at the same time on the planet Venus. Under the Soviet programme for the study of the planets and outer space, the first vehicle of the new mission, Venus-11, an automatic station, was launched on September 9th to continue the programme of exploration of Venus. In the course of its journey it will make studies of the solar wind, cosmic rays, ultra-violet and X-rays from outer space. Gamma-rays are also part of the programme. The instrumentation of the vehicle is a joint Soviet-French project.

Venus-11 was put into the inter-planetary flight path from an intermediate orbit of an artifical earth satellite. The spacecraft will reach the vicinity of Venus in December. The deputy director of the Academy of Sciences Space Research Institute, said that "The first flight of this kind was made in 1961, when Venus-1 was launched from a heavy earth satellite. Venus-4 made the first controlled descent into the Venusian atmosphere."

This mission was recognised as a suitable basic structure and has since been adopted for other flights. The present United States programme follows this pattern. Previous flights of both American and Russian spacecraft have resulted in extensive data about the atmosphere and the surface structure of Venus. Along with the discovery of the nature of the atmosphere was the fact that Venus has no measurable magnetic field. Later Venus vehicles, Venus-5 and Venus-6, made simultaneous measurements at different points. In 1975 Venus-9 made a soft landing and sent back details of the Venusian surface. The landing craft from Venus-10 landed on the surface, sending back a picture of another part of the planetary terrain.

The American programme already under way as described in previous Spacewatch issues has now reached its decisive stages. With the Russian Venus-12 launched on September 14th, four vehicles are due in the vicinity of Venus in December. The United States will in fact have six operative vehicles, four of which will enter the Venusian atmosphere and descend to various levels including the surface. The programmes so far undertaken by both the Soviet Union and the United States have followed similar patterns. Such a spectacular event as the one to take place in December this year is indeed a milestone of the greatest technical skills applied to extra-terrestrial exploration.

METEORITES

At a Conference in Sudbury, Ontario, Dr John Wood of the Harvard-Smithsonian Center for Astrophysics at Cambridge, Massachussetts, stated that his findings indicated that the most probable origins of meteorites was asteroidal bodies. Dr Wood finds that the bodies that most nearly fit the facts are asteroids of the order of tens of kilometres in diameter. He suggests that certain asteroids acquired molten cores from aluminium-26 decay, differentiated into iron core and stony shell and cooled quickly through the upper temperature levels. All this violently overturns the traditional theories.

NEW PLANETOID

The Soviet Institute of Theoretical Astronomy has registered a new asteroid which has been named "Constitution".

A HUNDRED DAYS IN ORBIT

A new record for a stay in space was made when Vladimir Kovalyonok and Alexander Ivanchenkov celebrated their hundredth day in space. September the 21st is a fitting date for that to have been accomplished. They have suffered no serious discomfort and together with other long term astronauts show no long term adverse effects of the long residence in the weightless condition. This is the general view of all those engaged in the medical and biological studies of such effects. However, one Soviet doctor has declared 120 days as the limit of human endurance. There does not appear to be much support for the idea. No doubt confirmation or otherwise will be provided in the near future.

The two record breakers did not use the first aid kit much during the period of 100 days, preferring to "buck themselves up" with a tonic drink made from eleuthera bark.

COMMUNICATIONS SATELLITES

On the 14th September Britain became one of the 16 countries committed to establish the European communications satellite system by the middle of the next decade. New wave lengths will be used and the method will be digital. The result of this will be to ensure not only a greater number of channels of operation but also better quality of long distance transmissions. Use will be made of the higher operational frequencies, 11 to 14 Gigahertz band, a little used band at the present time. Up till now the 4-6GHz band has been the most popular. Each year has, however, seen an almost regular doubling of traffic. The higher band and digital transmission will enable narrower bandwidths as well as improved levels of distortion.

LANDSATS SURVEY THE SEA

The multispectral scanners of the Landsats 1 and 2 have been turned onto the Indian Ocean. In a collaboration effort the Cousteau Society and the Mapping Agency of the United States have investigated the possibility of using satellite imagery for shallow water surveys. Present charts of the Chagos Archipelago are based on an 1837 survey by ship.

The Landsat surveys show a number of discrepancies. Some very dangerous reefs were shown to be up to 15 kilometres from the positions shown on those charts. In one area a new reef was discovered. It was more than eight kilometres long and in an area shown by the charts to be safe and deep water. This discovery was instantly radioed to all shipping centres and new charts quickly prepared.

This highlights the importance of the system and provides a quick method of checking charts and changes that have taken place. It also has the advantage of freeing small survey ships for other work such as the location of small navigation hazards.

SOME SPACE FACTS

At the end of August this year the total number of successful launches of spacecraft reached a total of 2,300 since the first Sputnik which heralded the space age. Of these vehicles 40 per cent came from the United States, 55 per cent from the Soviet Union and 5 per cent from other States. Of the 1,275 spacecraft launched by the USSR, 83 per cent were research satellites, three per cent were manned flights and two per cent were launched in co-operation with other States.

A DESIGN FOR A MAN-MADE CITY IN SPACE

Stanford University and Ames Research Centre (controlled by NASA) are both becoming more and more occupied with the idea of designing a protective environment. This would be large enough to support about 10,000 people. One of the main difficulties is the adaptation of the human body, the mind too, in a cosmic environment. The tendency in all such speculative design is to model on the known existence and build the new in a similar shape to the old. The predisposition to introduce artificial gravity is one of the common additives to such designs.

The shape that has been considered viable is a doughnut design which optimises the surface area/space ratio. It is claimed that an artificial community with simulated conditions akin to those on earth could be a viable creation. This scarcely seems like progress or a desirable substitute. To build in the stresses and strains of existing life style is surely the prostitution of technology. Rather would it not be reasonable to develop genetically the body or carrier for a new age and environment. Adaptation so far has not been difficult for astronauts. What can be achieved with one or two people together surely can be done with communities. In the size of space environment envisaged, only mental adaptation would be imperative, all else would follow. If no real desire exists to reach out, it is better to leave well alone and stagnate instead of progress.

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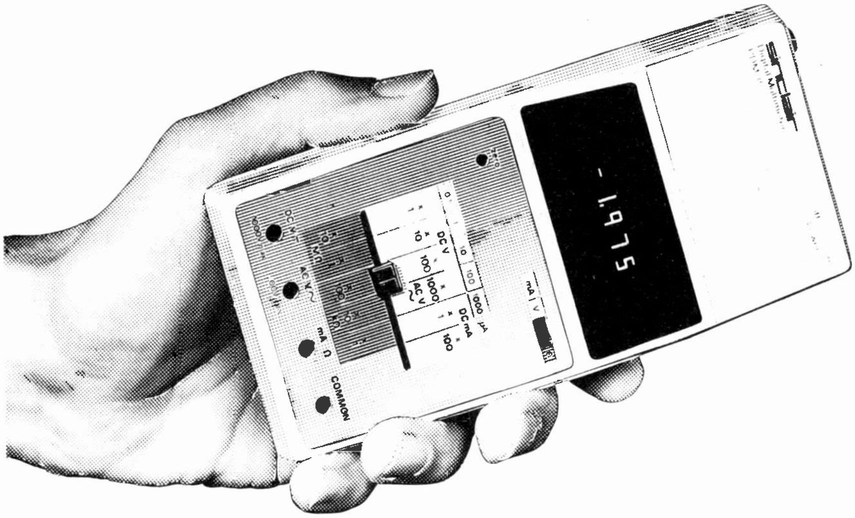

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A digital multimeter used to mean an expensive, bulky piece of equipment.

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With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ±1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 μA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adaptor.
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Compare it with an analogue meter!

The PDM 35's 1% of reading compares with 3% of full scale for a comparable analogue meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analogue meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analogue meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specification

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
Accuracy of reading: 1.0% ± 2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adaptor.
Sockets: Standard 4 mm for resilient plugs.
Options: AC adaptor for 240 V 50 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

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AC126	0·20	BD131	0·35	OA5	0·95	1N4006	0·08	7416	0·32
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AC128	0·20	BD135	0·34	OA10	0·60	1N4009	0·06	7420	0·17
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AC142K	0·30	BD139	0·43	OA81	0·30	1S44	0·04	7427	0·30
AC176	0·20	BD140	0·44	OA85	0·30	1S920	0·07	7428	0·43
AC187	0·20	BD144	2·00	OA90	0·08	1S921	0·07	7430	0·17
AC188	0·20	BD181	1·10	OA91	0·08	2G301	1·00	7432	0·30
ACY17	0·85	BD182	1·18	OA95	0·08	2G302	1·00	7433	0·36
ACY18	0·80	BD237	0·40	OA200	0·09	2G306	1·10	7437	0·32
ACY19	0·75	BD238	0·55	OA202	0·09	2N404	1·00	7438	0·32
ACY20	0·70	BDX10	0·91	OA211	1·00	2N696	0·25	7440	0·18
ACY21	0·75	BDX32	2·00	OAZ200	1·00	2N697	0·25	7441AN	0·85
ACY39	1·50	BDY20	1·25	OAZ201	1·00	2N698	0·30	7442	0·72
AD149	0·70	BDY60	1·50	OAZ206	1·00	2N705	1·20	7447AN	0·90
AD161	0·45	BF115	0·25	OAZ207	1·00	2N706	0·15	7450	0·18
AD162	0·45	BF152	0·18	OC16	2·00	2N708	0·20	7451	0·18
AF106	0·45	BF153	0·20	OC20	2·50	2N930	0·20	7453	0·18
AF114	0·35	BF154	0·17	OC22	2·50	2N1131	0·26	7454	0·18
AF115	0·35	BF159	0·23	OC23	2·75	2N1132	0·26	7460	0·18
AF116	0·35	BF160	0·16	OC24	3·00	2N1302	0·35	7470	0·35
AF117	0·35	BF167	0·20	OC25	0·90	2N1303	0·35	7472	0·33
AF139	0·40	BF173	0·20	OC26	0·90	2N1304	0·45	7473	0·36
AF186	1·20	BF177	0·24	OC28	2·00	2N1305	0·45	7474	0·40
AF239	0·45	BF178	0·24	OC29	2·00	2N1306	0·50	7475	0·54
AFZ11	2·75	BF179	0·25	OC35	1·50	2N1307	0·50	7476	0·40
AFZ12	2·75	BF180	0·30	OC36	1·50	2N1308	0·55	7480	0·55
ASY26	0·40	BF181	0·30	OC41	0·80	2N1309	0·55	7482	0·75
ASY27	0·40	BF182	0·30	OC42	0·75	2N1613	0·25	7483	0·90
ASZ15	1·25	BF183	0·25	OC43	2·25	2N1671	1·50	7484	1·00
ASZ16	1·25	BF184	0·25	OC44	0·60	2N1893	0·25	7486	0·35
ASZ17	1·25	BF185	0·25	OC45	0·55	2N2147	1·75	7490	0·52
ASZ20	1·50	*BF194	0·09	OC71	0·55	2N2148	1·65	7491AN	0·80
ASZ21	2·00	*BF195	0·09	OC72	0·55	2N2218	0·25	7492	0·60
*AU110	1·70	*BF196	0·10	OC73	1·00	2N2219	0·24	7493	0·60
*AU113	1·70	*BF197	0·12	OC74	0·65	2N2220	0·18	7494	0·80
*AUY10	1·70	BF200	0·27	OC75	0·65	2N2221	0·18	7495	0·72
*BA145	0·13	*BF224	0·20	OC76	0·55	2N2222	0·18	7496	0·80
*BA148	0·13	BF244	0·28	OC77	1·20	2N2223	2·75	7497	3·00
BA154	0·09	BF257	0·24	OC81	0·65	2N2368	0·17	74100	1·50
BA155	0·10	BF258	0·26	OC81Z	1·20	2N2369A	0·21	74107	0·45
BA156	0·09	BF259	0·32	OC82	0·65	2N2484	0·20	74109	0·70
BAW62	0·05	BF336	0·30	OC83	0·65	2N2646	0·55	74110	0·50
BAX13	0·06	BF337	0·30	OC84	0·65	2N2904	0·25	74111	0·70
BAX16	0·09	BF338	0·31	OC122	1·50	2N2905	0·25	74116	1·75
BC107	0·12	BFS21	3·96	OC123	1·75	2N2906	0·21	74118	1·00
BC108	0·12	BFS28	2·23	OC139	2·25	2N2907	0·21	74119	1·50
BC109	0·13	*BFS61	0·20	OC140	2·75	*2N2924	0·21	74120	0·83
*BC113	0·12	*BFS98	0·20	OC141	3·25	*2N2925	0·22	74121	0·40
*BC114	0·13	BFW10	0·65	OC170	1·00	*2N2926	0·14	74122	0·60
*BC115	0·14	BFW11	0·65	OC171	1·00	2N3053	0·25	74123	1·00
*BC116	0·15	BFX84	0·22	OC200	1·50	2N3054	0·50	74125	0·55
*BC117	0·17	BFX85	0·23	OC201	1·75	2N3055	0·70	74126	0·55
*BC118	0·10	BFX87	0·21	OC202	1·75	2N3440	0·60	74128	0·60
BC125	0·16	BFX88	0·21	OC203	1·75	2N3441	0·80	74132	0·70
*BC126	0·20	BFY50	0·26	OC204	2·50	2N3442	1·10	74136	0·55
*BC135	0·14	BFY51	0·26	OC205	2·50	2N3525	0·80	74141	0·80
*BC136	0·15	BFY52	0·26	OC206	2·50	2N3614	1·50	74142	2·30
*BC137	0·15	BFY64	0·26	OC207	1·75	*2N3702	0·11	74143	2·50
*BC147	0·09	BFY90	1·25	OCP71	1·25	*2N3703	0·13	74144	2·50
BC148	0·08	BSX19	0·21	ORP12	0·75	*2N3704	0·13	74145	0·90
*BC149	0·09	BSX20	0·20	*R200BB	1·75	*2N3705	0·13	74147	2·00
*BC157	0·09	BSX21	0·20	*R2009	2·25	*2N3706	0·13	74148	1·75
*BC158	0·08	BT106	1·25	*R2010B	1·75	*2N3707	0·13	74150	1·60
*BC159	0·10	BTY79/4	3·19	T1C44	0·30	2N3708	0·10	74151	0·85
*BC167	0·12	*BU205	1·75	T1C226D	1·20	2N3709	0·13	74154	1·75
BC170	0·11	*BU206	2·25	T1L209	0·20	2N3710	0·10	74155	0·85
BC171	0·10	*BU208	2·00	*T1P29A	0·41	2N3711	0·10	74156	0·85
BC172	0·10	BY100	0·45	*T1P30A	0·44	2N3771	1·75	74157	0·75
BC173	0·12	BY126	0·14	T1P31A	0·45	2N3772	2·00	74159	2·10
BC177	0·15	BY127	0·15	T1P32A	0·48	2N3773	3·00	74170	2·30
BC178	0·14	BZX61	0·18	T1P33A	0·69	2N3819	0·36	74172	4·40
BC179	0·16	Series		T1P34A	0·73	2N3820	0·45	74173	1·40
BC182	0·11	BZY88	0·13	T1P41A	0·63	2N3823	0·55	74174	1·50
BC183	0·10	Series		T1P42A	0·70	*2N3866	0·72	74175	0·90
BC184	0·11	CRS1/05	0·45	T1P2955	0·67	*2N3904	0·13	74176	1·10
BC212	0·13	CRS1/40	0·60	T1P3055	0·56	*2N3905	0·13	74178	1·25
BC213	0·12	CRS3/05	0·45	*T1S43	0·45	*2N3906	0·13	74179	1·25
BC214	0·15	CRS3/40	0·75	*ZS140	0·25	*2N4058	0·14	74180	1·15
BC237	0·09	CRS3/60	0·90	*ZS170	0·13	*2N4059	0·10	74190	1·50
BC238	0·12	GEX66	1·50	*ZS178	0·54	*2N4060	0·12	74191	1·50
BC301	0·25	GEX541	1·75	*ZS271	0·23	*2N4061	0·12	74192	1·35
BC303	0·24	GJ3M	0·75	*ZS278	0·57	*2N4062	0·13	74193	1·35
BC307	0·10	GJ5M	0·75	*ZTX107	0·11	*2N4124	0·15	74194	1·25
*BC308	0·10	GL7M	0·75	*ZTX108	0·10	*2N4126	0·15	74195	1·00
*BC327	0·20	GMO378A	1·75	*ZTX109	0·12	*2N4286	0·20	74196	1·20
*BC328	0·18	*KS100A	0·45	*ZTX300	0·12	*2N4288	0·22	74197	1·10
*BC337	0·18	MJE340	0·80	*ZTX301	0·13	*2N4289	0·24	74198	2·25
*BC338	0·17	MJE370	1·17	*ZTX302	0·15	*2N5457	0·35	74199	2·25
BCY30	1·00	MJE371	0·61	*ZTX303	0·17	*2N5458	0·35	*76013N	1·75
BCY31	1·00	MJE520	0·52	*ZTX304	0·19	*2N5459	0·35		
BCY32	1·00	MJE521	0·55	*ZTX311	0·12				
BCY33	0·90	MJE2955	1·25	*ZTX314	0·20	**INTEGRATED**			
BCY34	0·90	MJE3055	0·75	*ZTX500	0·13	**CIRCUITS**			
BCY39	3·00	*MPF102	0·30	*ZTX501	0·14	7400	0·16	Plugs in socket	
BCY40	1·00	*MPF103	0·30	*ZTX502	0·16	7401	0·16	—low profile	
BCY42	0·25	*MPF104	0·30	*ZTX503	0·17	7402	0·16	8 pin DIL	0·15
BCY43	0·25	*MPF105	0·30	*ZTX504	0·20	7403	0·16	14 pin DIL	0·15
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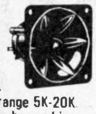

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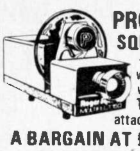

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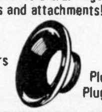

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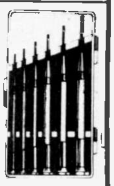

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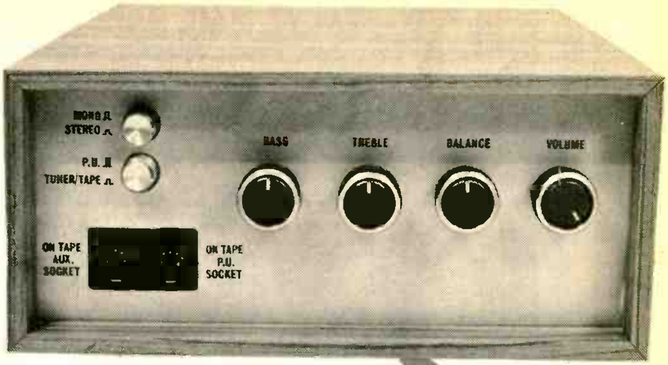

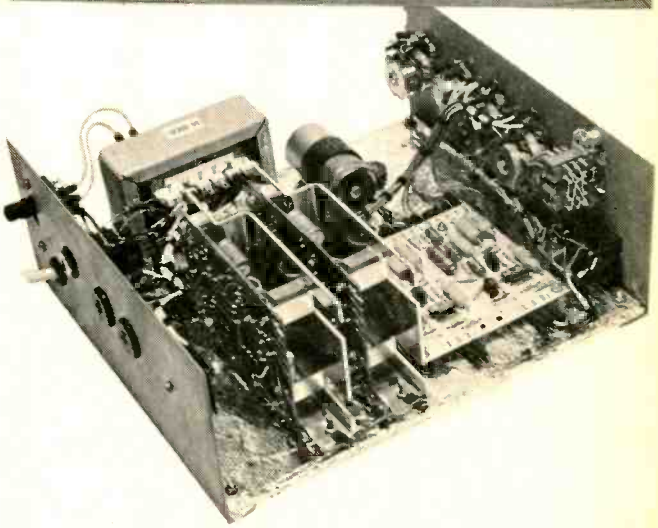

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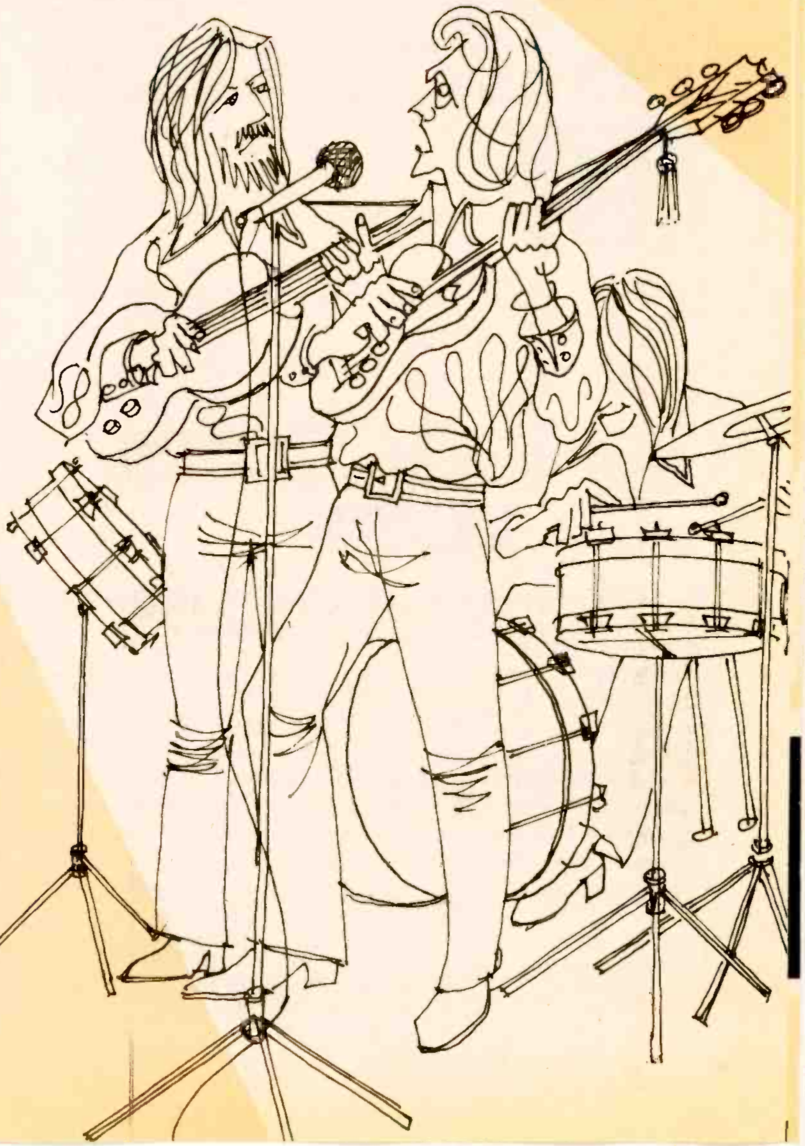
GUITAR SOUND MULTI-PROCESSOR

PART 1

Mark A. Sawicki M. Sc. (Eng.) **Alex. Kowalewski**



UNTIL now there has been no device which fills in the space between foot pedal effects and the incredibly expensive guitar synthesisers such as Roland, Arp and the Synthi Hi-Fli. Consequently the Guitar Sound Multiprocessor was designed to fill in the gap.

Some of the effects available are indicated opposite. These are of course variable and are only representative of what can be commonly achieved using the processor. By simple control manipulation it is possible to augment these, for example, to produce repeating echoes, rotary sounds, adding a metallic quality to the phaser effect or even computer voice sounds. To aid in achieving these a table of panel control settings is given in the final part.

To simulate the effects available with this unit one would have to rig up about six or seven separate effects units in a complex spaghetti network. The whole processor is based around a charge transfer device which processes incoming signals by varying delay times. Fig. 1 shows a fragment of a charge transfer unit such as the one used in this project. The device used is the Reticon SAD-1024 which is a dual analogue delay line, comprising two chains of 512 MOS transistors and storage capacitors arranged in a bucket brigade configuration.

