Australia 95c New Zealand 95c South Africa 90c Malaysia $2.75

PRACTICAL ELECTRONICS

JUNE 1979

50p

CINE SPEED CONTROLLER

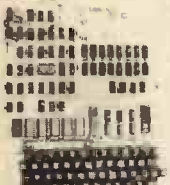
SPECIAL WATCH OFFER!

Plus...

OHIO SUPERBOARD II REVIEW

OHIO SUPERBOARD II *NEW* FIRST IN UK — ON DEMO

For electronic buffs. Fully assembled and tested. Requires +5V at 3 Amps and a video monitor or TV with RF converter to be up and running.



STANDARD FEATURES

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
  Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-keyboard with upper/lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM

Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters; without overscan up to 30 x 30 characters.

EX-STOCK — £263

Please phone to check availability or send £10 to reserve one and pay the balance on delivery

INTERESTED IN HOME COMPUTING?

FREE B BUG
valued at £23.00
plus 10 x C12 cassettes
valued at £4.00
plus Standard Modulator
valued at £2.25
WITH EVERY NASCOM

Start now and don't get left behind THE NASCOM 1 is here Ex-stock with full technical services

Plus the opportunity to join the fastest moving club of personal computer users enabling you to get the most our of your computer. You can OBTAIN and EXCHANGE programs and other software — many now available.

SAVE £60

- The Powerful Z80 Microprocessor
- Professional Keyboard
- 1 Kbyte Monitor in EPROM
- 2 Kbyte RAM (expandable)
- Audio Cassette interface
- Plugs into your domestic TV
- Easy construction from straightforward instructions
  - no drilling or special tools
  - Just neat soldering required.

Only ~~£197.50~~ + 8% VAT (includes p & p + insurance)

NEW LOW PRICE £165

Manuals seperately	2.95
Z80 programming Manual	6.90
Z80 Technical Manual	2.95
PIO Technical Manual	2.95
(All prices add 8% VAT)	
Power supply suitable for NASCOM	19.90

NASCOM AD ONS — Nascom improved monitor B Bug (2K) featuring — *Four times tape speed *Direct text entry without ASCII *Extended keyboard facility *Additional useful subroutines £23.00

Nascom Vero Case **£22.50**

Nascom Joy Stick Kit **£14.90**

Nascom Music Box Kit £9.90 *(write your own tunes and play them on your Nascom. Complete with full documentation).*

GRAPHICS ADD ON BOARD £9.90
Complete kit to upgrade your NASCOM for graphics capability includes full documentation and demonstration program.

SHORT C12 CASSETTES 10 for £4.00

FOR COMPUTER PROGRAMMES

THE TRS-80 *(SPECIAL SCOOP)*

Low Priced, Ready to Go!

Use your own cassette

Level-II with 4K RAM
Improved graphics, print formatting, and a faster cassette transfer rate are features of Level-II BASIC.

£399 + VAT

PLUGS INTO YOUR OWN TV

Level-II with 16K RAM
A combination of 16K RAM and the powerful Level-II BASIC produces a system capable of handling most demands.

£499 + VAT

KEY BOARD ONLY | **COMPLETE WITH UHF MODULATOR**

UK POWER SUPPLY — £9.90 + VAT

MODULATORS UHF Channel 36

Standard 6 meg band width £2.25
High Quality 8 meg band width £4.90

Teleplay presents the PROGRAMAGAME of all time!

TELEPLAY have produced a product of cartridge games for you and all your family that will not go out of date. Just ADD each new cartridge as it becomes available, and your colour video centre will be up to date the Teleplay way. You will save pounds in the long run. Works OK on Black and White TV

EX STOCK IMMEDIATE DELIVERY

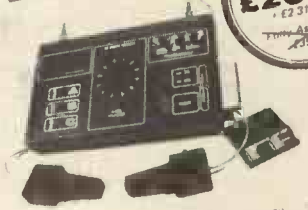
REALISTIC SOUND EFFECTS

The Teleplay 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

TELEPLAY GIVES YOU TWICE THE FUN BUILDING AND PLAYING THE MOST PROFESSIONAL TV GAME KIT EVER OFFERED

We offer all this to you for ONLY **£28·90** + £2.31 VAT
~~Fully Assembled £35.90~~

SAVE £10



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

Additional cartridges NOW available include

Stunt Cycle	4 games	Cartriges and Hand Controls	£14.90
Tank Battle	Cartridge and Hand Controls		£18.90
Road Race	2 games	Cartridge Controls already with basic kit	£12.90

Cartridges come complete with printed case and easy to follow instructions

NEW — WIPE OUT cartridge — 6 games £13.90

All parts fully guaranteed

All prices include VAT except where shown. Orders over £5 post and packing free otherwise add 20p. Please make cheques and postal orders payable to COMP, or phone your order quoting BARCLAYCARD or ACCESS number.

COMP COMPUTER COMPONENTS

14 STATION ROAD, NEW BARNET, HERTFORDSHIRE TEL: 01-441 2922 (Sales) 01-449 6596
CLOSE TO NEW BARNET BR STATION — MOORGATE LINE TELEX: 298755
OPEN — 10am to 7pm — Monday to Saturday CONTINUOUS DEMONSTRATIONS

£6 EXTRA FOR SECURICOR DELIVERY

PRACTICAL
ELECTRONICS

VOLUME 15 No. 6 JUNE 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR JULY ISSUE WILL BE ON SALE FRIDAY, 8 JUNE 1979
(for details of contents see page 49)

WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p* TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE.

SEND 50p (plus 25p p&p) FOR OUR CATALOGUE

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 8% to devices marked ★. To the rest add 12½%.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am – 6.00 pm. Ample Free Car Parking space available.

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF) 500V: 10 40p; 47 68p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8, 8, 10, 15, 22 8p; 47, 32, 50 11p; 63, 100 27p; 50V: 50 11p; 100, 220 25p; 470 32p; 1000 50p; 40V: 22, 33 8p; 100 12p; 2200, 3300 62p; 4700 85p; 35V: 10, 33 9p; 330, 470 32p; 1000 49p; 25V: 10, 22, 47 6p; 80, 100, 160 8p; 220, 250 13p; 470, 640 25p; 1000 27p; 1500 30p; 2200 45p; 3300 62p; 4700 68p; 16V: 10, 40, 47, 68 7p; 100, 125 8p; 330 14p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 4, 100 6p; 640 10p; 1000 14p.
Tag-End 70V: 2000 89p; 4700 135p; 64V: 3300 99p; 50V: 10,000 255p; 40V: 2500 65p; 3300, 4700 70p; 15,000 450p; 25V: 4700 68p; 2200 48p; 325V: 32 + 32 175p.

POLYESTER CAPACITORS: Axial lead type. (Values are in µF)
400V: 0.001 0.0015, 0.0022, 0.0033 9p; 0.0047, 0.0068, 0.01, 0.015, 0.018 10p; 0.022, 0.033 10p; 0.047, 0.068 14p; 0.10 15p; 0.15, 0.22 22p; 0.33, 0.47 39p; 0.68 45p. 160V: 0.039 0.15, 0.22 11p; 0.33, 0.47 19p; 0.68, 1.0 22p; 1.5 29p; 2.2 32p.
DUBILIER: 1000V: 0.01, 0.015 20p; 0.022 22p; 0.047 26p; 0.1 38p; 0.47 48p.

POLYESTER RADIAL LEAD (Values are in µF) 250V:
0.01 0.015, 0.022 0.027 6p; 0.033, 0.047, 0.068, 0.1 7p; 0.15 11p; 0.22 0.33 13p; 0.47 15p; 0.68 18p; 1.0 24p; 1.5 27p; 2.2 31p.

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

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF 6p
0.015, 0.02, 0.04, 0.05, 0.056µF 7p
0.01µF, 0.2 9p 50V: 0.47µF 11p

CERAMIC CAPACITORS: 50V
0.5pF to 10nF 3p each
15nF, 22nF, 33nF, 47nF 4p each
0.1µF 6p; 0.2µF 7p

POLYSTYRENE CAPACITORS
10pF to 1nF 8p; 1.5nF to 47nF 10p.

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220, 250 9p ea
300, 330, 360, 390, 600, 820 16p ea
1000, 1200, 1800, 2000, 2200 20p ea

MINIATURE TYPE TRIMMERS
2 5 6pF 3 10pF 10 40pF 22p
5 25pF 5 45pF 60pF 88pF 30p

COMPRESSION TRIMMERS
3-40pF, 10-80pF, 25-190pF 30p
100-500pF 45p; 1250pF 60p

SOLDERCON PINS*
100 pins 50p; 500 pins 200p

POTENTIOMETERS (AB or EGEN)

Carbon Track, ¼W Log & ½W Linear values 500Ω, 1K & 2K (lin only), Single	27p
5KΩ 2MΩ single gang	27p
5KΩ 2MΩ single gang D/P switch	65p
5KΩ 2MΩ dual gang stereo	78p

SLIDER POTENTIOMETERS

0.25W log and linear values 60mm	
5KΩ 500KΩ single gang	70p
10KΩ-500KΩ dual gang	80p
Self Stick Graduated Bezels	22p

PRESET POTENTIOMETERS

Vertical & Horizontal	
0 1W 50Ω 5MΩ Miniature	8p
0 25W 100Ω- 3-3MΩ Horiz	10p
0 25W 200Ω- 4 7MΩ Vert	10p

RESISTORS – Erie make 5% Carbon

	RANGE	VAL	1 99	100 +
Miniature High Stability Low noise				
¼W 2 2Ω 4 7M		E24	1.5p	1p
½W 2 2Ω-4 7M		E12	2p	1.5p
1W 2 2Ω 10M		E12	5p	4p
2% Metal Film 10Ω-1MΩ			6p	4p
1% Metal Film 51Ω-1M			10p	8p

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

PE Microprocessor Evaluation System: All parts available, send SAE for list.

OPTO ELECTRONICS★

LEDs plus clip	
TIL209 Red	13
TIL211 Grn	17
TIL2 12 Yellow	18
·2" Red	15
2" Yellow Green	18
Spare Clips	2
Square LEDs Red, Green, Yellow	48
ORP12	63
2N5777	45
7 Seg Displays	
TIL32 Infra Red	58
LS400	255
OCP71	120
TIL307	675
TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DI704 C Cth ·3"	99
DL707 C.A. ·3"	99
DL747 C.A. ·6	180
FND357	120
MAN3640	175
LCD 3½ digit	875

SWITCHES★

TOGGLE 2A 250V	
SPST	28p
DPDT	38p
4 pole on/off	54p
SUB-MIN TOGGLE	
3 pole c/over	155p
SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT Centre off	79p
DPDT Biased	115p
SLIDE 250V:	
1A DPDT	14p
1A DP C/off	15p
½A DPDT	13p
4 pole c/over	24p
PUSH BUTTON	
Spring loaded	
SPST on/off	65p
SPDT c/over	70p
DPDT 6 Tag	85p

JACK PLUGS			SOCKETS		
	Screened chrome	Plastic body	open metal	moulded with break contacts	in line couplers
2·5mm	13p	10p	8p		11p
3·5mm	15p	10p	8p	20p	12p
MONO	25p	14p	13p	20p	18p
STEREO	32p	18p	15p	24p	22p

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker	10p	8p	20p
3 4 5 Pin Audio	13p	10p	20p
Co-axial (plastic)	10p	12p	12p
(metal)	18p	18p	22p
PHONO assorted colours	10p	6p single 8p double	15p
Metal Screened	15p	18p 4-way	20p
BANANA 4mm	11p	12p	—
2mm	12p	12p	—
1mm	6p	6p	—
WANDER 3mm	7p	7p	

SWITCHES ★ Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER: SPST On/off 250V 23p
ROCKER: Illuminated. White with Chrome.
BEZEL: 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

ROTARY: "Make a switch". Make your own multiway switch. Adjustable stop shafting assembly. Takes 6 wafers. 69p
1p/12W. 2p/6W. 3p/4W. 4p/3W. 6p/2W 47p

TTL 74LS★ (TEXAS)

LS00	13	LS63	150	LS153	76	LS240	236	LS346	185		
LS01	13	LS73	46	LS155	96	LS241	231	LS347	48		
LS02	14	LS74	41	LS156	96	LS242	232	LS348	186		
LS03	14	LS75	48	LS157	76	LS243	232	LS352	228		
LS04	14	LS76	40	LS158	96	LS244	155	LS353	228		
LS05	23	LS78	40	LS160	128	LS245	270	LS365	65		
LS08	22	LS83	115	LS161	98	LS247	190	LS366	65		
LS09	22	LS85	118	LS162	138	LS248	190	LS367	65		
LS10	20	LS86	43	LS163	102	LS249	190	LS368	65		
LS11	22	LS90	38	LS164	114	LS251	134	LS373	180		
LS12	23	LS91	104	LS165	75	LS253	142	LS375	160		
LS13	38	LS92	89	LS166	226	LS257	110	LS374			
LS14	75	LS93	89	LS168	155	LS258	110	LS377	212		
LS15	30	LS95	116	LS169	150	LS259	160	LS378	184		
LS20	20	LS96	116	LS170	288	LS261	450	LS379	215		
LS21	22	LS107	44	LS173	105	LS266	52	LS384	86		
LS22	22	LS109	55	LS174	106	LS273	244	LS385	155		
LS26	48	LS112	55	LS175	110	LS275	250	LS386	86		
LS27	28	LS113	50	LS181	398	LS279	66	LS390	230		
LS28	48	LS114	50	LS183	298	LS280	256	LS393	230		
LS30	22	LS122	70	LS189		LS283	192	LS395	218		
LS32	27	LS123	70	LS190	140	LS290	128	LS396	215		
LS33	39	LS124	180	LS191	140	LS293	128	LS398	276		
LS37	39	LS125	60	LS192	132	LS295	185	LS399	230		
LS38	39	LS126	60	LS193	130	LS298	68	LS445	150		
LS40	28	LS132	95	LS194	166	LS299	468	LS447	144		
LS42	98	LS136	55	LS195	136	LS300	175	LS490	180		
LS47	63	LS138	85	LS196	100	LS302	175	LS668	182		
LS48	120	LS139	85	LS197	140	LS323	468	LS669	182		
LS49	120	LS145	108	LS199		LS324	240	LS670	248		
LS51	24	LS147	170	LS200	348	LS325	290	LS673	1050		
LS54	28	LS148	173	LS202	345	LS326	294	LS674	1450		
LS55	30	LS151	96	LS221	96	LS327	286	LS677	1050		

DIL SOCKETS★ (TEXAS)

	Low Profile	Wire Wrap
8pin	10p	25p
14pin	12p	35p
16pin	13p	46p
18pin	16p	52p
20pin	22p	65p
22pin	25p	70p
24pin	26p	78p
28pin	39p	85p
36pin	—	105p
40pin	50p	109p

More ICs Trans. SCRs Triacs Diodes Volt. Reg. Coils PCBs. Vero available.

COMPUTER/VDU HARDWARE★

2102	100	75450	120
2102-2	170	81LS95	99
2111	220	81LS96	99
2112	105	81LS97	120
2112-2	210	AY-3-1015	560
2114	786	AY-5-1013	450
2513	650	MC1488	85
2516	2950	CP1610	
2708	776	MC1489	90
4027	325	MC14411	958
4047	750	SFC71301	820
71301	820	SFF96364E	
74S188	185		1175
74S262	895	SFS80102	205
74S287	325	Z80	1150
74S470	325	UHF Modulator	
74S475	825		250

TTL 74★

7400	11	7494	78	74194	98
7401	11	7495	65	74195	98
7402	11	7496	57	74196	93
7403	12	7497	189	74197	80
7404	12	74100	119	74198	150
7405	18	74105	62	75150	175
7406	28	74107	29	75491	92
7407	38	74109	54	75492	92
7408	17	74110	54		
7409	17	74111	68		
7410	11	74112	125		
7411	20	74116	198		
7412	17	74118	83		
7413	30	74119	149		
7414	45	74120	115		
7416	30	74121	25		
7417	30	74122	46		
7420	16	74123	48		
7421	29	74125	38		
7422	17	74126	57		
7423	27	74128	74		
7425	27	74132	73		
7426	36	74136	65		
7427	27	74141	56		
7428	35	74142	209		
7430	17	74143	314		
7432	25	74144	314		
7433	40	74145	65		
7437	30	74147	175		
7438	33	74148	109		
7440	15	74150	99		
7441	74	74151	64		
7442	68	74153	64		
7443	115	74154	96		
7444	112	74155	53		
7445	94	74156	80		
7446	94	74157	67		
7447	57	74159	185		
7448	51	74160	82		
7450	17	74161	92		
7451	17	74162	92		
7453	17	74163	92		
7454	17	74164	105		
7460	17	74165	105		
7470	28	74166	140		
7472	25	74167	200		
7473	32	74170	185		
7474	25	74172	625		
7475	38	74173	120		
7476	36	74174	87		
7480	48	74175	87		
7481	86	74176	75		
7482	69	74177	78		
7483	72	74178	153		
7484	95	74180	85		
7485	75	74181	165		
7486	31	74182	88		
7489	140	74184	135		
7490	30	74185	135		
7491	75	74188	275		
7492	38	74190	95		
7493	32	74191	95		
		74192	98		
		74193	98		

CMOS★

4000	15	4056	134
4001	17	4057	1999
4002	16	4059	480
4006	92	4060	115
4007	18	4061	1425
4008	82	4062	999
4009	38	4063	110
4010	38	4066	58
4011	18	4067	380
4012	18	4068	22
4013	45	4069BE	20
4014	80	4070	32
4015	82	4071	21
4016	45	4072	21
4017	82	4073	21
4018	87	4075	23
4019	48	4076	85
4020	99	4077	40
4021	95	4078	21
4022	85	4081	20
4023	22	4082	21
4024	66	4085	74
4025	19	4086	73
4026	180	4089	150
4027	45	4093	85
4028	81	4094	190
4029	99	4095	105
4030	58	4096	105
4031	205	4097	372
4032	100	4098	110
4033	145	4099	145
4034	116	4160	109
4035	111	4161	109
4036	325	4162	109
4037	100	4163	109
4038	108	4174	110
4039	320	4175	99
4040	105	4194	108
4041	80	4408	720
4042	75	4409	720
4043	94	4410	720
4044	95	4411	958
4045	145	4412F	1650
4046	128	4412V	1380
4047	87	4415F	795
4048	58	4415V	795
4049	48	4419	280
4050	48	4422	545
4051	72	4433	995
4052	72	4435	825
4053	72	4440	1275
4054	110	4450	295
4055	128	4451	295
		4490F	695
		4490V	525
		4501	19
		4502	120
		4503	69
		4506	51
		4507	55
		4508	298
		4510	99
		4511	150
		4512	98

LINEAR IC'S

702★	75	M252AA★	750
709C 14 pin	35	M253AA★	795
710★	67	MC1303	88
723★	45	MC1304P	260
733★	125	MC1310	149
741C★ 8 pin	18	MC1312P	195
747C★	78	MC1495★	390
748C★	36	MC1496★	92
753★	150	MC1710★	79
810★	159	MC3401	52
AY-1-0212	580	MC3403★	135
AY 1-1313★	660	MC3340P★	120
AY-1-1320	315	MC3360P	120
AY-1-5050	180	MFC6040★	97
AY-1-5051	145	MK50398★	635
AY-1-6721/6	195	MK50362★	650
AY-3-8500★	385	MM5303★	635
AY-5-1224A★	260	MM57160★	620
AY-5-1230★	450	NE518A★	210
AY-5-1315	560	NE555★	22
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
CA3036★	110	NE567★	170
CA3043	190	NE570★	420
CA3046★	71	NE571★	450
CA3048	200	RC4136D★	120
CA3075	175	SAD1024A★	1350
CA3080E★	80	SG3402	295
CA3081	190	SN76003N	170
CA3085★	85	SN76013N	140
CA3089E	210	SN76023N	140
CA3090AQ	398	SN76033N	175
CA3123E	200	SN76115N	215
CA3130★	85	SN76477★	225
CA3140★	80	SN76227	.115
ICL7107★	975	TAA621AX1	250
ICL7106E★	795	TAA960	320
ICL7555★	95	TBA120S	70
ICL8038★	340	TBA5400	220
ICM7205★	1150	TBA6418X11	250
ICM7215★	1025	TBA651	180
ICM7217★	790	TBA800	90
LD130★	452	TBA810S	95
LF356★	98	TBA820	70
LM301A	30	TDA1004★	290
LM304	240	TDA1008★	290
LM308★	95	TDA1022★	575
LM318	195	TDA2020	320
LM324★	68	TL061CP★	48
LM339★	70	TL062CP★	125
LM348★	90	TL064CN★	199
LM379★	375	TL081CP★	52
LM380	90	TL082CP★	96
LM381N	145	TL084CP★	130
LM382	122	UAA170	198
LM1458★	50	VAA180	198
LM3900★	60	ZN414	90
LM3909N★	70	ZN424	135
LM3911★	125	ZN425E★	415
		ZN1034E★	200

TRANSISTORS

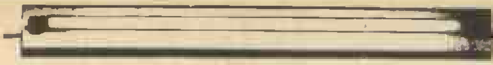
AC117★	35	BC169C	12	BF184★	38	OC29★	160	ZTX311	17	2N3663	26
AC125★	20	BC170	18	BF194	12	OC35★	130	ZTX314	24	2N3702	11
AC126★	20	BC171	11	BF195	12	OC36★	130	ZTX326	30	2N3703	11
AC127★	20	BC172	11	BF196	12	OC41★	148	ZTX341	20	2N3704	11
AC128★	20	BC177★	18	BF197	14	OC42★	48	ZTX500	15	2N3705	11
AC141★	24	BC178★	16	BF198	18	OC43★	85	ZTX501	15	2N3706	11
AC141K★	38	BC179★	18	BF200★	30	OC44★	31	ZTX502	19	2N3707	11
AC142★	24	BC182	9	BF224A	18	OC45★	28	ZTX503	15	2N3708	11
AC142K★	38	BC182L	11	BF244	30	OC46★	28	ZTX504	25	2N3709	11
AC176★	22	BC183	9	BF256★	60	OC70★	28	ZTX531	25	2N3710	16
AC178	22	BC183L	11	BF257★	30	OC71★	28	ZTX550	25	2N3711	12
AC187★	20	BC184	9	BF258★	30	OC72★	42	2N526★	58	2N3715★	250
AC188★	22	BC184L	11	BF259★	30	OC74★	55	2N696★	35	2N3771★	233
ACY17★	35	BC186	21	BF394	27	OC76★	36	2N697★	25	2N3772★	195
ACY18★	40	BC187★	28	BF594	40	OC77★	76	2N698★	44	2N3773★	288
ACY19★	40	BC212	10	BF595	38	OC79★	76	2N699★	54	2N3819	22
ACY20★	40	BC212L	11	BFR39	25	OC81★	50	2N706A★	19	2N3820	45
ACY21★	35	BC213	11	BFR40	28	OC82★	50	2N707★	39	2N3823★	95
ACY22★	40	BC213L	12	BFR41	28	OC83★	48	2N708★	19	2N3824★	70
ACY28★	40	BC214	12	BFR79	28	OC84★	44	2N914★	32	2N3866★	90
ACY39★	78	BC214L	13	BFR80	28	OC122★	48	2N916★	27	2N3903	20
ACY40★	48	BC307B	20	BFR81	28	OC123★	48	2N918★	40	2N3904	18
ACY44★	39	BC308	20	BFX29★	28	OC139★	110	2N920★	51	2N3905	18
AD140★	68	BC328	15	BFX81★	45	OC140★	110	2N930★	18	2N3906	17
AD149★	70	BC338	12	BFX84★	26	OC141★	110	2N961★	61	2N4037★	52
AD161★	42	BC441★	36	BFX85★	28	OC170★	40	2N1131★	22	2N4058	17
AD162★	42	BC461★	36	BFX86★	28	OC171★	40	2N1132★	22	2N4061	17
AF114★	40	BC477★	25	BFX87★	28	OC201★	75	2N1302★	35	2N4064★	120
AF115★	40	BC547	12	BFX88★	28	OC202★	95	2N1303★	50	2N4236★	145
AF116★	40	BC548	12	BFY18★	50	OC203★	85	2N1304★	50	2N4289	20
AF117★	40	BC549C	13	BFY50★	20	OC204★	85	2N1305★	28	2N4859	65
AF118★	65	BC557	15	BFY51★	20	TIP29A	44	2N1306★	35	2N5135	42
AF121★	48	BC559C	20	BFY52★	20	TIP29C	60	2N1307★	50	2N5136	42
AF124★	55	BCY30★	57	BFY71★	20	TIP30A	50	2N1308★	46	2N5138	20
AF125★	35	BCY34★	75	BSX20★	18	TIP30B	64	2N1613★	23	2N5179★	60
AF127★	35	BCY39★	80	BSY65★	30	TIP30C	65	2N1670★	150	2N5180★	38
AF139★	35	BCY40★	78	BSY95A★	18	TIP31A★	50	2N1671B★	215	2N5191★	70
AF178★	70	BCY43	85	BU105	140	TIP31B★	58	2N1893★	28	2N5305★	40
AF180★	70	BCY58★	90	BU205★	190	TIP31C★	66	2N1986★	60	2N5457	32
AF186★	50	BCY59★	90	BU208★	225	TIP32A★	55	2N2160★	350	2N5458	32
AF239★	42	BCY70★	18	E113	75	TIP32B★	70	2N2217★	43	2N5459	32
ASY26★	40	BCY71★	20	E176	115	TIP32C★	75	2N2218A★	34	2N5485	35
ASY27★	45	BCY72★	20	E421	96	TIP33A★	80	2N2219A★	20	2N5777★	45
BC107★	9	BCY78★	25	MD8001★	158	TIP33B★	100	2N2220A★	23	2N6027	40
BC107B★	10	BD115★	65	ME4102	10	TIP33C★	110	2N2221★	23	2N6109★	50
BC108★	9	BD121★	78	ME6002	10	TIP34A★	85	2N2222★	20	3N128★	112
BC108B★	10	BD123★	98	MJ400★	90	TIP34B★	110	2N2297★	45	3N140★	112
BC108C★	12	BD124★	115	MJ491★	160	TIP34C★	110	2N2303★	45	40311★	60
BC109★	9	BD131★	45	MJ2955★	120	TIP35A★	195	2N2368★	21	40313★	125
BC109B★	12	BD132★	45	MJE340★	54	TIP35C★	245	2N2369★	15	40316★	85
BC109C★	12	BD133★	43	MJE370★	58	TIP36A★	220	2N2476★	125	40317★	52
BC113	20	BD135★	38	MJE371★	60	TIP36C★	295	2N2483★	28	40324★	85
BC114	20	BD136★	37	MJE520★	65	TIP41A★	66	2N2484★	25	40326★	52
BC115	20	BD137★	36	MJE521★	74	TIP41B★	73	2N2646★	48	40327★	62
BC116	20	BD138★	50	MJE2955★	99	TIP42A★	72	2N2784★	55	40347★	80
BC117	20	BD139★	40	MJE3055★	70	TIP42B★	82	2N2846★	140	40348★	105
BC118	20	BD140★	36	MPF102	66	TIP2955★	65	2N2894★	30	40360★	43
BC119★	28	BD142★	59	MPF103	36	TIP3055★	52	2N2904A★	22	40361★	45
BC134	20	BD145★	198	MPF104	36	TIS43	34	2N2905A★	22	40362★	45
BC135	20	BD222★	75	MPF105	36	TIS44	45	2N2906★	22	40407★	52
BC136	18	BD695A★	65	MPF106	50	TIS45	45	2N2907★	22	40411★	295
BC137	20	BD696A★	65	MPF107	50	TIS46	45	2N2907A★	22	40412★	65
BC140★	35	BDY17★	195	MPSA05★	25	TIS47	50	2N2926G	10	40467★	95
BC142★	30	BDY60★	110	MPSA06★	25	TIS48	50	2N3011★	24	40594★	90
BC143★	30	BDY61★	165	MPSA12	42	TIS50	47	2N3053★	20	40595★	98
BC147	8	BF115★	34	MPSA55	25	TIS60	52	2N3054★	55	40603★	65
BC148	8	BF154★	25	MPSA56	25	TIS62	52	2N3055★	55	40636★	125
BC149	8	BF167	30	MPSA70	34	TIS74	47	2N3108★	32	40673★	68
BC153	27	BF173★	25	MPSU02★	58	TIS90	20	2N3121★	40		
BC154	27	BF177★	24	MPSU05★	50	TIS91	24	2N3133★	43		
BC157	10	BF178★	25	MPSU06★	56	ZTX107	12	2N3135★	33		
BC158	11	BF179★	30	MPSU52★	65	ZTX108	12	2N3250★	30		
BC159	11	BF180★	35	MPSU55★	55	ZTX109	14	2N3252★	36		
BC160	42	BF181★	35	MPSU56★	60	ZTX300	15	2N3302★	30		
BC167A	11	BF182★	35	MPU131★	39	ZTX301	15	2N3442★	146		
BC168C	12	BF183★	35	OC25★	170	ZTX302	20	2N3563	20		
				OC26★	170	ZTX303	25	2N3614★	269		
				OC28★	150	ZTX304	24	2N3615★	269		

Diodes

IN914	4
IN4148	4
CRO33★	148
Zeners 2.7V-33V	
400mW	9
1.3W	17

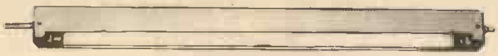
+ BATTERY FLUORESCENT LIGHTING —

Type "A"

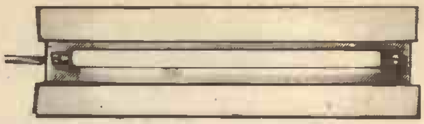


Type "C"

Type "B"



Type "D"



White Enamel cases as shown above, including lampholders. Type "A" or "B" **£1·50** + 12p VAT. Case only, **£1·00** + 8p VAT. Plastic Lampholders to suit **50p** + 4p VAT pair. Ceramic (adaptable) **40p** + 4p VAT pair. Tubes to fit (21 in.) **£1·00** + 8p VAT. (These can only be supplied when cases are ordered due to risk of postal damage.) Case type "C" (18 in.) or Case type "D" (12 in.) including lampholders **£1·25** + 10p VAT.

INVERTED TRANSFORMERS, special design for maximum efficiency .... **£1·00** each + 8p VAT

Transistor, Heat Sink, Circuit board cut to size, Resistor, Capacitors etc. .... **£1·00** pack + 8p VAT

21 in. Fittings built and tested .... **£4·95** + 40p VAT

12 in. ditto (Batten type) .... **£4·95** + 40p VAT

THIS IS ABOUT HALF THE PRICE THAT A SIMILAR FITTING WOULD COST YOU ELSEWHERE!!!!

WHY NOT DO AS MANY OTHERS ARE DOING, BUILD THEM AND SELL THEM TO YOUR CAMPING FRIENDS?

PRINTED CIRCUITS. WHY NOT MAKE YOUR OWN WITH *FOTOLAK* POSITIVE LIGHT SENSITIVE LACQUER

Now you can produce perfect printed circuits in minutes! Method: Spray cleaned board lightly with lacquer. When dry, place positive master of required circuit on now sensitised surface. Expose to daylight, develop and etch. Any number of exact copies can of course be made from one master. Widely used in industry for prototype work.

FOTOLAK Aerosol	£1·50 + 12p VAT
Developer	·30 + 3p VAT
Ferric Chloride	·40 + 4p VAT
Clear Acetate Sheet	·12
Daylo Pens	·75 + 6p VAT

Pre-coated 1/16" Fibre-glass board:	
204mm x 114mm	£1·50 + 12p VAT
204mm x 228mm	£3·00 + 24p VAT
408mm x 228mm	£6·00 + 48p VAT
467mm x 305mm	£9·00 + 72p VAT

Plain Copper-clad Fibre-glass	Single-sided	Double
Approx. 3·18mm thick, sq. ft.	£1·25 + 10p VAT	£1·50 + 12p VAT
Approx. 2·00mm thick, sq. ft.	£2·00 + 16p VAT	£2·25 + 18p VAT
Approx. 1·00mm thick, sq. ft.	£1·50 + 12p VAT	£1·75 + 14p VAT
Approx. ·79mm thick, sq. ft.	£1·25 + 10p VAT	

Giant packs of unused mixed components! Weight 4lbs., these contain an assortment of resistors (carbon and wire-wound); capacitors, (electrolytic, paper, silver-mica, polyester and polystyrene); transistors, diodes, volume and pre-set controls and hosts of other 'bits and pieces'. No two bags are the same, but all contain a jolly good mixture of parts. Ideal for the odds and ends box!!! Per bag .... **£3·00** + 38p VAT

SPECIAL OFFER! Few only 3-channel (each 750 watts) Sound-to-light units. Fantastic value for money! Plug into any loudspeaker socket and create your own disco-type light show! Any mains lamps may be used .... **£17·95** + £1·44 VAT

Brand new printed circuit boards containing I.C's., transistors, diodes, resistors, capacitors etc. etc. It is quite impossible to list these so we are selling by weight at **£1·00** + 8p VAT per lb. This could include upwards of 100 intregated circuits! Send as many £1's as you wish, we will weigh as varied a parcel as possible and refund your change!

PLEASE NOTE: Prices + VAT as shown. No VAT on overseas orders. Postage **INLAND** 65p per order. Overseas include extra to cover. We will refund any excess paid. Any enquiries for further details MUST include stamped addressed envelope!

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the Crofton ASCII Encoded Keyboard

in kit form £38·40 inc. VAT and p/p

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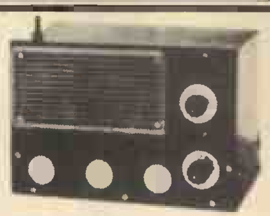
NEW ROAMER TEN R.K.3.

Multiband V.H.F. and A.M. Receiver. 13 Transistors and Six Diodes. Quality 6" x 3" Loudspeaker.

With Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations etc. and Multi-band A.M. section with Airspaced Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands S.W.1, S.W.2, S.W.3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc., Chrome-plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception, Push-Pull output using 600mW Transistors. Gain. Wave-Change and Tone Controls. Plus two Slider Switches. Powered by P.P.9-9 volt Battery.

Complete kit of parts including carrying strap. Building Instructions and operating Manuals.



£14.79 + £1.10 P & P

For further details of our other kits please write, enclosing S.A.E., to:

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JOANNA 72 & 88 PIANOS
Six and $7\frac{1}{4}$ Octave Electronic Pianos with unique Touch Sensitive Action, as used in the P.E. JOANNA, which electronically simulates piano key inertia – a feature not available in any other design. A new physical layout has been adopted to simplify construction.

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The only kit available to the proven A. J. Boothman Design for this versatile String Machine.

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AND OTHER PROJECTS

PHOTOGRAPHS In this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list: Europe—send 20p; other countries—send 50p.

KIMBER-ALLEN KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes)	£25·50
4 Octave (49 notes)	£32·25
5 Octave (61 notes)	£39·75

Contact Assemblies (gold-clad wire) for use with the above KBDS (1 for each note):

Type GJ: Single-pole change-over	each 25½p
Type GA: 1 pair of contacts, normally open	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with most contacts (thus eliminating much interwiring) are available. Details in our lists.

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

Main component set (incl. PCB)	£14·93
Power supply set (incl. PCB)	£6·28

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl sw.)	£7·45

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)
A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

Component set	£24·05*
Printed circuit board	£3·03*

*This kit & PCB are at 8% VAT (all others are 12½%)

TAPE NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs

Standard tolerance set of components	£2·96
Superior tolerance set of components	£3·76
Regulated power supply (will drive 2 sets)	£4·69

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.

Component set (incl. PCB)	£4·58

DISCOSTROBE (P.E. Nov. 76)
4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation.

Basic component set	£18·19
Printed circuit board	£3·45

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)
Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Components set (incl. PCB)	£3·95
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6·59
Audio Amplifier Module Type PC7	£7·75

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.
Details in lists.

SOPHISTICATED POWER SUPPLIES
A wide range of highly stabilised low noise power supply kits is available—details in our lists.

NEW PCB SERVICE

PCBS FOR ALL NEW P.E. & E.E. PROJECTS FOR WHICH PCB LAYOUTS HAVE BEEN PUBLISHED AND FOR WHICH FULL COPYRIGHT CLEARANCE IS AVAILABLE.

LIMITED QUANTITIES ONLY FOR AN EXPERIMENTAL PERIOD.

LET US KNOW YOUR NEEDS AND WE WILL ADVISE YOU OF AVAILABILITY AND PRICES.

INTEGRATED CIRCUITS

301	8-pin DIL	48p
318	8-pin DIL	220p
320-15	---	195p
324	14-pin DIL	87p
341-15	---	87p
709	8-pin DIL	48p
723	TO5	87p
723	14-pin DIL	51p
726	TO5	1005p
741	8-pin DIL	24p
748	8-pin DIL	57p
4007	14-pin DIL	17½p
4011	14-pin DIL	17½p
4024	14-pin DIL	46½p
4069	14-pin DIL	18p
4136	14-pin DIL	126p
AM2833	8-pin DIL	360p
AY10212	16-pin DIL	617p
AY16721/6		188p
CA3046	14-pin DIL	71p
CA3080	8-pin DIL	63p
CA3084	14-pin DIL	209p
FX209	16-pin DIL	729p
LM323	---	562p
M252	16-pin DIL	680p
MC3340	8-pin DIL	150p
MCM6810	24-pin DIL	670p
SG3402N	14-pin DIL	262p
STK025	---	595p
TDA1022	16-pin DIL	582p
XR2207	14-pin DIL	420p
ZN425E	16-pin DIL	375p

TRANSISTORS

AC128	32p
AC176	28p
BC107	13p
BC108	13p
BC109	15p
BC109C	16p
BC177	18p
BC184	11p
BC187	18p
BC204	10p
BC209C	13p
BC213	11p

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OSCILLOSCOPES

We have available from stock the following SCOPEX models: 4D10A – DC-10MHz; 10mV sensitivity; Stab Power supplies; Dual beam; 3% accuracy; Excellent value at **£214** inc VAT and Carr.
4S6 – DC-6MHz; 10mV sensitivity. Ideal portable scope. Solid state circuitry. All for **£150** inc VAT and Carr.

RELAYS

W847 Low profile PC mntg 10 x 33 x 20mm 6V coil, SPCO 3A contacts. **93p**
W817 11 pin plug in relay, rated 24V ac, but works well on 6V DC. Contacts 3 pole c/o rated 10A. **95p**
W839 50V ac (24V DC) coil. 11 pin plug in type. 3 pole c/o 10A contacts Only **85p**
W846 Open construction mains relay. 3 sets 10A c/o contacts, **£1.20**
W877 675R 12-27V DPCO 23 x 20 x 10mm sealed can **86p**
W880 230V ac DPCO 10A contacts, enclosed case **£1.30**
W830 200R 6-12V DPCO 23 x 20 x 10mm sealed can **88p**
Send SAE for our relay list – 84 types listed and illustrated.

AMPLIFIER KIT £1·75

Mono gen. purpose amp with tone and Vol/on-off controls. Utilizes sim. circuitry to above amp. Output 2W into 8 ohms. Input matched for crystal cartridge. 4 transistor circuit. Simple to build on PCB provided. Can be either battery or mains operated. (For mains powered version add **£2·20** for suitable transformer.) Blue vinyl covered aluminium case to suit (W372) **£1·30**

STEREO V.U. METER

2 meters 40 x 40mm plus driver board supplied with full data and circuit **£3.50**

DIN SOCKET OFFER

2 pin switched speaker socket, PC mounting; 5 pin 180° PC mntg or chassis mntg (clip fix). All the same price, any mix: 10 for **70p** 25 for **£1·60** 100 for **£5·50**.

TMS4030 RAM

4096 bit dynamic RAM with 300ns access time; 470ns cycle time; single low capacitance high level clock i/p; Fully TTL compatible; Low power dissipation. Supplied with data **£2·75**

MISCELLANEOUS IC's

Supplied with data if requested. MC3302 quad comp. **120p**; 710 diff comp. (TO99) **40p**; ZN1034E precision timer **£2·25**; LM711 Dual diff comp **65p**; LM1303 dual stereo pre-amp **75p**; MC1469R voltage reg **£1·50**; UPC1025H audio **£3·50**; 575C2 audio **£2·88**; TDA2640 audio **£2·92**; SN75110 dual line driver **70p**; MC8500 CRCC gen POA

EDGE CONNECTORS

Special purchase of these 0·1" pitch double-sided gold-plated connectors enables us to offer them at less than one-third of their original list price!
40 way **90p**

HEAT SINK OFFER

Copper TO5 sink 17mm dia x 20mm. 10 for **40p**; 100 for **£3**; 1000 for **£25**

74 SERIES PACK

Selection of boards containing many different 74 series IC's. 20 for **£1**; 50 for **£2.20**; 100 for **£4**.

THE NEW 1978-9
GREENWELD
CATALOGUE

FEATURES INCLUDE:

- 50p Discount Vouchers
- Quantity prices for bulk buyers
- Bargain List Supplement
- Reply Paid Envelope
- Priority Order Form
- VAT inclusive prices

PRICE **30p** + 15p POST

KITS! KITS!

Send S.A.E. for list of kits from a single Amplifier to a Reaction Tester, etc.

NIXIE TUBES

ITT Type GNP7AH. Supplied with data **60p** each
7-seg display, wire ended tube NEC type LD8012 ½" high, with data **65p**
7-seg display, (as above) Futaba type DG-10Q1 0.3" char. **70p** with data

PUSH BUTTON BANKS

Illustrated list of types from 30p in our Bargain List No 6 – Send SAE.

BC182B OFFER

Special Offer for quantity users 1k .035+ VAT; 5k .032+VAT. Price negotiable on 10k. Approx 70k available.

DIODE SCOOP!!!

We have been fortunate to obtain a large quantity of untested, mostly unmarked glass silicon diodes. Testing a sample batch revealed about 70% useable devices – signal diodes, high voltage rects and zeners may all be included. These are being offered at the incredibly low price of **£1·25**/1000 – or a bag of 2500 for **£2·25**. Bag of 10,000 **£8**. Box of 25,000 **£17·50**. Box of 100,000 **£60**.
Disc Ceramic Caps = big variety of values and voltages from a few pF to 2.2uF; 3V to 3kV. 200 for **£1**; 1000 **£4**.

PC ETCHING KIT MK III

Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. **£4·25**

BUY A COMPLETE RANGE OF COMPONENTS AND THESE PACKS WILL HELP YOU

★ ***SAVE ON TIME**—No delays in waiting for parts to come or shops to open!*

★ ***SAVE ON MONEY**—Bulk buying means lowest prices—just compare with others!*

★ ***HAVE THE RIGHT PART**—No guesswork or substitution necessary!*

ALL PACKS CONTAIN FULL SPEC, BRAND NEW, MARKED DEVICES— SENT BY RETURN OF POST. VAT INCLUSIVE PRICES.

K001 50V ceramic plate capacitors, 5%. 10 of each value 22pF to 1000pF. Total 210, **£3.60**
K002 Extended range, 22pF to 0·1μF. 330 values **£5.40**
K003 Polyester capacitors, 10 each of these values: 0·01, 0·015, 0·022, 0·033, 0·047, 0·068, 0·1, 0·15, 0·22, 0·33, 0·47μF. 110 altogether for **£4.95**
K004 Mylar capacitors, min 100V type. 10 each all values from 1000pF to 10,000pF. Total 130 for **£3·75**
K005 Polystyrene capacitors, 10 each value from 10pF to 10,000pF, E12 series 5% 160V. Total 370 for **£12·30**
K006 Tantalum bead capacitors. 10 each of the following: 0·1, 0·15, 0·22, 0·33, 0·47, 0·68, 1, 2·2, 3·3, 4·7, 6·8, all 35V; 10/25 15/16 22/16 33/10 47/6 100/3. Total 170 tants for **£14·20**
K007 Electrolytic capacitors 25V working, small physical size. 10 each of these popular values: 1, 2·2, 4·7, 10, 22, 47, 100μF. Total 70 for **£3·50**
K008 Extended range, as above, also including 220, 470 and 1000μF. Total 100 for **£5·90**
K021 Miniature carbon film 5% resistors, CR25 or similar. 10 of each value from 10R to 1M, E12 series. Total 610 resistors, **£6·00**
K022 Extended range, total 850 resistors from 1R to 10M **£8·30**
K041 Zener diodes, 400mW 5% BZY88, etc. 10 of each value from 2·7V to 36V, E24 series. Total 280 for **£15·30.**
K042 As above but 5 of each value **£8·70**

TRANSFORMERS

All mains primary: 12-0-12V 50mA **85p**; 100mA **95p**; 1A **£2.50**. 6-0-6V 100mA **85p**; 1½A **£2.40**. 9-0-9V 75mA **85p**; 1A **£2.10**. Multitapped type 0-12-15-20-24-30V, 1A **£3.95**; 2A **£5.35**; 3A **£6.90**. 20V 2½A **£3.90**; 25V 1½A **£2.25**; 12V 8A **£4**; 24V 5A **£7.50**; 0-22-34-41V 4A **£7.50**; 20V @ 300mA twice **£2.50**;

SEMICONDUCTORS POTS & IRONS

SOCKETS

1611	8 pin DIL	£0·11
1612	14 pin DIL	£0·12
1613	16 pin DIL	£0·13
1614	24 pin DIL	£0·25
1615	28 pin DIL	£0·30
1616	TO18 Transistor	£0·12
1617	TU3 Transistor	£0·35
16117	TO5 Transistor	£0·12

VOLTAGE REGULATORS

Positive

MVR7805 v.a. 7805 TO220	£0·70
MVR7812 v.a. 7812 TO220	£0·70
MVR7815 v.a. 7815 TO220	£0·70
MVR7818 v.a. 7818 TO220	£0·70
MVR7824 v.a. 7824 TO220	£0·70

Negative

MVR7905 v.a. 7905 TO220	£0·80
MVR7912 v.a. 7912 TO220	£0·80
MVR7915 v.a. 7915 TO220	£0·80
MVR7918 v.a. 7918 TO220	£0·80
MVR7924 v.a. 7924 TO220	£0·80
v.a. 723C TO99	£0·45
72723 14 pin DN	£0·45
LM309K TO3	£1·50

ZENER DIODES

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.