THE CHARGE TRANSFER DEVICE

Charge Transfer Devices form a fairly new family of integrated circuits which have only recently become cheap enough and available enough for the amateur to use. Charge transfer is the key to their operation, as the device samples an analog signal and shunts the samples along from cell to cell, just like a bucket brigade moving water. Indeed this analogy is so popular that the two types of CTDs are called Bucket Brigade Devices (BBDs) and Charge Coupled Devices (CCDs) respectively. Their relative merits lead to slightly different applications on the basis of price and complexity.

•Cover shows Mike Rutherford from *Genesis*

Fuzz
This is a particularly simple and well-known effect implemented by symmetrical clipping of the signal. The result is to harden the sound by introducing very large odd-harmonic distortion.

Tremolo
Periodic modulation of the amplitude of a signal produces the well-known effect which, once implemented using a lamp and photo resistor is now achieved by variable gain amplifiers.

Vibrato
This effect is produced by a periodic variation in the pitch of a signal at a fairly slow rate (about 4Hz to 16Hz). In the past unreliable mechanical devices had to be used but the variable delay produced by a bucket brigade device provides an ideal solid-state solution.

The change in pitch occurs since the rate at which the signal exits is different from that at which it enters the device.

Flanging
Flanging gives a spacey sound as though the sound had travelled down a long tunnel. This is caused by passing the signal through a comb-filter, that is regularly spaced minima in the response.

In flanging, the minima are harmonically related while in a "phaser", which produces a similar but less profound effect, they are not. To obtain the full effect the notch spacing is varied periodically with time by using a variable delay circuit.

In the past, tape recorders had to be used to obtain the delay so that the effect was impractical when playing live.

Reverberation
This is the decaying multiple echo audible in concert halls and large rooms. Before the advent of solid state delay, the effect could only be produced by use of tape recorders or delicate and accoustic feedback-prone spring lines. The delayed signal is attenuated and fed back additively to obtain "reverb" which as opposed to "echo" only utilises short delays.

Let's look at the BBDs since this is the device used in this project. Going back to our analogy, in Fig. 1 the buckets are capacitors, the firemen are MOSFETs and the fire-chief is a two phase clock oscillator.

The two clocks ($\emptyset_1$and $\emptyset_2$) are simply in antiphase and are non critical in terms of mark-space ratio and rise time as long as they do not overlap. Each time $\emptyset_1$ is high, the first MOSFET turns on, and capacitor C_s is charged to the input voltage. $\emptyset_1$ then goes low, freezing the voltage on C_s and $\emptyset_2$ goes high turning on the third device. This combined with the second in the so-called tetrode configuration, discharges C_s into C_1 so that the voltage which was on C_s is now on C_1—the action is like a switch buffered by a unity gain amplifier. On the next transition, $\emptyset_1$ his high, taking a new sample and putting the previous one on C_2—there are thus two "buckets" per sample cell.

With the clock instructions, and pursuing the analogy, the bucket filling continues down the line (n cells) until the last bucket contains the same charge quantity as was present in the first bucket at the commencement of the sequence.

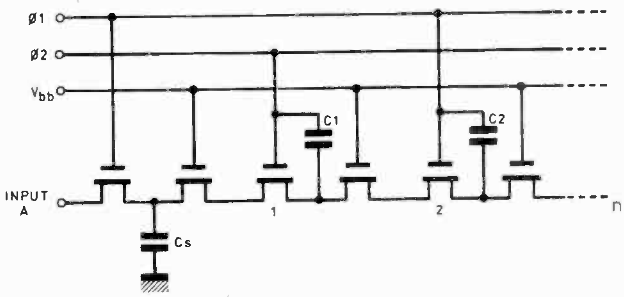


Fig. 1. Section of SAD 1024 equivalent

SCHEMATIC

Fig. 2 shows a complete block diagram of the sound processor. Block 1, the pre-amp, is required to maintain the output from the processor at a suitable level to drive any popular type of ancillary equipment, Block 2, the input low pass filter, is required to limit the input bandwidth with a sharp professional roll off. Delays are matched such that the cut off frequency is approximately 0·3 times the clock frequency giving a band below the Nyquist frequency of 0·5 times the clock frequency.

Prototype Sound Multiprocessor. Note the easy accessibility of all controls to the performer

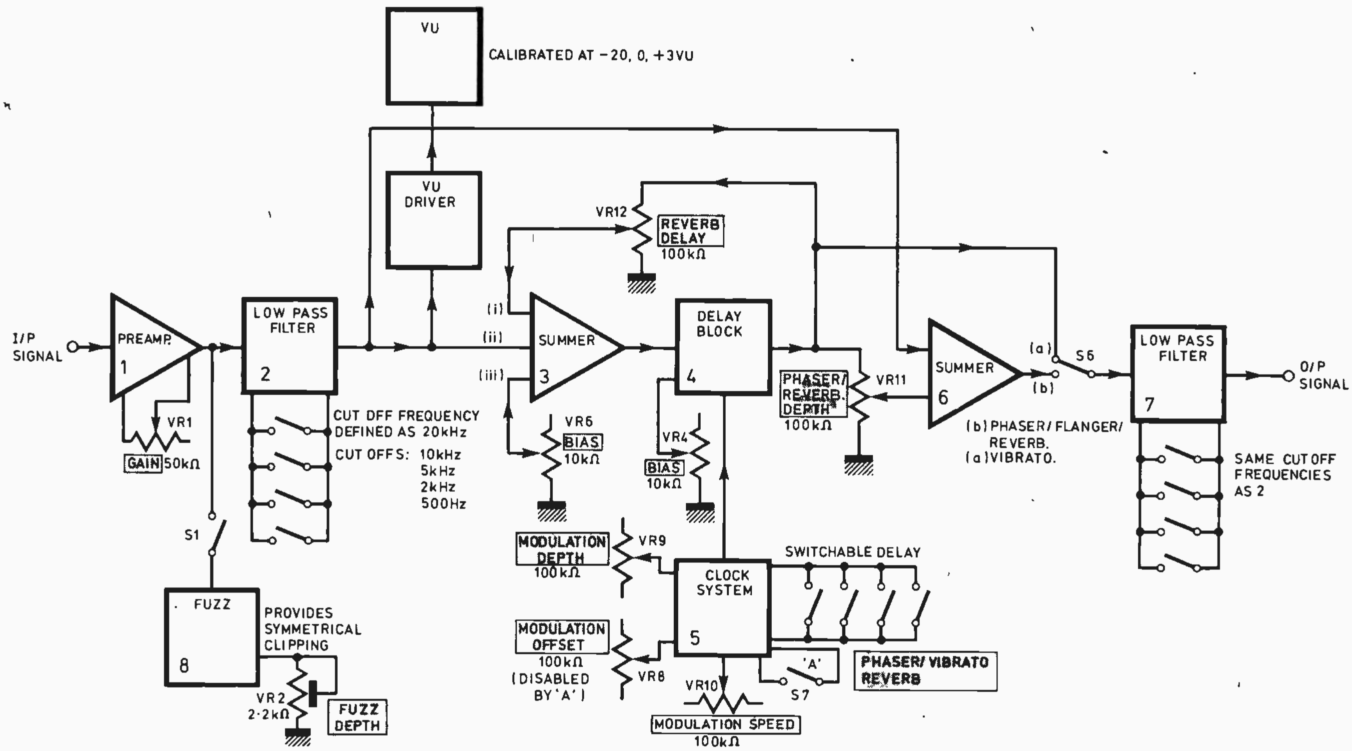


Fig. 2. Block diagram of the Sound Processor

Table 1 shows the frequency to delay time configurations. Roll off is 36dB/octave giving approximately 20dB rejection at the Nyquist frequency.

Table 1.

Filter Frequencies	Clock Frequencies	Delay Times
20kHz	60kHz	4·27ms
10kHz	30kHz	8·53ms
5kHz	15kHz	17·07ms
2kHz	6kHz	42·67ms
500Hz	1·5kHz	170·67ms

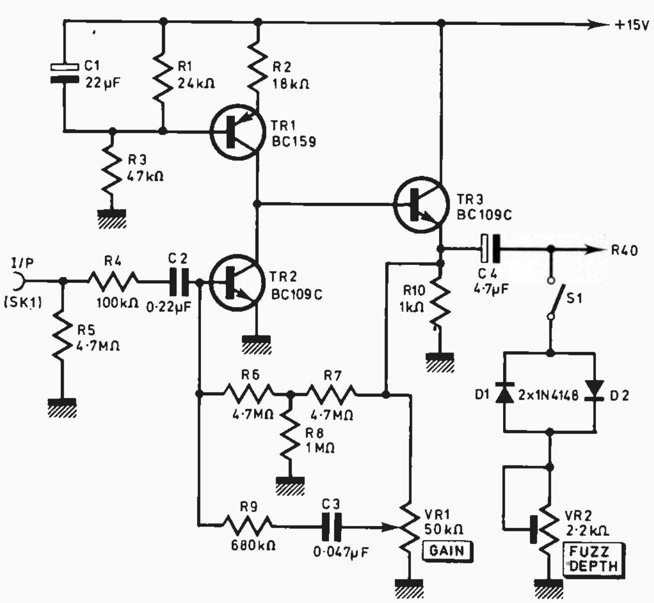


Fig. 3. Circuit of preamplifiers and fuzz

Block 3, the input summer, derives a proportion of the delayed signal for reverberation and phaser (flanger) reinforcement.

Block 4, the delay block based on the SAD1024 bucket brigade, provides a clock controlled delay where:

$$\text{Time delay} = \frac{256}{f(\text{clock})} \text{ seconds}$$

Block 5, the clock system, provides the delay block with suitable clock frequencies for controlling the amount of delay. The clock system has a frequency range of 1·5kHz to 60kHz.

The frequency modulation is produced by a triangle oscillator built on a pair of popular 741 op-amps, with variable frequency and modulation depth, individually adjustable to suit your requirements.

Block 6 is the output summer which determines phaser depth and controls the amount of reverberation fed through with the original signal.

Block 7 is an output low pass filter similar to block 2, giving a low impedance output and smooths the output by removing the sampling steps. Its cut-offs can be selected to match the input filter and delay settings.

Block 8 is an optional fuzz effect employing a pair of low cost silicon diodes providing standard symmetrical clipping.

PRE-AMPLIFIER AND FUZZ

Fig. 3 shows the complete circuit diagram of the preamplifier. It is comprised of a constant current section, with a BC109C and BC159 in a common emitter configuration, and another BC109C as an emitter follower. The gain of the pre-amp is determined by VR1, the minimum gain being about 7 and the frequency response being approximately 7Hz to 20kHz. The optional fuzz effect is produced by two diodes connected back to back for symmetrical clipping of the incoming signal waveform, and its level is adjusted by means of VR2. The whole pre-amplifier is mounted on the main board as can be seen in Fig. 5.

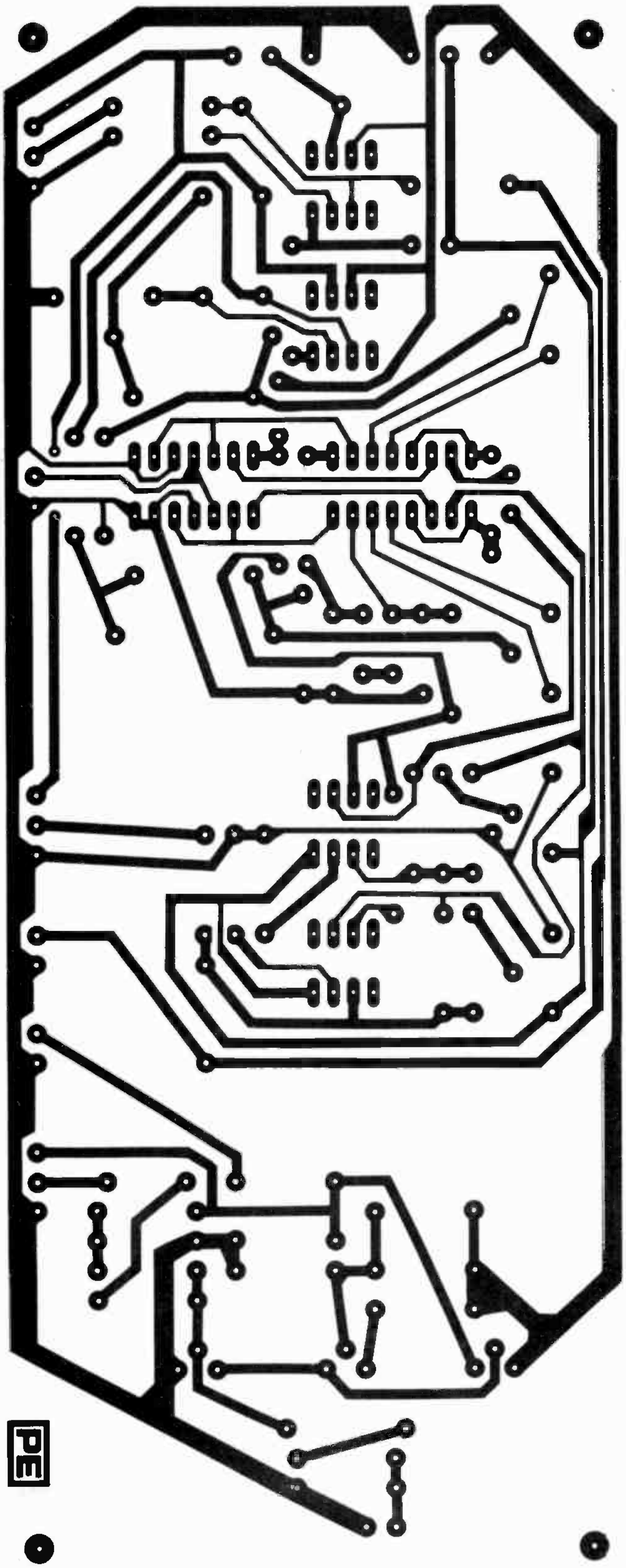


Fig. 4. Printed circuit of main board

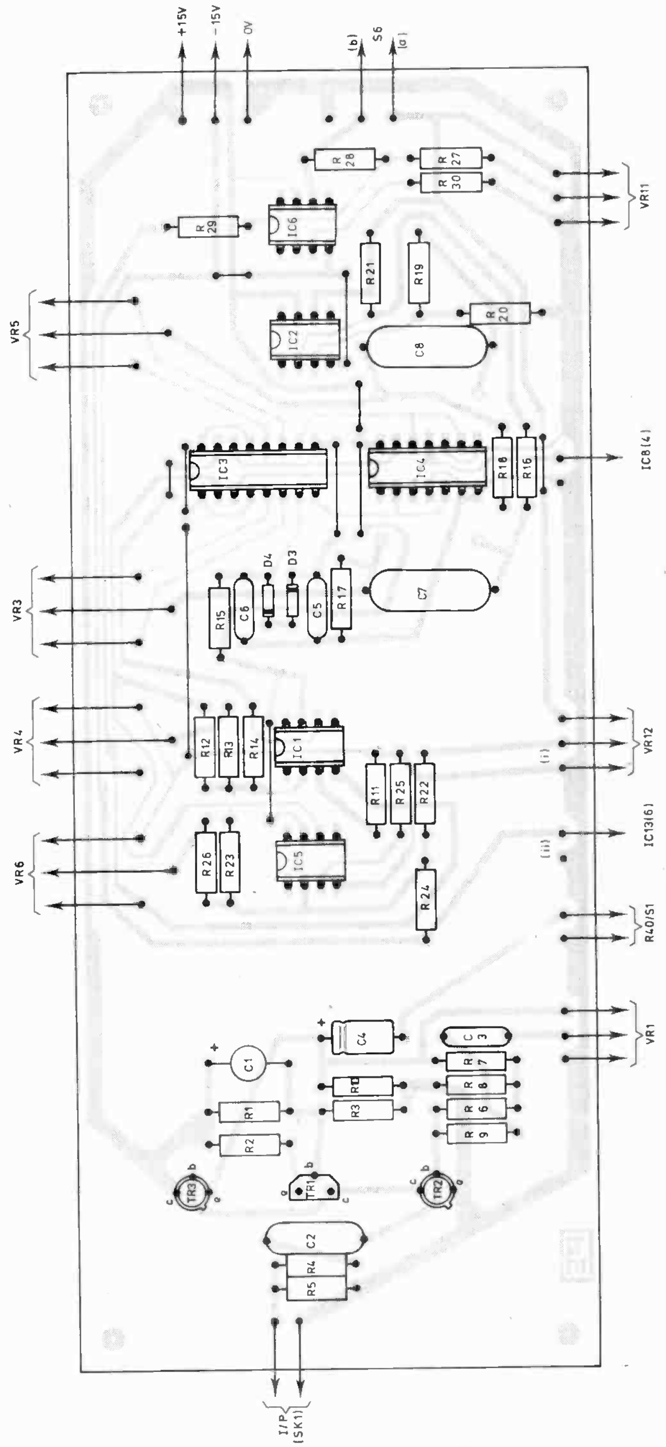


Fig. 5. Component layout

COMPONENTS . . .

Resistors

R1	24kΩ
R2	18kΩ
R3	47kΩ
R4	100kΩ
R5–R7	4·7MΩ (3 off)
R8	1MΩ
R9	680kΩ
R10	1kΩ
R11	47kΩ
R12	100kΩ
R13	47kΩ
R14	100kΩ
R15	10Ω
R16	33kΩ
R17–R18	1kΩ (2 off)
R19	33kΩ
R20–R24	100kΩ (4 off)
R25	33kΩ
R26–R29	100kΩ (4 off)
R30–R32	33kΩ (3 off)
R33	72kΩ
R34	25kΩ
R35–R37	100kΩ
R38	270kΩ
R39	100kΩ
R40–R41	8·2kΩ
R42–R43	100kΩ
R44–R45	100kΩ
R46–R47	8·2kΩ
R48–R51	100kΩ
R52	47kΩ
R53	100kΩ
R54–R55	1kΩ
R56–R57	6·8kΩ

All 5% carbon thin film

Capacitors

C1	22μF bead tantalum 16V
C2	0·22μF polyester 250V
C3	0·047μF polyester 250V
C4	4·7μF elect. 16V
C5–C6	0·1μF polyester 250V
C7–C8	0·68μF polyester 250V
C9	8·2nF polystyrene ±2½%
C10	2·2nF polystyrene ±2½%
C11	680pF polystyrene ±2½%
C12–C13	220pF polystyrene
C14	0·22μF polyester 250V
C15–C16	1nF polystyrene ±5%
C17–C18	1nF polystyrene ±5%
C19–C20	3·3nF polystyrene ±5%
C21–C22	8·2nF silver mica 1%
C23–C24	39nF (3 x 10nF ceramic + 6·8nF polystyrene + 2·2nF polystyrene)
C25–C26	56pF polystyrene ±5%
C27–C28	2·2nF polystyrene ±5%
C29–C30	470pF polystyrene ±5%
C31–C32	150pF polystyrene ±5%
C33–C34	56pF polystyrene ±5%
C35–C36	4·7nF polystyrene ±5%
C37–C38	820pF siver mica 1%
C39–C40	330pF polystyrene ±5%
C41–C42	100pF polystyrene ±5%
C43–C44	100pF polystyrene ±5%
C45–C46	1nF polystyrene ±5%
C47–C48	1nF polystyrene ±5%
C49–C50	3·3nF polystyrene ±5%
C51–C52	8·2nF silver mica 1%
C53–C54	39nF (made up before)
C55–C56	4·7nF polystyrene ±5%
C57–C58	820pF silver mica 1%
C59–C60	330pF polystyrene ±5%
C61–C62	100pF polystyrene ±5%
C63–C64	56pF polystyrene ±5%
C65–C66	56pF polystyrene ±5%
C67–C68	150pF polystyrene ±5%
C69–C70	470pF polystyrene ±5%
C71–C72	2·2nF polystyrene ±5%
C73	100pF polystyrene ±5%
C74	82pF silver mica 1%
C75	1,000μF elect. 16V
C76–C77	1,000μF elect. 25V
C78	0·1μF polyester
C79	0·1μF polyester
C80–C81	10μF elect. 25V

Transistors

TR1	BC159
TR2–TR3	BC109C (2 off)

Integrated Circuits

IC1–2	741N (2 off)
IC3	SAD1024
IC4	CD4013B
IC5–IC7	741N (2 off)
IC8	CD4046
IC9–IC13	741N
IC14	Dual (±15V) voltage regulator (RC4195D)

Diodes

D1–D2	1N4148
D3–D4	1N914
D5–D6	1N4001
D7/D9	TIL209 Green (2 off)
D8/D10	TIL209 Red (2 off)
D11	TIL209 Yellow
D12–D15	1A silicon bridge rectifier

Switches

S1	On/off slide type
S2–S5	Two pole push button change-over (4 off)
S6	Single pole change-over
S7	Single pole change-over
S8–S15	Six pole push button change-over

Miscellaneous

LP1—Mains neon, T1—15V, 0·2A. 15V, 0·2A 6VA low voltage transformer with two secondaries (R.S. 207–217) FS1–200mA fuse, fuseholder, Euroconnector mains socket, ME1–100μA f.s.d. VU meter

Potentiometers

VR1	50kΩ
VR2	2·2kΩ
VR3	1kΩ ¾in. 20 turn cermet trimmers
VR4	10kΩ ¾in. 20 turn cermet trimmers
VR5	1kΩ ¾in. 20 turn cermet trimmers
VR6	10kΩ ¾in. 20 turn cermet trimmers
VR7	25kΩ preset
VR8–VR12	100kΩ lin. (5 off)

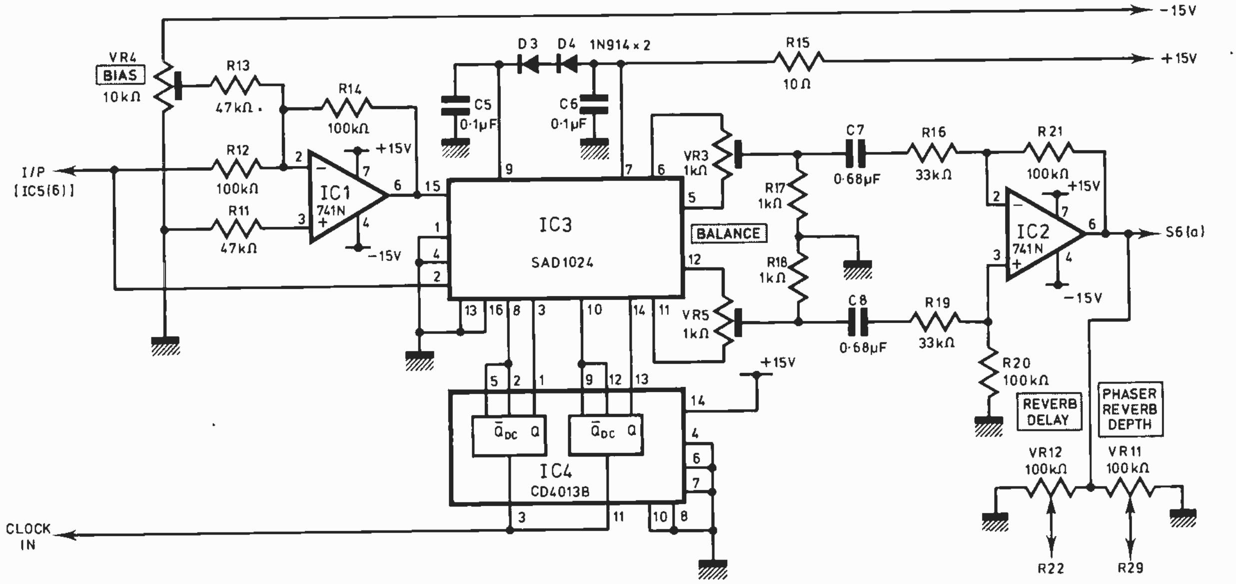
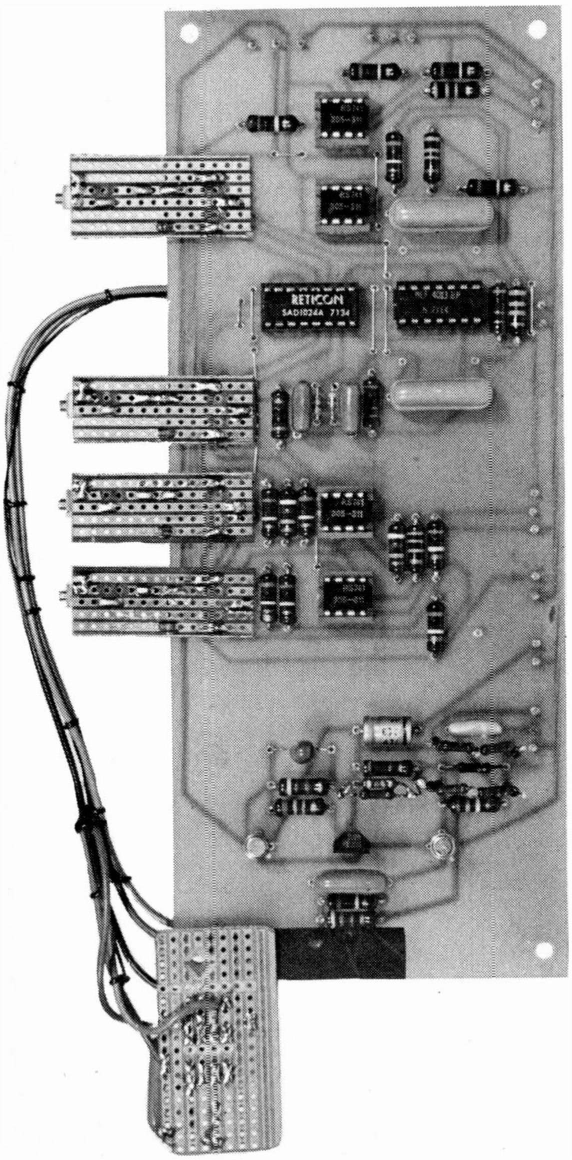


Fig. 6. Circuit of delay block



(Left) Main board. Here the cermet multiturn trimmers are mounted on small strips of Veroboard. The small Veroboard at the base is the meter driver circuit

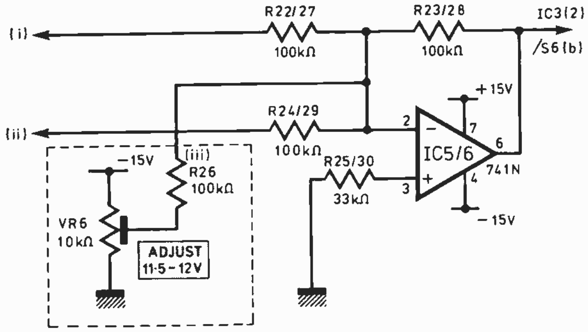


Fig. 7. Circuit of Summer 3. Summer 6 is identical apart from the exclusion of the boxed circuit

Due to the small amount of components required for the fuzz effect unit, it can easily be mounted on switch S1 situated on the far right-hand side of the control panel.