1w-1·5w *Plastic and metal 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, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v
No. Z13 15p ea.

10w *Metal stud type SO10 case.* 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, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v.
No. Z10 35p ea.

SILICON RECTIFIERS

200mA	
IS920 50v	£0·06
IS921 100v	£0·07
IS922 150v	£0·08
IS923 200v	£0·09
IS924 300v	£0·10
1 Amp	
IN4001 50v	£0·04½
IN4002 100v	£0·05
IN4003 200v	£0·06
IN4004 400v	£0·07
IN4005 600v	£0·08
IN4006 800v	£0·09
IN4007 1000v	£0·10
1·5 Amp	
IS015 50v	£0·09
IS020 100v	£0·10
IS021 200v	£0·11
IS023 400v	£0·13
IS025 600v	£0·14
IS027 800v	£0·16
IS029 1000v	£0·20
IS031 1200v	£0·25
3 Amp	
IN5400 50v	£0·14
IN5401 100v	£0·15
IN5402 200v	£0·16
IN5404 400v	£0·17
IN5406 600v	£0·21
IN5407 800v	£0·25
IN5408 1000v	£0·30
10 Amp	
IS10/50 50v	£0·19
IS10/100 100v	£0·21
IS10/200 200v	£0·23
IS10/400 400v	£0·35
IS10/600 600v	£0·42
IS10/800 800v	£0·51
IS10/1000 1000v	£0·60
IS10/1200 1200v	£0·69
30 Amp	
IS30/50 50v	£0·56
IS30/100 100v	£0·69
IS30/200 200v	£0·93
IS30/400 400v	£1·25
IS30/600 600v	£1·76
IS30/800 800v	£1·94
IS30/1000 1000v	£2·31
IS30/1200 1200v	£2·88
60 Amp	
IS70/50 50v	£0·75
IS70/100 100v	£0·84
IS70/200 200v	£1·20
IS70/400 400v	£1·75
IS70/600 600v	£2·25
IS70/800 800v	£2·50
IS70 1000 1000v	£3·00
BYX38/300 6A 300v	£0·45
BYX38/600 6A 600v	£0·60
BYX38/300 Rev 6A 300v	£0·45
BYX38/600 Rev 6A 600v	£0·60

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*
1843 10kohms £0·26* 1847 220kohms £0·26*
1844 22kohms £0·26* 1848 470kohms £0·26*
1845 47kohms £0·26* 1849 1Meg £0·26*
1850 2M2 £0·26*

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 £0·86* 1855 100kohms £0·86*
1852 10kohms £0·86* 1856 220kohms £0·86*
1853 22kohms £0·86* 1857 470kohms, £0·86*
1854 100kohms £0·86* 1858 1Meg £0·86*
1859 2M2 £0·86*

DUAL CARBON POTS (Log Law)

1860 4k7ohms £0·86* 1864 100kohms £0·86*
1861 10kohms £0·86* 1865 220kohms £0·86*
1862 22kohms £0·86* 1866 470kohms £0·86*
1863 47kohms £0·86* 1867 1Meg £0·86*
1868 2M2 £0·86*

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 £0·65* 1874 100kohms £0·65*
1871 10kohms £0·65* 1875 220kohms £0·65*
1872 22kohms £0·65* 1876 470kohms £0·65*
1873 47kohms £0·65* 1877 1Meg £0·65*
1878 2M2 £0.65*

SWITCHED POT (Log Track)

Specification as VC2 but track having (log) law.

1879 4k7ohms £0·65* 1833 100kohms £0·65*
1880 10kohms £0·65* 1884 220kohms £0·65*
1881 22kohms £0·65* 1885 470kohms £0·65*
1882 47kohms £0·65* 1886 1Meg £0·65*
1887 2M2 £0·65*

DUAL GANG LOG-ANTI-LOG POT

1888 Track specification as dual gang pots VC3, but tracks mounted to log-anti-log action 100kohms £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 £0·09* 1808 22kohms £0·09*
1802 220ohms £0·09* 1809 47kohms £0·09*
1803 470ohms £0·09* 1810 100kohms £0·09*
1804 1kohms £0·09* 1811 220kohms £0·09*
1805 2k2ohms £0·09* 1812 470kohms £0·09*
1806 4k7ohms £0·09* 1813 1Mohms £0·09*
1807 10kohms £0·09* 1814 2M2ohms £0·09*
1815 4M7ohms £0·09*

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 £0·09* 1823 22kohms £0·09*
1817 220ohms £0·09* 1824 47kohms £0·09*
1818 470ohms £0·09* 1825 100kohms £0·09*
1819 1kohms £0·09* 1826 220kohms £0·09*
1820 2k2ohms £0·09* 1827 470kohms £0·09*
1821 4k7ohms £0·09* 1828 1Megohms £0·09
1822 10kohms £0·09* 1829 2M2ohms £0·09
1830 4M7ohms £0·09*

ANTEX IRONS

O/No. 1943. 15 watt high quality soldering iron totally enclosed element in a ceramic shaft fitted with 3/32" bit. £3·80

O/No. 1947. Replacement element for 1943 iron. £1·90

O/No. 1944. Iron coated bit 3/32" for 1943 iron. £0·46

O/No. 1945. Iron coated bit 1/8" for 1943 iron. £0·46

O/No. 1946. Iron coated bit 3/16" for 1943 iron. £0·46

O/No. 1948. General purpose 18 watt iron fitted with iron coated bit. £3·60

O/No. 1952. Replacement element for 1948 iron. £1·90

O/No. 1949. Iron coated bit 3/32" for 1948 iron. £0·46

O/No. 1950. Iron coated bit 1/8" for 1948 iron £0·46

O/No. 1951. Iron coated bit 3/16" for 1948 iron. £0·46

O/No. 1931. Highly popular X25 25 watt quality soldering iron ceramic shafts to provide near perfect insulation break-down voltage of 1500 volts AC and a leakage current of only 3-5uA and another shaft of stainless steel to ensure strength. £3·60

O/No. 1935. Replacement element for 1931 iron. £1·60

O/No. 1932. Iron coated bit 1/8" for 1931 iron. £0·50

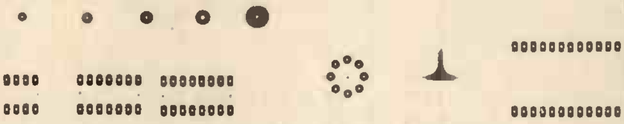
O/No. 1933. Iron coated bit 3/16" for 1931 iron. £0·50

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. £5.55

O/No. 1939. ST3 soldering iron stand. Stand made from high grade bakelite material chromium plated strong steel spring, suitable for all models, includes accommodation for six spare bits and two sponges which serve to keep the soldering iron bits clean. £1·50

PRINTED CIRCUIT BOARD TRANSFERS



Draw your own boards with the new BI-PAK etch-resist transfers. Lay the symbols on the board, rub over with a soft pencil. The transfer will adhere to the board. Then complete the circuit with your BI-PAK etch-resist pen.

Each pack contains 11 sheets of transfers 1 of each as shown above.
Illustrations – approx. ½ size.
O/No: TR400 @ £1·50 p&p £0·10

BRIDGE RECTIFIERS

Type	Order No.	Price
SILICON 1 amp		
50V RMS	BR1/50	£0·20
100V RMS	BR1/100	£0·22
200V RMS	BR1/200	£0·25
400V RMS	BR1/400	£0·36
SILICON 2 amp		
50V RMS	BR2/50	£0·45
100V RMS	BR2/100	£0·48
200V RMS	BR2/200	£0·52
400V RMS	BR2/400	£0·58
1000V RMS	BR2/1000	£0·68

OPTOELECTRONICS

NEW INCREASED RANGE – ALL 1ST QUALITY

LED'S (diffused)

O/no.	Type	Size	Colour	Price
1501	ARL209(TIL209)	.3mm (.125)	RED	£0·10
1502	MIL3232(TIL211)	.3mm (.125)	GREEN	£0·15
1503	MIL3331 (OPL212A)	.3mm (.125)	YELLOW	£0·15
1504	ARL4850(FLV117)	.5mm (.2)	RED	£0·10
1505	MIL5251(TIL222)	.5mm (.2)	GREEN	£0·15
1506	MIL5351(MV5353)	.5mm (.2)	YELLOW	£0·15
1509	FLV111	.5mm (.2)	CLEAR (ill., Red)	£0·11
	SUPER 'HI-Brite' Type			
1521	MIL32	.3mm (.125)	RED	£0·10
1522	MIL52	.5mm (.2)	RED	£0·10
1514	ORP12 Light dependent resistor			£0·55
1520	OCP71 Photo transistor			£0·35

LED CLIPS

1508/125	pack of 5	125 clips	£0·15
1508/2	pack of 5	2 clips	£0·18

ALL @ 8% V.A.T.

DISPLAYS

DL303 7 segment O.P. left (.30" height)	Common Anode	
RED Single Digit	O/NO: 1523	£0·70
DL707 7 segment O.P. left (.0.3" height)	Common Anode	
RED Single Digit	O/NO: 1510	£0·95
DL527 7 segment D.P. left (.50" height)	Common Anode	
RED Two-Digit Reflector	O/NO: 1524	£1·70
DL727 7 segment D.P. right (.510" height)	Common Anode	
RED Two-Digit Light Pipe	O/NO: 1521	£2·20
DL747 7 segment D.P. Left (.630" height)	Common Anode	
RED Single-Digit Light Pipe	O/NO: 1511	£1·70

ALL @ 8% V.A.T.

OPTO-ISOLATORS

Isolation Breakdown – Voltage 1500 – continuous fwd current 100mA

CIL74 Single-Channel 6 pin DIP standard type – optically coupled pair with Infra-red LEO Emitter and NPN Silicon Photo Transistor. O/NO: 1497 £0·50

CILD74 Multi-Channel 8 pin DIP Two Isolated Channels. O/NO: 1498 £1·00

CILQ74 Multi-Channel 16 pin DIP Four Isolated Channels. O/NO: 1499 £2·20

ALL @ 8% V.A.T.

2nd GRADE LED PACK

A pack of 10 standard sizes and colours which fail to perform to their very rigid specification, but which are ideal for amateurs who do not require the full spec.
O/NO 107 £1·50

THYRISTORS

Volts	No.	Price
600ma TO 18 Case		
10	THY600/10	£0·15
20	THY600/20	£0·16
30	THY600/30	£0·20
50	THY600/50	£0·22
100	THY600/100	£0·25
200	THY600/200	£0·38
400	THY600/400	£0·44
1 amp TO 5 Case		
50	THY1A/50	£0·26
100	THY1A/100	£0·28
200	THY1A/200	£0·32
400	THY1A/400	£0·38
600	THY1A/600	£0·45
800	THY1A/800	£0·58
3 amp TO 66 Case		
50	THY3A/50	£0·28
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		
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
800	THY5A/800	£0·81
5 Amp TO 220 Case		
400	THY5A/400P	£0·57
800	THY5A/600P	£0·69
800	THY5A/800P	£0·81
7 Amp TO 48 Case		
50	THY7A/50	£0·48
100	THY7A/100	£0·51
200	THY7A/200	£0·57
400	THY7A/400	£0·62
600	THY7A/600	£0·78
800	THY7A/800	£0·92
10 Amp TO 48 Case		
50	THY10A/50	£0·51
100	THY10A/100	£0·57
200	THY10A/200	£0·62
400	THY10A/400	£0·71
600	THY10A/600	£0·99
800	THY10A/800	£1·22
16 Amp TO 48 Case		
50	THY16A/50	£0·54
100	THY16A/100	£0·58
200	THY16A/200	£0·62
400	THY16A/400	£0·77
600	THY16A/600	£0·90
800	THY16A/800	£1·39
30 Amp TO 94 Case		
50	THY30A/50	£1·18
100	THY30A/100	£1·43
200	THY30A/200	£1·63
400	THY30A/400	£1·79
600	THY30A/600	£3·50

No.	Price
BT101/500R	£0·80
BT102/500R	£0·80
BT106	£1·25
BT107	£0·93
BT108	£0·98
2N3228	£0·70
2N3535	£0·77
BTX30/50L	£0·33
BTX30/400L	£0·46
C106/4	£0·60

CABLES

DESCRIPTION	O/NO	PRICE/ Metre
Microphone Cable	3126	£0.10
Twin Microphone	3127	£0.20
Twin Stereo Screened Cable	3128	£0.15
Multicore Standard 4-Core Screened	3129	£0.30
4-Core Individually screened	3130	£0.22
Heavy Microphone Cable	3131	£0.18
Light 3-Core mains	3132	£0.10
Twin Oval Mains	3133	£0.09
Speaker Cable	3134	£0.07
Low Loss Co-axial Cable	3135	£0.22
15 Way Multi Coloured Ribbon Cable	3136	£0.40

BOOKS AND COMPONENTS

BOOKS BY BABANI

BP6	Engineers & Machanists Ref. Tables	40p‡
BP14	2nd Book Transistor Equivs & Subs	£1.10‡
BP22	79 Electronic Novelty Circuits	75p‡
BP24	52 Projects Using IC741 (or Equiv)	75p‡
BP26	Radio Antenna Book Long Distance Reception and Transmission	85p‡
BP27	Giant Chart of Radio Electronic Semiconductor and Logic Symbols	60p‡
BP32	Build Metal and Treasure Locators	85p‡
BP34	Practical Repair/Renovation C/TV	95p‡
BP35	Handbook of IC Audio Preamplifier and Power Amplifier Construction	95p‡
BP36	50 Cicts use Germ/Sil/Zener Diodes	75p‡
BP37	50 Projs Using Relays/SCR/Triacs	£1.10‡
BP39	50 Field Effect Trans Projects	£1.25‡
BP40	Digital IC Equivs and Pin Connection	£2.50‡
BP41	Linear IC Equivs and Pin Connection	£2.75‡
BP42	50 Simple LED Circuits	75p‡
BP43	How to make Walkie-Talkies	£1.25‡
BP44	IC 555 Timer Projects	£1.45‡
BP45	Projects on Opto-electronics	£1.25‡
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Description	No.	Price
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DPDT standard slide	1974	£0.15*
Toggle switch SPST 1½ amp 250V a.c.	1975	£0.33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0.42*
Rotary on-off mains switch	1977	£0.50*
Push switch – Push to make	1978	£0.14*
Push switch – Push to break	1979	£0.18*

ROCKER SWITCH	Colour	No.	Price
A range of rocker	RED	1980	£0.30*
switches SPST – moulded	BLACK	1981	£0.30*
in high insulation.	WHITE	1982	£0.30*
Material available in a	BLUE	1983	£0.30*
choice of colours ideal	YELLOW	1984	£0.30*
for small apparatus.	LUMINOUS	1985	£0.30*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0.70*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0.75*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0.80*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0.95*
Push button SPST, 2 amp 250V a.c.	1962	£0.90*
Push button SPST, 2 amp 250V a.c.	1963	£0.95*
Push button DPDT, 2 amp 250V a.c.	1964	£1.20*

MIDGET WAFER SWITCHES

Single-bank wafer type – suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactiver loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	£0.48*
2 pole 6 way	1966	£0.48*
3 pole 4 way	1967	£0.48*
4 pole 3 way	1968	£0.48*

MICRO SWITCHES	Order No.	Price
Plastic button gives simple 1 pole change over action. Rating 10 amp 250V a.c.	1970	£0·25

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	£0.16*
1¼in x ¼in chassis mounting	507	£0.12*
1¼in car inline type	508	£0.16*
Panel mounting 20mm	509	£0.20*
Panel mounting 1¼in	510	£0.32

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	6p	1A	615	5p	3A	619	5p
250mA	612	5p	1·5A	616	6p	4A	620	9p
550mA	613	5p	2A	617	5p	5A	621	5p
800mA	614	7p	2·5A	618	6p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
2A	637	3A	639	5A	642

All 6p each

NUTS AND BOLTS

8A BOLTS – packs of 8A threaded cadmium plated screws slotted cheese head.

Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1·20	½in 4BA	846	£0·32
½in 0BA	840	£0·75	¼in 4BA	847	£0·25
1in 2BA	842	£0·65	1in 6BA	848	£0·40
½in 2BA	843	£0·45	½in 6BA	849	£0·21
¼in 2BA	844	£0·52	¼in 6BA	850	£0·25
1in 4BA	845	£0·44			

8A NUTS – packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	855	£0·72	4BA	857	£0·30
2BA	856	£0·48	6BA	858	£0·24

8A WASHERS – flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
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2BA	860	£0·12	6BA	862	£0·12

SOLDER TAGS – hot tinned supplied in multiples of 50.

Type	No	Price	Type	No.	Price
0BA	851	£0·40	4BA	853	£0·22
2BA	852	£0·28	6BA	854	£0·22

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	£1.12

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1.60*
2025	MT150-0-12V, 0-12V RMS	£1.60*

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No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2·50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2·00*	P. & P. 45p
2028	12V-0-12V 1 amp	£2·60*	P. & P. 55p
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2032	1 amp	£4.40*	P. & P. 86p
2033	2 amp	£5.45*	P. & P. £1·10

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116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1.25*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0·68*
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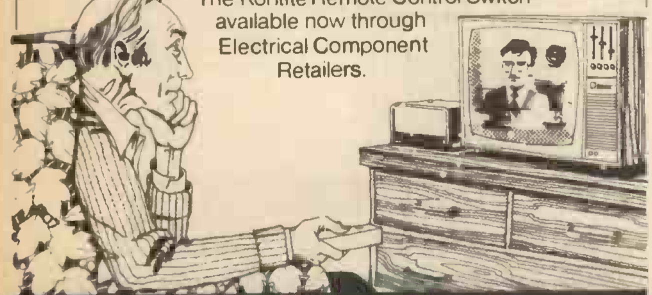

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74C00N	0·24	74C48N	1·38	74C95N	1·04	CD4000	0·20	CD4013B	0·52
74C02N	0·24	74C73N	0·54	74C107N	1·22	CD4001B	0·20	CD4014	1·00
74C04N	0·24	74C74N	0·56	74C150N	4·14	CD4002	0·18	CD4015	0·75
74C08N	0·24	74C76N	0·54	74C151N	2·47	CD4006	1·25	CD4016	0·52
74C10N	0·24	74C83N	1·30	74C154N	3·68	CD4007	0·18	CD4017B	1·05
74C14N	0·95	74C85N	1·30	74C157N	2·21	CD4008B	0·99	CO4918B	1·05
74C20N	0·24	74C86N	0·64	74C160N	1·11	CD4009	0·58	CD4019B	0·52
74C30N	0·24	74C89N	4·39	74C161N	1·11	CD4010	0·58	CD4020B	1·15
74C32N	0·24	74C90N	0·85	74C162N	1·11	CD4011B	0·20	CD4021	1·05
74C42N	0·92	74C93N	0·85	74C163N	1·11	CD4012	0·20	CD4022B	1·00

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2N5060	0·5A	25v	TO18	£0·32
2N5061	0·5A	50v	TO18	£0·33
2N5062	0·5A	100v	TO18	£0·40
2N5063	0·5A	150v	TO18	£0·43
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SN74H05N	0 60	74LS63N	1·26	74LS183N	2·70
SN74H10N	0·56	74LS73N	0·42	74LS189N	3·74
SN74H11N	0·55	74LS74N	0·42	74LS190N	1·00
SN74H20N	0 55	74LS75N	0·58	74LS191N	1·00
SN74H21N	0·55	74LS76N	0·42	74LS192N	0·95
SN74H30N	0·55	74LS78N	0·42	74LS193N	0·95
SN75H40N	0·55	74LS83AN	0·90	74LS194N	0·70
SN74H51N	0·55	74LS85N	0·95	74LS195N	0·70
SN74H53N	0·56	74LS86N	0 44	74LS196N	0·80
SN74H54N	0 55	74LS90N	0·64	74LS197N	0·80
SN74H55N	0·55	74LS91N	1·20	74LS221N	0·80
SN74H60N	0·55	74LS92N	0·70	74LS240N	1·50
SN74H62N	0·55	74LS93N	0·64	74LS241N	1·50
SN74L00N	0·55	74LS95AN	0·90	74LS242N	1·25
SN74L02N	0 56	74LS96N	1·35	74LS243N	1·25
SN74L04N	0 60	74LS107N	0·42	74LS244N	1·50
SN74L47N	3·10	74LS109N	0·42	74LS245N	1·65
SN74L74N	0·90	74LS112N	0·42	74LS247N	1·09
SN74L85N	2·62	74LS113N	0·42	74LS248N	1·09
SN74L93N	2·30	74LS114N	0·42	74LS249N	1·09
74LS00N	0·26	74LS122N	0·62	74LS251N	1·00
74LS01N	0·26	74LS123N	0·83	74LS253N	1·00
74LS02N	0·26	74LS124N	1·70	74LS257N	1·00
74LS03N	0·26	74LS125N	0·60	74LS258N	1·00
74LS04N	0·29	74LS126N	0·50	74LS259N	1·55
74LS05N	0·29	74LS132N	0 85	74LS261N	3·25
74LS08N	0·26	74LS136N	0 42	74LS266N	0·44
74LS09N	0·26	74LS138N	0 65	74LS273N	1·30
74LS10N	0·26	74LS139N	0 65	74LS275N	3 20
74LS11N	0 26	74LS145N	1·30	74LS279N	0·58
74LS12N	0·26	74LS147N	1 65	74LS280N	1·85
74LS13N	0·58	74LS148N	1 35	74LS283N	1·20
74LS14N	0·75	74LS151N	0·58	74LS289N	3·74
74LS15N	0·26	74LS153N	0·58	74LS290N	1·00
74LS20N	0·26	74LS154N	1·45	74LS293N	1·00
74LS21N	0·26	74LS155N	0·80	74LS295N	1·35
74LS22N	0·26	74LS156N	0·80	74LS298N	1 35
74LS26N	0·32	74LS157N	0·60	74LS299N	2 95
74LS27N	0·26	74LS158N	0·65	74LS323N	3·50
74LS28N	0·29	74LS160N	0·80	74LS324N	1 65
74LS30N	0 26	74LS161N	0 85	74LS325N	2·40
74LS32N	0·27	74LS162N	0 80	74LS326N	2·70
74LS33N	0 29	74LS163N	0·85	74LS327N	2·55
74LS37N	0·32	74LS164N	1·10	74LS348N	1·10
74LS38N	0·32	74LS165N	1 15	74LS352N	1·07
74LS40N	0·26	74LS166N	1·85	74LS353N	1·07
74LS42N	0·80	74LS168N	1·45	74LS365N	0·55
74LS47N	1·09	74LS169N	1·45	74LS366N	0·55
74LS48N	1·00	74LS170N	1·90	74LS367N	0·55
74LS49N	1·09	74LS173N	1·10	74LS368N	0·55
74LS51N	0·26	74LS174N	0·75	74LS373N	0·85
74LS54N	0·26	74LS175N	0·75	74LS374N	0·85
74LS55N	0·26	74LS181N	2·75	74LS375N	0·66