DELAY BLOCK

Fig. 6 shows the complete circuit diagram of the delay block which is centred on the SAD1024 dual-in-line bucket brigade on either side of which there is a buffer of a 741 op-amp (Summers 3 and 6 respectively). The first being inverting and the second of differential configuration. The SAD 1024 requires a dual clock drive, one for each path, hence a dual D-type flip flop is used to split the signal from the clock. The logic level present at the D input is transferred to the Q output during the positive going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset line respectively. The SAD1024 is trimmed for symmetrical clipping. The bias on summer 3 is used for channel A, providing approximately 6V d.c. at pin 2, and channel B is at the same level at pin 15.

Next Month: Filters and board construction

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

PROGRAMMING PROMS

MICROPROCESSORS are now so cheap that it is feasible for the amateur to consider designing equipment based on a dedicated micro, but this is not possible without some way of programming memories so that this equipment will retain its "operating system" even when it is switched off. The most satisfactory type of non-volatile memory to emerge so far is the UVEPROM (Ultra-Violet Erasable Programmable Read-Only Memory), and the most economical of these, the 2708, provides 1K bytes of storage for as little as £7.

There are, however, two disadvantages of the 2708 which have been avoided in the next generation device from Intel—the 2716. The first is that the 2708 needs two supply rails of −5V and +12V in addition to the regular +5V supply; this can be overcome by deriving these supplies from the primary of the transformer supplying the +5V by using voltage doubler circuits as shown in Fig. 1.

The second drawback is that the 2708 is rather tricky to program; the memory locations must be programmed in sequence in several passes, and a 27V pulse is needed to program each byte. Nevertheless these difficulties are worth surmounting until the 2716 becomes available at a reasonable cost, and what follows is a description of a simple system of programming 2708s received from *Tony Marshall* of London.

"This PROM programmer is being used with an M6800-based microprocessor system, but could easily be adapted for others. The hardware was kept as simple as possible by doing as much work as possible in the software, and it is based on a design described by D. W. Hoare and K. H. Yap at the 1977 SERT symposium "Microprocessor Systems and Software". The complete software for an M6800 to program and check a 2708 will be given here.

"To program a 2708 the $\overline{CS}$/WE input is first taken to +12V to put the chip in Write Enable mode. The address and data for a particular byte to be programmed are latched and a delay of 20 microseconds allowed for these to stabilise, and then a 27V 500 microsecond program pulse is applied to the PROG input. This is repeated for the 1024 bytes in the ROM, and the whole chip is

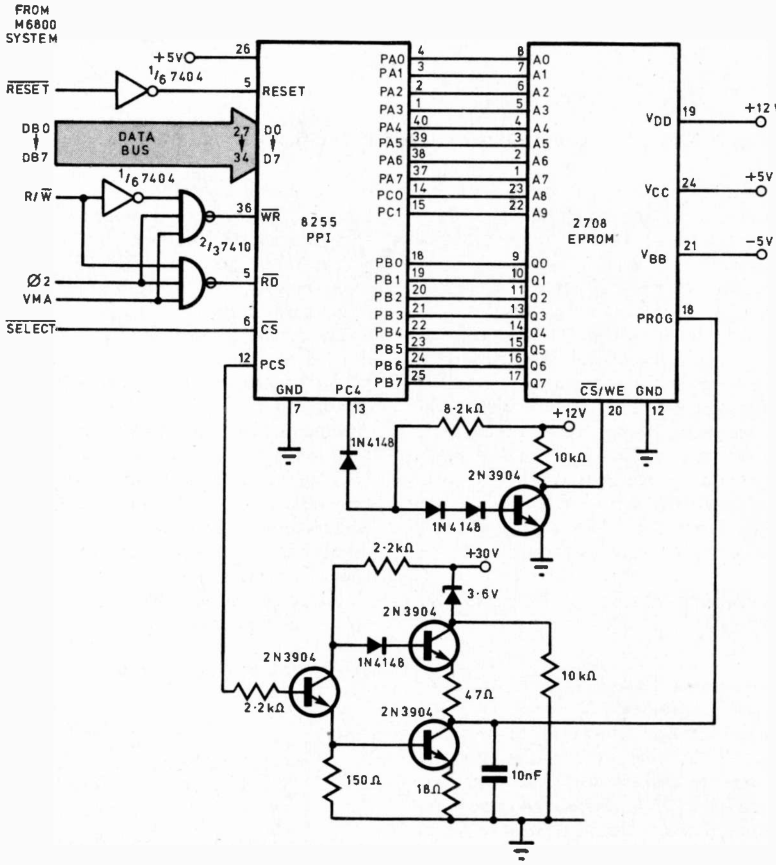


Fig. 2. Programmer for 2708-type ultra-violet arasable programmable read-only memories.

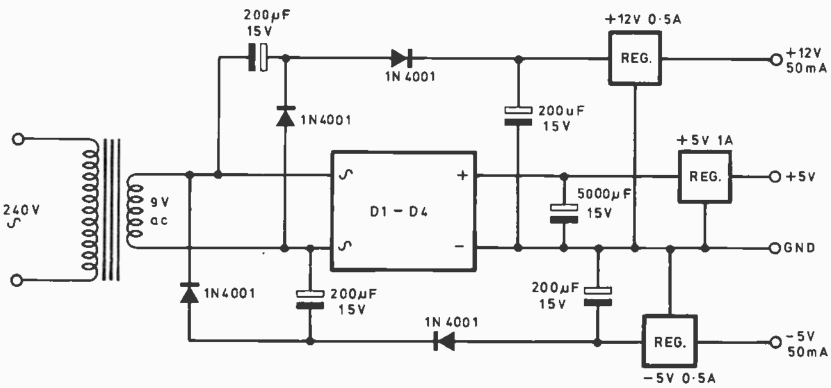


Fig. 1. Circuit showing how supplies of +12v and −5v may be derived from a standard +5v supply.

```
                NAM    PROM
        * PROM PROGRAMMER USING PPI
        *
   2000 START  EQU    $2000    DATA IN MEMORY
   0400 SIZE   EQU    1024     ROM SIZE
   8100 PPIA   EQU    $8100    PPI SELECT ADDRESS
   8101 PPIB   EQU    PPIA+1
   8102 PPIC   EQU    PPIA+2
   8103 PPICNT EQU    PPIA+3
        *
        * VARIABLES
        *
0000 0001 COUNT  RMB    1
0001 0002 ROM    RMB    2
0003 0002 XTEMP  RMB    2
        *
        * SUBROUTINE TO PROVIDE DELAY
        * DELAY = 6 * A + 15 USEC (1 MHZ CLOCK)
        *
0005 4A      DELAY  DEC A
0006 26 FD          BNE    DELAY
0008 39             RTS
        *
        * PROGRAM PROM : BEGIN HERE
        *
0009 86 80   SET    LDA A  #$80
000B B7 8103        STA A  PPICNT
000E 86 D8          LDA A  #216
0010 97 00          STA A  COUNT
0012 CE 0000 LOOP1  LDX    #0
0015 DF 01          STX    ROM
0017 CE 2000        LDX    #START
001A 96 02   LOOP2  LDA A  ROM+1
001C B7 8100        STA A  PPIA     LOW 8 ADDRESS BITS
001F D6 01          LDA B  ROM
0021 CA 20          ORA B  #$20     SELECT
0023 F7 8102        STA B  PPIC
0026 A6 00          LDA A  0,X      DATA
0028 B7 8101        STA A  PPIB
002B 86 01          LDA A  #21-15/6
002D 8D D6          BSR    DELAY    21 USECS
002F C4 03          AND B  #$03
0031 F7 8102        STA B  PPIC     PROGRAM PULSE
0034 86 50          LDA A  #500-15/6
0036 8D CD          BSR    DELAY    500 USECS
0038 CA 20          ORA B  #$20
003A F7 8102        STA B  PPIC     REMOVE PROGRAM PULSE
003D 7C 0002        INC    ROM+1    NEXT ROM ADDRESS
0040 26 03          BNE    NOC
0042 7C 0001        INC    ROM
0045 08      NOC    INX
0046 8C 2400        CPX    #START+SIZE
0049 26 CF          BNE    LOOP2
004B 7A 0000        DEC    COUNT    FINISHED?
004E 26 C2          BNE    LOOP1    NO!
0050 C6 30          LDA B  #$30
0052 F7 8102        STA B  PPIC     PUT IN READ MODE
0055 3F             SWI             FINISHED
        *
        * READ / COMPARE PROGRAM
        *
0056 86 82   CHECK  LDA A  #$82
0058 B7 8103        STA A  PPICNT   B = INPUT
005B CE 0000        LDX    #0
005E DF 01          STX    ROM
0060 CE 2000        LDX    #START
0063 96 02   LOOP3  LDA A  ROM+1
0065 B7 8100        STA A  PPIA
0068 D6 01          LDA B  ROM
006A CA 30          ORA B  #$30     READ MODE
006C F7 8102        STA B  PPIC
006F B6 8101        LDA A  PPIB     GET DATA
0072 A1 00   TEST   CMP A  0,X      SAME?
0074 27 03          BEQ    EQUAL
        * NOTIFY ERROR
        * X = ADDRESS
        * A = ACTUAL DATA IN PROM
        * B = WHAT IT SHOULD BE
0076 E6 00          LDA B  0,X
0078 3F             SWI
0079 7C 0002 EQUAL  INC    ROM+1
007C 26 03          BNE    NOC2
007E 7C 0001        INC    ROM
0081 08      NOC2   INX
0082 8C 2400        CPX    #START+SIZE
0085 26 DC          BNE    LOOP3
0087 3F             SWI             FINISHED OK
        *
                    END
```

Fig. 3. Complete program for the M6800 to program and verify a 2708.

programmed a total of 216 times so that each location receives a total program-pulse width in excess of 100ms. The total time needed is about 2 minutes.

To latch the address and data lines for the duration of the program pulse some sort of interface circuit is needed. The Motorola M6820 PIA does not provide enough output lines, but there is no reason why, with care, parts from one microprocessor family should not be used with a system based on another; the Intel "Programmable Peripheral Interface" or PPI provides three 8-bit ports and so is ideal, and its control signals $\overline{WR}$ and $\overline{RD}$ can be generated from the M6800's 02, R/$\overline{W}$, and VMA using two TTL gate packages.

PROGRAMMABLE PERIPHERAL INTERFACE

Intel's 8255 PPI contains four 8-bit registers; three of these control the three read/write I/O ports, A, B, and C, and the fourth is a write-only control buffer used for programming the mode of operation. Ports A and B can be defined for either input or output, and port C is divided into two 4-bit halves each of which can be defined for input or output. Two of the three modes of operation use port C to provide special purpose control signals; mode 1 allows ports A and B to be either input or output with port C providing handshake control signals, and mode 2 allows port A to act as a bidirectional data port, again with control signals provided by port C.

There is also a facility for setting or clearing individual bits in port C by writing an appropriate word to the control buffer. The PROM programmer uses the PPI in mode O in which all three ports provide simple I/O; this is selected by writing $80 or $82 to the control buffer, the former defining port B for output and the latter defining it for input.

PROGRAMMER CIRCUIT

The complete circuit of the PROM programmer is shown in Fig. 2. The 12V Write Enable signal is switched from a PPI output using a transistor, and the 27V programming pulse is switched with a three-transistor circuit; the rise-time of the program pulse must lie between 0·5 and 2·0 microseconds, and the 10nF capacitor at the output ensures this.

The program shown in Fig. 3 will program a 2708 using this interface circuit, and then verify that the data is correct. It assumes that the data is stored in a 1K block of memory starting at $2000, and the PPI is addressed as locations $8100 to $8103. Subroutine DELAY uses a software timing loop to provide a delay proportional to the value in accumulator A; in systems with clock rates of other than 1MHz the delay constants should be recalculated.

To program the PROM the program is entered at SET, and if all is well it will return to the monitor in under two minutes. To then verify the data the program is entered at CHECK and if all is well to $0087; any errors will be reported with a return at $0078. In fact the system has programmed 2708s from several sources without ever giving any errors.

To erase a 2708 for re-use an ultra-violet lamp unit similar to the CHAMP-U.V. described in the June 1978 PRACTICAL ELECTRONICS was used, and it takes about 30 minutes. Complete erasure can be checked using the CHECK part of the program in Fig. 3 by first modifying the instruction at $0072 to 'CMP A £$FF'."

ONE-LINE CHARACTER DISPLAY

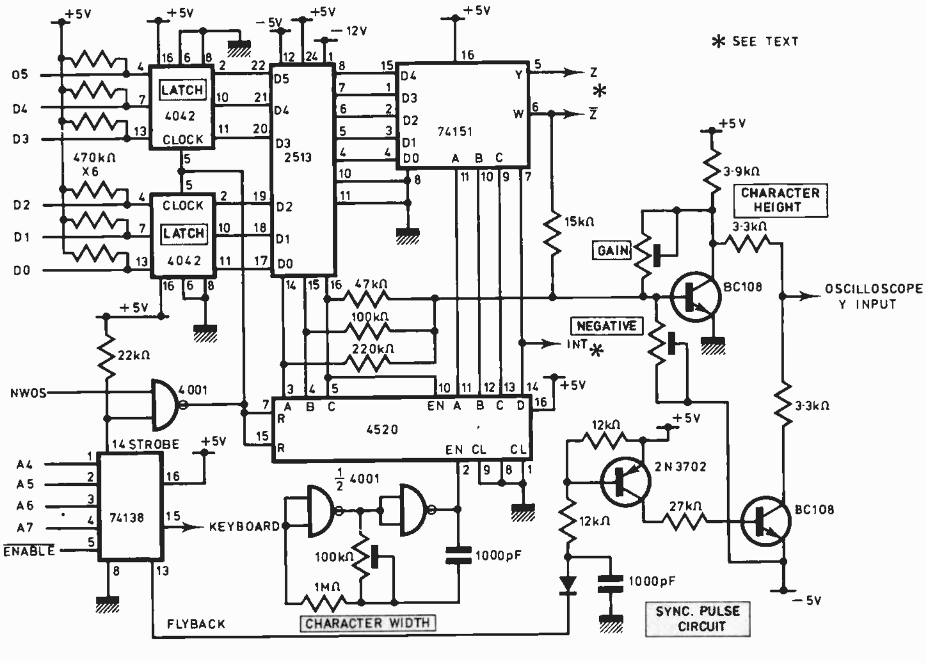
The following ingenious circuit displays a line of ASCII characters on a standard oscilloscope; it was received from *Dr. S. C. Craddock of Consett*, and what follows is based on his description.

"This simple one-line VDU fills the gap between 7-segment displays and T.V. based full-sized VDUs. The oscilloscope needs no modification provided that it has a flat response from 10Hz to 500kHz, a time-base setting of 50Hz or thereabouts, and negative pulse synchronisation. Few oscilloscopes would fail to meet these specifications."

The circuit is shown in Fig. 4. It uses a mixture of 74 series TTL devices and 40/45 series CMOS devices. The 2513 is a character generator with a 64-character set. The microprocessor has only to output one of the 16-20 characters every millisecond. The subroutine listing in Fig. 5 shows how to do this.

The particular keyboard used clears a status bit, D7, when a key is pressed to indicate that data is ready in the keyboard buffer; the subroutine therefore first sets this bit by writing to the keyboard address. It then outputs a set of 16 characters one at a time at 1 millisecond intervals until the keyboard

Fig. 4. Dr. S. C. Craddock's one-line V.D.U. circuit.



status bit is cleared, and then returns with the key value in the accumulator.

As it stands the circuit deflects the spot up away from the undeflected raster to form the characters; there is therefore a negative image of the line of characters below the actual line, as shown in the photograph of Fig. 6. This avoids the need for a z-modulation input on the oscilloscope, but if one is available one of the outputs Z or $\overline{Z}$ can be used to blank the spot instead, and the 15kΩ resistor from $\overline{Z}$ should then be omitted. A negative-going sync. pulse is generated at the end of the line of characters to trigger the oscilloscope.

The display could be interrupt-driven by taking the point marked INT (pin 14 of the 4520) to the interrupt input on the microprocessor; a character could then be output at each interrupt, generated when the previous character had been displayed, and between interrupts the micro would be free to do something else. In Dr. Craddock's system the oscilloscope input is switched automatically between the VDU circuit and the output of a digital-to-analogue converter by the strobe pulses for the relevant latch, so that text and waveforms are displayed together on the same oscilloscope.

```
                        .TITLE 'ONE LINE V.D.U.'
             ; P1 POINTS TO 16 CHARACTERS TO BE DISPLAYED
             ; P2 POINTS TO DISPLAY CIRCUIT ADDRESS
             ;
        0000 KYBD    =       X'00        ;KEYBOARD ENABLE
        0020 STROBE  =       X'20        ;DISPLAY STROBE
        0030 FLYBK   =       X'30        ;FOR SYNC/FLYBACK
             ;
0000                 .=0F20
             ;
0F20 03      BEGIN:  SCL
0F21 CA00            ST      KYBD(2)     ;SET KYBD STATUS BIT
0F23 C4EF    C:      LDI     -17         ;FOR COUNT
0F25 01      A:      XAE
0F26 C501            LD      @1(1)       ;LOAD CHARACTER
0F28 CA20            ST      STROBE(2)   ;STORE TO VDU
0F2A C400            LDI     0
0F2C 8F01            DLY     1           ;DELAY 1 MS.
0F2E 01              XAE
0F2F F401            ADI     1           ;INCREMENT AND
0F31 9CF2            JNZ     A           ;  TEST COUNTER.
0F33 C230            LD      FLYBK(2)
0F35 C5F0            LD      @-16(1)     ;RESET P1
0F37 C200            LD      KYBD(2)     ;KEY PRESSED?
0F39 9402            JP      B           ;YES
0F3B 90E6            JMP     C           ;NO - DISPLAY AGAIN
0F3D 3F      B:      XPPC    3           ;RETURN
0F3E 90E0            JMP     BEGIN
             ;
        0000         .END
```

Fig. 5. Subroutine for SC/MP to read then write 16 characters from memory.

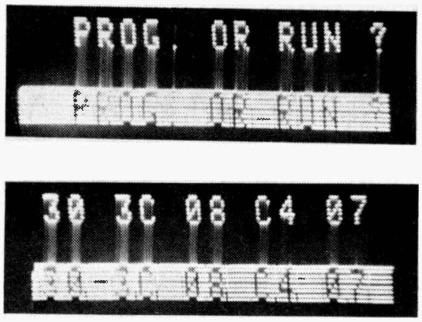


Fig. 6. Typical display generated by the one-line V.D.U. To avoid the need for Z-modulation the spot is deflected clear of the raster to generate a character.

readout

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Patently Obvious?

Sir—I read with great interest the details of the patent application by Tokyo Shibaura Electric Company on improving musicality. *(P.E. Oct. p. 1100).*

It must be easily realised that no electrical component can be a perfect realisation of its electrical value. Components are manufactured according to manufacturing tolerances using various materials. An electrical component such as a resistor or capacitor will give harmonic distortion to a sine wave due to its non linearity. This will be usually very low and negligible for most practical applications.

Aluminium electrolytic capacitors are usually the worst commonly used component in this respect. Listeners have claimed to detect audible differences due to the inclusion of a large capacitor between amplifier and loudspeaker. Indeed, one writer to a hi-fi magazine claimed that the published distortion figures of the PE Gemini amplifier featured some years ago could only be obtained if the amplifier was measured before the electrolytic capacitor.

In the circuits of Fig 1 and Fig 3 of your review of the patent, the capacitors are used in smoothing the DC supplies. In fact this is a very common practice in amplifier design. A small non-polarised capacitor (0·1 to 2·2μF) is placed on the circuit board of the power amplifier. Its purpose is to prevent amplifier instability at high frequencies. Hence it is not placed with the main electrolytics as its effect will be negated by the inductance of the power leads to the power amp.

The amount of improvement will depend on how susceptible the power amplifier is to supply variations. Owing to the nature of transistors, fluctuations on the power supply can be present at the output. This is one of the causes of dynamic crosstalk between amplifier channels. In practice, feedback will reduce this to low proportions. Other techniques of reducing dynamic crosstalk are additional smoothing of low current circuits and cascade circuitry.

In the circuit of Fig 4 the aluminium electrolytic is used in the signal path. Here additional components are added to present as low an impedance as possible at all audio frequencies. Ideally because of the non linearity of the aluminium electrolytic, an alternative capacitor should be of high enough value to present a low impedance at audio frequencies with the aluminium capacitor being used to maintain the phase response at low frequencies. If the second capacitor is a tantalum—as occurs in some parts of moving coil head amps—a third non polarised capacitor is used to maintain the low impedance at very high frequencies. It may be of course that the very high frequencies are removed by the designers, bandwidth limits, but in audio terms, it is better to remove extreme high frequencies by a linear filter than a non linear.

I find it hard to believe that the patent exists as described in your magazine. The ideas behind it have been applied many times in the past by audio engineers, including myself, who would appear to have a far greater understanding of the problem than the author of the patent would appear to have as read from your article.

I trust that this information is of help to your readers.

Graham Nalty,
Borrowash,
Derby.

To obtain a patent is often surprisingly easy—if the Patent Office Examiner doesn't know of, or can't find, any prior publication of what is claimed, then he will accept the application. It is thus quite conceivable that the patent in question is a re-hash of old ideas, even though those ideas are new to the inventor. But, and it is a big but, sometimes an inventor stumbles on an idea that, although simple in hindsight, has been overlooked or forgotten by others over the years. One object of reporting new patents in PE is to give readers an opportunity to make up their own minds on just such issues.

Adrian Hope

Communications

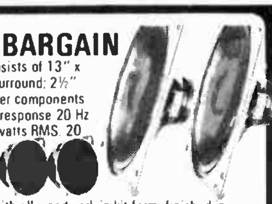
Reader D. N. Townsend, interested in electronics and computers, would be pleased to know if there are any amateur computer clubs or associations in the Leeds area.

124 Main Street,
Leeds,
Yorks.,
LS17 8JB.

Reader M. V. Ramesh would like to establish a few pen friends in England (preferably students undergoing graduate study in electronics).

F-76, Students Hostel,
Indian Institute of Science,
Bangalore-560 012,
India.

EMI SPEAKER BARGAIN



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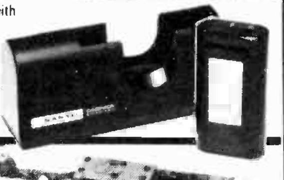

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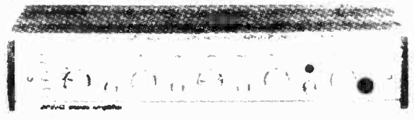

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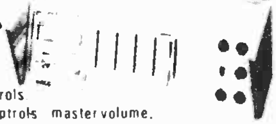

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impedance

BY TOBY BAILEY & BOB WHITAKER — PART 2

IF you examine the specification of, say, a tuner or a tape deck output it will generally be stated in the form of the output level and the output impedance. For example, if the output impedance is 10kΩ and the output is connected to an input with an impedance of 5kΩ then only a third of the open-circuit output voltage will appear at the input.

Once you know the open-circuit output voltage and the impedance of an output you can predict how it will behave when faced with any load.

Thevenin's theorem states that any chunk of linear circuitry connected to two terminals can be represented as a perfect voltage source in series with an impedance. It also says how to find the output of the voltage generator and the value of the impedance. By a perfect voltage generator is meant a voltage source which is capable of supporting its full output into arbitrarily small load impedances, i.e. the voltage doesn't drop when heavy currents are supplied. By a linear network is meant circuits made up of a mixture of some or all of resistances, capacitances and inductances.

The output voltage of the voltage generator can be measured as the open circuit voltage across the terminals of the network, the series impedance can be measured across the same terminals if we first turn off all internal generators in the circuit and replace them with their internal impedances; which will be zero in the case of a perfect voltage generator.

EXAMPLES

Look at the circuit shown in Fig. 9(a). A 1kHz source with an unloaded output of 1V and an internal impedance of 100Ω is connected to a T-network. We will now use Thevenin's theorem to simplify it to an equivalent circuit consisting of a perfect voltage generator and a single impedance. First, however, we will redraw the circuit with complex impedances—R1 has been lumped together with C1 to make one impedance.

You should have no trouble with the calculations if you follow the first article in this series (October '78). The result is shown in Fig. 9(b). Now we can calculate the open-circuit output voltage which is:

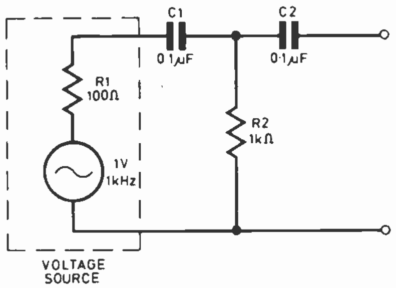


Fig. 9(a). Circuit to which Thevenin's theorem can be applied to get a simpler equivalent

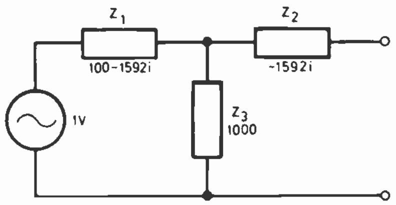


Fig. 9(b). The same circuit with complex impedances

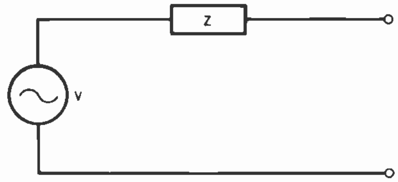


Fig. 9(c). Abstract equivalent of previous

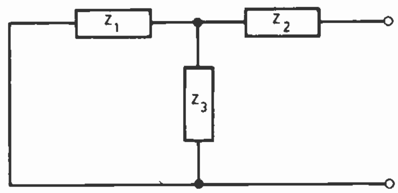


Fig. 9(d). Translating the complex impedance Z into its components

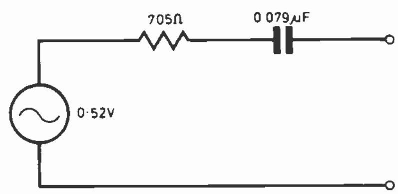


Fig. 9(e). Thevenin equivalent

$$V \times \frac{Z_3}{Z_1 + Z_3} = \frac{1 \times 1000}{1\,100 - 1592i} =$$

$$\frac{1 \times 1\,000 \times (1\,100 + 1592i)}{3{\cdot}74 \times 10^6} =$$

$$0{\cdot}294 + 0{\cdot}425i$$

This complex number has a magnitude of 0·52 and a phase angle of 55 degrees. This means that the voltage generator in our equivalent circuit of Fig. 9(c) has an output of 0·52V and is 55 degrees out of phase with the original one—the latter piece of information isn't often of much interest.

The impedance Z which must be put in series with the generator is the impedance across the terminals if we switch off the voltage generator and replace it with its internal impedance of 100Ω; see Fig. 9(d). Readers who have followed the examples in Part 1 should have little difficulty in arriving at a value of:

$$Z = 705 - 2017i$$

We can now translate this complex impedance back into its components. The real part of Z corresponds to a 705Ω resistor and using the formula for the impedance of a capacitor on the remaining imaginary part we get:

$$2017 = \frac{1}{2\pi f C}$$

$$C = \frac{1}{2\pi 1000 \times 2017}$$

$$= 0{\cdot}079\ \mu F$$

So we see the equivalent circuit of Fig. 9(a) in Fig. 9(e). From this circuit we can deduce the effect of any sort of load.

BIAS NETWORK

Another example of the use of Thevenin's theorem is shown. In Fig. 10(a) a typical biasing stage where the values of the base biasing resistors have been found by assuming a base current of 10µA and employing the rule of thumb that the current through them should be ten times the base current. But what effect does the loading actually have? If we assume that the 10V supply has negligible internal resistance then we can produce the Thevenin equivalent of the bias network, as shown in Fig. 10(b). The open-circuit output of the bias networks is:

$$\frac{39}{56 + 39} \times 10V = 4{\cdot}1V$$

and the series resistance is simply the

parallel impedance of the bias resistors (22kΩ). We can now see that if the base of the transistor draws 10μA then the voltage will drop by

$$22 \times 10^3 \times 10 \times 10^{-6} = 0{\cdot}22V$$

On the basis of this calculation we could well decide this was far within the necessary tolerances and increase the bias resistor values to save current and increase the input impedance of the stage.

NORTON'S THEOREM

There is another very similar theorem which allows all sources to be converted into a perfect current generator (one with infinite internal impedance) and an impedance connected in parallel. The output of the current generator is the current produced when you short the output of the network. The impedance is calculated in exactly the same way as for the Thevenin impedance (Fig. 11).

The two theorems are essentially very similar because any Thevenin equivalent can be turned into a Norton equivalent very easily and vice-versa.

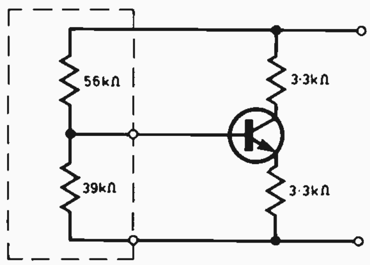


Fig. 10(a). Typical biasing stage

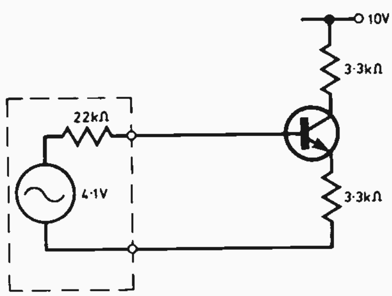
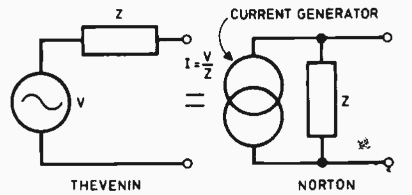


Fig. 10(b). Thevenin equivalent

As an example, suppose we have a transistor connected as a common emitter amplifier with an output impedance of 20kΩ and a signal current of 0·5mA. We then have two possible equivalent circuits, Figs. 12(a) and 12(b), often one will be more useful than the other for a particular calculation.

MAXIMUM POWER TRANSFER THEOREM

Another theorem relating to the loading of sources deals with the way to extract the maximum power from any given one. Good engineering design requires loading a source with a resistance that will permit



THEVENIN AND NORTON CIRCUITS ARE INTERCHANGEABLE

Fig. 11. Equivalent voltage and current generators

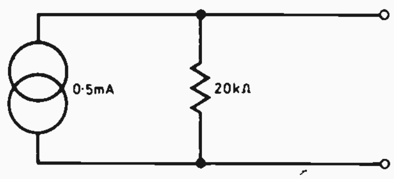


Fig 12(a). Norton equivalent of common emitter amplifier

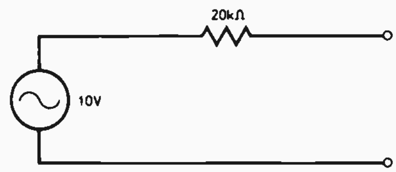


Fig. 12(b). Thevenin equivalent of same

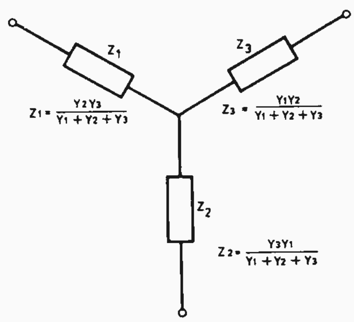


Fig. 13. Star network with delta to star conversion formula

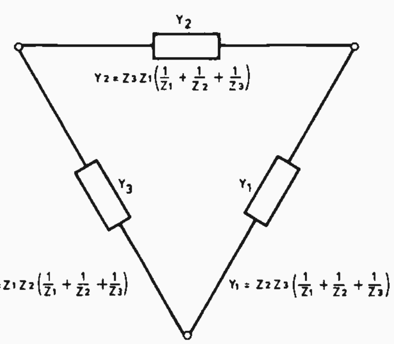
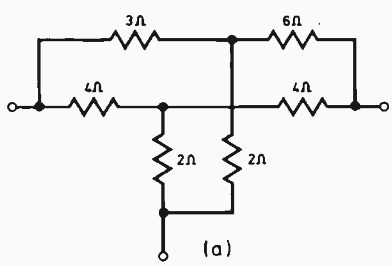


Fig. 14. Delta network with star to delta conversion formula



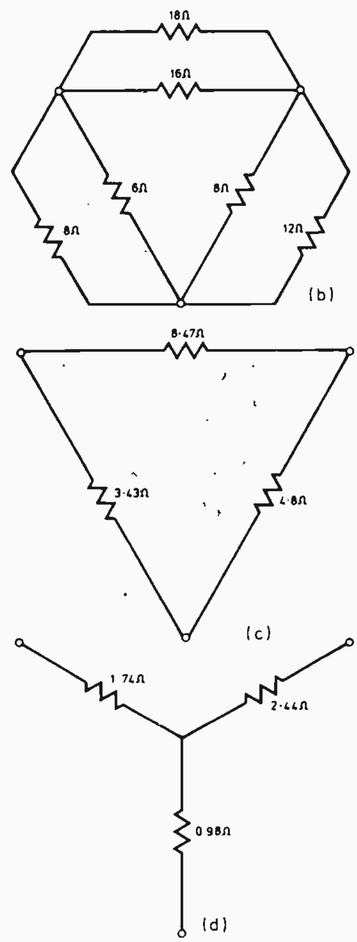


Fig. 15(a-d). All of these circuits are equivalent

maximum power transfer. Let us first take the purely resistive case, where we put a load R2 across a source with open-circuit voltage V and internal resistance R1. The power dissipated in R2 changes as R2 is varied—it reaches a maximum when R1 = R2.

The general case of this is when we have a complex internal impedance and a complex load impedance is $R+X_i$, the maximum power is dissipated into the load when the load impedance is $R-X_i$

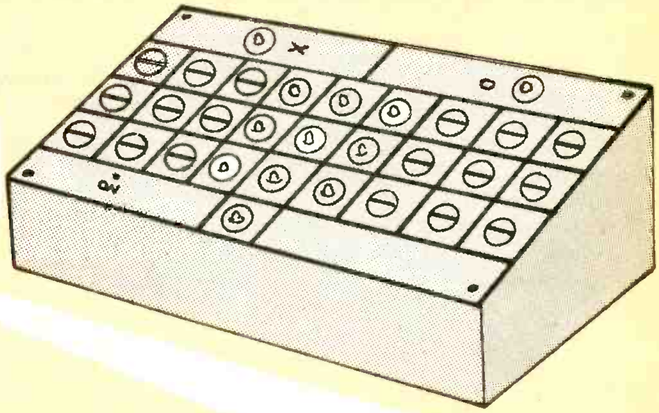
STAR-DELTA TRANSFORM

The last of this selection of useful impedance theorems for this article states that the networks shown in Figs. 13 and 14 are interchangeable, if the component values are changed according to the formulae shown with each circuit.

Using the circuit in Fig. 15(a) as an example of the use of these formulae for simplification of networks, first we transform each of the "stars" in Fig. 15(a) to a delta in Fig. 15(b). Note that we can reduce the two "deltas" to one delta since there are now three pairs of parallel resistors—this was not the case with the two "stars". We now have a single delta, Fig. 15(c), from which we can return to a single star form if we wish as in Fig. 15(d).

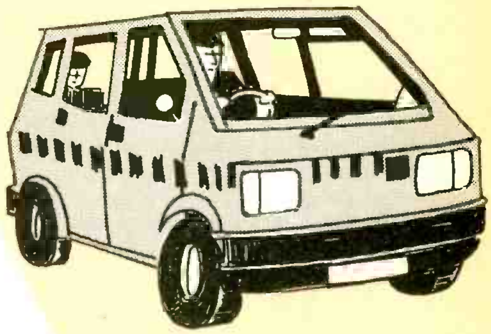
NEXT MONTH

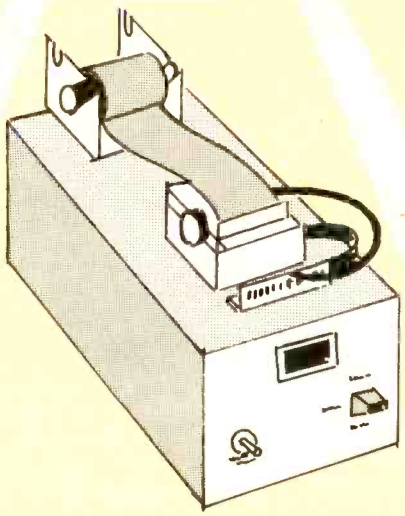
Electronic NOUGHTS and CROSSES



Electric VEHICLES

Why is it taking so long for electric traction to take over from the conventional internal combustion engine (i.c.e.) powered vehicle? A look at what's going on in the UK has revealed some interesting facts.



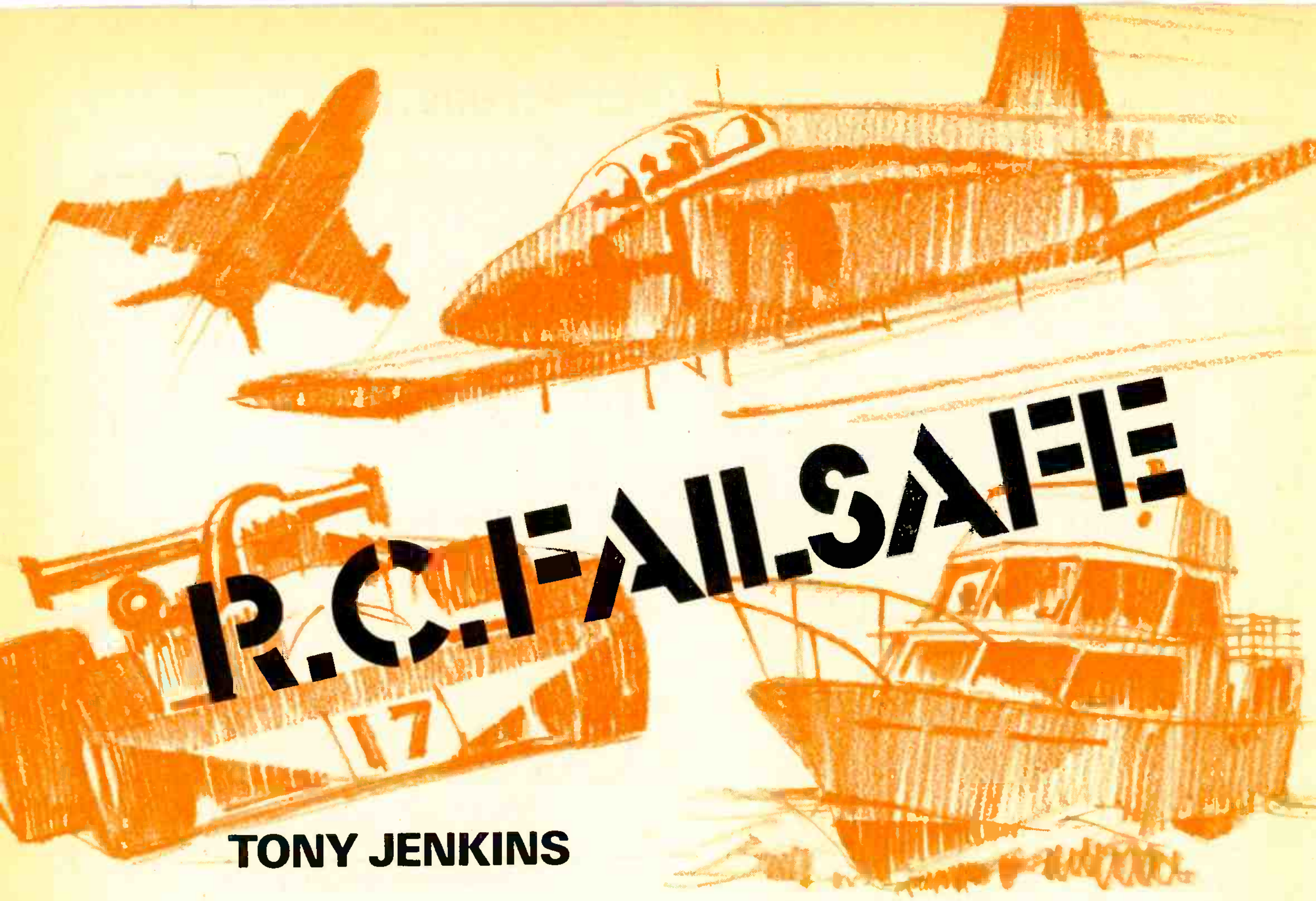


This issue sees the completion of the P.E. V.D.U. and next month we bring you another first in the microcomputer field; the first d.i.y. printer. Suitable for most systems the P.E. Microprinter slashes the cost of this invaluable peripheral.

PE MICROPRINTER

PRACTICAL
ELECTRONICS

OUR JANUARY ISSUE WILL BE ON SALE FRIDAY, 12 JANUARY 1979



R.C. FAILSAFE

TONY JENKINS

If your radio controlled model out-ranges the transmitter, pre-program it to avoid a crash, with this simple circuit

MODERN digital radio control equipment is normally very reliable, but there is always a danger of loss of signal, due to faulty transmitter, dead transmitter battery, or the model even going out of range.

The normal result of this is total loss of control, and probable loss of the model as well!

The unit to be described can eliminate this problem, because when it is connected in line with a servo, if the signal is lost, after a short time (approx. half a second) the unit feeds a signal to the servo, which causes it to take up a preset position (which can be adjusted throughout the servo's normal range of movement), where it will remain until signal is regained, when control will revert to the transmitter as normal.

A typical installation may require two to four units, normally one for each servo in use, set so that if signal is lost, a model aircraft for example, may go into a shallow dive, circling slowly, with engine at idle.

It is also possible to use them on a glider, so the transmitter may be switched off, and the model left circling, thereby conserving battery life, as receiver consumption is minimal with no servo movement.

CIRCUIT DESCRIPTION

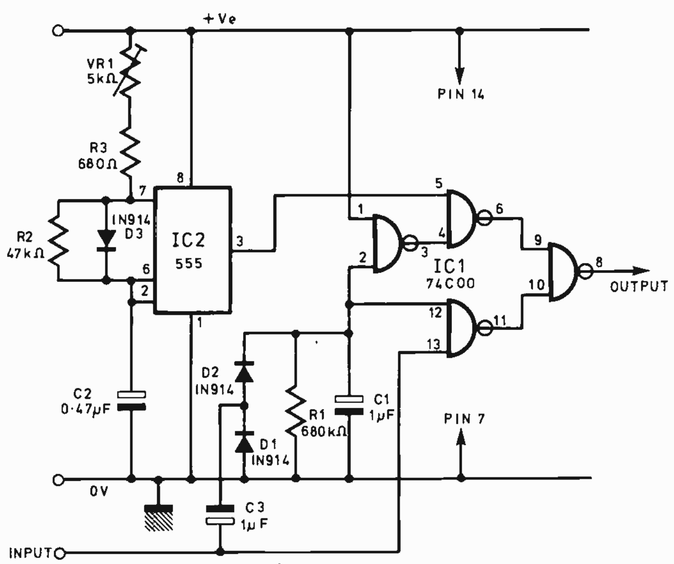
Referring to Fig. 1, IC1 is a CMOS quad 2 input NAND gate connected to function as a data selector. When pins 2 and 12 are "high" the pulses on pin 13 appear at the output, pin 8. When pins 2 and 12 are "low", pulses from the 555 oscillator (connected to pin 5 of IC1), are fed to pin 8.

Control of pins 2 and 12 is via the rectifier circuit consisting of C3, D1, D2, R1, and C1. When there is a signal from the receiver coming into pin 13 on IC1 (and also C3), the voltage on the positive end of C1 will be around 4·5 volts, well above the threshold of the CMOS logic i.c., so the pulses from the receiver will be fed through to pin 8, and from there to the servo.

When the signal is lost, there will be a d.c. level on the input to the unit, no signal will pass through C3, capacitor C1 (1µF) will discharge via R1 (680kΩ), and the voltage on C1 will fall below the switching threshold of IC1, and so approximately half a second after loss of signal, control of the servo will be transferred to IC2. When the signal is recovered, C1 will again charge, and control of the servo will be transferred back to the receiver.

The oscillator formed by IC2 is slightly unusual, in that instead of the usual near square wave output, the output consists of short 1–2ms (variable by VR1) positive pulses, with a gap of approximately 20ms between, thus simulating the output of the receiver decoder.

The operation of the oscillator is as follows: C2 charges via VR1, R3, and D3, until the voltage across it equals two thirds of the supply voltage, at which point pins 3 and 7 of the i.c. go "low", as the internal comparator (I/P at pin 6) switches. C2 then discharges at a much slower rate, via R2 (D3 now being reversed biased) until the voltage on it is reduced to one third of the supply voltage, when the other comparator (I/P at pin 6) in IC2 switches, pin 7 is then effectively open circuit, pin 3 goes "high", and the cycle commences again.