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2N3402	·21	2N3567	·25	2N3704	·14	2N4908	3·72	2N5035	1·10	2N5195	·97	2N5306	·33	2N5543	7·50	2N6131	·70	BD181	1·90	BFW43	1·65
2N3404	·21	2N3570	4·50	2N2705	·14	2N4909	4·98	2N5036	1·20	2N5209	·35	2N5307	·30	2N5550	·38	2N6132	·70	BD182	2·20	BFW59	1·75
2N3405	·21	2N3571	1·90	2N3706	·14	2N4910	1·20	2N5086	·30	2N5210	·38	2N5308	·33	2N5551	·44	2N6133	·70	BD183	2·35	BFW87	1·75
2N3414	·18	2N3572	3·00	2N3707	·14	2N4913	1·45	2N5087	·30	2N5219	·16	2N5354	·27	2N5555	·65	2N6134	·70	BD187	·95	BFW90	1·75
2N3415	·18	2N3583	1·25	2N3708	·12	2N4914	1·65	2N5088	·30	2N5220	·15	2N5355	·20	2N5638	·45	2N6179	·77	BD201	1·10	BFX12	·35
2N3416	·21	2N3584	1·35	2N3709	·12	2N4915	2·40	2N5089	·30	2N5221	·16	2N5356	·23	2N5640	·45	2N6180	1·05	BD202	1·25	BFX13	·33
2N3417	·25	2N3605	·18	2N3710	·12	2N4916	·22	2N5126	·44	2N5222	·20	2N5358	1·75	2N5654	·55	2N6181	·88	BD203	1·28	BFX19	·49
2N3420		2N3606	·18	2N3711	·12	2N4917	·27	2N5127	·22	2N5223	·16	2N5365	·24	2N5655	·55	2N6253	1·00	BD204	1·35	BFX29	·34
	12·50	2N3607	·18	2N3712	1·35	2N4918	·65	2N5128	·22	2N5224	·16	2N5400	·33	2N5656	·65	2N6254	1·45	BD220	·66	BFX30	·34
2N3439	·85	2N3632		2N3713	1·50	2N4919	·70	2N5129	·22	2N5225	·16	2N5401	·44	2N5657	·75	2N6288	·50	BD221	·66	BFX34	·66
2N3440	·75		12·75	2N3714	1·55	2N4920	·83	2N5130	·22	2N5226	·16	2N5415	1·05	2N5661		2N6289	·50	BD222	·66	BFX37	·49
2N3441	·92	2N3638	·17	2N3715	1·55	2N4921	·54	2N5131	·22	2N5227	·16	2N5416	1·65		17·00	2N6290	·50	BD223	·75	BFX68	1·10
2N3442	1·45	2N3638A	·17	2N3716	2·29	2N4922	·60	2N5133	·22	2N5232	·22	2N5447	·18	2N5786	·98	2N6292	·50	BD224	·75	BFX84	·30
2N3444	1·35	2N3639	·33	2N3724	·65	2N4923	·75	2N5137	·22	2N5232A		2N5448	·16	2N5813	·55	AF239	·70	BD232	·75	BFX85	·38
2N3445	0·50	2N3640	·25	2N3725	·60	2N4924	1·15	2N5138	·22		·23	2N5449	·20	2N6027	·64	AF240	1·75	BD233	·45	BFX86	·30
2N3446		2N3641	·25	2N3732	2·00	2N4926	1·70	2N5139	·22	2N5239	2·25	2N5450	·16	2N6036	1·39	AF279	·88	BD234	·46	BFX87	·35
	10·00	2N3642	·22	2N3734	·75	2N4927	1·70	2N5140	·22	2N5245	·37	2N5451	·16	2N6039	1·17	AF280	·95	BD235	·48	BFX88	·30
2N3447		2N3643	·38	2N3735	7·00	2N4928	2·20	2N5142	·22	2N5246	·38	2N5457	·35	2N6099	·62	AFY42	1·65	BD538	·77	BFX89	1·37
	10·50	2N3644	·40	2N4871L	·51	2N4944	·30	2N5143	·22	2N5247	·44	2N5458	·36	2N6107	·45	AU110	1·70	BD539	·60	BFY10	1·10
2N3448		2N3645	·38	2N4888	·54	2N4945	·30	2N5172	·24	2N5248	·44	2N5459	·32	2N6108	·55	AU113	1·70	BD540	·60	BFY18	1·10
	12·00	2N3646	·26	2N4889	·75	2N4964	·28	2N5179	·75	2N5249	·38	2N5460	·65	2N6109	·55	BC409	·27	BD581	1·10	BFY19	1·10
2N3468	1·32	2N3662	·25	2N4891	1·30	2N4965	·28	2N5180	·58	2N5266	3·00	2N5461	·53	2N6111	·49	BC413	·10	BD582	1·30	BFY87	1·19
2N3507		2N3663	·29	2N4898	1·55	2N4966	·28	2N5183	1·20	2N5293	·44	2N5462	·66	2N6121	·41	BC414	·17	BD675	·60	BFY89	·38
	10·00	2N3690	·45	2N4901	1·65	2N4967	·28	2N5188	·44	2N5294	·44	2N5484	·37	2N6122	·44	BC415	·16	BD676	·65	BFY41	·88
2N3512	1·10	2N3691	·45	2N4902	2·20	2N4968	·28	2N5189	·49	2N5295	·44	2N5485	·40	2N6123	·48	BD153	1·95	BD677	·70	BFY50	·35
2N3553	3·25	2N3692	·45	2N4903	2·75	2N4969	·28	2N5190	·65	2N5296	·44	2N5486	·40	2N6124	·45	BD155	1·10	BD678	·82	BFY51	·35
2N3563	·25	2N3693	·50	2N4904	1·85	2N5010	5·75	2N5191	·75	2N5298	·44	2N5490	·64	2N6125	·47	BD157	·70	BFS98	·33	BFY52	·35
2N3564	·25	2N3694	·50	2N4905	2·40	2N5011	8·25	2N5192	·80	2N5301	4·00	2N5492	·64	2N6126	·48	BD158	·70	BFW10	·83	BFY53	·40
2N3565	·25	2N3702	·14	2N4906	2·99	2N4030	·22	2N5193	·75	2N5303	5·90	2N5494	·65	2N6129	·60	BD159	·70	BFW11	·83	BFY72	·99
2N3566	·25	2N3703	·14	2N4907	4·00	2N5033	·65	2N5194	·80	2N5305	·20	2N5496	·67	2N6130	·65	BD160	3·40	BFW30	2·45	BFY75	·77

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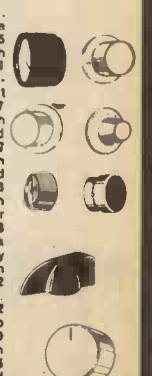

PE VOLUME 15 No. 6 JUNE 1979

THE BIG GUNS!

LAST month in the leader we looked at one aspect of the manufacturers and industrial distributors involvement in component supply. Although many companies are not interested in supplying one-off components on a mail order retail basis they are now becoming more interested in encouraging hobbyist use of their products and in making the hobbyist aware of their company name.

The fact that a good percentage of our readers are employed in industry, does, of course, not escape them and they also realise that the spending power of the hobbyists as a collective unit is considerable. We are gradually finding more companies that are willing to spend some time and effort wooing the hobbyist.

This issue carries the second part of our *Microprocessor Evaluation System*, it will have been noted by many readers that this system is based on a General Instruments device and the article is written by one of their engineers. G.I. actively encourage their employees to develop ideas for publication and it is likely that more projects will come from this stable. We are also in contact with Ferranti, Mullard and Texas and expect these contacts to also bear fruit.

It is true to say that this is not something new and we have had similar tie-ups in the past. What is interesting is that at the present time, more large organisations are becoming aware of the potential in this market, and, because of this, we should all benefit. Obviously the knowledge and industrial backup that such companies provide can lead to the best possible projects, often developed by the very engineers involved in the design of the i.c.s. employed. We can thus offer readers projects developed with the aid of test gear and facilities that are out of reach of a small company, let alone most hobbyists.

This factor is probably not significant when related to a sound to light system or remote control but when a high quality amplifier is to be described, immense benefit in the performance of a project constructed at home can result. We believe that this involvement by such companies can only do good to our hobby, however, we will not overlook the fact that it is often possible to improve on commercial equipment.

COMPUTER

If you read the review of Superboard II in this issue, that long awaited product of Ohio Scientific Industries, you will realise that it is possible to improve on the design and, even for its extremely competitive price, the Superboard, although very versatile, is not the best *possible* product. It follows that although a great deal of time and company effort has been expended in the design of this product, the final result could still be improved on; fantastic though that may sound when related to such an excellent computer for less than £300.

As we have noted at the end of the review, improvements are being incorporated in a design based on Superboard and we expect a full series to be published in P.E., starting in the August issue, describing what we honestly believe will be a computer to outstrip all others in the price range — kit or complete.

EAR PLUGS?

It seems that the bit of trumpet blowing we did a couple of months ago has had no effect on any readers as, to date, we have not received a single comment on it!

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OHIO SUPERBOARD II REVIEW

A.A.BERK B.Sc. Ph.D.

It is not often, even in the lightning-fast field of Microcomputers, that we have a chance to review a system quite as up-to-the-minute as the one described below. The machine lent to us by COMP Components (14 Station Road, New Barnet, Herts. Tel: 01-441 2922) was perhaps one of the only two in the country at that time. Supply problems have been immense for Ohio Scientific Industries who make the machine. It can only be hoped that, by the time this review appears, the Superboard will be available ex-stock, or on very short delivery, not only from COMP but from the many stockists who started taking orders before Xmas on a full cash basis from the hundreds of hobbyists who have shown interest in this remarkable machine.

The photographs in this article show the compact form the Superboard takes—along with the type of video output which can be expected. Prices range from just over £260 to around £280—see current adverts in this issue for the latest information.

THE machine comes as a single p.c.b. which includes the keyboard section, plus a set of manuals and cassette-based demonstration programmes.

P.C.B. LAYOUT

The p.c.b. is extremely well laid-out, as the photograph shows, with the keyboard deciding the total width of the board which is approximately 370 by 305mm ($14\frac{1}{2}$in. × 12in.) in size. The quantity of room and uncramped nature of the assembly would make this a very acceptable kit with few of the usual problems associated with highly dense component layouts. Plenty of high frequency by-passing is also provided as can be seen from the number of disc-ceramic capacitors dotted about the board.

Referring to the p.c.b. photograph: just above, and to the left of the keyboard, is a line of six 24-pin d.i.l. sockets holding, from left to right, one ACIA (6850) for serial communication devices such as cassette and teletype, the monitor ROM (2K Bytes) and four BASIC ROMs (2K Bytes each). These are followed by the 6502 MPU which is at the heart of this machine. Further to the right is a pair of two-way data bus buffers—using 8T28 chips—and some logic for running the keyboard. Finally, at extreme right, is a 40-pin d.i.l. expansion socket labelled J1. The 8T28's are used purely for expansion via J1.

The next couple of rows of i.c.s are for various logic functions and include some unoccupied i.c. pads labelled PROTO on the circuit diagram in the manual and not connected to any p.c.b. tracks. The two rows above these form the next two main blocks of the system—VDU and RAM sections. The RAM is seen implemented by two half-rows of 2114 (1K by 4 BITs) RAM i.c.s over to the right. Eight of these sockets contain i.c.s in the basic system giving 4K bytes of memory and eight more are provided for 4K of expansion simply by plugging in the extra chips.

Only 7K of memory is shown in the photograph. Further to the left is another pair of 2114s forming a further 1K of RAM for the VDU. Next to these is the 24-pin character-generator chip and switching i.c.s for the VDU which is of the memory-mapped type for speed and complete flexibility of use. Over to the extreme left is the crystal-controlled clock generator from which the whole computer, from MPU to cassette interface, derives its timing information.

At the top of the board is the remaining support logic and cassette interface (over to the left), along with various unoccupied holes and pads—the components for which may be added later to complete an asynchronous communications interface including RS232. The top right of the board has provision for power supply unit components, and in the photograph houses an efficient little u.h.f. modulator (ASTEC) which allows direct connection to the aerial socket of a TV (tuning around Channel 36) and gives the excellent results shown in the photographs in this article.

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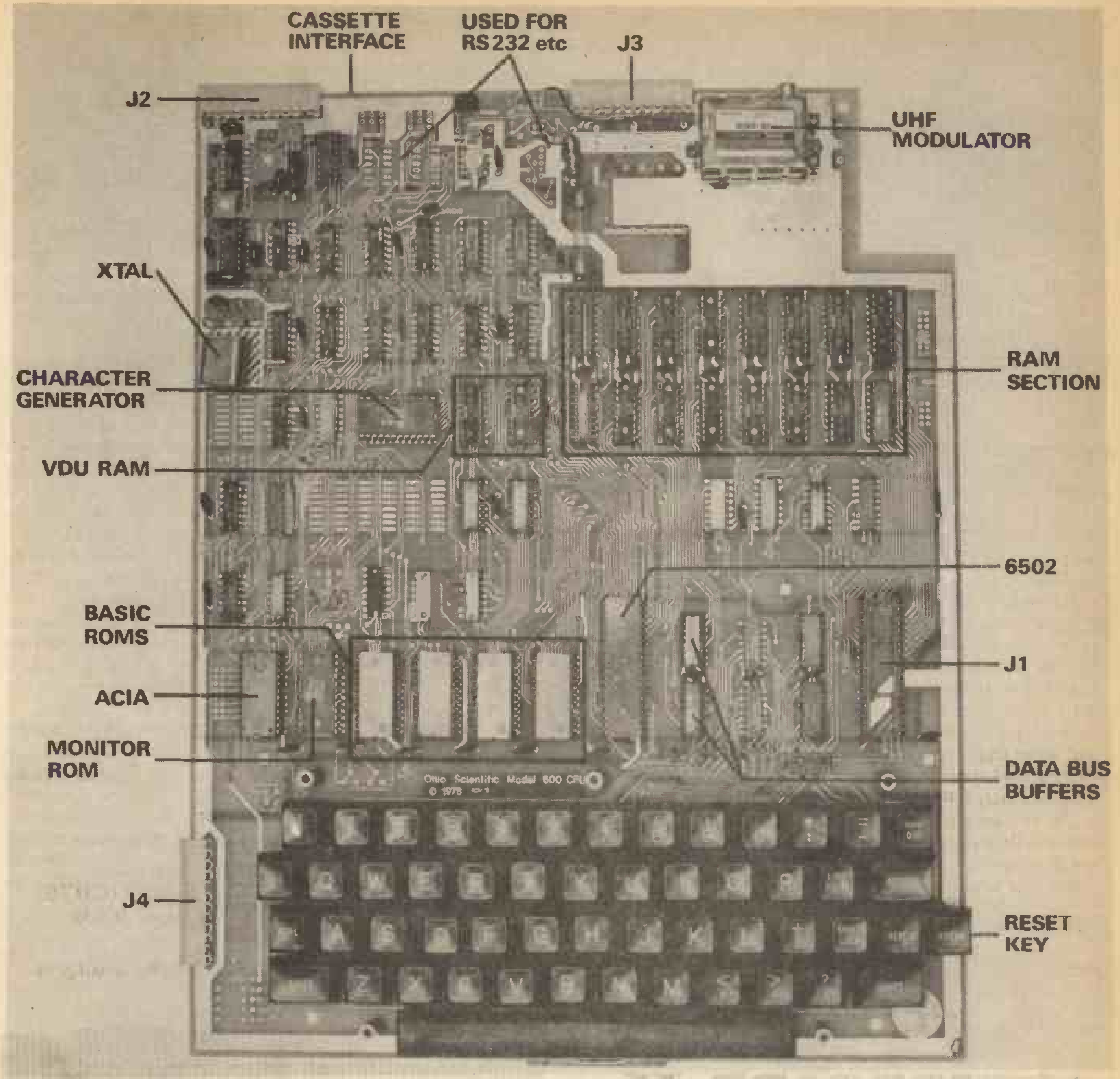


SUPPLY

The Superboard is a single supply device requiring a regulated +5 volt source. The current depends heavily on the number and type of 2114 employed on the board. OHIO supplies the low-power versions, and with the full 8K the p.s.u. will have to deliver 2·5 to 3 amps. There are also two sockets (with plugs included!) on the top edge of the board. The most important of these is J2—to the left—as this supplies inputs and outputs to cassette and video monitor (or u.h.f. modulator). The other, J3, is for asynchronous communications.

The various "links" printed on the p.c.b. may be cut and connected differently for a variety of uses, and a further edge connector, J4, next to the keyboard (left) may be used to expand the key-functions for a separate programmable application.

The ambitious user will certainly find the p.c.b. construction and layout more flexible than most single-board computers on the market, not least for the reason of spaciousness of design.

KEYBOARD

The integral keyboard gains its best "touch" when the whole p.c.b. is screwed firmly to a base-board of some rigid material such as chip-board. It is pleasant to operate and apparently instantaneous in use. There are 53 keys which form a familiarly spaced type-writer format with legends properly moulded-in for durability and excellent readability.

One's unconscious emotional reaction to any computer is almost certainly heavily dependent upon three things:

(a) The keyboard.
(b) The display.
(c) The software monitor and programming language employed.

These three areas are described overleaf.

To the computer, the keyboard is an array of 8 rows and 8 columns occupying a single address location (DFOO). One location is enough as the 8 rows are write-only and the columns read-only. The keyboard routine, stored in the monitor ROM, constantly sends "walking-bit" information to the rows—latched by two 4-bit latches (74LS75s)—and reads the columns looking for the result of a key-closure. The keyboard is thus read for information and decoded by the monitor—this obviates the necessity for a hardware keyboard-encoder chip and ensures speed and accuracy with a low (and hence cheap) chip count. Multiple key readings are prevented by carefully written software and, indeed, this keyboard was considerably less prone to "doubling" than that of some other personal computers.

One or two idiosyncrasies of the keyboard are worth mentioning. The BREAK key to the far right of the keyboard, is simply a RESET button and will be described later. RUBOUT and ESC seem to have no effect for normal operation and the REPEAT key appears to do the exact opposite. If any key is pressed for more than about half a second, that character or function starts repeating continuously (a very useful feature) until the key is released—pressing REPEAT stops this process!

The character generator in the VDU section contains upper and lower case letters plus all the necessary special characters in the ASCII set. These are accessable via the keyboard but not all are indicated. For instance, "UP ARROW"—here implemented by $\wedge$—is an essential part of BASIC programming and is given by SHIFT N, a fact which the experienced programmer will already know, but not so the first time user. There are several other "hidden" special characters, and the complete list, which I discovered, is shown in Table 1 along with any function they perform.

Table 1

Shifted Character	Special Character	Function
P	@	deletes current line
O	—	deletes last character typed
S	$\subset$	none
K	[	none
L	\	none
M	]	none
N	$\wedge$	"up arrow" in BASIC

Normal operation of the keyboard is in upper-case mode and for this, the SHIFT LOCK must be set in its "down" or "locked" position. My first mistake was to miss this point in an initial enthusiasm to see the BASIC working! Here the manual has its own poignant, if ungrammatical, reminder to the user not to be guilty of the adage about—"reading the instructions when all else fails".

As BASIC text is entered into the machine each line may be corrected or deleted before the computer reads the line for execution or filing. When such a line is complete, RETURN is pressed to transfer the line into the machine.

Two control characters are used on the keyboard: CONTROL O and CONTROL C. The first suspends the VDU display during command and program entry, the second suspends program execution. CONTROL O is very useful, for instance, for running from a clear screen—the command RUN, typed after CONTROL O, will not appear.

DISPLAY

As explained above, the VDU section is of the memory mapped type and hence each character on the screen occupies a specific memory location. The Hex address of the "screen" can be found on the memory map diagram (Table 2) and will be seen to occupy 1024 (1K) locations. These are arranged as 32 characters by 32 lines on the screen, but many of them remain undisplayed by the majority of TV sets. The reason for this is quite simple and rests on the fact that a 4MHz (approx.) crystal is employed to generate the "dot" frequency for the characters. Each character is formed from an 8 × 8 dot matrix and the width of a dot on a TV screen is inversely proportional to the dot frequency; 4MHz is simply too low (and hence the dots are too large) to accommodate much more than 24 characters on a horizontal line.

I could only fit 23 on the Philips set illustrated. It is possible to adjust some sets to accommodate more characters per line, but the machine is meant for the average domestic TV, and the majority of rental companies will show a remarkable lack of enthusiasm for your rearrangement of the internals of their £300 colour sets.

In setting up the machine for initial use, the SHIFT LOCK is pressed to lock it into the "down" position and then the BREAK key operated. BREAK may be pressed at any time during use causing the display to clear and present the letters D/C/W/M? on the lowest line used by the monitor. These letters, as with all entries to the machine under monitor control, scroll upwards on the display as new entries take their place on the lowest line. BREAK places the machine in its command mode and only one of the above four command letters will be accepted at this point.

The letter D is for disk operation and is not applicable here. C clears the memory of the machine and causes the words MEMORY SIZE? to appear. At this point the user may reserve memory space to hold machine code routines or binary data blocks. Typing just RETURN reserves no memory space, while typing any number greater than 769 (the minimum number of memory bytes needed as workspace for the monitor and BASIC interpreter) will restrict the RAM available for writing in BASIC. This prevents subsequent programming from using the reserved space and destroying its contents.

The next message to appear is TERMINAL WIDTH? Typing RETURN assumes the number 24, while typing any number from 16 to 23 restricts the use by the BASIC interpreter to that number of characters per line VDU display. Any number greater than 24 is assumed to mean 24, and any number less than 16 is ignored causing TERMINAL WIDTH? to reappear. When other output devices are used, the width may be specified up to 72 characters.

After terminal width has been specified, the Superboard enters its BASIC function by printing up a quick advert for itself and giving the number of free bytes of RAM available, which it determines using a memory test. Any RAM malfunction may be noted at this point.

Table 2. Memory Map of the Superboard II

Hex Address	Function
0000 – 02FF	This block of RAM is used by the monitor and BASIC ROMs as scratch-pad—included here is the stack and all necessary vectors and flags
0300 – 0FFF	Rest of basic 4K system RAM
2000 – 1FFF	Optional extra on-board 4K RAM
A000 – BFFF	BASIC ROMs (8K)
D000 – D3FF	Video RAM
DF00	Keyboard
F000 – F001	ACIA for serial communications
F800 – FFFF	Monitor ROM including: floppy disk bootstrap, keyboard routine, 65V machine code monitor, BASIC support and hardware vectors for NMI, RESET and IRQ

The other two command letters are used in the following way. W allows a re-entry after the BREAK without clearing memory. A most thoughtful addition—if only for the reason that the BREAK key is placed far out to the right of the keyboard and very exposed. It is easy, after setting up a BASIC program to brush the BREAK key causing the screen to clear and D/C/W/M? to appear—pressing C at this point would delete the program completely. M is used to enter the machine code monitor and will be described later.