COMPONENTS . . .

Resistors
R1 680kΩ
R2 47kΩ
R3 680Ω
All $\frac{1}{8}$ watt 5%

Potentiometers
VR1 5kΩ Sub min hor'preset (4·7kΩ will do)

Capacitors
C1, C3 1μF Tantalum bead (2 off)
C2 0·47μF Tantalum bead

Integrated Circuits
IC1 74C00
IC2 LM/NE 555

Diodes
D1, D2, D3 1N914/1N4148

Miscellaneous
Printed circuit board (available from W.K.F. Electronics. Worksop 720695)
Servo extension lead—to suit equipment in use.

Fig. 1. (left). Circuit diagram of Failsafe

CONSTRUCTION

This unit is *only suitable for positive pulse systems,* which the majority of modern R.C. equipments use.

Construction is fairly straightforward, if normal care is taken. Figs. 2 and 3 show the p.c.b. layout.

Insert and solder all components (taking care to observe correct polarity, etc.), leaving IC1 to the last. This is a CMOS device, and may be damaged by careless handling, unless precautions are taken.

A servo extension lead to suit the equipment is required. To connect the unit, the positive and negative wires in the extension lead should be cut, a short length of insulation should be removed, both positive leads connected to the positive pad on the board, and both negative leads to the negative pad. Now trace the control lead from the receiver (in three wire systems the remaining wire), normally if the receiver connecting block is checked, it will be the only wire not common to all servos.

This should be cut and the insulation removed from the ends. The end that will connect to the receiver should be connected to the "in" pad on the unit, and the other end to the "out" pad. The unit is now ready for testing.

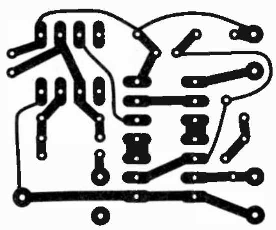


Fig. 2. Printed circuit layout (actual size)

TESTING

Set the preset to mid travel, connect up the R.C. equipment with the unit in line, with the servo. Switch on the transmitter, then the receiver, and check that control is as normal. Switch off the transmitter, the servo should jerk towards one end of its travel, as normal. After a short delay, the servo should move back towards the centre of its travel, and the position may now be varied by means of the preset.

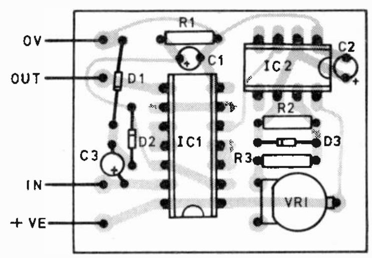


Fig. 3. Component layout

WARNING

To cope with the different pulse lengths used by different manufacturers, the pulse range available from the unit is wider than required by most servos. Do not exceed the servos normal range of movement, as it is possible (although most types will withstand a certain amount of mistreatment), that damage may occur. *Adjust the preset slowly.*

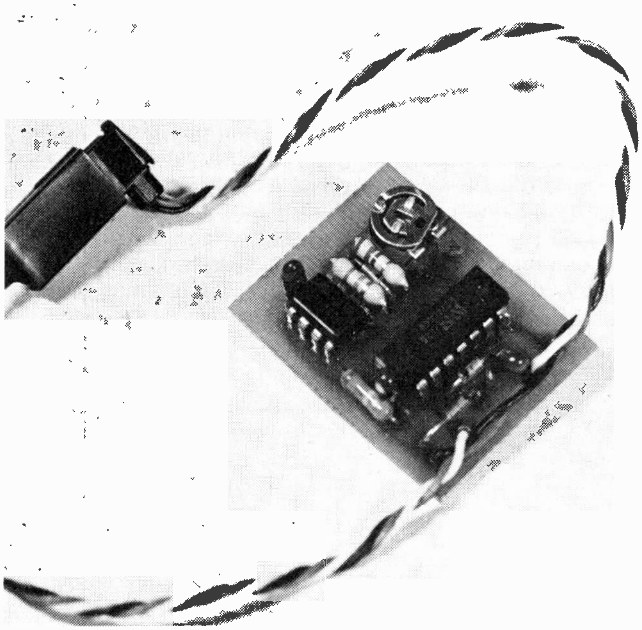
INSTALLATION

If all is well, the unit(s) may now be installed in the model. This is simply a matter of sticking them in a suitable position with "servo-tape", and adjusting them for a suitable trajectory with no signal.

If the unit does not work in one mode, but is okay in the other, check the area around the rectifier (C3, D1, D2, R1 C1). If the unit does not work at all, carefully inspect the board for solder bridges or wrongly placed components.

If nothing is visibly wrong, temporarily transfer the lead from the output to pin 3 of IC2, if control by the preset is now possible, it is probable that IC1 is faulty. If still no output, it is probably IC2 (or associated components).

The unit may also be built as a servo tester, in which case only R2, R3, C2, D3, IC2, and VR1 are then required. VR1 should now be a calibrated potentiometer, and the output is taken from IC2 pin 3. It can be built into a suitable box with 6V battery and on/off switch, and a socket for the servo. ★



One R.C. Failsafe board. As many can be used as required to preset the various servos

R.C. MOTOR CONTROL

P.A. DAKIN

Transistor proportional control with no junction losses at full power

MOST motor controls for R.C. systems use a servo to operate switches and resistors or wipers on a resistance board, etc. This causes heat, reduces the torque available from the motor and is susceptible to dirt and wear.

This circuit will overcome these problems and unlike most solid state controllers will have *full power* output, as well as proportional control forwards and reverse.

It is suitable for cars and boats, and with modifications can be used in aircraft. The receiver must give a positive pulse output of 1 to 2ms every 20ms.

CIRCUIT DESCRIPTION

The full circuit diagram is shown in Fig. 1. The controller uses two 3140 operational amplifiers connected in the voltage comparitor mode, one inverting and the other non-inverting. The positive incoming pulses from the decoder produce a ramping voltage across R2 C1 which is used to trigger the i.c.s. VR1 and VR2 are adjusted so that a 1·5ms pulse is "neutral" (sticks centre) and no voltage appears at point A.

As the pulse lengthens to 2ms (full forward) IC1 produces an output of varying duty cycle between 0–100 per cent which turns on TR4, and supplies drive current to the Darlington output pair TR5 and TR6. Transistor TR6 has an inherent volt drop of approximately 0·65V. Therefore to supply full voltage to the motor, VR4 is adjusted so that at maximum voltage at point A, relay RLB operates and short-circuits TR5 and TR6.

As the decoder pulses shorten to 1ms (full reverse) IC2 will produce an output of varying duty cycle. When an output appears at point B relay RLA is operated reversing the motor connections. The motor drive is exactly as before except in the opposite direction. Again RLB operates at full reverse to give maximum power.

TR3, R9 and D7 form a simple series regulator to supply a constant voltage to the relays. This is essential since the motor battery volts may vary by up to ±16 per cent of nominal voltage, which would affect the relays, pull-in point.

Diodes D2 and D3 prevent the i.c. with a low output, sinking the output of the other i.c. when it is high. D5 and D6 are protection diodes across the relay coils to prevent high voltage transients affecting the circuit.

Capacitors C2 and C3 prevent relay chatter. C4 is motor suppression. D9 and D10 give visual indication of output from the i.c. These may be left as permanent fixtures or temporarily wired for setting up only.

It should be stated at this point that the relay contacts are rated at 5A. It has been found that the contacts will handle up to 15A when not *switching* at these high currents. RLA operates when little or no current is flowing, and RLB provides a low resistance path across TR5 and TR6. If a single-pole-make is not available a d.p.d.t. may be used, and the contacts paralleled up to handle up to 10 amps. Although the 3140 is specified, several units have successfully been built using the standard 741, and it must be emphasised that the minimum specified voltage for this i.c. is ±3V (6V supply). However, with careful selection some can be found to work well with a single 4V supply.

COMPONENTS

Resistors

R1	10kΩ
R2	180kΩ
R3, R4	2·2kΩ (2 off)
R5, R6	150Ω (2 off)
R7–R9	1kΩ (3 off)
R10	10kΩ
R11	(See Table 1)
R12	1kΩ
R13	27kΩ*

All ¼W 5% except where stated. * required for smooth changeover if 3140 op-amps are used

Potentiometers

VR1–VR4 10kΩ min cermet.

Capacitors

C1	1μF
C2	47μF
C3	100μF
C4	1μF non polarised

All tantalum bead types (12V minimum) except where stated

Integrated Circuits

IC1, IC2 3140 or 741 (2 off)

Diodes

D1–D6	1N4148 or similar (6 off)
D7	(See Table 1)
D8	1N4148
D9, D10	Any 20mA l.e.d. red and green (1 off each)
D11, D12	BZX61 (2 off)

Transistors

TR1–TR4	BC182L or BC184L (TR3 – BD131 if relay currents exceed 100mA each)
TR5	BD131 or TIP31A
TR6	2N3055 or TIP3055

Miscellaneous

Stripboard or p.c.b. (approx 35 x 75mm)
Metal box 63 x 76 x 25mm approx.
6BA or M3 nuts and screws as required
Solder tags, heatsink compound, plug to suit receiver
Wire suitable for 10A minimum
2 relays p.c.b. mounting 5A contacts d.p.d.t.
100mA operating current max. (RS 349-642)

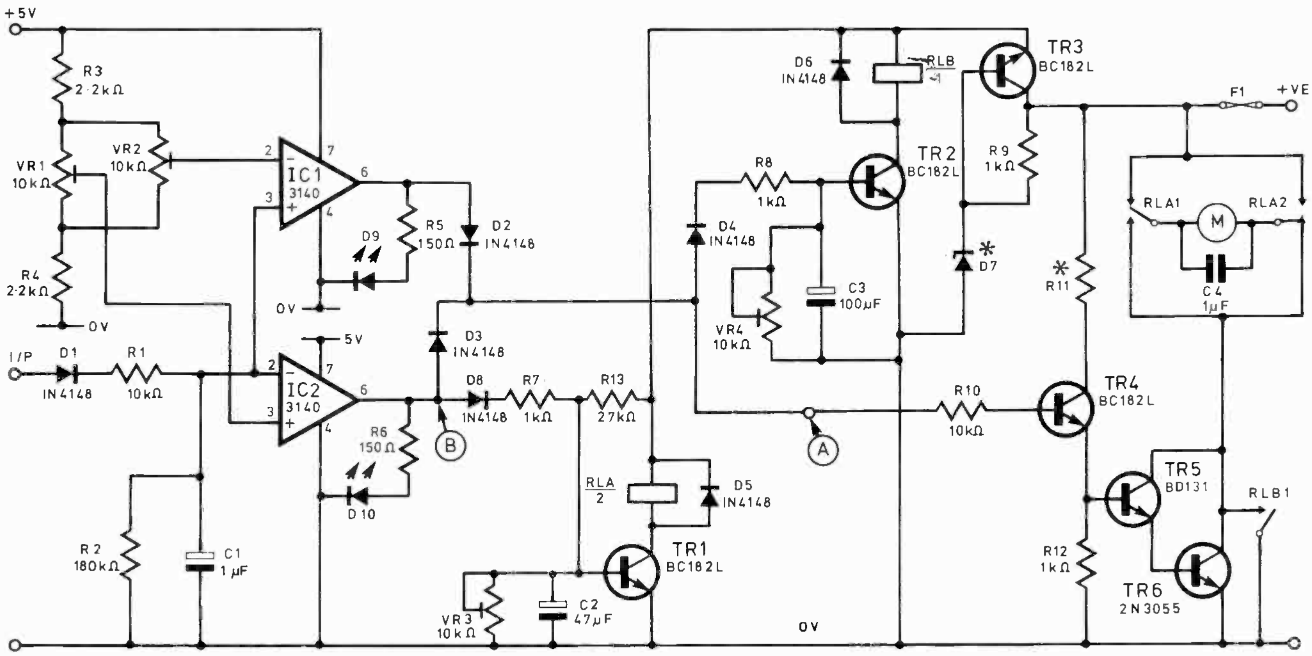


Fig. 1. Circuit diagram

CIRCUIT CONSTRUCTION

For use in aircraft, only part of the circuit need be constructed. Omit IC2, D3, D8, D5, D7, TR3–TR6, R5, R7, R8–R10, R13, VR3, C2, and RLA. This will give an "all or nothing" control which is all that is required for electric flight.

The circuit can be constructed on a p.c.b. (or stripboard), of approximate dimensions 35 × 75mm (smaller for aircraft). See Figs. 2 and 3.

Resistor R11 and diode D7 must be chosen to suit motor supply voltage. See Table 1. Pay particular attention to polarites of diodes, capacitors, and pin connection of i.c.s and transistors. TR5 and TR6 must be mounted on the case which acts as a heatsink. If 12–15V supplies are used, and the motor is drawing more than about 8A, an extra heatsink may need to be added to the top of the case. For the lower power controller (6–9V supplies), RS type Extra Flex may be used for the heavy current wires. If the average current consumption is greater than 8A a higher rated wire should be used. See Fig. 4 for relay wiring.

SETTING UP PROCEDURE

First check again the position, value and pin connections of all components. Having done this, connect the unit to the receiver only, ignore centre taps on 4-wire systems. Switch on transmitter and receiver with transmitter throttle control in the centre (neutral position) and the l.e.d.s may glow. Adjust VR1 and VR2 until both l.e.d.s are just extinguished (The l.e.d.s may have to be shaded so that an accurate setting can be made.) Slowly move the stick to the forward position; D9 should gently glow and increase to full brightness. The same should happen to D10 when the stick is moved in the reverse direction. This has set the neutral position. Leave the transmitter controls in Neutral. Connect the motor supply but not the motor. It would be advisable to substitute a low value fuse of about 0·5A or 1A for F1, to protect TR5 and TR6 against shorts whilst setting up. Set VR3 to its earth end, and VR4 to its "base" end. Neither relay should be energised. Gently give *reverse* until D10 just starts to glow, and adjust VR3 to pull in relay RLA. Return sticks to neutral and relay RLA should drop out. If not, readjust VR3. Now move sticks to full forward position and adjust VR4 to operate Relay RLB. Return sticks to neutral and check that no l.e.d.s glow and no relays are energised.

Table 1.

Nominal Motor Voltage	R11 Value & Rating		D7 Voltage
6	33Ω	2W	5·6
9	47Ω	2W	6·2
12	62Ω	2·5W	6·8
15	75Ω	3·0W	6·8 or 12V if 12V relays are used

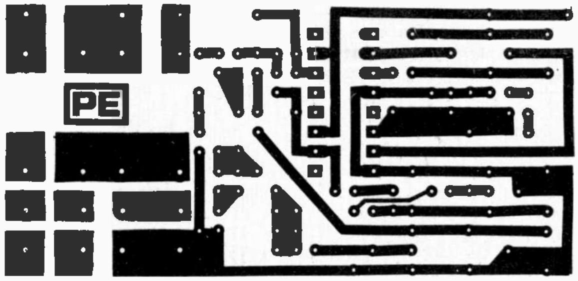


Fig. 2. Printed circuit layout shown at full size

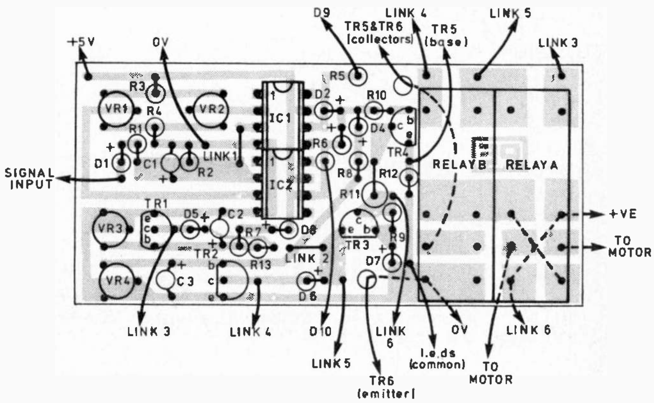


Fig. 3(a). Component layout. IC1 and IC2 may be plugged into a single d.i.l. socket

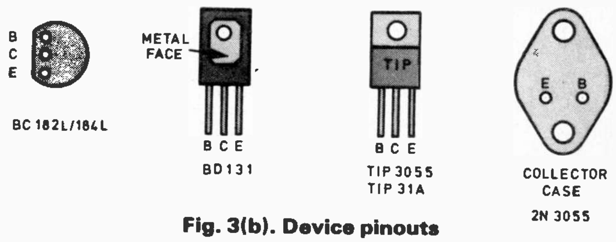


Fig. 3(b). Device pinouts

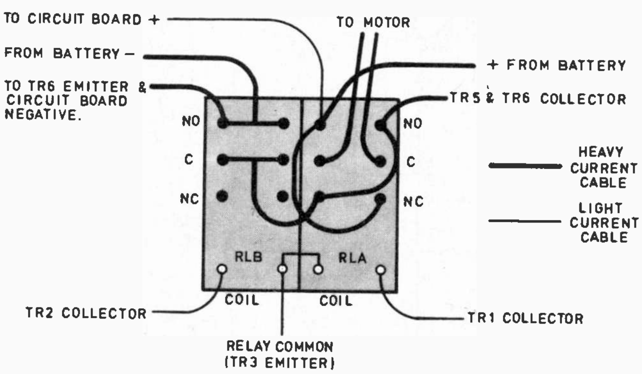


Fig. 4. Relay wiring arrangement for the standard configuration of two-pole change-over type relays.

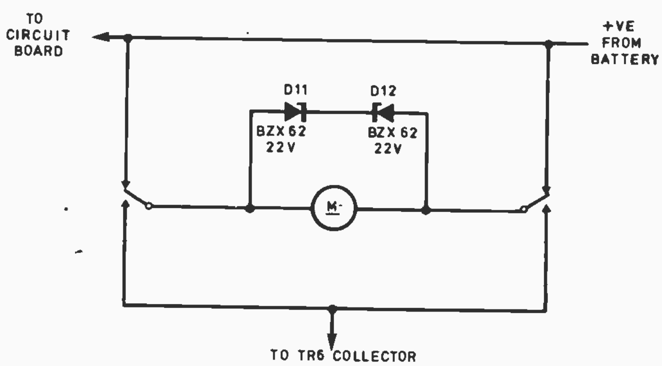
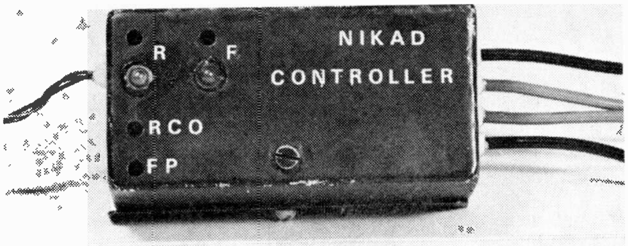
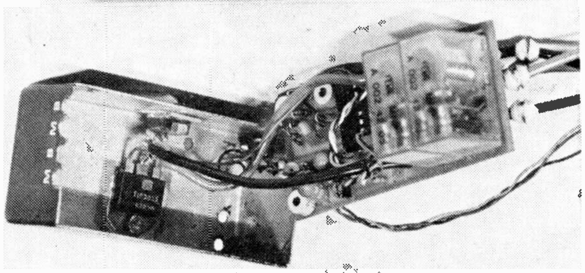
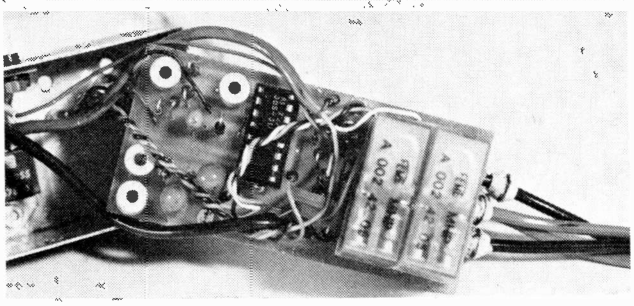


Fig. 5. Clamping diode circuit to suppress motor interference.







Increase to full reverse and again check that RLB operates. If not, adjust VR4 slightly until it operates at full forward and reverse.

When all is satisfactory remove the low value fuse and connect the controller output to the motor and check for full proportional control in both directions. If the motor is run with no load, the full effect of the controller will not be seen, since the motor will run up to full revs at approximately half throttle. Having set up the controller and fitted it in its box the unit can now be mounted in the model.

FURTHER NOTES AND SUGGESTIONS

For relays that require a pull-in current greater than 100mA, TR3 should be a BD131 or TIP31A. This may be soldered directly into the board and will handle approximately 500mA without a heatsink. R11 is a high wattage type because when a TIP 3055 and TIP 31A are used for the Darlington output pair, should both have low gain, 200mA or so will flow as base current in TR5. This current is limited by R11. However if TR5 and TR6 are fairly high gain, the wattage may be reduced to 0·5W.

Fig. 3(b) shows semiconductor connections for specified types. If interference is suspected from the motor, try earthing one side of the motor connections to its case *but ensure the batteries are left floating* or damage to the control unit may occur.

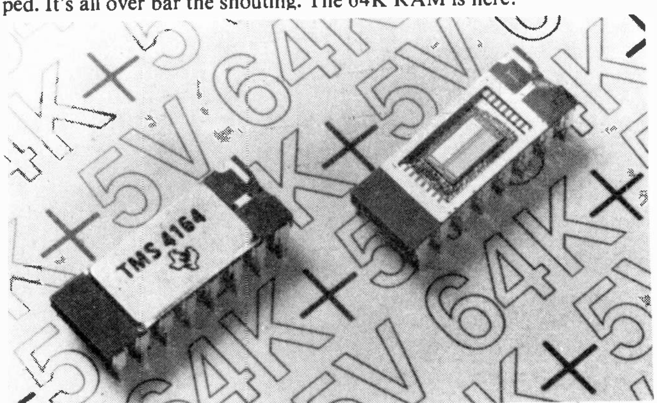
If motor interference still persists, remove C4 and add clamping diodes as shown in Fig. 5. These are BZX61 22V. These should limit any r.f. spikes to approximately 22V. ★

News Briefs

by Mike Abbott

HEY! 64K!

ANYONE who read October's Industry Notebook might puzzle over the plan being debated whereby a mass production unit would be created using government money, to produce a 64K RAMin the UK. There was a time when one would have heralded an attempt at a single supply 64K RAM with a blast of trumpets, but the drum roll has stopped. It's all over bar the shouting. The 64K RAM is here!



Sample quantities of a new dynamic RAM became available in the fourth quarter of 1978, from Texas Instruments. Volume production is scheduled for the first quarter of 1979.

Organised as 64K × 1, the TMS 4164 was expected to be the first available 5V 64K dynamic RAM on the market. It comes in a 16-pin, 300-mil standard dual-in-line package, complying with Jedec standardized pin-out requirements and allowing upward compatibility with the 16K Dynamic RAM.

The TMS 4164 single 5V power supply design is TTL compatible, offers considerably lower power dissipation and is more immune to system noise. Five-volt operation also reduces the effective electric field across gate oxide offering higher system reliability. In addition, a compact layout and optimized design/process combination for 5V-only operation results in improved performance.

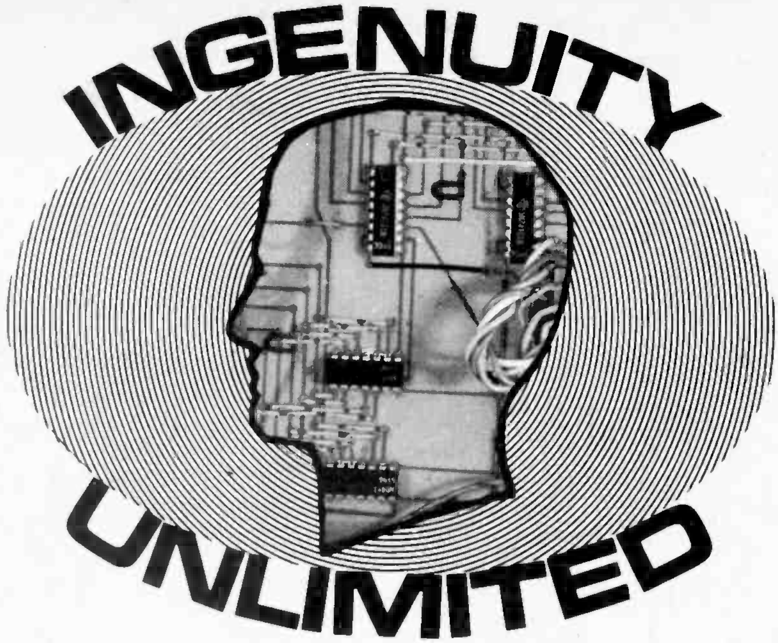
Access times range from 100 to 150 nanoseconds maximum, with minimum cycle times of 200 to 250 ns. Power dissipation is 200 mW maximum or three µW maximum per bit. Comparing the 462 mW power dissipation of the 16K RAM at 375 ns cycle time, total maximum power dissipation of the new 64K RAM is reduced by 60 per cent with improved cycle times while bit density is quadrupled. This advancement allows practically an order of magnitude power per bit improvement.

The TMS 4164 features a 256 cycle refresh with a 4 ms maximum refresh period, as a result of the lower power dissipation. This refresh period is a 100 per cent improvement over the 2-ms refresh period of current 4K and 16K RAMs. The small chip size of 34,000 square mils is a significant contributing factor to lower production costs and improved reliability.

Due to TMS 4164 refresh compatibility with the 16K RAM, the basic refresh controller timing does not require major changes. The only provision required is for an 8-bit refresh counter/multiplexer when upgrading to 64K from a 16K system. Also contributing to higher system operating efficiency is a 1·3 to 1·6 per cent refresh overhead time, compared to 2·4 per cent on the 16K RAM.

Two clocks, RAS/ROW address select and CAS column address select control the gating of the 8-bit addresses so that timing characteristics are essentially identical to the TMS 4116 16K RAM. Row address set-up time is zero nanoseconds; hold time, 15ns. Column address set-up is 5ns and RAS/CAS spacing is 15 and 50ns. This allows the system designer a full 35ns interval to change addresses and bring CAS low, without extending access time beyond 150ns.

More details from Texas Instruments Ltd., Memory Products Group, Manton Lane, Bedford, MK41 7PA.



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

BINARY TO 7-SEGMENT DECODER

WITH the addition of just two i.c.s a 7447 BCD to 7-segment decoder can be made to decode any four bit binary number to display zero to fifteen on a one and a half or two digit common anode 7-segment display.

Gates IC1a–c detect any binary number with a decimal value greater than nine with the output of IC1c going high. IC2a inverts this output so that its output goes low turning on segments b and c of the ten digits.

From Table 1 it can be seen that for numbers with a decimal value greater than nine inputs B and D must be inverted and input C must be inverted when input B is low. These functions are carried out by IC1d and IC2a–c.

The circuit was devised to give an easily read indication of the binary address on a 7489 RAM but can be used in any application where a four bit binary number has to be monitored.

W. McIvor,
Accrington,
Lancs.

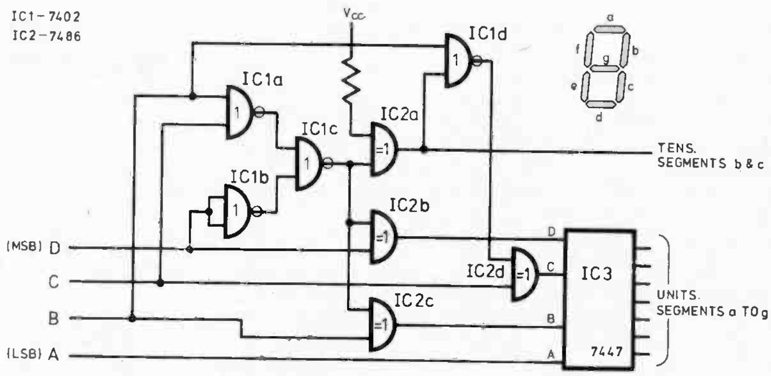
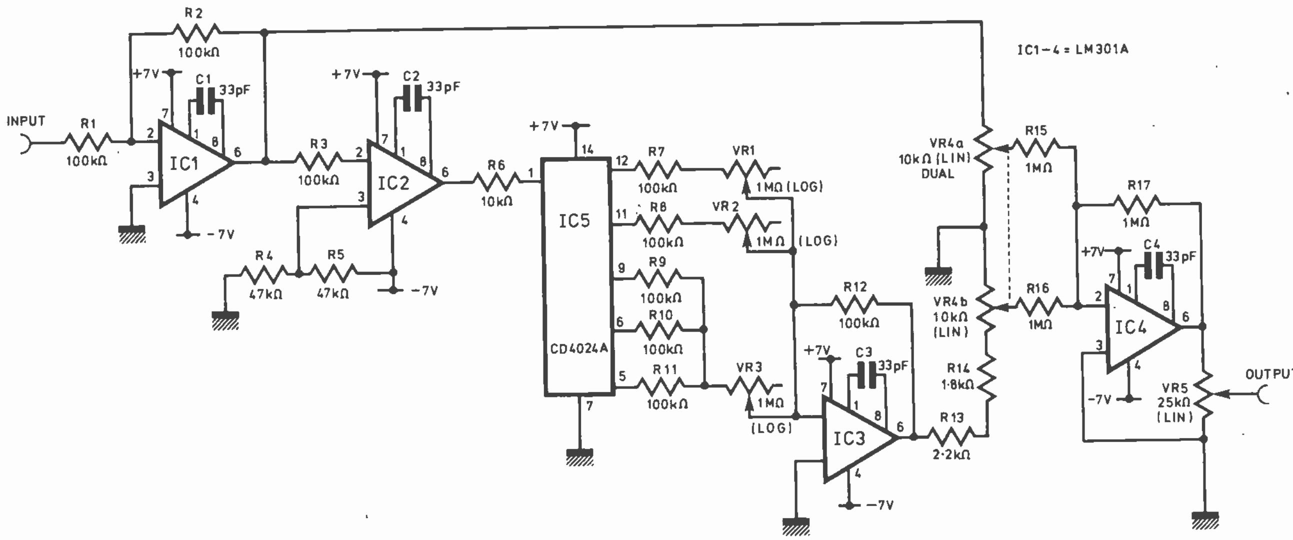


Table 1

Decimal	Binary D C B A	Input to 7447 D C B A
10	1 0 1 0	0 0 0 0
11	1 0 1 1	0 0 0 1
12	1 1 0 0	0 0 1 0
13	1 1 0 1	0 0 1 1
14	1 1 1 0	0 1 0 0
15	1 1 1 1	0 1 0 1

SUB-OCTAVE GENERATOR



SHOWN is a circuit for a sub-octave generator, developed for use with a synthesiser. It functions as follows.

IC1 is an inverting unity gain buffer which drives the comparator IC2. The trigger level of this comparator is set for convenience at half the negative supply level (it could, of course, be set at almost any other negative value if desired). The output from this ic then feeds the clock input of a CMOS CD4024 binary divider. Only five of the seven outputs are used in this version although the others could be added quite easily.

Each output from 12 down is an octave below the other and these divided versions of the original frequency input are then fed through individual level controlling pots (VR1–3) to the buffer IC3. The ratio of "original" to "treated" sound is varied with the dual pot VR4, the original content being siphoned off from the output of IC1. The signals are then mixed into IC4 and fed via the level control VR5 to the output.

Although the supply lines quoted are ±7V there is no reason why ±9V should not suffice. Since the maximum level of input signal must exceed the comparator threshold without going higher than about 75 per cent of the positive line, some adjustment of input signal level might then become necessary. In its present use the unit is used with a 5V signal level.

P. L. Watson,
Bromham,
Bedford.

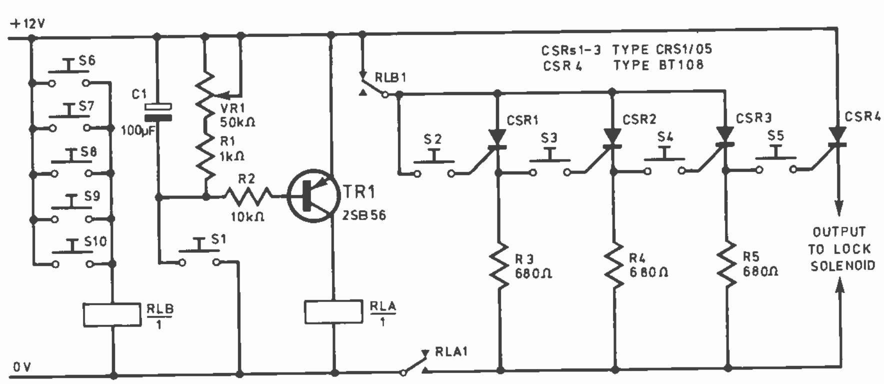
COMBINATION LOCK

SHOWN is an electronic combination lock. It uses four thyristors that latch on when the correct push-buttons are operated. TR1 and associated circuitry form a timer circuit that closes RLA1 for a pre-set period of time; about 5–7 seconds. This means that anyone who is uncertain of the combination, even if he is lucky enough to find S1, would not have enough time to find the rest. S6–S10 are connected so if depressed during or at the end of a combination, any number sequence already set up, would be destroyed. In the same way the timer destroys a sequence at the thyristors, when the time runs out, by releasing the thyristor current.

Any 9–12 volt relays will do to switch the thyristors, but to be on the safe side, the solenoid or lock must not draw more than 1–2 amps.

The combination can be changed by moving the position of the switches and it will be found that it is almost impossible to operate the solenoid unless the combination is known.

A. J. Bexley,
Woking,
Surrey.



ONE ARM BANDIT MOD

HAVING built the one-armed bandit featured in *Practical Electronics* May 1977, the author was very pleased with its performance except for the operation of the "Hold" switches. In the original design these were s.p.d.t. switches which had to be made to obtain a hold and cancelled after operating the handle, otherwise one was left with a hold on the next operation. In the heat of a hectic battle against five children, it was quite easy to forget to cancel the "Hold" switch which would lead to considerable argument as to whether one would have scored a win if one had remembered to cancel the hold!

For the sake of peace and quiet it was therefore decided to modify the circuit to:

(a) replace the switches with push-buttons (to give a more realistic effect)

(b) to give a HOLD SELECTED indication, and

(c) to incorporate circuitry that would automatically cancel any selected hold after each operation.

The circuit is shown in block form in Fig. 1. ICs 1, 2 and 3 are components from the original circuit. Normally the Q outputs from the latches are high thereby enabling the displays. When a hold becomes available, pin 8 of IC1 goes low. When a hold button is pressed (S2, 3 or 4), the Q output of the latch will go low disabling the display. The $\bar{Q}$ outputs of the latches are wired to the decimal points of the displays to indicate a hold has been selected.

The start handle is now operated causing the output of IC2 to go high for approximately 5 seconds. At the end of this time IC2 output goes low and the negative going transition will trigger the latch reset one shot.

This will give a negative pulse which will reset the latches ready for the next operation.

An optional extra is the "Cancel Hold" switch which allows one to cancel a selected hold if one should so desire. This is simply an RC circuit which gives a negative-going pulse to the latch reset one-shot when the button is pressed. The diode prevents the RC circuit from incrementing the hold available counter IC1.

As in the block diagram, ICs 1, 2 and 3 are from the original circuit whilst ICs 20, 21 and 22 form the new circuitry together with R37–41, C7, C8 and D5.

Each latch is constructed from two cross coupled NAND gates, the latch reset and one-shot from two more NAND gates and three NAND gates are used as inverters for driving the decimal points in the displays.

K. Longley,
Heywood,
Lancs.

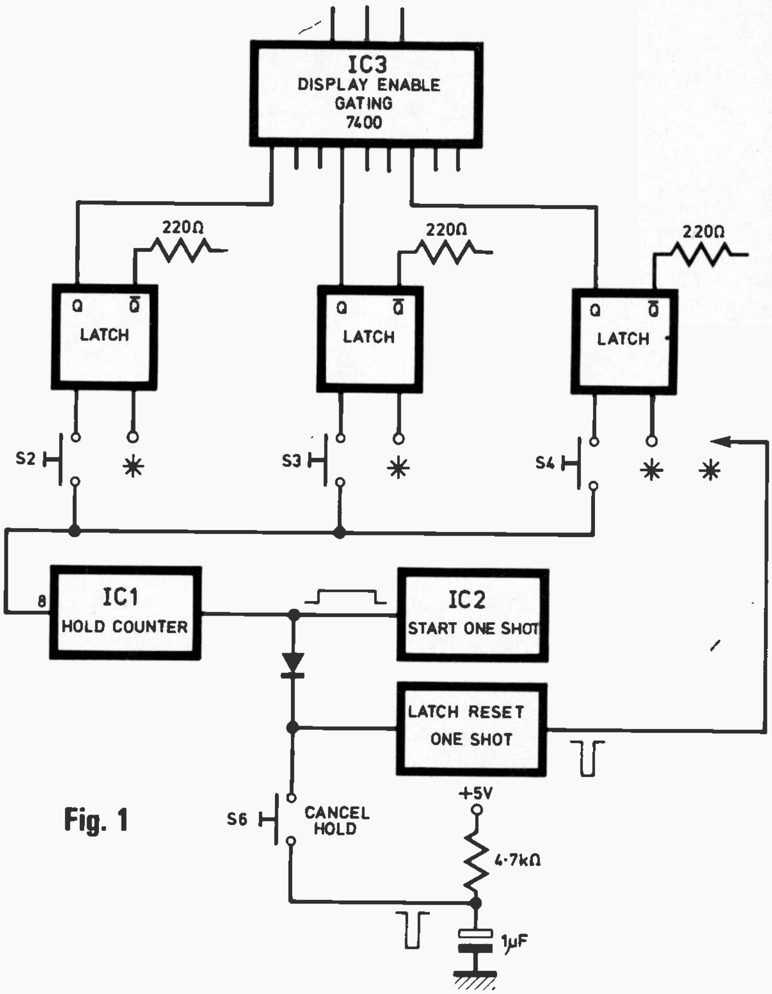


Fig. 1

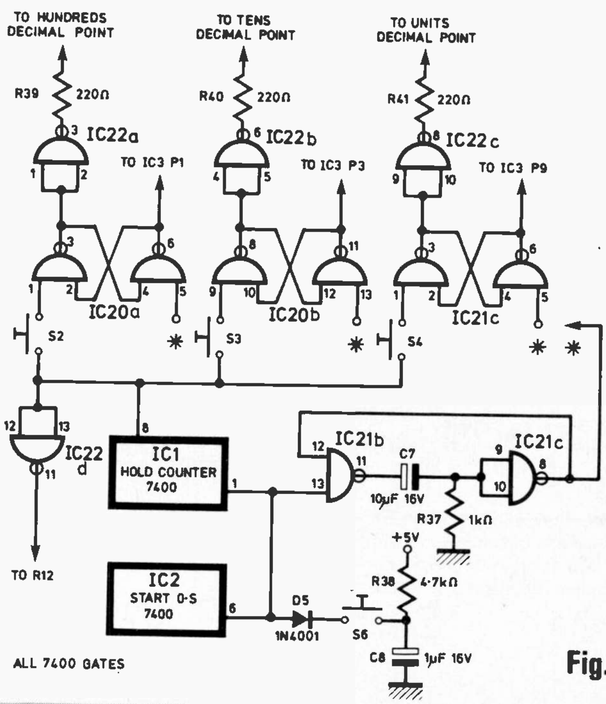


Fig. 2

COINCIDENCE/ERROR DETECTOR

This circuit will detect whether two inputs occur simultaneously or one before the other. It is basically a modified half-adder. With no inputs applied, the output from IC1a is at zero, disabling all output gates. The outputs from inverters IC3c and IC3d set the inputs of IC1b and IC1c ready to accept signals.

If A and B are set to 1 simultaneously no change will occur on the output of IC4a. As this is high and the output of IC1a is high, Q_2 is enabled. IC2a, 1d, 3a, 3d and 4a make up an EXCLUSIVE OR which performs the "no-change" function.

Suppose A occurs before B. The outputs of IC1b and IC2a go high. The output of IC3c goes low, disabling IC1c. When the B input occurs, this is prevented from entering into the EXCLUSIVE OR and the state of A and "not B" only is recognised. IC2b combines this information with the output of IC1b and gives the "A before B" condition at Q_1. If B occurs before A, this time IC1b is disabled, and the "B before A" condition is decoded as above.

P. Landau,
Southend-on-Sea,
Essex.

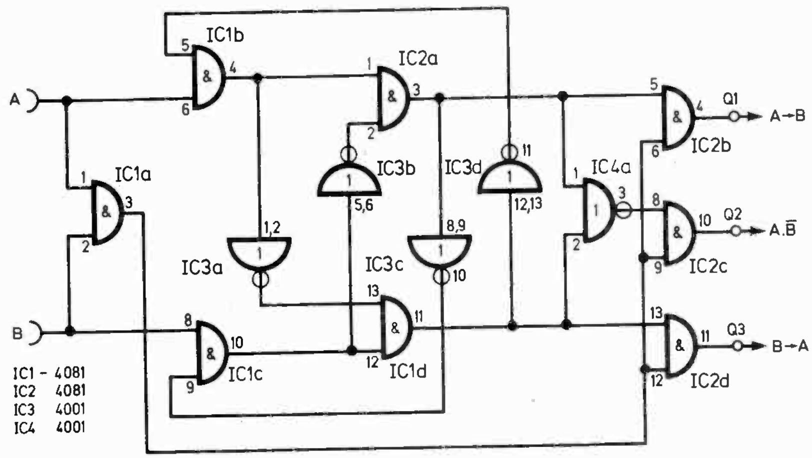
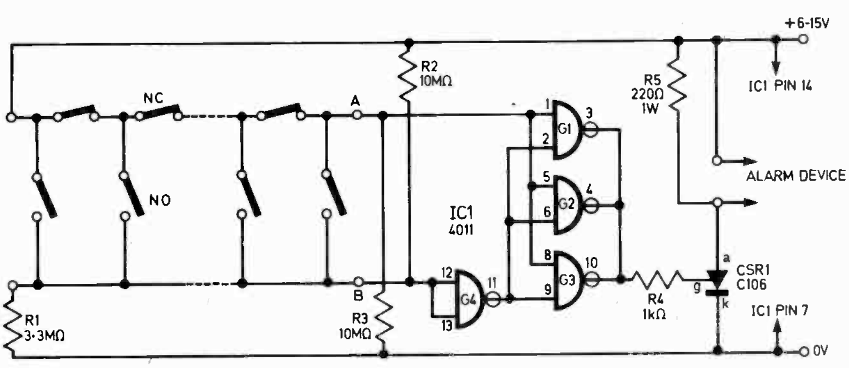


Table 1

t_n		t_n+1		Q_1	Q_2	Q_3	
A	B	A	B				
0	0	0	0	0	0	0	No output
0	1	1	1	0	0	1	B operated before A
1	0	1	1	1	0	0	A operated before B
1	1	1	1	0	1	0	A & B operated simultaneously

CMOS BURGLAR ALARM



This circuit features high sensitivity with an extremely low current consumption—under 3μA at 12V. The circuit is so sensitive that a finger placed on each guard line will set the alarm off.

Normally, both of the inputs to gates G1/2/3 are high, so the output is low. If, however, either of these inputs go low (by breaking line A or shorting lines A and B together), the outputs of gates G1/2/3 will go high and trigger the thyristor. The gates G1/2/3 are in parallel to provide ample gate current for the thyristor. This should be a sensitive type such as the C106.

Any battery voltage from 6V to 15V can be used, to suit the alarm device. The sensitivity of the circuit can be increased by increasing resistors R1, R2 and R3.

R. C. Hoare,
Leeds.

Semiconductor UPDATE...

FEATURING: SN76477N SH1705 H11F1, 2, 3

R.W. Coles

NOISES OFF?

Electronic games and novelties are always popular, and thanks to advances in Large Scale Integration, they are now reaching a level of sophistication which will make them more than a passing fad. The well-known "Tele-Tennis" and its derivatives are already with us, but soon we can expect to be deluged with crafty microprocessor-based games which will pose a challenge not only to our manual dexterity, but also to our intellect! Those fortunate enough to own home computers such as the PET, can already enjoy the delights of "Lunar Lander", "Star Trek" and "Klingon Capture", but in the near future I feel sure that many lower cost, dedicated, microprocessor games will also appear.

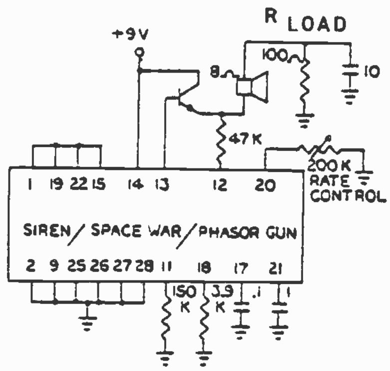
To give these future games an air of realism, Texas Instruments have designed a complex, programmable, sound generator chip which provides an excellent complement to the video displays on which most games will be based. And of course, a device like the **SN76477N** sound generator is ideal for use with all of those simple electronic party games you have had buzzing around in your head for weeks, whether they involve your pet micro or not!

"What sort of sounds?" you may ask. Well, the data sheet shows examples of the SN76477N connected up to pretend it's a train, propeller 'plane, gun shot, explosion, siren, phasor gun, musical organ and a "space war" (whatever *that* is!). Not that that's *all* it can do. The nicest thing about this new chip is that it's up to *you* to program the noise of your dreams. A dragon snoring, a bull bellowing, a bandersnatch snatching, all may be simulated with a handful of resistors and capacitors, a little trial and error, and an SN76477N.

Within the portals of its plastic 28 pin package the new chip contains a bewildering array of programmable sound generator building blocks. A super low frequency oscillator which generates square and triangular ramp waveforms, a voltage controlled audio oscillator, a noise generator and filter, a mixer, a monostable, an output amplifier and even facilities for adjusting the attack/decay of the output waveform, are all included.

The chip will drive a speaker with the aid of a single external transistor and will run from either an existing regulated 5V supply or from an internal regulator fed from an external unregulated 7·5 to 9·0V supply. Bipolar I²L technology is employed, rather than MOS, to facilitate the combination of logic and linear circuitry on the same chip.

Typical SN76477N Application



Notes. The value of resistor R_{load} may be varied to produce the desired sound loudness. Pins that are not shown in the application schematic are not connected (open). All capacitors in microfarads.

To produce a single type of noise, the SN76477N can be used alone, but if you want to switch from gun-shots to choo-choo trains, an external switching array, either mechanical or electronic, will be necessary.

At last! The electronic "Whoopee-cushion" has arrived!

BRIDGE THAT GAP

In the past, if you needed a 3 to 5A power supply for 5V TTL systems or microprocessors, you had to wire up three or more LM309 regulator devices, a smoothing capacitor, a bridge rectifier and a transformer. The three or more LM 309's and the bridge rectifier needed to go on a heatsink of course, and the resultant assembly was both complex and bulky.

For future designs, the heat sink assembly can be very much simplified by the use of the **SH1705** regulator from Fairchild. First, the SH1705 reduces the number of TO3 packages required from a possible *five* to just *one*, because it boasts a 5A regulator current rating. Second, the new device gets rid of the big bridge rectifier package altogether, because Fairchild have crammed a diode bridge into the SH1705 as *well* as the regulator chip!

To make a 5V 5A supply, then, all you now need is a single SH1705, a capacitor, and a transformer. (You will still need a heatsink of course!)

The new device has all the usual features you have come to expect from fixed voltage regulators, such as internal over-current and over-temperature protection, excellent line and load regulation and more than 40dB of ripple rejection (even at 5A). The TO3 package used has four pins, with the case acting as the ground or 0V connection. Pins 2 and 3 are a.c. input pins, pin 4 is the output from the bridge/input to the regulator, and pin 1 is the regulated 5V output.

Quite an improvement!