During text entry, the monitor moves a "dash" symbol (the cursor) across the screen to keep the user updated with his current writing position. "SHIFT O" may be used at any time to delete the previous character written—this causes a dash to appear permanently at that point to remind the user that, as far as the machine is concerned, the previous character has been deleted. Several such dashes imply the deletion of that number of previous characters; and SHIFT P deletes the whole line, writing an @ symbol and moving the cursor to a new line.

In this way editing may be performed on a line adequately but slightly awkwardly. A better way would be to actually remove the deleted character from the display and backstep the cursor.

As can be seen from the photographs, the display provides very large characters separated vertically by very little space; this tends to make the text less readable than the majority of VDU pictures. However, it allows a very cheap system of "character slot" graphics to be implemented on the system. 128 of the character-generator ROM's patterns are graphic characters—inaccessable from the keyboard, incidentally. This includes a rich variety of tanks, guns, gaming characters, playing-card suits, lines, blocks and many more, to be displayed during program execution. Due to the lack of space between the character rows, these join up vertically as well as horizontally to produce continuous patterns. Separate dots within the 8 × 8 matrix of each character slot cannot be lit separately, and hence the term "character slot" graphics as opposed to "point graphics".

In addition, the top few TV lines of the top row of characters are rather indistinct as there is no delay and blanking at the start of each frame.

Most TVs find it easy to synchronise with the Superboard even though it produces 60Hz frame information for the US market: some adjustment of the vertical hold is often necessary. The 60Hz frame frequency (non-interlaced) provides one other slight drawback. Most TVs have badly smoothed d.c. rails, and a little 50Hz hum is always present—this tends to beat with the 60Hz frame frequency causing a constant jitter of the screen contents—more noticeable as the brightness control is increased.

As the display is memory mapped, the user may access it simply by "POKE"ing information into the RAM block (1K) dedicated to storing the screen's contents. As explained, many of these slots are undisplayed on an average TV screen. The monitor carefully starts each line of BASIC text 5 spaces in from the left on each line and uses only the top 26 lines in order to ensure that no information is lost during program development. The full screen is 32 characters by 32 lines, and most British TVs will show all the lines though not all the characters on each line. However, much of the software supplied for the Superboard uses all 32 lines of the display which actually covers less than the normal 625 lines of UK TVs.

It is clear that some considerable thought has been employed in providing a display capable of use in gaming and "animation" applications. This has been successful up to a point given the extremely low price of this powerful system—the designers have even included a monostable circuit to blank the video display each time the MPU accesses the VDU. This helps to prevent spurious noise from appearing on the screen during continuous use of the VDU.

SOFTWARE MONITOR AND PROGRAMMING

The above section contains a full description of the commands available to the user and below is described use of the two languages employed in programming the Superboard—BASIC and 6502 machine code.

The fact that the system offers the language BASIC to the user will undoubtedly be the prime reason for his buying this machine. It should be emphasised that this is no Tiny BASIC or in any sense a minimal version. It is a full 8K Microsoft BASIC and even includes the very useful DEF FN.

It was clear from the start that program execution was fast, but I was unprepared for the remarkable speed of calculation which became apparent. When reviewing the TRS80, I ran some standard (Benchmark) programs and carefully timed them for later comparison. Programs not concerned with arithmetic or scientific calculation ran in about 55 per cent of these times on the Superboard—not surprising as the TRS80 is known to have a slightly slow clock. However, the 6502 on the Superboard was clocked at 1MHz, and the 2MHz version would halve these times again. This is still interesting but unremarkable.

I then tried my scientific calculation program. A large number of intermediate results are required, and the TRS80 had run this program in 117 seconds. I typed RUN on the Superboard and pressed return. There was no time to notice the reading on my watch—it ran in 7 seconds! I tried re-running the program 20 times and even juggled it about—still 7 seconds. The original program had no print-out so I made it print all 500 intermediate results on the VDU—the time shot up to just on 15 seconds. At this point, I noticed that the actual chip on the board was the "A" version of the 6502—able to run at 2MHz.

Swopping a few wires around increased the MPU clock to 2MHz, and I was fascinated to watch the Benchmark program run in 3½ seconds—about 1½ seconds slower than the time quoted for its running on an IBM 370/115 mainframe computer. The speed of the Superboard rests entirely with the version of the BASIC interpreter included in its design, and not to any special feature of the 6502 for example—presumably Microsoft could do just as well on any other system, if they tried.

The BASIC statements may be typed in for immediate execution or, by giving them line numbers, may be written as part of a larger program for running later. In immediate mode, the computer acts like a super calculator—with responses to Sine and Cosine markedly faster than those of my Texas SR56 calculator. Any level of parenthesis is available along with all the usual BASIC scientific functions to a floating-point accuracy of 6½ digits and including the random number function.

The only omission I discovered in the repertoire worth noting was the PRINT USING statement. Otherwise, everything is there, including numeric and string arrays plus an excellent set of string-handling functions.

Memory efficiency and speedy programming are aided by omitting "LET" in assignments and using "?" for PRINT. Multiple statements are allowed on a single line by the use of a colon as separator. Variables may be two characters in length (the first must be alphabetic) and, with array variables, there are as many as could be wished for by the most voracious scientist.

The BASIC manual, as implied in the documentation, was not written as a primer. It is a quick-reference list for the knowledgeable user. In parts, it is a little too quick and even now I am unable to fathom out the use of the USR function which has the useful capability of being able to call machine code routines from a BASIC program.

LIST is one of the most important BASIC editing features. On the Superboard it is very versatile. "LIST 50-" and "LIST 50-100" will give a listing of a program from line 50 onwards and between 50 and 100 respectively; also, "LIST -50" gives the list up to line 50, and "LIST 50" gives line 50 alone. This is all very useful and appears nowhere in the manual!

The BASIC interpreter also supplies 17 stated error codes to assist in the debugging of programs. Each code is composed of a letter plus a graphic symbol for some reason. SYNTAX ERROR for instance, is denoted by S_| as opposed to the more usual SN. I also discovered one unlisted error code—B ■. This turned up after typing (in immediate mode) A(1000), among other things. Perhaps someone should run a competition to discover how many other codes, plus their access statements, exist—could be interesting!

It is certain that the first time user will find the documentation on BASIC, supplied with the kit, inadequate, and he is well advised to seek out one of the excellent primers on this subject best found from a local library or by browsing in the technical section of most sizeable bookshops. The language is easy to learn and will enable programming to quite a sophisticated level in an hour or two.

MACHINE CODE

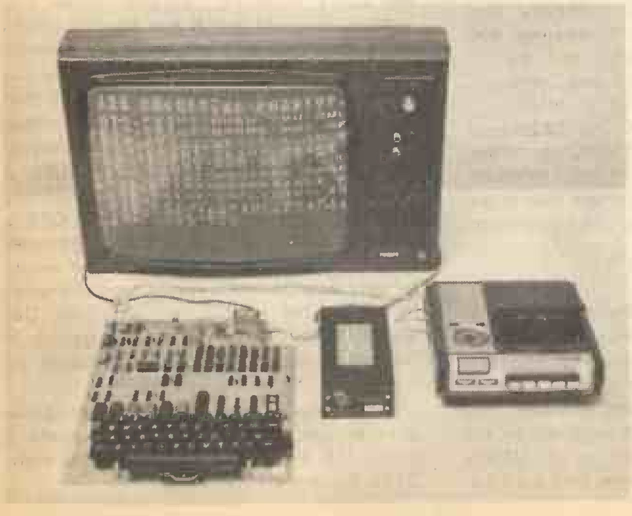
The fact that the Superboard can also be programmed in machine code, via the machine code monitor, impresses me very strongly. It adds that touch of flexibility which is prevalent throughout the system's design. The machine code is accessed by typing "M" when D/C/W/M? appears on the screen after BREAK. This causes six characters to appear at top left of the screen—four hex characters for address, followed by a space, and two characters for the data contained at that location.

The commands available for program writing are rudimentary but adequate. Typing a full stop allows subsequent hex characters to load the address field of the display. The data field is kept updated during this process allowing the user to view the contents of any memory location. To load the data field, a "/" must be typed. "L" allows loading from the cassette and "G" causes execution of a machine code program starting at the current address displayed on the screen. The manual also gives the starting address, in the monitor, of several useful routines, thus allowing a very low level utilisation of the machine.

A user who wishes to write many machine code routines, perhaps for control purposes, would do well to write a sophisticated BASIC program, using PEEK and POKE, to aid the loading and construction of such routines.

CASSETTE INTERFACE

I had a little trouble loading both the standard and my own saved programs, at first—nothing serious, however, and a little experience with the tape-recorder's controls gave acceptable results most of the time. The cassette interface runs at about 300 BAUD and depends upon the constant crystal-controlled clock of the whole system for both recording and retrieving data. This means that changes in tape speed will diminish performance more severely than would be the case if the retrieval clock were derived from the recorded data itself. Data is stored on the CUTS (Kansas City) standard of recording a low pitch tone for a logic zero and high for a one. Decoding one's and zero's from the tape depends upon the decay time of a monostable to distinguish between high and low tones—its time constant is adjustable, for setting up, by a subminiature pot on the board.



The software supplied with the board, on cassette, formed a strange mixture of games, educational programs, calculations and financial packages. Some of the tapes actually seemed to contain software errors—if the tape interface can be trusted—and one, at least, was complete rubbish. One or two of the games were good—particularly "New York Taxi" where the player has to hail a taxi without being run over; and "Hectic"—a game well outside my powers of speed and co-ordination—the display left me staring fascinated by the mayhem-like destruction implied by a spinning bomb which hurtles from random points in the sky and removes bits of the landscape.

There is also a Ratio Analysis program giving an idea of the machine's business capabilities, and one or two educationally useful teaching programs.

As a very rough guide to the speed of loading and size of programs, "New York Taxi" takes up about 2·7K of memory, occupies 81 lines of program and takes 2 minutes 20 seconds to load.

MANUAL AND EXPANSIONS

The user's manual is not bad but could do with re-writing in a more concise and logical form. Very complete circuit diagrams are included which appear, on the whole, accurate and well drawn; however, a little verbal explanation in this area would help the user to appreciate some of the finer points of design more easily.

The short section on BASIC and two pages describing the whole of microprocessor theory will leave the beginner mystified and the expert bored. Most of the facts appear somewhere in the quite lengthy text but are either laboured or under explained.

The final section is devoted to the 6500 series of MPU chips and their machine code. This is most useful for reference, but is entirely for the experienced.

The Superboard II, to give its full title, is the name given to the OSI 600 board, and may be incorporated into a special metal case with power supply to form the CHALLENGER 1P. The 610 board is an expansion p.c.b. containing 24K RAM and a floppy disk controller. Sockets are provided for dual mini floppy drives as well as a d.i.l.-plug terminated ribbon cable to plug into J1 on the Superboard. The 610 also interfaces to the 620 expansion board designed to run the OSI 48-line bus for the full range of OSI add-ons.

Expansion capabilities and flexibility of the basic p.c.b. are very varied—for instance, there is a link option on the board to enable the future use of a single 64K bit ROM for the BASIC interpreter instead of the four 16K bit ROMs supplied. This would free three 2716-pin-compatible sockets for other things. This type of detail will remain unused by the majority of users but tends to imply a high degree of thoughtful system design.

CONCLUSION

The machine described here is certainly one of the most exciting on the present market for both the hobbyist and anyone needing an introduction to computers in general and microcomputers in particular.

The video output is probably not fitted for business applications though the power of the machine may well be. The addition of an asynchronous video terminal and printer would, however, solve the problem quite quickly.

In a short time, the home computer man will learn the limitations of cassette storage in general and will begin to hanker after the yet largely unappreciated advantages of disk. Here again the Superboard provides the answer with a cheap plug-in floppy disk system.

The price of the Superboard puts it into a class of its own which is going to be very hard for the current purely machine-code systems to match. Its BASIC is nearly as powerful as, and faster than, that of the Tandy TRS80, for instance. It is, of course, written by the same firm and takes up the same amount of ROM. The monitor on the other hand (half the size of the, TRS80's) is less powerful in many ways but better in others—allowing machine code, for instance. The graphics and VDU, though more than adequate, are not up to the standard of the more expensive systems, however.

It is perhaps here, while discussing its comparison with a computer three times its price, that the finest compliment is to be found for this excellent innovation into the UK market.

As a consequence of the remarks in this article, COMP Components have designed and are producing a computer—The Compukit UK 101 (in kit form for £219 + VAT)—based on the Superboard but with many enhancements. These include up to 48 characters per line—with much clearer type and a superior character font with many useful technical symbols. The VDU will generate 50Hz frame information with a faster "dot" clock to produce a rock steady picture even through a modulator—which will be included on the board, as well as a regulated p.s.u. just requiring a transformer to make the system fully operational. Keyboard management will be much improved and include all the missing characters mentioned in Table 1.

Our contributor Dr. Berk will be writing a series of articles fully describing the design and construction of Compukit UK 101 and these should be published in P.E. commencing in the August issue, thus providing readers with a better Superboard at even lower cost.

Semiconductor UPDATE...

FEATURING: FRED IM 7224/5 DM 8678

R. W. Coles

FRED

To me, Fred will always be Fred Bennett, the previous Editor of our favourite electronics mag, and, incidentally, its founder. Well Fred, if you are reading this you'll be pleased to know that at long last your services to electronics have been officially recognised. They have named a series of semiconductor devices after you, so you can join the ranks of Hertz, Ohm, Ampere and all the rest!

Hang on a minute though, leafing through the FRED data sheet I find no unsolicited testimonial, only a bleak paragraph which informs me that **FRED** stands for Fast Recovery Epitaxial Diode.

Joking aside, the FRED is a device worth a second look. The name has been coined by Thomson–C.S.F., the French semiconductor house, and they have made a whole series of diodes available under the FRED banner. The diodes are intended for use as rectifiers in switching power supplies and the like, and they represent a big improvement on the traditional silicon diode design.

The need for these devices has been emphasised by the new power-supply-wonder-of-the-age, the D.O.L. (Direct-Off-Line) switcher. These power supplies get rid of the heavy iron transformer of traditional designs and make possible small, lightweight, regulated power packs in a fraction of the normal space.

The way they work is simple enough. Take a 230V a.c. input and half-wave rectify it to give a high d.c. voltage. Now chop up this d.c. supply into a high frequency . . . pulse train using transistors and then pass it through a small, lightweight, high frequency isolating and step down transformer. Finally, rectify in the traditional way, only use FREDs. To achieve voltage regulation, monitor the output voltage and use it to control the width of the pulses produced by the chopper transistors.

Easy isn't it, but as you can imagine the "high frequency" bit causes problems not only for the choppers, but also for the rectifiers. Old fashioned rectifiers are fine at 50Hz but at 20kHz? forget it. FREDs on the other hand have a low forward voltage drop, low conduction losses, high surge current rating, low reverse recovery time, low forward recovery time and are great at 20kHz. The range includes the BYW80 at 7 Amps, the BYW 81 at 12 Amps, the BYW 77 at 20 Amps, the BYW 92 at 35 Amps, and the BYW 78 at 50 Amps. Better luck next time Fred!

COUNT ON IT

You have probably seen the delectable Intersil D.V.M. chips, the ICM 7106 and 7107. Well now Intersil have done it again with a whole family of counters in the same image. Once again you can have a choice of l.e.d. or l.c.d. displays, but in addition you can choose either a 19999 full scale count or the 15959 timer variety. As usual, the chips drive their displays directly, and they'll run from five volt supplies too. CMOS technology is used, and so the **IM7224** l.c.d. version draws only 10 microamps at 1kHz and a miserly 1 milliamp at a full 10MHz! The **7225** l.e.d. version takes a lot more of course, or rather, the displays do. To get the 15959 versions, just add an "A" suffix. This new chip is going to be a big success, you can count on it!

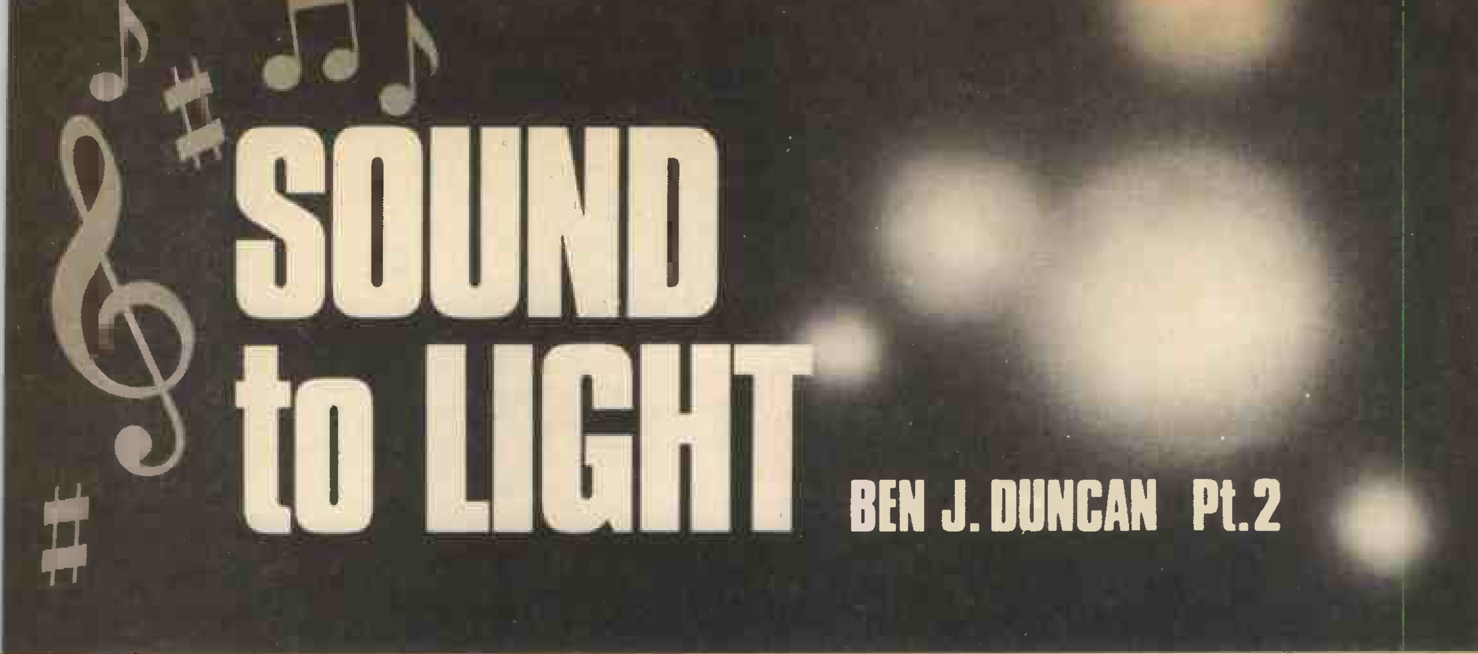
DOTTY CHIP

Anyone who studied the excellent P.E. VDU SYSTEM series must have been impressed by the capabilities of the SFF 96364 TV controller chip which helped to make that low cost system possible. You may have noticed that in addition to the control chip, the system used NMOS RAMs, several TTL packages and a 24 pin character generator ROM which contained the character dot matrix information for the raster scan display. If you are thinking of building this sort of system into, say, a home computer, you may be interested to learn that you can save quite a lot of board space and trade three packages for one if you substitute a National **DM 8678** for the existing 2513 ROM and two of its TTL support chips.

In the existing system, 6 bit ASCII character data from the screen RAM memory area is latched in a TTL 74174 register before being used to control the character select lines of the 2513 ROM. Output data from the ROM appears in parallel a row at a time, and has to be serialised in another TTL package, a 74165 parallel in/serial out shift register, before being applied to the modulator.

The DM8678 device replaces the two 16 pin TTL devices and the 24 pin ROM with a single 16 pin package. Not a bad trade! The pin reduction is possible because whereas the 2513 ROM had parallel inputs and outputs, the DM 8678 has parallel inputs but a serial output. The speed requirements of such a fast system can be met by the National device because it is a bipolar (not MOS) chip which is fully TTL compatible. The DM 8678 chip comes in a variety of optional forms which each contain a different character font. For compatibility with the P.E. system, the DM 8678 CAB is required because it has a 7 x 5 character dot matrix in upper case. Of course it would be very easy to add a lower case character facility to the system by using two DM 8678s, with some simple extra gating. In this case a DM 8678 CAH would be required.

If you really were cramped for space, another saving might be to substitute a single MK 4118 IK x 8 RAM for the eight 2102 S currently specified.



SOUND to LIGHT

BEN J. DUNCAN Pt.2

IN this part constructional details will be given together with display techniques.

CONSTRUCTIONAL NOTES

If the PSU regulators' heatsink is mounted vertically, then the signal processing circuitry can be mounted on the rear, the heatsink then acting as a screen.

The inductors L1 and L2 consist of 500 turns of 19 s.w.g. enamelled copper wire, close wound in layers on a 200 x 10mm ferrite rod. Each layer should be covered with good quality p.v.c. tape, particularly the top layer. This reduces the likelihood of problems arising from damaged insulation.

The plastic regulators share a 2·1°C/W heatsink. The 7915 regulator must be isolated from the sink. The C106D thyristors are wired directly into the Zero Voltage Switch p.c.b., and are bolted to a 19°C/W sink, which should not be able to touch other components on the p.c.b.

The pulse transformers should be mounted so that their 2·5kV isolation is not negated (a good quality insulating base should be ultilised).

The Triacs are individually mounted on isolated 2·1°C/W heatsinks. The holes should not be drilled until the size of the p.t.f.e. standoff washers is known. After drilling, carefully remove all burrs. It is most important that the stud nut is tightened slowly and not excessively, until the device is firmly held against the heatsink.

When mounting the above devices, there are three important considerations:

(a) Use proper heatsink compound between mating surfaces, and use it in moderation. (b) Remove the anodisation from the heatsink where the device is to be mounted, but do this with great care in order to maintain a smooth mounting plane. (c) After drilling, remove all burrs and projections with a smooth cut file. The insulating properties of mica are easily destroyed by partial rupture and punctures resulting from rough metal surfaces. Great care must be taken to maintain a smooth heatsink surface for this reason.

The heatsink specified for the triacs will maintain their junction temperature at around 60°C at full load current. If very light loads are connected, the junction temperature will drop and this results in a decrease in gate sensitivity. To maintain reliable triggering, R5 and R6 may be reduced to 27 ohms. If further current is required, then additional pulse transformers could be wired in parallel. The load current at which triggering begins to fail cannot be predicted owing to the spread in triac sensitivities, but the prototype would drive a single 100W lamp. Gate insensitivity may also be corrected by judiciously increasing the junction temperature. This is achieved simply by adding more mica washers and/or omitting thermal mounting compound on one or more interfaces. The BTX 94 data sheet must be consulted and soak tests should be made to ensure that reliability is not reduced as a result of excessive temperature rise. If possible, the triacs should be selected for I_{GT}<90mA, V_{GT}<2V, hence avoiding the need for trial and error methods.

The low junction temperature achieved with the specified heatsink ensures reliability consistent with the adage "The cooler you keep the device, the longer it lives".

TRANSFORMER PHASING

Correct phasing of the pulse transformers is essential for reliable triggering. The gate pulse should be negative with respect to triac terminal MT1. Linking the anode and cathode of the C106 thyristor should cause the lamps to light. If this test fails, then either the zero voltage switch or the transformer phasing is in error. Prior to testing the unit, check that the pulse transformers are wired between the gate and MT1 triac terminals, and that terminal MT2 is wired to the live via the load. Also test the isolation between MT2 and the heatsink. Finally, thoroughly check the circuitry.

ALTERNATIVE VERSIONS

If power capacity is to be sacrificed for a lower cost, then the following substitutions may be made:

Component	Design Version (6·2A/channel)	Low Power Version (4·8A/channel)
Triac	BTX94–600	BTW37–600
Heatsink	2·1°C/W	4·0°C/W
High speed fuse	Ferraz 600.CP.AS.10.38–12	600.CP.AS.38–6
Slow fuse	5A, 1¼in. glass, 'quick blow'	3A, 1¼in. glass, 'quick blow'

A single channel version is another expedient economy. On the other hand more channels may be accommodated

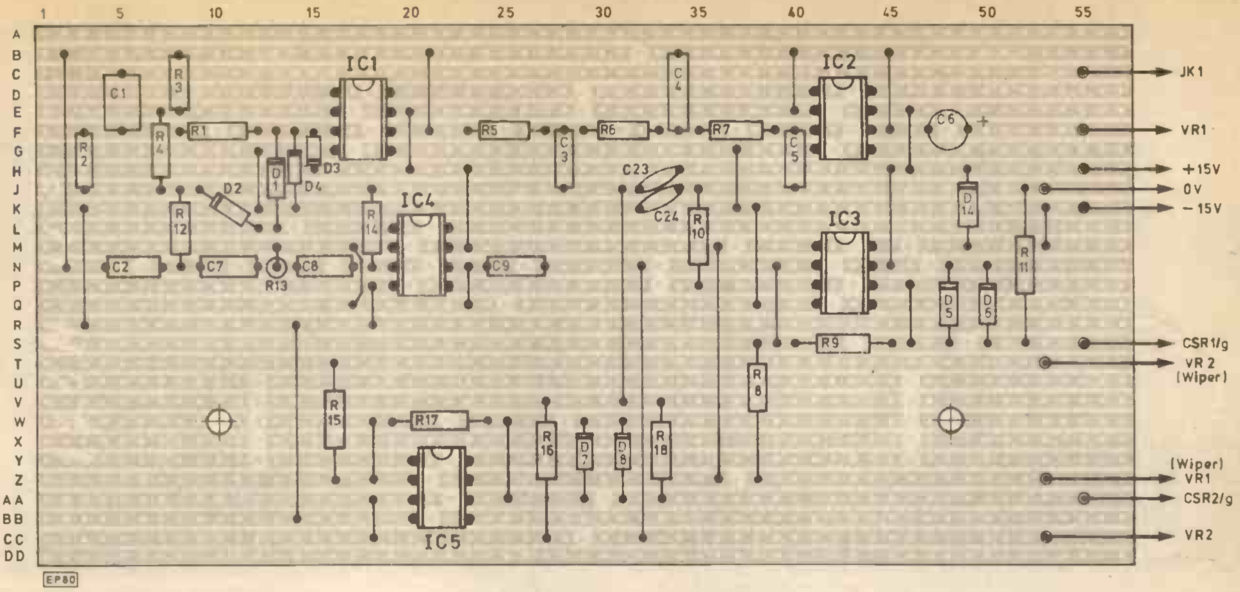


Fig. 6. Signal processing board

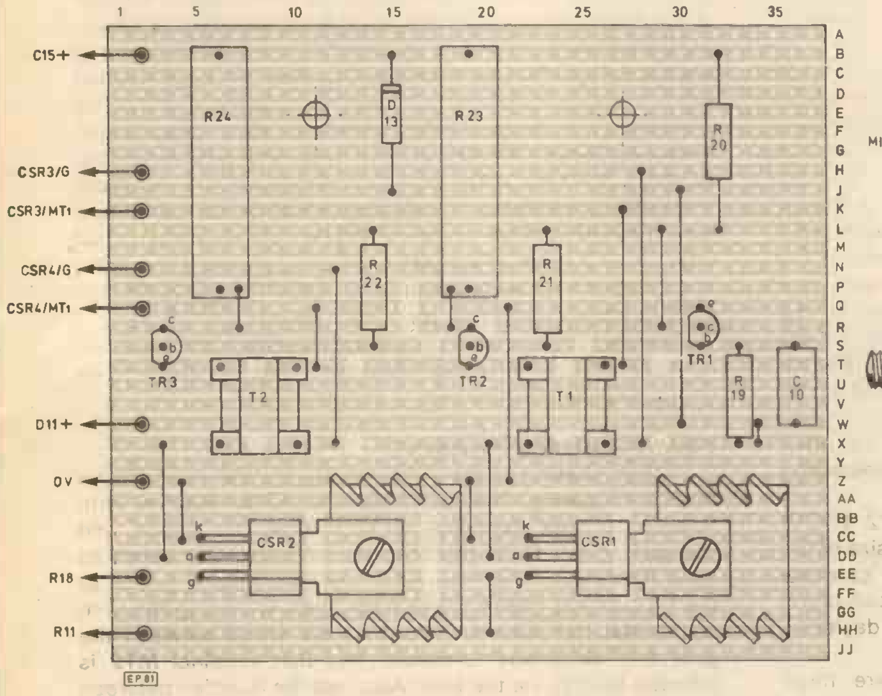


Fig. 7. Zero voltage switch board

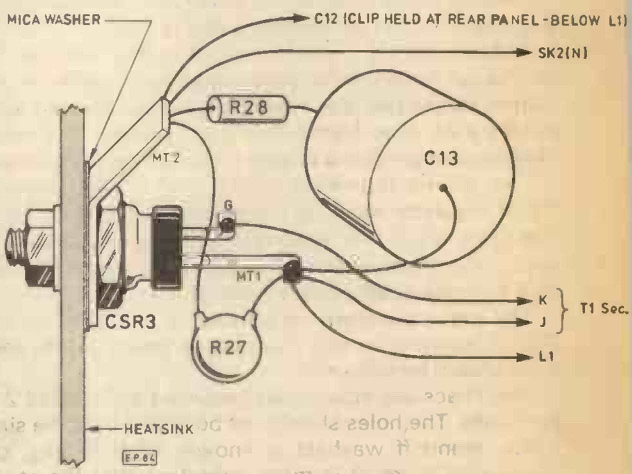


Fig. 8. Circuitry directly mounted to channel triac. Layout is similar for both channels

with modifications to the signal processing circuitry. Steep bandpass filters, possibly based on cascaded low and high pass Chebyshev filters are required for an unambiguous display. In both cases, a pro-rata change in the rating of the power supply transformer and rectifiers is the only modification necessary to the remainder of the unit. The unit may be wired into 30A mains feeds with complete confidence. Higher current feeds are suitable provided the prospective short circuit current is under 900A. This value may be derived from the supply impedance. A simple method of measuring the latter parameter is to connect the largest allowable load to the feed. The difference between loaded and open circuit supply voltage will indicate the supply impedance reasonably accurately.

The use of loads in excess of 6·2A in the design version is limited primarily by lamp surge current. On certain mains supplies, where impedance is relatively high, one may well get away with greater loads. Under no circumstances however should the high speed fuses be subjected to currents in excess of 11·5A. This implies the use of a 7A fuse (If $1\frac{1}{4}$in. glass) to protect the high speed fuse. As such a fuse is not available, and its use would significantly reduce triac protection it is recommended that the point where 5A $1\frac{1}{4}$in. fuses start to go 'pop' is taken to be the safe limit.

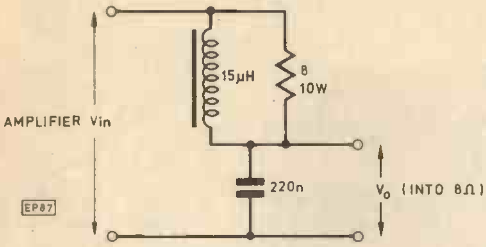


Fig. 9. Theile network

R.F.I. PROBLEMS

If r.f.i. is troublesome, assuming that the r.f.i. elimination routine has been dutifully followed, then the best course of action is to suppress at the point of pickup. This is usually sensitive audio circuitry. The use of a Theile network in power amplifiers prevents r.f.i. picked up in speaker cables being fed back to the input via feedback networks (Fig. 9). If unbalanced lines are used for interconnection, the use of balanced line cable is helpful. One of the inner cores is used for the return, and the screen is connected *at one end only*.

Earthing arrangements should be under suspicion, particulary mains earths. The SLM should ideally have its own, low impedance cable to the mains socket. In exceptionally difficult cases, copper screening may be employed. This should hermetically encase the power control circuitry. All mains cables should be screened with copper braid.

Audio circuitry power supplies should incorporate suppression chokes of the bifilar variety.

Normally however, no problems will be experienced provided speaker cables are kept well away from mains cables connected to the SLM.

LAMPS

In order to minimise lamp filament failure rate and thereby avoid unnecessary loss of high speed fuses it is expedient to use single coil lamps, having longer life and more robust filaments. Inherently heavy duty lamps such as PAR 38 types are strongly recommended. Wherever possible, 240 or 250V lamps should be specified. If, say 230V lamps were used at a venue with a 250 volt supply, the 9 per cent increase in voltage over the nominal will shorten lamp life by 60 per cent. Using 250V lamps will of course entail a small loss in potential light output in most cases; 240V lamps are the best compromise.

Zero voltage switching, applying intermittent power (as in this application) and good ventilation also increase filament life expectancy. 100W lamps are the compromise between a large number of small lamps with low thermal inertia giving a responsive display but with high hardware costs, and a smaller number of high power lamps exhibiting a sluggish response. Thermal lag will significantly affect the character of a display, so experimentation is urged.

Stage lighting gelatines (Cinemoid) are a cheaper colour medium than coloured lamps and provide a wide range of colours of differing densities. No's 11, 18, 34, 41 and 46 are typically of optimum density for efficient projection. It has been stressed that good display technique is the crucial factor in successful discotheque lighting; operators who are seriously concerned with lighting display techniques should study stage lighting and carry out extensive experiments. Whilst the difference between theatrical (stage) and discotheque lighting in the applied sense is wide, the basic principles are similar.

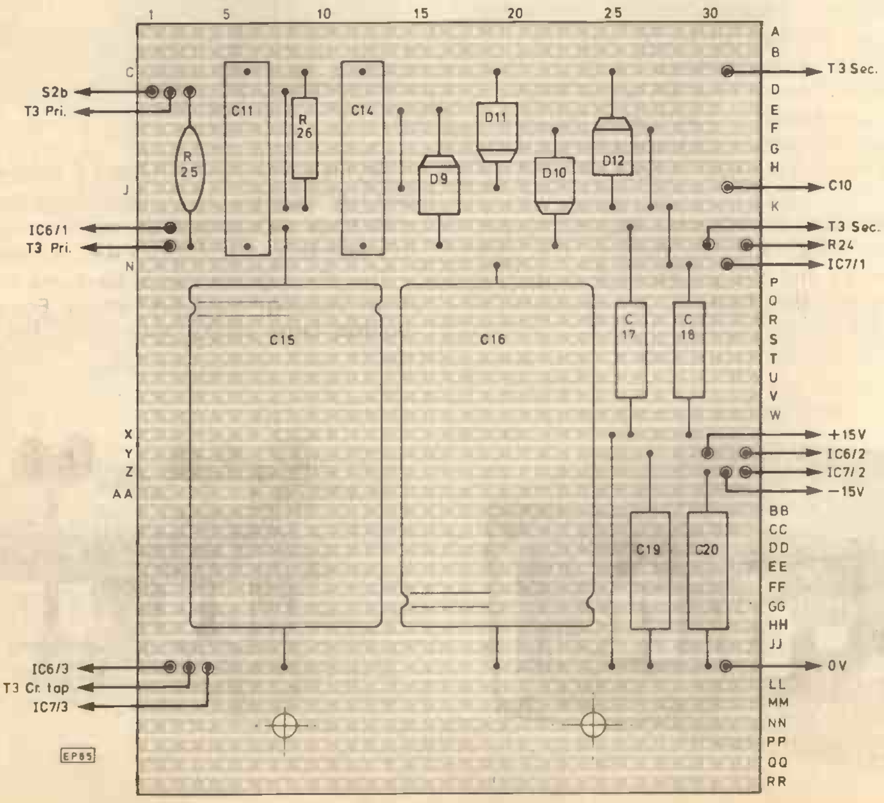
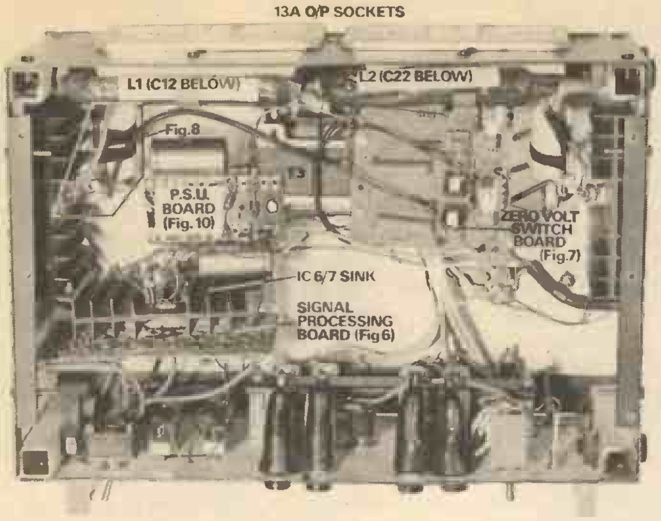
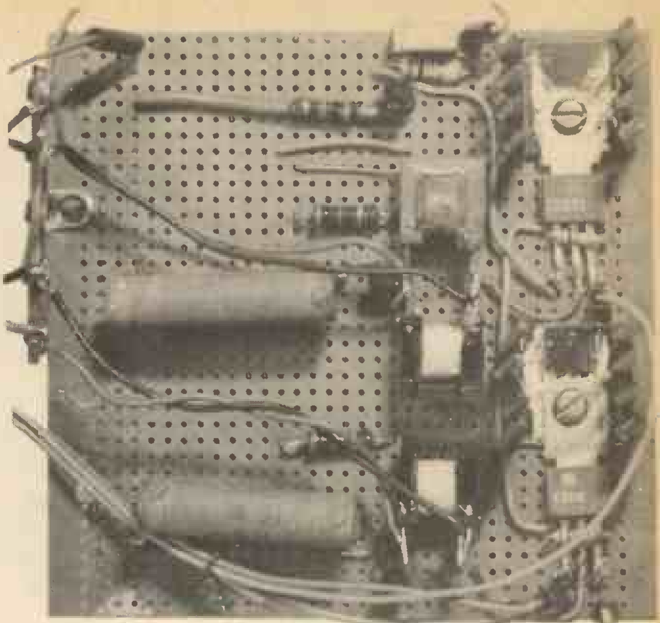


Fig. 10. Power supply board



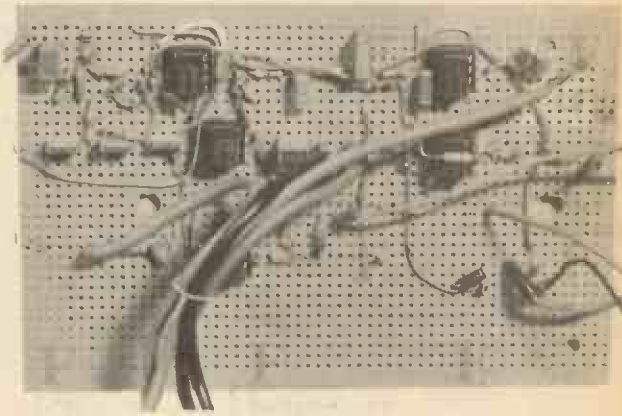


DISPLAYS

Displays are dichotomised by the two classes of music: those which are viewed and those which are experienced, appertaining to cerebral and physical music respectively. For the former, suitable "viewed" displays consist of lamps faced by coloured and patterned diffusion screens. Unfortunately, this display mode, in the form of "lightboxes" is common in discotheques, yet is *totally* unsuited to the enhancement of physical music.

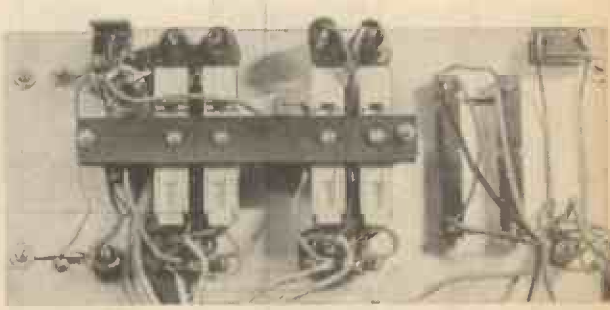
A "physical display", in the same manner as physical music must "cry out for physical participation", hence a display which is "experienced". To achieve this, light must be projected. Of course, "lightboxes" project light, but the effect is weak and ineffectual, because they are not usually designed to act as an efficient projector they have a multiplicity of close seated colours project a mixed light which tends towards pale hues or even white and the light source is often in the line of sight and acts as a distraction, hence the rule of physical displays, (a) use efficient light projectors (b) project a minimal number of bold colours from discrete sources.

Strategic placing of bass and treble displays causes violent oscillation which is stimulating. Remove the light source form the audience's line of sight. Ideally it should be overhead, but close to the floor is an acceptable compromise.



An idealised overhead display system based on rock concert techniques would consist of lighting units in steel boxes with hook clamps and parabolic reflector lamps, which in this case should be 100W PAR 38s instead of PAR 56s.

The direct opposition of bass and treble lamps gives rise to an exciting "cross-fire" effect. Equipment of this calibre requires large capital investment, but it is certainly worth



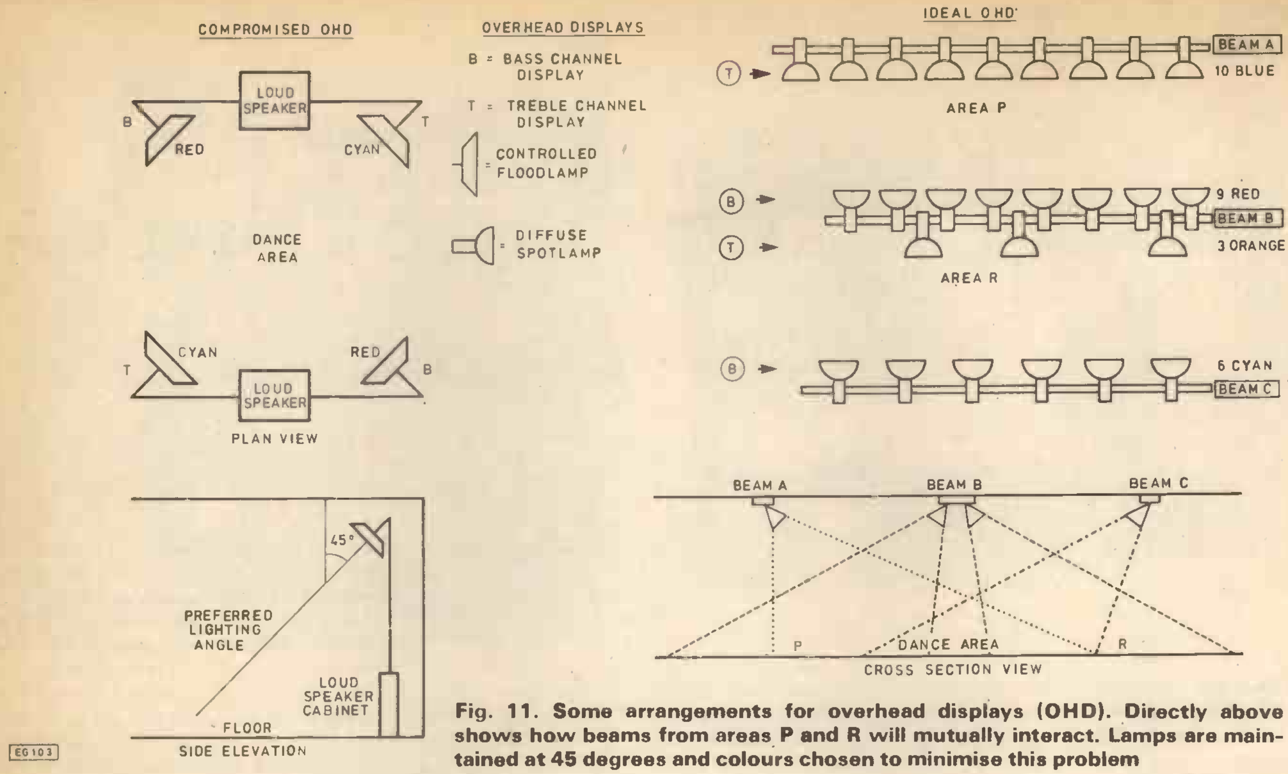


Fig. 11. Some arrangements for overhead displays (OHD). Directly above shows how beams from areas P and R will mutually interact. Lamps are maintained at 45 degrees and colours chosen to minimise this problem

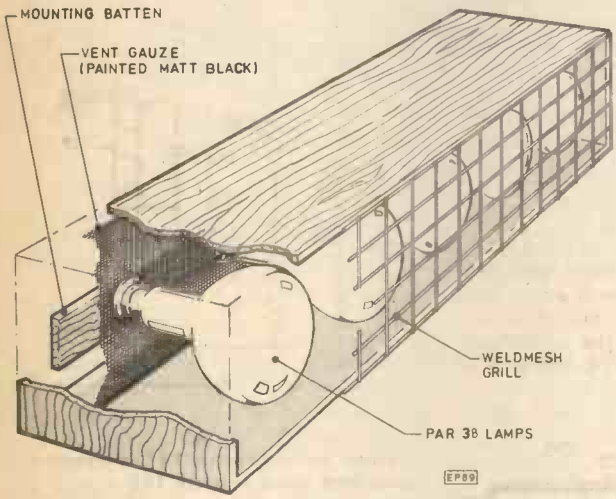
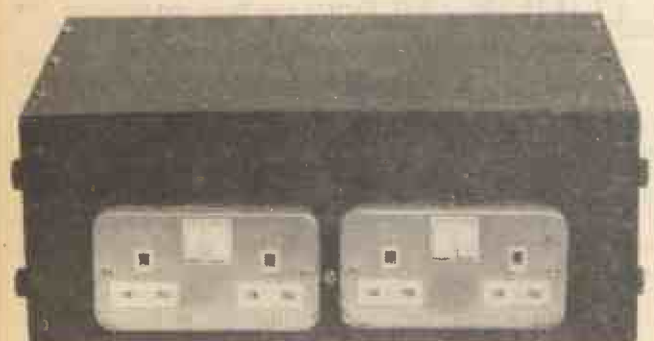


Fig. 12. Low cost projection box



hiring it from PA hire contractors for special occasions.