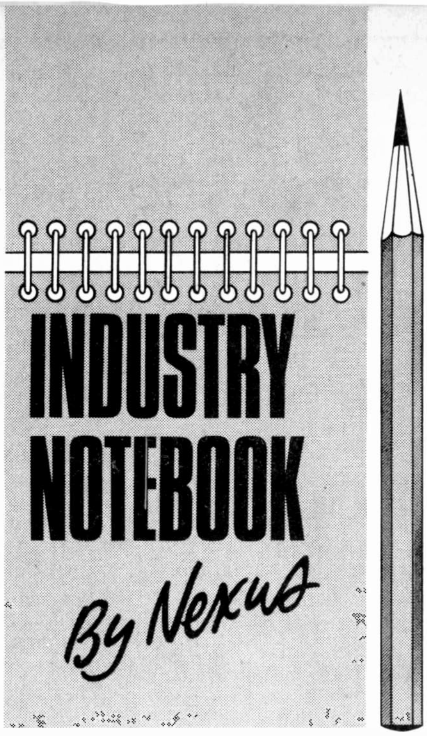
PHOTON F.E.T.

I have mentioned optical-isolators before in this column, but in the past the devices I referred to were really *logic* isolators, where a logic input applied to a light emitting diode was coupled within the package to a phototransistor to produce a logic level change at the output. The consequent GΩ insulation resistance between inputs and outputs has made these devices very useful in some applications, but equivalent devices for isolating *analogue* signals have been rather more difficult to produce due to the need for a linear transfer function.

A new device family from General Electric, comprising the **H11F1, 2 and 3,** are ready to put this right, and may reduce the status of the analogue optical isolator to that of a "Jelly bean" part like their digital precursors. The new devices are described as Photon Coupled Bilateral Analogue FETs and they use the combination of a gallium arsenide infra-red emitting diode and a symmetrical bilateral silicon photo detector which behaves as an ideal isolated FET.

Because the output device is an FET, you can use it as a linear variable resistance which is controllable over a 100Ω to 300MΩ range, in isolated attenuators or a.g.c. systems for example. You can also use it as an analogue switch. A logic level applied to the input diode can be used to switch a 60V peak to peak sine wave in less than 15µs, a useful facility in solid state audio switches and instrumentation systems.

The new devices come in low cost 8 pin mini-d.i.p. packages and boast a linearity of 99·9 per cent. (Well, nobody's perfect!)



Man v Machine

I am sometimes accused of enthusiasm for technology to the extent of being insensitive to its impact on society and the dignity of man. I recall from my earliest student days being warned that electricity could kill people. A very good servant, it was explained, but a very bad master. So, with all forms of technology. It needs to be kept in its place as a servant, a useful tool, no more, no less.

Yet who has not experienced a trembling fear that one day 'artificial intelligence' would get the better of us? I was pleased to see, therefore, that David Levy, a former chess champion of Scotland, easily defeated the most advanced machine in a match of six games, Levy scoring three wins, a draw and only one lost game, the sixth game being redundant as Levy had already won.

The match, held in Canada, was played against a CDC Cyber 176 computer programmed to examine up to three million positions and analyse up to a dozen moves ahead.

Now for the bad news. The program used, Chess 4.7, is reckoned to be stronger than 99·5 per cent of all chess players in the world. Levy thinks that a machine of even greater analytic power with super-programming could be outright world champion by the year 2001, defeating even the best human player. Would this be a reason for putting a hatchet through the machine? Or would it just prove that the best human computer programmers, aided by the machine, are better than the best human chess players? The machine itself is still but a machine, just as an intelligently applied block and tackle enables a physically puny man to lift great weights.

Muddle

Computer programming again but in a different context, that of defence. I have often written of startling falls in electronic hardware costs. But while hardware costs continue to tumble, software costs of computer-based systems continue to rise because programming is labour intensive and good programmers in short supply. In the United States the defence forces between them are currently using 200 different computer architectures which use 450 programming languages. This has come about because engineers have been optimising hardware and then specifying tailor-made computer systems to suit.

Now an attempt is being made to rationalise computer usage so that all purposes can be met from half a dozen user architectures and seven programming languages.

A similar, though less acute, problem exists in the UK forces and there is now an attempt at similar rationalisation, one of the new contenders for a "standard" computer being the established Ferranti Argus 700 now being developed in a military version.

I like the quote, attributed to a US Air Force General, "More and more our radios and radars tend to look like computers which, just coincidentally, happen to radiate and receive".

How true this is can be seen from the initial announcements on the new WG34 anti-submarine helicopters being built by Westland and scheduled for service by the mid 1980's. Prime contractor for the avionics systems is Marconi and by extensive use of distributed microprocessors, the WG34, it is said, will do the work of the 13 men in to-day's Nimrod, with a crew of only three.

The Little Marvel

Well over a million 6500 type 8-bit MPUs were delivered in the first six months of the year according to market analysts.

But as well as MPUs there are dozens of other exciting single-chip devices coming to the market place. RCA, for example, now has a smoke detector on a single chip. GIM has an appliance timer for cookers, central heating and similar domestic functions and, amazingly, TI has compressed into a single chip a complete speech synthesizer which is used as the heart of their Speak & Spell teaching aid. I have heard Speak & Spell in action. It has an all-American drawl but I understand an English-accent version will be available for the UK.

The single-chip 64K random access memory (RAM) has arrived. First off the mark appears to be TI with trade samples available, according to latest reports, this month (November). So far as I know, no official book has been opened on runners and riders in the great 64K hurdle, but if there were it might look something like this. Top favourite to be first past the post, TI at odds-on. Second and third favourites Mostek and National Semiconductor. A dark horse who may yet be a surprise, Motorola. Among the also-rans, Inmos, lagging by about two years but likely to improve.

Ferranti

The National Enterprise Board has done handsomely, profiting from participation in Ferranti. In turn, Ferranti has done well with NEB support. But I seem to remember that Ferranti, some years ago, was clobbered heavily by the government of the day for doing rather too well on a fixed-price missile contract and had to cough up millions which could have been held in reserve against a rainy day. And that part, at least, of Ferranti's misfortunes came about because of cut-backs in CEGB ordering from Ferranti's heavy electrical division, still suffering from depression.

A new venture for Ferranti is entry into the CCTV market, with accent on large security surveillance projects. It seems Ferranti will be systems engineers, bringing in CCTV equipment from outside, although some equipment may be developed in-house eventually. This new area of diversification is within the newly formed Ferranti Instrumentation Ltd., a re-vamp of the old Instrumentation Division which is also getting involved in building containerisation equipment in the old heavy transformer plant.

Calculator Market

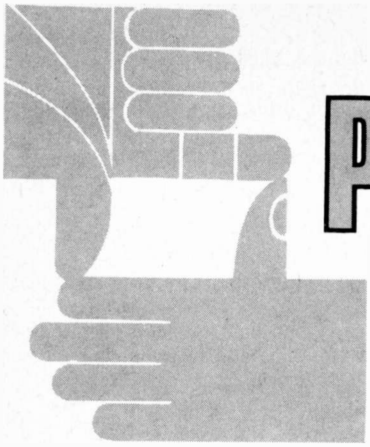
In a recent survey the world calculator market shows only a modest increase this year. But no need to get worried because total sales are forecast at nearly 24 million units as compared with 22 million in 1977. There is, however, a small drop in the cheapest hand-held models from 6·8 million to 6·7 million, indicating perhaps the beginning of market saturation for those costing less than 15 US dollars. The more expensive hand-held, including programmable, units all show an increase in sales.

Automation

At the recent Internepcon Show of electronic production equipment one of the star exhibits was the Dynapert automatic component insertion machine. Computer-controlled, it mounts components in bandoliers (testing them at the same time is an option) and in correct sequence at the rate of 19,000 components an hour. It then inserts them in p.c.b.s at the rate of 9,000 components an hour per operating head. Another Dynapert machine, destined for ICL, can stuff d.i.p. components into p.c.b.s at 4,000 an hour.

Iran Goes Solid State

Iran is getting ready for when the oil runs out. Latest move in industrialisation is a brand new semiconductor plant located at Shiraz. Some £11–12 million has been invested and the plan is to produce 30 million transistors and up to 20 million i.c.s a year. Output will be marketed through Iran's state-owned Electronic Component Industries and most of it is expected to be absorbed within Iran. If so, then Iran's electronics industry must be growing faster than most of us had imagined. The new plant will start with finished imported wafers but plans to move to diffusing its own within a few months. Among equipment suppliers are Teradyne with some £1·5 million of automatic test equipment installed, placed on Teradyne's UK base at Weybridge, Surrey.



PATENTS REVIEW...

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the Patent Office Sales, St. Mary Cray, Orpington, Kent   Price 95p each

FUEL/AIR RATIO

FIG. 1

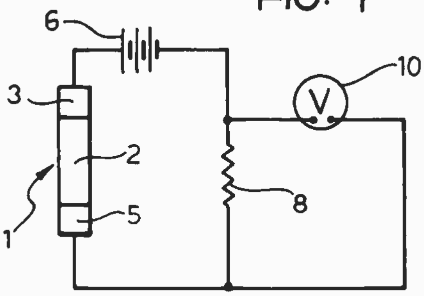


FIG. 2

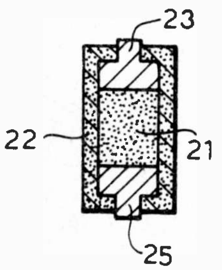
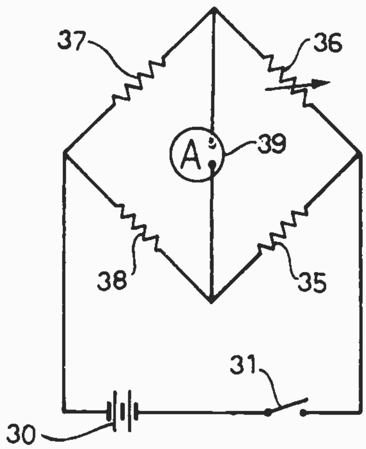


FIG. 3



Fiat in BP 1 496 265 refers to new electronic devices for analysing the percentage of carbon monoxide and oxygen in the exhaust gases of a motor vehicle. Such analysis is necessary to optimise engine performance and fuel-air ratios.

In a known system (Fig. 1) a sensor 1 is formed from a bar of semi-conductor metallic oxide, such as chromic oxide or titanium dioxide, which is sandwiched between two metallic electrodes 3 and 5.

The sensor is fixed in the vehicle exhaust, fed with current from battery 6 and the voltage drop across resistor 8 read by meter 10.

The conductivity of the metallic oxide can be directly related to the composition of the engine exhaust gases, particularly the relative amounts of carbon monoxide and oxygen, when raised to a temperature of between 500°C and 900°C.

The voltage drop across resistor 8 can thus provide either a direct reading of the air/fuel ratio or direct control on the engine. But Fiat have found such systems unreliable in practice due to temperature fluctuations and now use a new type of sensor reminiscent of primitive, pre-war semi-conductor devices.

Fig. 2 shows such a Fiat sensor, with a sleeve 22 of ceramic material containing metallic oxide powder 21 compressed between electrodes 23, 25.

Fig. 3 shows the improved method of connection. Two similar sensors of the new type are incorporated as arms 37, 38 in a Wheatstone Bridge with fixed resistance 35 and variable, nulling resistance 36. The sensor in arms 37, 38 are both located in the exhaust system and thus both rise to the same exhaust temperature while bathed in the same exhaust gas flow.

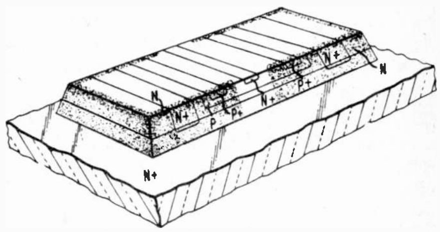
The ceramic wall of one sensor is porous and the wall of the other is impermeable to exhaust gas. It follows that changes in the sensors due to exhaust gas temperature fluctuations and other irrelevant factors will cancel out.

The bridge will be unbalanced by, and give a reading on, only those variations which are due to the parameter it is desired, to measure, namely the physical composition of the exhaust gases. Thus bridge ammeter A will give a correct and accurate reading representative only of air-fuel ratio, independent of exhaust gas temperature.

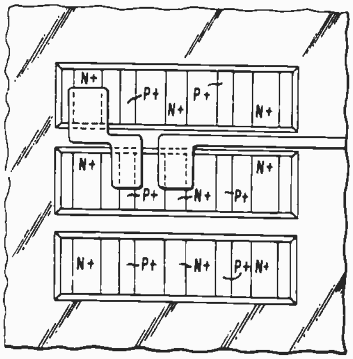
BIPOLAR TRANSISTOR

In BP 1 494 151 RCA of the U.S.A. explains how it is practically impossible to make a satisfactory bipolar transistor by conventional methods of diffusing impurities into a thin, epitaxial layer of silicon on an insulating substrate.

To produce accurate diffusion of impurities using silicon on sapphire (SOS) is impractical because silicon as deposited epitaxially on sapphire is inferior in crystalline structure to bulk silicon, and short circuits result. The patent seeks to avoid such problems. Although lengthy in content details, the basic ideas are simple.



The RCA bipolar transistor is formed from a silicon layer of "n" type which consists of two separate strata which are both epitaxially deposited but differently doped. Using conventional photo. resist techniques the base region is formed by a double ion implantation of "p" type impurity, such as boron.



The emitter region is formed by "n"-type ion implanting. This implantation is through an elongated opening in the previously formed silicon dioxide layer. According to RCA this ion implantation technique and multi-strata foundation provides the missing link to reliability.

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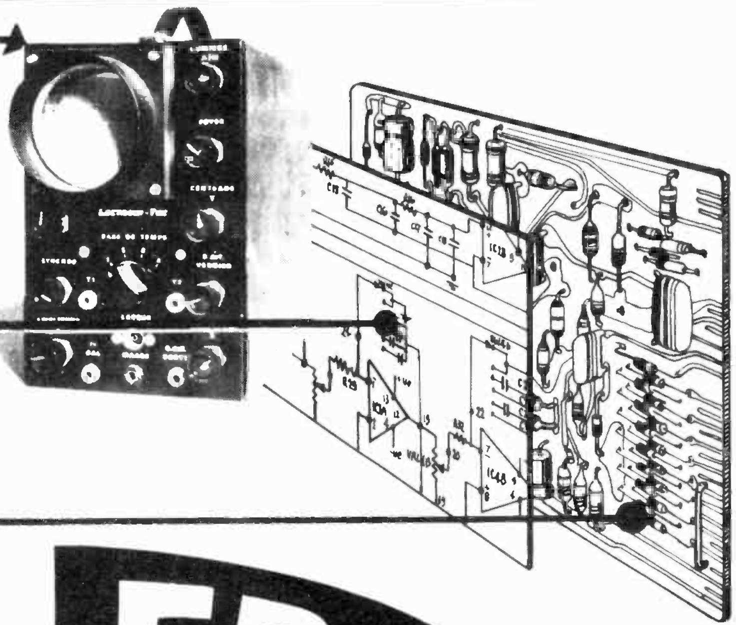

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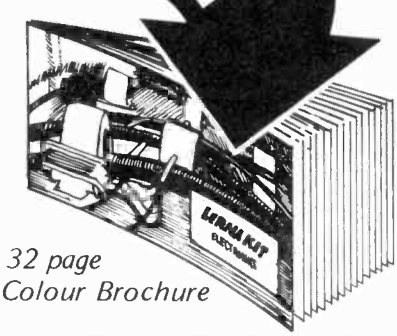

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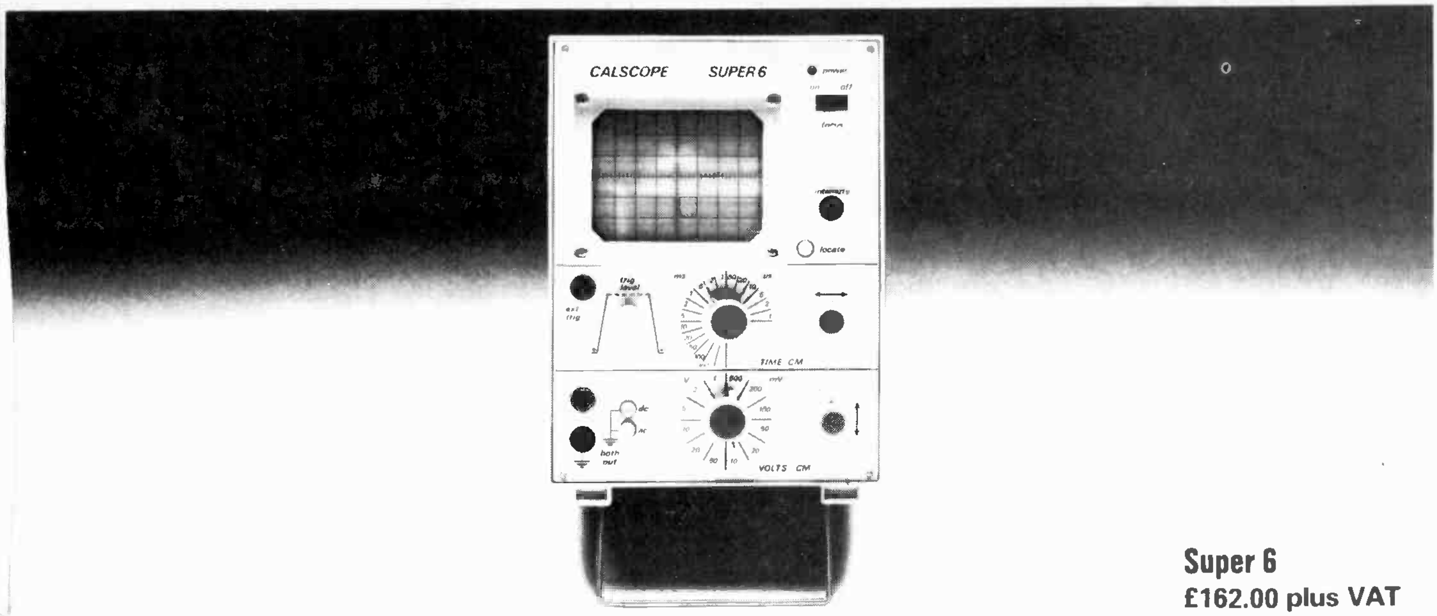

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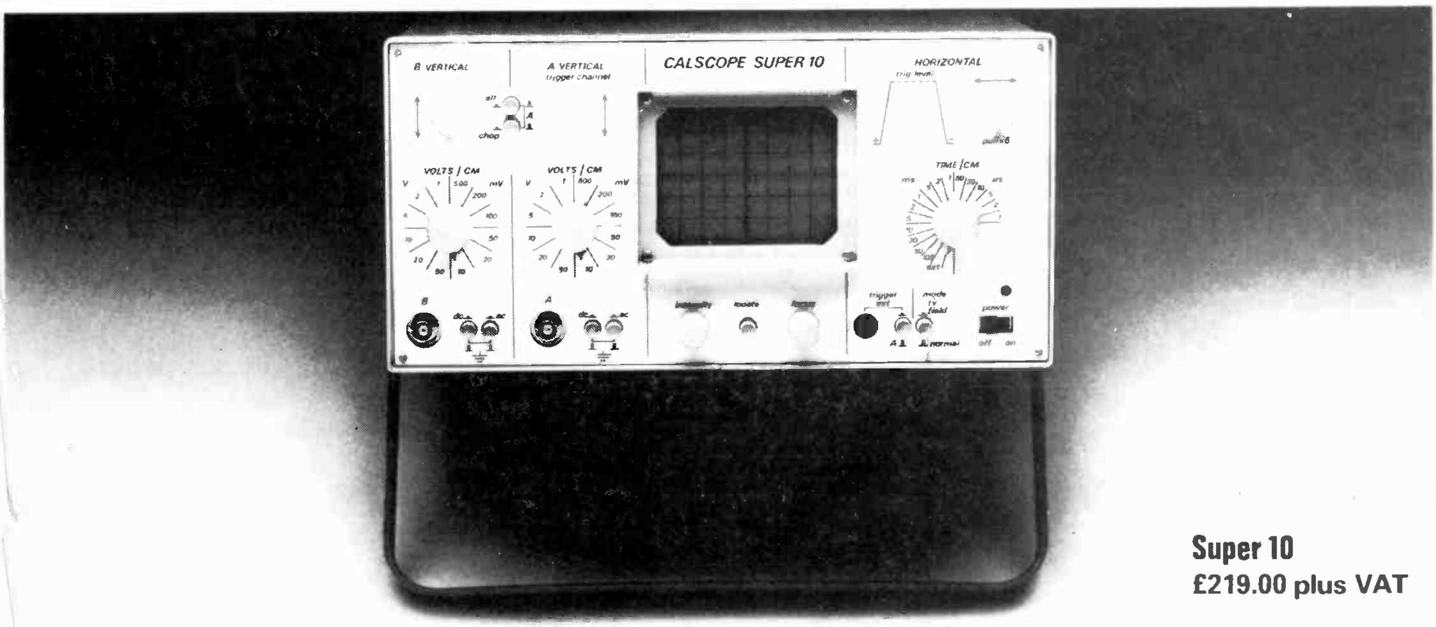

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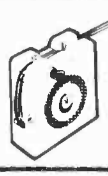

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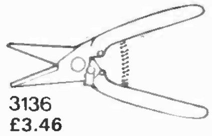

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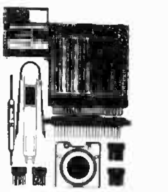

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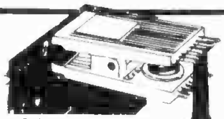

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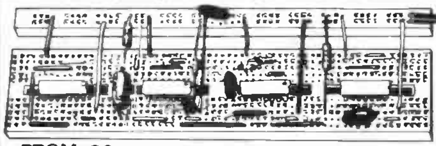

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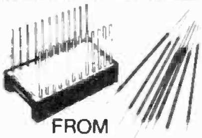

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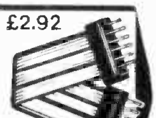

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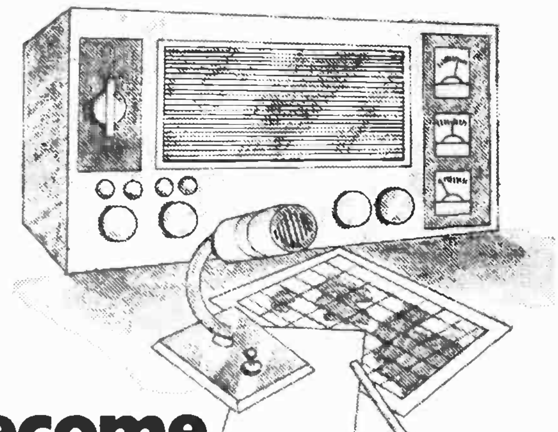

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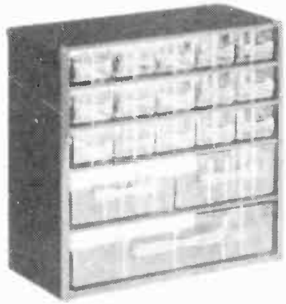

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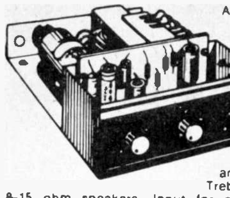
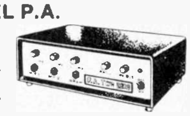


A superb solid state audio amplifier Brand new components throughout 5 silicon transistors plus 2 power output transistors in push-pull Full wave rectification Output approx 13 watts r m s into 8 ohms Frequency response 12Hz 30KHz ± 3db Fully integrated pre-amplifier stage with separate Volume Bass boost and Treble cut controls Suitable for 8-15 ohm speakers Input for ceramic or crystal cartridge Sensitivity approx 40mV for full output Supplied ready built and tested with knobs, escutcheon panel, input and output plugs Overall size 3in high · 6in wide · 7½in deep AC 200 250V

PRICE £15·00 P & P £1 20

HARVERSONIC MODEL P.A. TWO ZERO



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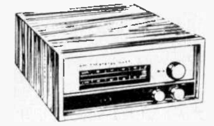

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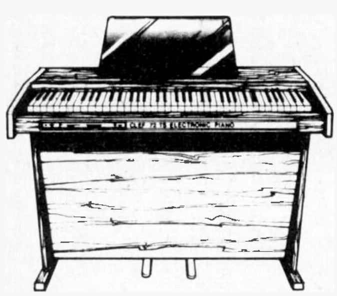

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2N699	0.58	2N2221	0.25	2N3441	0.92	2N4121	0.27	2N5295	0.44	40595	0.98	BC147B	0.13	BC182L	0.15	BC214LB	0.18	BC558	0.13	BD245C	0.85	BF185	0.37	BFY52	0.27	MPF3055	1.05
2N706	0.30	2N2221A	0.25	2N3442	1.45	2N4122	0.27	2N5296	0.44	40673	0.80	BC148	0.13	BC182LA	0.15	BC214LC	0.18	BC559	0.15	BD246A	0.72	BF194	0.16	BFY90	1.35	MPF102	0.33
2N706A	0.30	2N2222	0.25	2N3638	0.17	2N4123	0.19	2N5298	0.44	40669	1.30	BC148B	0.13	BC182LB	0.15	BC237B	0.15	BCY70	0.21	BD246C	0.93	BF195	0.16	BR101	0.55	MPF103	0.44
2N708	0.30	2N2222A	0.25	2N3638A	0.17	2N4124	0.19	2N5447	0.16	AC126	0.48	BC148C	0.13	BC183	0.12	BC238A	0.13	BCY71	0.26	BD433	0.44	BF196	0.16	BRY39	0.55	MPF104	0.44
2N718	0.30	2N2369	0.27	2N3702	0.14	2N4125	0.19	2N5448	0.16	AC127	0.48	BC149	0.15	BC183A	0.12	BC238B	0.13	BCY72	0.18	BD434	0.46	BF197	0.18	BSX19	0.35	MPS105	0.44
2N718A	0.54	2N2369A	0.27	2N3703	0.14	2N4126	0.19	2N5449	0.20	AC128	0.48	BC149C	0.15	BC183B	0.13	BC238C	0.13	BD115	0.88	BD435	0.46	BF198	0.19	BSX20	0.35	MPSA05	0.27
2N720A	0.85	2N2646	0.80	2N3704	0.14	2N4284	0.38	2N5457	0.38	AC151	0.43	BC157A	0.15	BC183C	0.13	BC239B	0.16	BD131	0.55	BD436	0.46	BF199	0.19	BSX21	0.35	MPSA06	0.27
2N722	0.45	2N2647	1.55	2N3705	0.14	2N4286	0.22	2N5458	0.35	AC152	0.54	BC158A	0.15	BC183L	0.15	BC239C	0.17	BD132	0.75	BD437	0.55	BF224J	0.22	BU104	1.80	MPSA12	0.44
2N727	0.50	2N2903	1.60	2N3706	0.14	2N4287	0.22	2N5459	0.32	AC153	0.59	BC158B	0.15	BC183LA	0.15	BC257A	0.18	BD135	0.40	BD438	0.55	BF225J	0.27	BU105	1.55	MPSA14	0.33
2N914	0.38	2N2904	0.31	2N3707	0.14	2N4288	0.22	2N5460	0.65	AC153K	0.59	BC159A	0.17	BC183LB	0.15	BC258B	0.19	BD136	0.40	BD529	0.49	BF244A	0.38	BU126	1.08	MPSA55	0.27
2N916	0.33	2N2904A	0.31	2N3708	0.12	2N4289	0.22	2N5484	0.37	AC176K	0.70	BC159B	0.17	BC183LC	0.15	BC259B	0.19	BD137	0.41	BD530	0.55	BF244B	0.33	BU204	2.20	MPSA56	0.27
2N917	0.38	2N2905	0.31	2N3709	0.12	2N4347	2.20	2N5485	0.40	AC176	0.54	BC160	0.38	BC184	0.12	BC300	0.43	BD138	0.41	BD535	0.70	BF245A	0.44	BU205	2.40	R2008B	2.45
2N918	0.45	2N2905A	0.31	2N3771	2.16	2N4348	2.65	2N5486	0.40	AC187	0.59	BC161	0.38	BC184B	0.13	BC301	0.43	BD139	0.43	BD536	0.70	BF245B	0.44	BU206	2.70	R2010B	2.15
2N929	0.37	2N2906	0.25	2N3772	2.20	2N4918	0.65	2N5490	0.64	AC187K	0.65	BC167	0.13	BC184C	0.13	BC302	0.37	BD140	0.43	BD537	0.74	BF257	0.35	BU208	2.70	TIP29A	0.49
2N929A	0.37	2N2906A	0.25	2N3773	3.15	2N4919	0.70	2N5492	0.64	AC188	0.54	BC167B	0.13	BC184L	0.15	BC303	0.54	BD181	1.90	BD538	0.77	BF258	0.35	ME0401	0.22	TIP29C	0.65
2N930	0.37	2N2907	0.25	2N3819	0.36	2N4920	0.83	2N5494	0.65	AC188K	0.65	BC168A	0.13	BC184LB	0.15	BC307	0.16	BD182	2.20	BD539	0.60	BF259	0.35	ME0402	0.22	TIP30A	0.54
2N930A	0.95	2N2907A	0.25	2N3820	0.39	2N4921	0.54	2N5496	0.67	AD161	1.00	BC168B	0.13	BC184LC	0.15	BC307A	0.16	BD183	2.35	BD540	0.60	BF336	0.42	ME0404	0.17	TIP30C	0.70
2N1711	0.30	2N2923	0.17	2N3821	0.96	2N4922	0.60	2N6027	0.64	AD162	1.00	BC168C	0.13	BC212	0.15	BC307B	0.16	BD187	0.95	BDX14	1.32	BF337	0.49	ME0412	0.22	TIP31A	0.54
2N1889	0.30	2N2924	0.17	2N3900	0.28	2N4923	0.75	2N6107	0.45	AF106	0.60	BC169B	0.13	BC212A	0.15	BC308	0.16	BD235	0.46	BDX18	1.90	BF338	0.52	ME0414	0.22	TIP31C	0.72
2N1890	0.30	2N2925	0.19	2N3901	0.30	2N4924	1.15	2N6108	0.55	AF109	0.52	BC169C	0.13	BC212B	0.15	BC308B	0.16	BD236	0.44	BDY20	1.10	BFR39	0.30	ME4001	0.16	TIP32A	0.59
2N1893	0.30	2N2926	0.17	2N3903	0.20	2N5086	0.30	2N6109	0.55	BC107	0.16	BC177	0.22	BC212L	0.18	BC309A	0.16	BD237	0.44	BDY55	1.90	BFR40	0.29	ME4002	0.16	TIP32C	0.82
2N2102	0.50	2N3053	0.25	2N3904	0.18	2N5087	0.30	2N6111	0.49	BC107A	0.16	BC177A	0.22	BC212LA	0.18	BC309B	0.16	BD238	0.44	BDY56	2.10	BFR41	0.30	ME4003	0.16	TIP41A	0.76
2N2192	0.58	2N3054	0.72	2N3905	0.18	2N5088	0.30	2N6121	0.41	BC107B	0.16	BC177B	0.25	BC212LB	0.18	BC309C	0.16	BD239A	0.44	BF115	0.39	BFR79	0.30	ME4101	0.11	TIP41C	0.97
2N2193	0.50	2N3055	0.75	2N3906	0.18	2N5089	0.30	2N6122	0.44	BC108	0.16	BC178	0.22	BC213	0.15	BC327	0.22	BD239C	0.59	BF160	0.33	BFR80	0.30	ME4102	0.11	TIP42A	0.86
2N2193A	0.52	2N3390	0.50	2N4031	0.55	2N5190	0.65	2N6123	0.48	BC108A	0.16	BC178A	0.25	BC213A	0.15	BC328	0.20	BD240A	0.49	BF161	0.65	BFR81	0.30	ME4103	0.11	TIP42C	1.08
2N2194	0.42	2N3391	0.40	2N4032	0.65	2N5191	0.75	2N6124	0.45	BC108B	0.16	BC178B	0.35	BC213B	0.15	BC337	0.20	BD240C	0.59	BF167	0.37	BFX29	0.34	ME4104	0.11	TIP2955	0.70
2N2194A	0.45	2N3391A	0.45	2N4036	0.72	2N5192	0.80	2N6125	0.47	BC108C	0.17	BC179	0.25	BC213C	0.15	BC338	0.23	BD241A	0.49	BF173	0.37	BFX30	0.34	ME6101	0.22	TIP3055	0.59
2N2195	0.40	2N3392	0.17	2N4037	0.60	2N5193	0.75	40361	0.55	BC109	0.16	BC179A	0.25	BC213L	0.17	BC547	0.13	BD241C	0.65	BF177	0.27	BFX84	0.30	ME6102	0.22	TIS34	1.05
2N2195A	0.40	2N3393	0.17	2N4058	0.22	2N5194	0.80	40362	0.55	BC109B	0.17	BC179B	0.25	BC213LA	0.17	BC547A	0.13	BD242A	0.55	BF178	0.27	BFX85	0.38	MJ2955	1.35	TIS42	0.50
2N2217	0.55	2N3394	0.17	2N4059	0.17	2N5195	0.97	40363	1.45	BC109C	0.18	BC179C	0.26	BC213LB	0.17	BC547B	0.13	BD242C	0.62	BF179	0.33	BFX86	0.30	MJE340	0.62	TIS43	0.47
2N2218	0.35	2N3395	0.19	2N4060	0.22	2N5245	0.37	40408	0.82	BC140	0.30	BC182	0.12	BC213LC	0.17	BC548	0.13	BD243A	0.65	BF180	0.37	BFX87	0.35	MJE370	0.62	TIS90	0.22
2N2218A	0.38	2N3396	0.19	2N4061	0.19	2N5246	0.38	40409	0.82	BC141	0.32	BC182A	0.12	BC214	0.17	BC549	0.14	BD243C	0.87	BF181	0.37	BFX88	0.30	MJE371	0.86	TIS91	0.27

LINEAR CIRCUITS

CA3018	0.75	LM379S	4.25	LM7815K	1.75	TAD100	2.00
CA3018A	1.10	LM380N8	0.96	LM7824K	1.75	TBA120	0.80
CA3020	2.20	LM380N14		LM78L05CZ		TBA500	2.24
CA3020A	2.50		1.08		0.30	TBA5000	2.34
CA3028A	0.90	LM381AN	2.70	LM78L12CZ		TBA510	2.35
CA3028B	1.25	LM381N	1.69		0.30	TBA5100	2.48
CA3030	1.50	LM382N	1.32	LM78L15CZ		TBA520	2.60
CA3030A	2.20	LM384N	1.55		0.30	TBA5200	2.70
CA3038	2.90	LM386N	0.88	MM5314	4.60	TBA530	2.35
CA3038A	4.10	LM387N	1.10	MM5316	4.60	TBA5300	2.45
CA3045	1.55	LM388N	1.00	NE555	0.33	TBA540	2.60
CA3046	0.77	LM389N	1.00	NE556	0.85	TBA5400	2.70
CA3048	2.45	LM702C	0.81	NE558N	1.98	TBA550	3.60
CA3052	1.78	LM709	0.70	NE560	4.50	TBA5500	3.80
CA3080	0.85	LM7098	0.50	NE561	4.50	TBA56000	3.00
CA3080A	2.10	LM70914	0.49	NE562	4.50	TBA570	2.10
CA3086	0.50	LM710	0.67	NE565	1.39	TBA5700	2.20
CA3088B	1.87	LM71014	0.64	NE566	1.75	TBA7000	2.20
CA3089B	2.90	LM711CN	0.72	NE567	1.90	TBA720A0	2.06
CA30900	4.40	LM723C	0.75	NE571N	4.95	TBA750	2.36
CA3130	1.06	LM723C14	0.45	SAS560	2.70	TBA7500	2.45
CA3140	1.04	LM741C	0.70	SAS570	2.70	TBA800	1.30
LM301	0.30	LM741C8	0.30	SAJ110	2.10	TBA810S	1.30
LM307N	0.50	LM741C14	0.30	S041P	1.35	TBA820	0.80
LM308N	0.95	LM747CN	0.99	S042P	1.35	TBA920	2.99
LM309KC	1.95	LM7488	0.50	SN76001N		TCA160C	2.36
LM317K	3.35	LM74814	0.90		1.30	TCA160B	2.55
LM318N	2.45	LM1303N	1.15	SN76003N		TCA270	2.99
LM320TS	2.15	LM1304N	1.52		2.38	TCA730	4.50
LM320T12	2.15	LM1305N	1.52	SN76013N		TCA740	4.50
LM320T15	2.15	LM1307N	1.22		1.50	TCA750	3.00
LM320T24	2.15	LM1310N	2.10	SN76023N		TCA760	2.00
LM320P5	1.15	LM1351N	1.30		1.50	TCA105	1.49
LM320P12	1.15	LM1458N	0.45	SN76033N		TCA440	1.65
LM320P15	1.15	LM1496N	0.97		2.35	TDA1022	7.50
LM320P24	1.15	LM1808N	2.10	TAA263	1.35	TDA1024	1.24
LM323K	6.95	LM1812N	6.20	TAA300	3.70	TDA1034	4.75
LM339N	0.60	LM1820N	1.16	TAA320A	1.15	TDA2020AD	
LM340T5	0.88	LM1828N	1.90	TAA350A	3.00		4.50
LM340T15	0.88	LM1830N	1.90	TAA521	1.10	UAA170	2.15
LM340T24	0.88	LM1841N	1.90	TAA522	2.10	UAA180	2.15
LM341P5	0.80	LM1845N	1.50	TAA550	0.48	TL080CP	1.25
LM341P12	0.80	LM1848N	1.98	TAA560	2.10	TL081CP	0.90
LM341P15	0.80	LM1850N	1.90	TAA570	2.20	TL082CP	1.10
LM341P24	0.80	LM1889N	4.90	TAA370A	5.45	TL083CN	1.40
LM348N	0.95	LM3301N	0.60	TAA630	2.40	TL084CN	1.45
LM358N	0.60	LM3302N	0.55	TAA960	3.90	LF355N	0.80
LM360N	3.00	LM3401N	0.55	TAA970	4.20	LF356N	0.80
LM370N	3.30	LM3900N	0.68	TAA611B	2.50	LF357N	0.80
LM371H	2.35	LM3905N	1.15	TAA621	2.50	LF13201N	3.00
LM350K	6.45	LM3909N	0.78	TAA661A	1.65	LF13331N	3.00
LM373N	3.35	LM3911N	1.10	TAA661B	1.45	LF13741H	0.80
LM374N	3.36	LM7805K	1.75	TAA700	4.50	LF13741N	0.55
LM377N	1.80	LM7812K	1.75	TAA930A	1.45		
LM378N	2.40	LM324	0.75	TAA930B	1.45		

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KIM 4 – Motherboard (takes 6 x KIM 3) + power supply	£96.00
KIM 6 – Prototype board for user designation	£42.00

The Commodore PET and KIM are both based on the 6502 micro

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4002	0.22	4018B	1.05	4031B	2.25	4051B	0.85	4070B	0.85	4093B	1.00
4006	1.25	4019B	0.52	4035B	1.30	4052B	0.86	4071B	0.24	4094	2.30
4007	0.22	4020B	1.15	4037	1.20	4053B	0.98	4072	0.27	4095	1.30
4008B	0.99	4021	1.05	4041B	0.85	4054	1.48	4073B	0.24	4096	1.30
4009	0.58	4022B	1.00	4042B	0.86	4055	1.65	4075B	0.24	4097	4.65
4010	0.58	4023B	0.22	4043	1.05	4056	1.65	4076B	0.99	4098	1.00
4011B	0.22	4024B	0.76	4044	1.00	4059	6.00	4077	0.70	4510B	1.20
4012	0.22	4025B	0.22	4045	1.76	4060B	1.15	4078	0.27	4511	1.75
4013B	0.52	4027B	0.55	4046B	1.50	4063	1.35	4081B	0.24	4516	2.10
4014	1.00	4028B	0.92	4047B	0.96	4066B	0.75	4082	0.27	4518B	1.20
4015	1.05	4029B	1.10	4049	0.96	4067	4.85	4085	0.89		

TTL

74LS00N	0.26	74LS162N	1.43	7400N	0.17	7490AN	0.45
74LS01N	0.26	74LS164N	1.43	7401N	0.17	7491AN	0.85
74LS02N	0.26	74LS168N	2.43	7402N	0.17	7492N	0.45
74LS03N	0.26	74LS169N	2.43	7403N	0.17	7493N	0.45
74LS04N	0.29	74LS174N	1.33	7404N	0.17	7494N	0.90
74LS10N	0.26	74LS175N	1.26	7405N	0.22	7495N	0.76
74LS12N	0.26	74LS181N	3.95	7406N	0.56	7496N	0.70
74LS13N	0.58	74LS189N	3.74	7407N	0.55	7497N	1.95
74LS14N	1.43	74LS190N	1.00	7408N	0.22	74100N	1.40
74LS20N	0.26	74LS191N	1.00	7409N	0.22	74107N	0.35
74LS26N	0.39	74LS192N	1.98	7410N	0.20	74118N	0.95
74LS27N	0.50	74LS193N	1.98	7411N	0.26	74119N	1.40
74LS28N	0.42	74LS196N	1.28	7412N	0.20	74121N	0.28
74LS30N	0.26	74C00N	0.24	7413N	0.36	74122N	0.55
74LS37N	0.32	74C02N	0.24	7414N	0.80	74123N	0.55
74LS38N	0.32	74C04N	0.24	7416N	0.36	74125N	0.45
74LS40N	0.29	74C08N	0.24	7417N	0.36	74141N	0.86
74LS42N	1.07	74C10N	0.24	7420N	0.22	74148N	1.35
74LS47N	1.09	74C14N	1.41	7423N	0.32	74145N	0.86
74LS48N	1.09	74C20N	0.24	7425N	0.32	74150N	1.20
74LS49N	1.09	74C30N	0.24	7427N	0.32	74151N	0.76
74LS51N	0.26	74C32N	0.24	7430N	0.22	74153N	0.76
74LS54N	0.26	74C42N	0.92	7432N	0.30	74154N	1.20
74LS73N	0.42	74C48N	1.38	7437N	0.35	74155N	0.70
74LS76N	0.42	74C73N	0.54	7438N	0.32	74157N	0.78
74LS78N	0.42	74C74N	0.56	7440N	0.20	74160AN	1.10
74LS83AN	1.20	74C76N	0.54	7441AN	0.84	74161AN	1.10
74LS85N	1.10	74C83N	1.30	7442N	0.76	74162AN	1.10
74LS90N	1.10	74C85N	1.30	7445N	1.40	74163AN	1.10
74LS91N	1.20	74C86N	0.64	7446AN	0.90	74164N	1.36
74LS92N	0.86	74C89N	4.39	7447AN	0.80	74165N	1.36
74LS93N	1.10	74C90N	0.85	7448N	0.80	74167N	2.50
74LS95AN	1.10	74C93N	0.85	7450N	0.22	74174N	1.60
74LS96N	1.35	74C95N	1.04	7451N	0.22	74175N	1.00
74LS107N	0.42	74C107N	1.22	7453N	0.22	74176N	0.90
74LS109N	0.42	74C150N	4.14	7454N	0.22	74177N	0.90
74LS122N	0.80	74C151N	2.47	7460N	0.22	74180N	1.00
74LS123N	0.83	74C154N	3.68	7470N	0.46	74181N	2.00
74LS124N	2.70	74C157N	2.21	7472N	0.30	74182N	0.80
74LS125N	0.50	74C160N	1.11	7473N	0.44	74184N	1.50
74LS126N	0.50	74C161N	1.11	7474N	0.32	74185AN	1.50
74LS136N	0.44	74C162N	1.11	7475N	0.80	74188AN	3.25
74LS145N	1.30	74C163N	1.11	7476N	0.45	74189N	2.60
74LS151N	1.07	74C164N	1.04	7480N	0.60	74190N	1.40
74LS153N	0.58	74C165N	1.04	7481N	1.00	74191N	1.20
74LS154N	1.45	74C173N	0.90	7482N	0.90	74192N	1.20
74LS155N	1.20	74C174N	0.90	7483N	1.05	74193N	1.20
74LS156N	1.20	74C175N	0.90	7484N	1.20	74196N	1.20
74LS158N	0.65	74C192N	1.11	7485N	1.36	74197N	1.00
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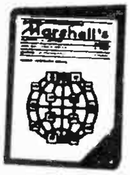

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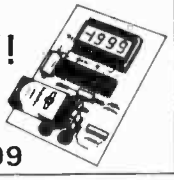

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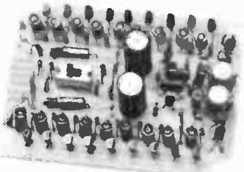

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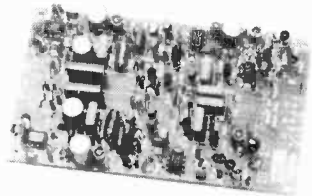

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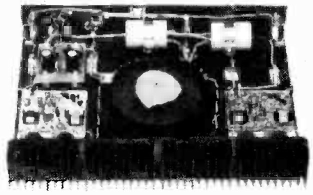

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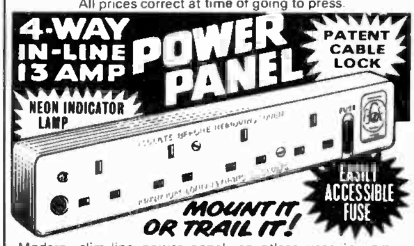

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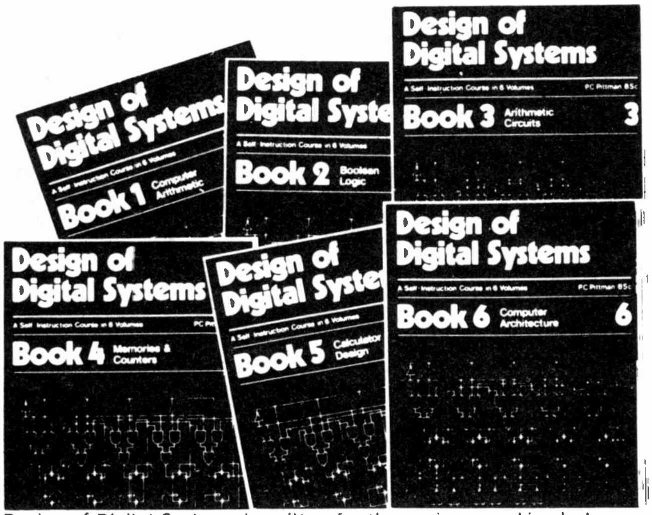

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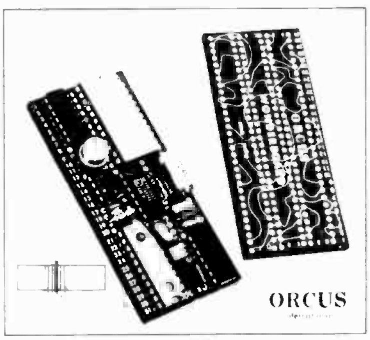

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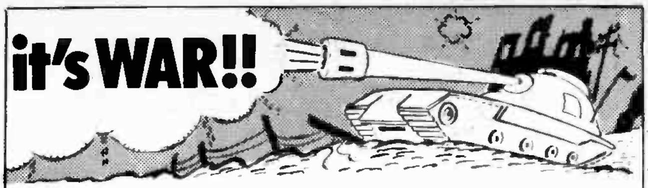

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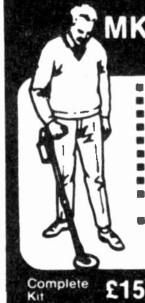

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