A compromise arrangement suitable for small venues is shown in Fig. 11; setting up is rapid. Note again the arrangement of bass and treble lamps in order to give a cross-fire effect. The compromise between a large number of discrete sources which are costly and take a long time to set up and a small number which concentrate the light sources unduly is around 500W per box, made up of 5 x 100W PAR 38s.

PROJECTION BOX

The key details of a simple projection box are shown in Fig. 12 or 50mm grid x 8 or 12 gauge "Weldmesh" serves to protect the lamps and gelatine sheet which is pinned behind it; PAR 38s are however extremely tough and it may be omitted if desired. The lamps are mounted on a centre batten. Local power connection should be of butyl cable and brass holders should be used in order to ensure a long service life at high temperatures.

A fine zinc or aluminium mesh, matt black painted flush with the aforementioned batten will provide reasonable ventilation with minimal light leakage. When setting up an SLM or judging the aesthetic effect of a display, study the effect of the lighting on people rather than viewing the light source. The use of too many colours will only create an ambiguous, confusing pattern which defeats the object of using a two channel SLM. Stray white light can be troublesome and if elimination is impossible, exchanging the offending light source for a 60W "Fireglow" lamp is a reasonably diplomatic solution. Bear in mind that the location of floor mounted sources often defines the nucleus of the dance area in discotheque applications.

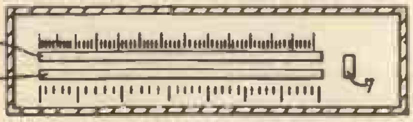
Finally, remember that the discotheque is primarily concerned with music and dancing. A good sound system is the first prerequisite; lighting is a secondary consideration, but lighting which stimulates dancing must be the foremost choice. ★

PATENTS REVIEW...

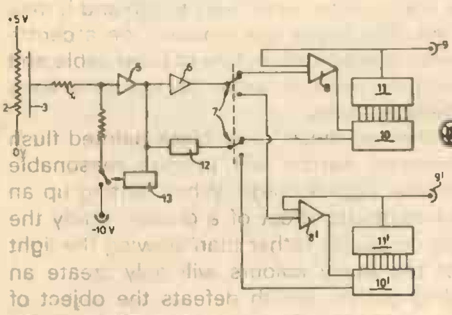
Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

TOUCH CONTROL

Fidelity Radio Ltd. of London NW10 in BP 1 513 562 propose a simple and cheap touch or tuning control for an amplifier or radio. It is suggested that the device can also be used to control lighting or power. The patent was applied for in early 1975 and is granted under the old laws.



A control panel carries two parallel strips, 2, 3, of conductive ink, which are printed by silk screen techniques. The strip 2 serves as a resistor and is connected at one end to a low voltage supply, e.g. 5 volts. The strip 3 offers negligible resistance. When a finger is placed as a bridge at any position along the length of the parallel strips, the potential at that position on strip 2 is applied to strip 3, i.e. the finger acts as the movable contact of a potential divider.



Strip 3 is connected to the circuit under control by resistor 4 which is incorporated to protect the circuit components against static discharge. Amplifer 5 connects to signal processing device 6 which removes any residual a.c. and supplies one input of a comparator 8.

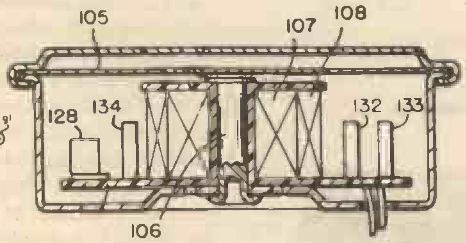
The second comparator input is derived from output 9 and the comparator feeds an up-down signal to digital counter 10 so that the count changes as the potential at 6 varies with respect to the potential at 9. Clock pulses for counter 10 are sourced from pulse generator 12.

When the potential at strip 3 is very low, i.e. when there is no finger contact, the output of amplifier 5 drops to a value which operates switching device 13 to connect the amplifier input to a fixed potential source (e.g. −10 volts). This drops the output of amplifier 5 further to establish a positive closed position of the switch 13 and de-activate the clock pulse generator 12. This ensures that spurious charges on strip 3 cannot achieve a control function. Counter 10 and an analogue converter 11 at the counter output together act as a store for the last sensed finger position on strip 3.

The output at 9 is used as a control signal, for instance to vary receiver tuning or amplifier volume.

ALARM HORN

General Signal Corporation of New York in BP 1 523 909 describes a simple but efficient horn design, suitable for generating an alarm tone. The patent was first applied for in late 1974 and thus is granted under the old laws.

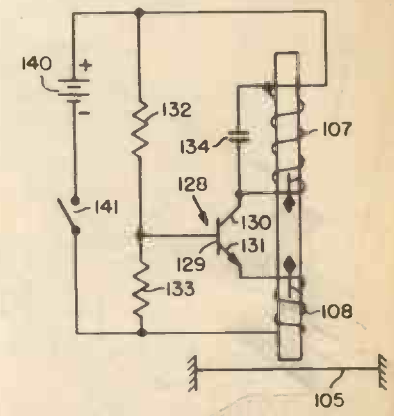


The horn has a two part coil, inner or primary coil 107 being wound inside secondary coil 108 on the same core 106.

Primary coil 107 has five or six times the number of turns in coil 108 and the two coils are wound in opposite sense and in series. The magnetic fluxes generated by a common current are thus in opposition and the overall flux is equal to the difference between the two fluxes.

As the circuit shows the lower end of primary coil 107 is coupled to the collector 130 of a control transistor 128 and the upper end of coil 107 is coupled to the transistor base 129 via resistor 132.

The upper end of secondary coil 108 is coupled to the transistor emitter 131 and the lower end of coil 108 is coupled to transistor base 129 via resistor 133. Resistor 132 is approximately 10 times the value of resistor 133, the two resistors thus defining a potentiometer chain connected in parallel with the series connected coils. Capacitor 134 bridges coil 107.



When control switch 141 is closed d.c. flows from battery source 140 through the potentiometer chain to put transistor base 129 slightly positive with respect to the emitter. Transistor 128 turns on initiating conduction from collector 130 to emitter 131. Current now flows and capacitor 134 charges.

As a consequence of the turns ratio and sense of the coils a positive voltage is induced in coil 108 which reverse biases transistor 128. But current continues to circulate in the series RC circuit 107, 134 to dissipate stored energy. As the current and flux from coil 107 reduces, transistor 128 switches on and the whole cycle repeats.

A diaphragm 105 adjacent to the coils and core 106 will move with the flux to produce sound. The pitch of the sound produced will depend on the diaphragm resonance and component values. The patent suggests values suitable for generating a piercing tone of 2·2kHz.

FRANK W. HYDE

VENUS 11 AND VENUS 12

The two Russian Probes released from Venus 11 and Venus 12 landed on the surface of the planet at points some 500 miles apart. Venus 11 was launched from Earth first and then four days later Venus 12 was also launched. However the flight path differed so that although Venus 11 was launched first it was sent along a different and rather longer path. Consequently Venus 12 was the first vehicle to arrive at Venus and release its probe. Four days later the second probe was on its way to the surface of the planet.

Both probes commenced a regular stream of data. The report of the temperature and pressure at the surface was to the effect that the pressure was of the order of 88 times that of the Earth's atmosphere, and the temperature in excess of 450°C. Each probe, during its descent, relayed information about the state of the Venusian atmosphere. Nine samples were taken and the result has enabled the profile to be modelled. There is close agreement with that of the American probes. The chromatographs have confirmed that the major constituents are carbon dioxide and nitrogen. The chromatographs at the surface have also detected carbon monoxide.

There is a significant point of interest about these chromatographs. Usually they are somewhat bulky pieces of equipment. In this case the "sigma" units were small and weighed only two pounds. With the data from the Russian units and that from the American mission the knowledge of the bright planet should be increased considerably.

TROUBLE FOR SCATHA

The United States Air Force satellite, which was designed for a project of special importance, the investigation of the electrical charges built up on spacecraft, has run into difficulties. Since its launch on January 30 a power supply has malfunctioned and one of the transmitters gave trouble. A back-up instrument was brought into service but the data signals received back on Earth were not strong enough. The mission engineers felt that they could overcome the problem but this meant waiting for the period March/April when the vehicle was eclipsed. However this cannot help the "Light Ion" mass spectrometer which seems to have developed a short-circuit on one of the load resistors.

So far Scatha has had the experience of three charge conditions. One of these built up to −300V. These charges are thought to be related to geomagnetic storms stirred up by the Sun. The eclipse was not detected by Scatha. This was the total eclipse of February 26. The Field Detector experiment uses an antenna of 100 feet span. It consists of two fine wires attached at one end to the satellite and having a small mass at the other end. The rotation of the satellite, about 1 rpm, deploys the wires by "centrifugal" reaction.

The orbital characteristics are: apogee 43,225km., perigee 27,780km, an inclination of 8·3°. There is a drift rate of 6° east daily. The vehicle has a designed lifetime of one year.

UK-6 BRITAIN'S SPECIAL STARGAZER

UK-6 has the launch date of May 24 this year. A Scout vehicle will launch the satellite which will go into a high circular orbit. Originally it was intended that the altitude should be 550km. In fact the altitude will be 625km with an inclined orbit of 55°. This situation has been achieved by improvements in the Scout vehicle. In addition to the achieving of the greater height the lifetime of the satellite will be increased. It is expected that its life will be 3 years, but if the same nursing by the team who kept UK-5 in operation is available, the life will be extended.

It is predicted that there will be a period of intense solar activity at the end of this year resulting in the raising of the top limit of the Earth's atmosphere. There will therefore be the possibility of detecting particles which come from the Sun's corona. The inclination of the orbit was chosen in the interest of the cosmic ray detector. At the inclination of 55° the instrument will be able to scan through the Earth's magnetic field. This position however does reduce slightly the best achievable measurements by X-ray apparatus.

ALTITUDE CONTROL

The mass of the UK-6 is 155kg. The payload is about 40 per cent of the total, which is a high proportion. The satellite is spin stabilised. The altitude control is rather unusual, being based on a magnetic coil which encircles the base of the satellite body. When a current is passed through the coil a force is set up which enables the whole satellite to be precessed to another position. There is provision for passive thermal control and the solar array will be able to deliver 95W continuously to the end of its life. Batteries are available to provide power when the satellite is eclipsed. The X-ray sensors are directed away from the Sun so that simultaneous observations may be made from Earth.

It is hoped that UK-6 will provide more data so that an even better assessment may be made of the manner in which stars are formed. There are three principal experiments on board and these will provide information on variable X-ray sources, low energy X-ray sources, such as the possible Black Hole Cygnus X-1 or the Crab nebula. There will also be information on the heavier nuclei of cosmic rays. These are suspected to come from the remnants of super-novae. These data will enable astrophysicists to understand more about how the radiation is produced and perhaps provide a clue as to formation or collapse of stars.

COSMIC-RAY DETECTOR ON UK-6

The cosmic-ray detector was supplied by a team from Bristol University. It is the largest of the experiments. It consists of a pair of concentric spheres 75cm in diameter. They are filled with a mixture of neon, helium and argon with traces of nitrogen. The mixture is maintained at a pressure of a little over one atmosphere. A battery of photomultiplier tubes surround the chamber and these observe any events taking place within. The outer sphere acts as a supporting structure. The inner which is made of plastic and contains a wavelength "shifter" is the working part of the detector. The designers believe that this will be the first instrument to accurately measure the rays formed from elements over a wide range, specifically from iron to uranium and possibly beyond. The action of the cosmic-ray detector is such that when a cosmic-ray, which is an atom that has lost its electrons, passes through the chamber it produces flashes of visible radiation, one each time it passes through the plastic sphere and one each time it passes through the gas mixture. This is the Cherekov effect which is observed by the photomultipliers. The detector is arranged so that several of the multipliers "see" each flash. The charge on the nuclei is measured as it passes through.

The second experiment which is designed for the investigation of low energy X-rays is a joint contribution by the University of Birmingham and the University College, London. The experiment has four gazing incidence X-ray reflectors which lead to proportional counters. These are intended to be pointed at possible X-ray sources, to allow detailed observations to be made. These studies will work in cooperation with ground based observation to ensure the accurate position fixing of the sources.

Leicester University supplied the third principal experiment and it is designed to observe the variable X-ray sources. The apparatus is similar to the University College and Bristol University experiment with the ability to observe rapidly varying sources.

Two minor experiments from the Royal Aircraft Establishment are aboard the satellite. One is a collection of new types of solar cells which are to be tested under space conditions and the other investigates how space effects metal oxide semiconductors.

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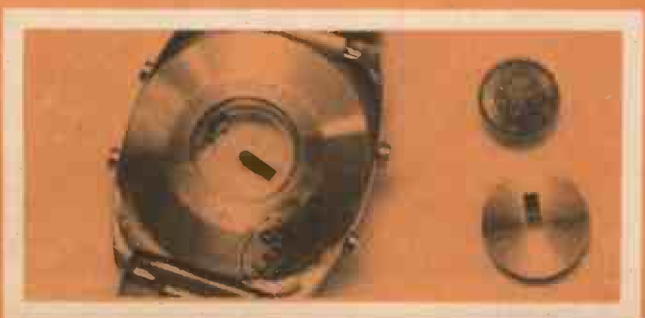

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CINE SPEED CONTROLLER

M. YEOMANS

EVEN the simplest form of sound track cannot be synchronised unless the projector speed can somehow be stabilised. This particular speed controller is designed to eliminate speed variations from any cause, and is entirely automatic in operation. It operates within very close limits and can be preset to run the projector at any desired speed. This version provides switching between 16 and 24 f.p.s. for a standard 8 mm projector. The 24 f.p.s. setting is used for showing silent versions of sound films.

The principle may be applied to any variable speed motor where some form of revolution detector can be fitted.

PRINCIPLE OF OPERATION

Pulses are derived from the projector using a photo-darlington and lamp, located on either side of the shutter blades (see Fig. 1). The pulses are fed to a Schmitt trigger to eliminate noise. The squared up pulses are then fed to a digital filter. The filter gives two low outputs if the frequency of the input pulses is within the passband. If the input frequency is above this band, point A goes high, and if the frequency is below the passband, point B goes high. The outputs A and B are used to drive an electronic switch which will charge or discharge a capacitor as appropriate. The voltage across the capacitor is amplified and used to drive an opto-isolator. The opto-isolator drives a triac switching circuit via a two transistor amplifier.

A digital filter is used, since it requires very few components and can provide a very narrow, sharply defined band width.

CIRCUIT OPERATION

Pulses from the photo-darlington are first cleaned up by the Schmitt trigger formed by TR2, TR3, R1, 2, 3, 4 and 5. Refer to Fig. 2. They then pass to the 4528 CMOS IC whose catalogue description is a *dual retriggerable-resettable monostable multivibrator!* In this application the two monostables contained within the i.c., are configured as a digital filter.

The pulses from the Schmitt trigger are fed into the two monostables via the leading edge trigger inputs. The time constants of the two monostables define the lower and upper limits of the passband. With the respective R set high, output pulses appear at Q for input pulses below the crossover frequency. For higher frequencies Q remains high. With R set low, the output at Q remains low.

IC1(a) defines the lower limit of the passband, so that below this band its Q output varies at the input frequency, setting R on the (b) circuit low for the leading edge of each new pulse, and therefore holding "Qb" low. Within the passband Qa remains high and Qb varies at the input frequency. Above the passband Qb remains high.

Components D1, D2, C3, C4, R8, R9 form low pass filters, so that the inputs to the switches can only be set high when Q and $\overline{Q}$ are in steady states outside the passband.

The electronic switches are provided by one half of a 4016 CMOS quad bilateral switch i.c. The switches cause the capacitor C5 to charge or discharge according to the frequency of the input pulses, and the voltage is applied to the gate of the 2N3819 FET. The very high gate impedance ensures that the charge remains constant until the next operation of one of the switches. The l.e.d. is driven by TR5.

The LDR of the opto-isolator varies the current drawn by TR6 and TR7, and hence the current through the bridge rectifier. These components take the place of the variable resistor in the normal triac control circuit.

The control circuit is connected in series with the projector motor and its normal variable speed control resistor.

DESIGN PARAMETERS

For stable speed control and rapid response at switch-on without overshoot, an appropriate value for C5 must be selected. If C5 is too small, the motor speed will hunt about the desired value, since the effective time constant of the speed controller is smaller than the reaction time of the motor. If C5 is too large the motor will take too long to reach the correct speed when switched on. The optimum value of C5 will depend upon the characteristics of the motor and the load presented by the projector, and is easily found by experiment.

CONSTRUCTION

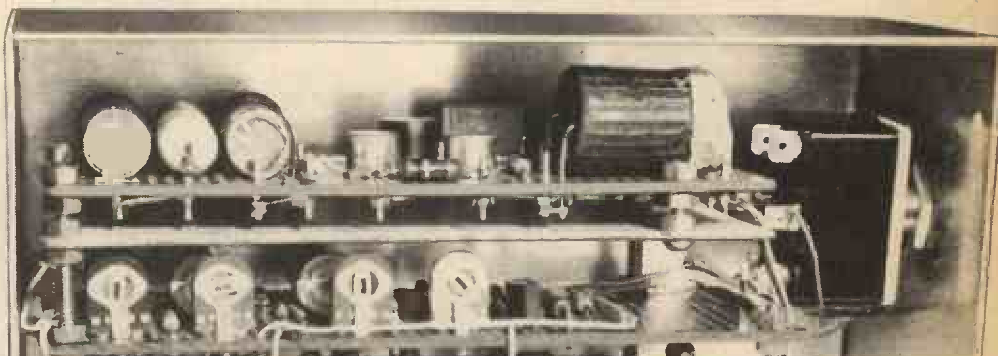
The lamp and photo-darlington are mounted on a small piece of veroboard which is supported by a conveniently placed bracket adjacent to the projector shutter blades. The low voltage power supply is derived from the 8V a.c. projector lamp supply. All the leads, including those for the motor control circuit, are taken out of the base of the projector body to a separate box, mounted behind the projector on a common baseboard. This form of construction was chosen so that no physical modification of the projector would be necessary.

The low voltage circuits are mounted on two pieces of veroboard approximately 45 x 120mm. A third plain matrix board of the same size holds the a.c. circuitry and opto-isolator, and the three boards are mounted as a sandwich, using 6BA studding and spacing nuts, inside an aluminium box.

A single toggle switch provides switching for 16 and 24 f.p.s. Slower speeds may be obtained using the normal projector speed control. The control circuit is energised by switching on the projector and no other controls are necessary.

The layout and form of construction are not critical, apart from the need to ensure that the high voltage triac circuit is mounted separately from the rest of the components.

Using a variable speed cine projector can be very frustrating. Continuous adjustment may be necessary to keep the speed of the projector constant as the machine warms up, and the load on the take up spool varies.



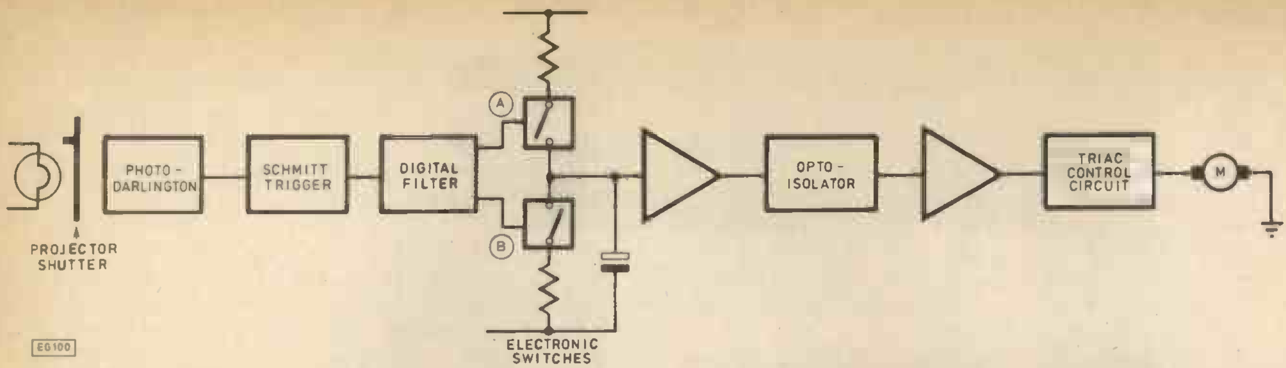


Fig. 1. Block diagram of Cine Speed Controller. Solid state switches are used to transfer the digital filter output to the integrating capacitor.

COMPONENTS . . .

Resistors

R1	100k
R2	1k
R3	47k
R4	100k
R5	3k3
R6, R7	270k (2 off)
R8–R10	4M7 (3 off)
R11	2M
R12	3k9
R13	1k2
R14	22k
R15	390
R16	100k
R17	200k
R18	22
R19	1k5
R20	82
R21	47
R22	ORP12 LDR

Potentiometers

VR1–VR4 250k presets (4 off)

Capacitors

C1–C4	100n (4 off)
C5	4μ7
C6, C7	100n/400V (2 off)
C8, C9	100μ (2 off)

Transistors and Diodes

TR1	2N5777
TR2, TR3	BC147 (2 off)
TR4	2N3819
TR5	BC148
TR6, TR7	BF259 (2 off)
D1, D2	1N914 (2 off)
D3	TIL209
D4	BR100
D5–D8 } D9–D12 }	full wave rectifier 400V p.i.v.
D13	BZY88C6V8
CSR1	T2800D

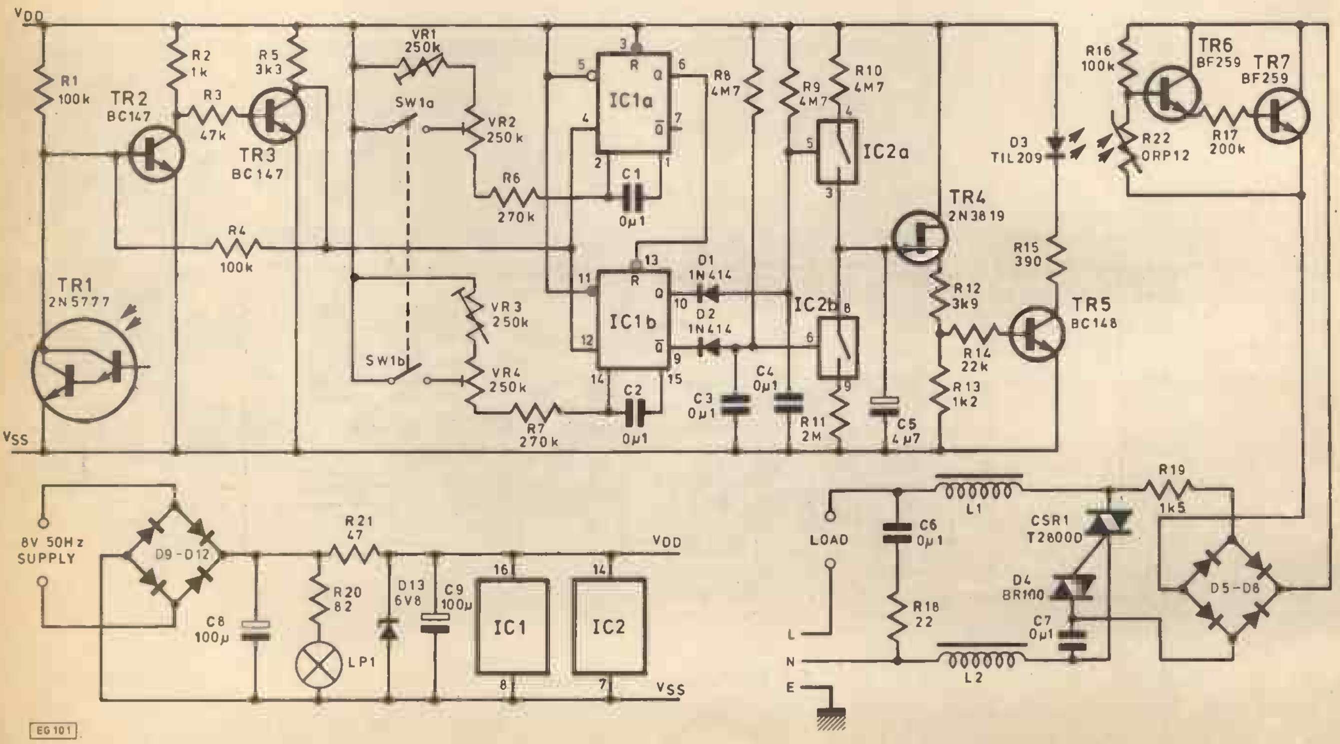
Integrated Circuits

IC1	4528
IC2	4016

Miscellaneous

L1, L2 55 Turns 28 s.w.g. $1\frac{1}{4} \times \frac{1}{4}$ inch ferrite rod.
LP1 miniature 5V incandescent bulb.
S1 DPDT toggle switch.

Fig. 2. Full circuit diagram.



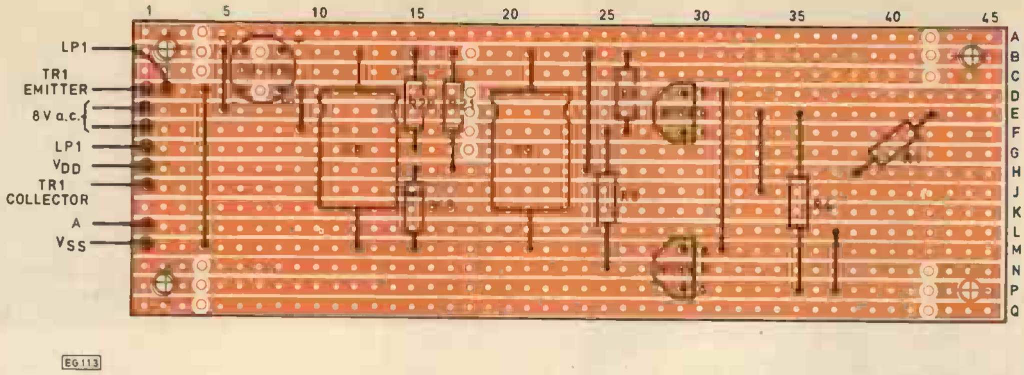


Fig. 3. Supply Board.

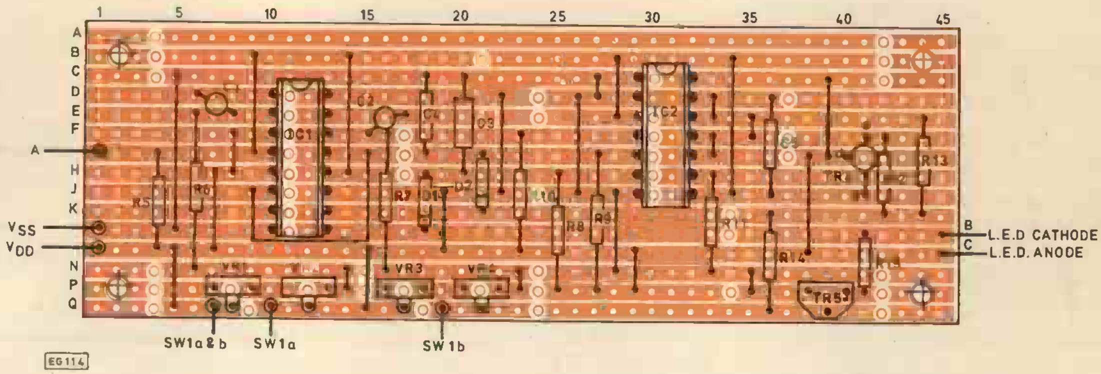


Fig. 4. Main Board.

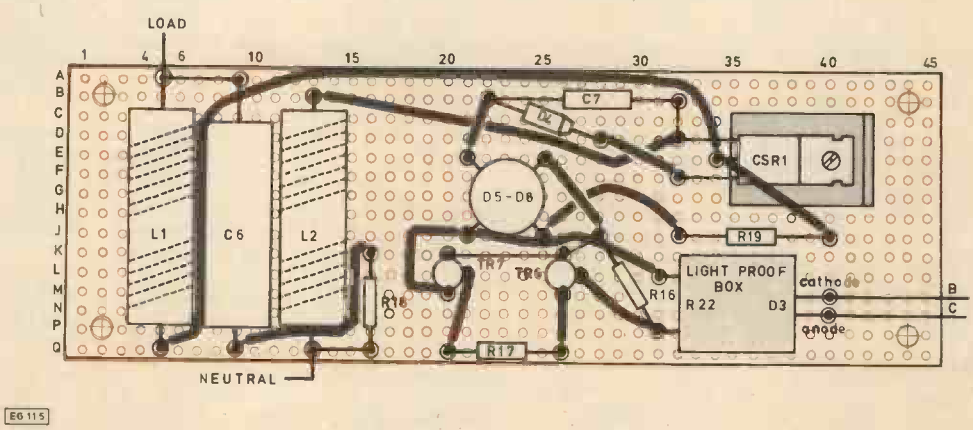


Fig. 5. Mains Voltage Board.

SETTING UP PROCEDURE

Apart from the selection of an appropriate value for C5, the only other adjustments required are the tuning of the digital filter. VR1 and VR3 have to be set to define the lower and upper limits of the passband respectively.

Some method must be used to indicate when the projector is running at the correct speed. A strobe disc on a convenient shaft provides a very accurate method of measurement.

With S1 set to 16 f.p.s., the passband of the digital filter is first set to its maximum by adjusting VR1 to its maximum, and VR3 to its minimum value. The normal speed control is set to *fast* and when the projector is switched on, C5 will be uncharged and the motor speed will rise to the top of the passband. VR3 is now increased, bringing down the motor speed until it reaches a value fractionally above 16 f.p.s. The top of the passband is now set. If a load is now applied to the projector by grasping the take-up spindle, the speed will drop. VR1 is decreased until the motor speed has risen to a value fractionally below 16 f.p.s. The bottom of the passband is now set. Further fine adjustment of the two resistors may now be made as necessary to achieve the minimum passband. S1 is then set to 24 f.p.s. and the procedure repeated with VR2 and VR4.

CONCLUSIONS

There is no *simple* electronic solution to the accurate control of a variable speed motor, but with the right time constants and the band width correctly set up, this solution works extremely well! It provides a stable projector speed which is totally independent of motor temperature or load. No modification of the projector was necessary and no additional power supplies are required. With a common base board, the projector and speed control are completely portable. At last the projectionist can watch the film instead of the projector. ★

News Briefs

by Mike Abbott

COUNTDOWN

Muirhead '79 —May 15-16. Muirhead is a company which specialises in communications technology and servo control systems, and the exhibition and symposium will take place at the Glaziers Hall in London. Further details: Mrs. P. Boreham on 01-650 4888.

The first **All-Electronics Show/Seminex, Scotland,** will take place on May 15–17, 1979, at Edinburgh's Assembly Rooms. Some 68 exhibitors were listed at the time of writing. Details: Saffron Walden 22612.

Welsh Amateur Radio, TV, Electronics and Computer Exhibition—Sunday, May 20. Barry Memorial Hall. There will be trade, and bring-and-buy stands. Further details: Reg Knowles on 0222-565656.

Midlands Breadboard—May 23–26. Bingley Hall, Birmingham. Details: Trident.

Intel Fair—June 11, 1979. Wembley Conference Centre. Details to be announced.

Tranducer 79 + Testmex 79—June 19–21. Wembley Conference Centre. Details: Trident.

Great British Electronics Bazaar—June 28–29, 1979. Alexandra Palace, London. Details: 0799-22612.

1979 Microcomputer Show (incorporating the DIY Computer Fair)—July 5–7. Bloomsbury Centre Hotel, London. Will include seminars. Further details: Online Conferences Ltd. Tel: Uxbridge (0895) 39262.

Consumer Electronics Symposium —July 8-11, 1979. University of Essex. Organised by the Society of Electronic and Radio Technicians. Details: The Symposium Office (CE), SERT, Faraday House, 8-10 Charing Cross Road, London, WC2 0HP.

The **International Word Processing** exhibition and conference will take place July 10-13, 1979, at the Wembley Conference Centre.

Word processing is having a dramatic effect on business procedures, and this event, which is claimed to be the largest in Europe, will display "virtually every available system and piece of equipment".

Details: BETA Exhibitions, Business Equipment Trade Association, 109 Kingsway, London WC2B 6PU.

Harrogate International Festival of Sound—August 18–19 (public), August 20–21 (trade) 1979. The Exhibition Centre + hotels. Details: Exhibition and Conference Services Ltd., Tel. 0423-62677.

Telecom '79—September 20–26. Palais des Expositions, Geneve. Details: Secretariat Telecom '79, Orgexpo, 18 Quai Ernest-Ansermet, Case Postale 65. CH-1211, Geneve 4 (Suisse).

Eltro Hobby '79—October 3-7. Killesberg Exhibition Grounds, Stuttgart. Details: 01-236 0911.

Compec—November 6–8, 1979. Grand Hall Olympia, London. Details: Iliffe Promotions Ltd. Tel: 01-261 8437/8.

Electronics 79—November 20–23. Olympia, London. Details: 021-705 6707.

Breadboard 79—December 4–8. Royal Horticultural Halls, Westminster. Details: Trident International Exhibitions. Tel 0822 4671.

IEA/Electrex—February 25–29, 1980. National Exhibition Centre, Birmingham. Details: Industrial and Trade Fairs Ltd. Tel: 021-705 6707.

All-Electronics Show (1980)—April 29–May 1. Grosvenor House, London. Details: 0799-22612.

News Briefs

BRITISH SATELLITE

by Mike Abbott

THE FIRST all British amateur satellite is to be built at the University of Surrey, co-ordinated by the Telecommunications Research Group within the Department of Electronics and Electrical Engineering. The satellite's purpose and proposed features are a departure from the international OSCAR series, in that it will provide practical experience in developing an inexpensive UK spacecraft programme, and will feature a series of high frequency beacons, enabling radio amateurs worldwide to study the changing effects of the ionosphere on radio signals.

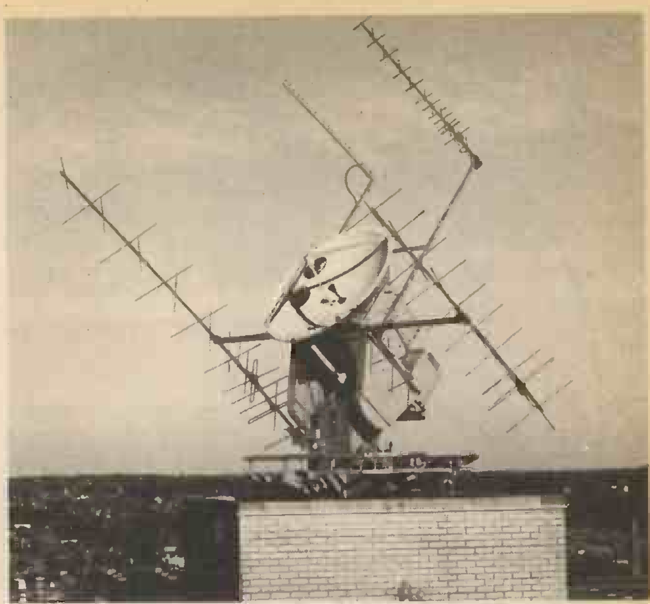
Collaboration will involve the university's Electronics and Amateur Radio Society (EARS), the Amateur Satellite Corporation (AMSAT), AMSAT-UK, and the Radio Society of Great Britain. Many companies such as Racal are to give active support.

Priority will be given to telecommand and other fundamental services, but complex experiments are anticipated, to be undertaken either by the university or amateur groups in this country. With a possible launch opportunity in early 1981, the satellite is intended for a polar orbit at an altitude of 900km.

These satellites house VHF and UHF receiver/transmitters which allow radio amateurs to extend the range of their transmissions in the same way television programmes are relayed around the globe.

With the fault which developed in OSCAR-6 causing it to switch on and off unexpectedly, extra command stations were set up in Canada and Australia to control its use. Lacking in a similar facility, indiscriminate use by European radio enthusiasts threatened the satellite with drained batteries, and to counteract this EARS set up the only command station in the world, run (to this day) by students.

The EARS command station has since 1974 commanded successive OSCAR satellites while in orbit over Europe.



The command station at Surrey University has a steerable aerial complex capable of tracking to an accuracy of 0·5 deg, using an ex-Admiralty 2-metre paraboloid, and a tracking mount which was originally part of a Bofors anti-aircraft gun.

MARSHALL'S BRISTOL MOVE

DUE TO expansion, Marshall's have now moved from Fishponds Road, Bristol, to 108A Stoke's Croft, which is approximately five minutes' walk from the main shopping centre.

POINTS ARISING

TRS 80 REVIEW *(April 1979)*

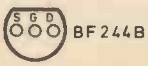
Unfortunately some errors appeared in the programs given in the TRS 80 review. The programs should read:

```
PRINT((389*14.761) ↑ 8.7)*SIN(0.87)

10 CLS
20 FOR X = 129 TO 191
30 PRINT X; " "; CHR$ (X);
40 IF INT((X–128)/9) = (X–128)/9 THEN PRINT: PRINT
50 NEXT
```

METRONOME *(September 1978)*

If the unit does not operate correctly, swap the two gates IC3d and IC1d so that IC3c is driven from IC3d. D3 should be 7·5V.



PHASER *(April 1979)*

The pin connections for the BF244B were incorrectly given in Fig. 2. The correct connections are shown above.

CHAMP-PROG *(April 1978)*

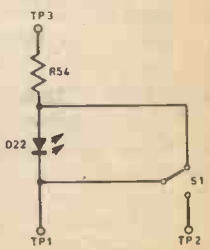
Fig. 8.2. D1 should go to pin 15 on IC1, and C2 should go to pin 14, IC1. Also, pin 2 should connect to pin 12 of IC1 and not pin 5. The timing capacitor of IC3 (C6) should be 47nF. TR20 configuration should conform to that of TR19-26. The connections to pins 1 and 3 of the PROM socket should be interchanged.

Fig. 8.5. These waveforms may seem to be upside-down, but are in fact correct. See Readout September 1978.

If the supply over-voltage protection circuit triggers unnecessarily due to the regulator's slow response at switch-on, reduce the unregulated input voltage to 72 volts.

The data bus should not be taken from the transistors of CHAMP, since they perform an inversion, but direct from the CHAMP data bus.

The circuit around D22 and S1 should be wired as below.



AUTORANGING MULTIMETER *(May 1979)*

A printing error has placed the green wiring overlays in Figs. 2.8 and 2.9 about 5mm "North West" of their intended positions. Correct registration can be recognised by noting that wires 1 to 5 should go to the wafer poles (below mounting lugs).

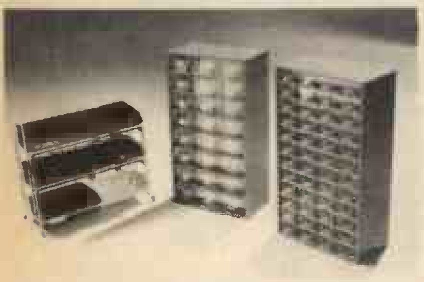
Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by Alan Turpin and David Shortland

STORING AND DISPENSING

If you are not a smoker who stores components in 2 oz. tobacco tins you may be interested in one of Verospeed's smart multi-drawer units. They are available in 24 and 48 drawer sizes. The drawers are easily labelled and dividers are available in packs of ten.



Also shown is a component dispenser for small production runs. It has three rows of picking bins of varying widths.

Multi-drawer units are £16·80, plus VAT, inc. p&p. The component dispenser is £5·52, plus VAT, inc. p&p. Bins, from 38p to 92p.

Verospeed, Barton Park Industrial Estate, Eastleigh, Hampshire, SO5 5RR. (0703 618525).

IRONS AT EXCLUSIVE PRICES

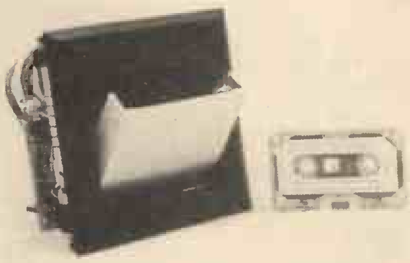
A company offering Litesold irons at reduced prices has just been set up. The company, called Future Electronics, is advertising the irons exclusively to P.E. readers.

The Litesold Model 15, 12W iron, fitted with a 1/16in. bit, operating at 360°C and weighing 14·9gms is available at £3·90 inc. VAT and p&p from **Dept. MA1, Unit B1, Park Hall Trading Estate, Martell Road, London SE1. (01-761 3919).**

MINI CASSETTE DECK

The CM600 miniature cassette system is a completely self contained unit measuring only 76 × 76 × 64mm and has been designed specifically for digital applications. With the drive motor, read/write amplifiers and control circuitry all included in the unit it only requires a 5V power supply for operation.

The CM600 has a two track recording head which produces a maximum recording density of 800 bits per in. and a data rate of 2,400 baud. Data capacity on a standard 100ft miniature cassette is 1·6M bits. The reel to reel drive system has a forward search speed of 5 i.p.s. with a rewind speed of 15 i.p.s. and a stop/start time of 150ms.



Operation of the system is controlled entirely by external logic signals. Typically these represent tape direction (forward/release), tape motion (stop/go), tape speed (fast/slow), select read/write and data input. Output lines carry data and indicate which side of the cassette is being used.

The price of the CM600 is £110 plus VAT and p&p.

BFI Electronics Limited, 516 Walton Road, West Molesey, Surrey KT8 0QF. (01-941 4066).

DISPLAY CONSOLES

The new range of easy access display consoles from Boss Industrial Mouldings offers the option of either a satin black aluminium display panel or red, green or neutral grey, translucent filter windows if illuminated displays are to be used.

The contoured sides of the BIM7500 series are 12·7mm thick, solid oiled walnut, with textured sand finished exterior panels, the top one being 1·2mm thick steel and the keyboard panels being 1·6mm thick aluminium.

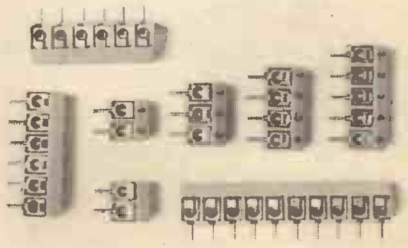
The consoles are available in nine sizes offering the combination of 4 keyboard panel widths and overall sizes ranging from 250 × 260 × 112mm high to 500 × 431 × 200mm high with the larger sizes having a fully hinged upper section.

The exterior panels of all models are quickly detachable on removal of two or three concealed screws to enable rapid component accessibility.

The consoles vary in price from £38·44 to £81·54 excluding VAT and p&p. For further information contact **Boss Industrial Mouldings Ltd., Higgs Industrial Estate, 2 Herne Hill Road, London SE24 0AU.**

P.C.B. TERMINAL BLOCKS

A range of p.c.b. mountable terminal blocks from two to 12 ways is available from Carrier Electronics. The pins are on a 5mm pitch or two pitches of 0·1in matrix board. Wires up to 1·5mm² are accepted in a nickel plated brass bush with screws clamping on to captive phosphor bronze wire protectors. The terminals have a 13A continuous rating.

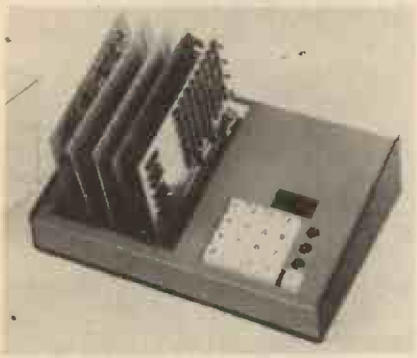


Prices range from 18p for two way to 74p for 12 way, plus, VAT at eight per cent, and postage.

Carrier Electronics Ltd., 48 Chester Street, Wrexham, Clwyd. (0978 56671).

ELF II

The Elf II microcomputer kit is based on the RCA1802 8 bit microprocessor. The basic system includes a 256 bit RAM expandable up to 64K, a fully decoded hex keyboard and a 5 slot plug-in expansion bus (less the 86 pin connectors). The system is mounted on a double sided plated through p.c.b. A 1861 video i.c. is also supplied to enable segments of the memory to be displayed on a TV screen.



Also included in the basic kit is an owner's manual and complete instructions for assembly and testing. A power supply is available for £5·00 together with a complete range of expansion modules, including a fully encoded ASCII keyboard.

The basic Elf II kit is available from £99·95 with a steel cabinet and plexiglas dust cover for an extra £29·95. All prices are exc. VAT and p&p. *P.E. will soon be reviewing this kit.*

HL Audio, 138 Kingsland Road, London E2 8BY. (01-739 1582).

KEYBOARD KIT

This keyboard kit has a 7 bit parallel ASCII encoded output with dual polarity strobe edges and it can generate both upper and lower case ASCII codes. The unit has a power requirement of 5V 120mA and features long keystroke (3mm) keys throughout. All the keytops have removable transparent caps suitable for special legends if required.

The overall size of the keyboard is 290 × 140 × 25mm and it is priced at £28·50 plus VAT and p&p.

Video Terminals, 197 Hornbeams, Harlow, Essex. (0279 30132).

PSUs

The TPS range of precision bench power supplies consists six high accuracy dual and single output units from 0–30V, 1A up to 0–60V, 2A.

Although they are similar, the six units in the range offer different specific features: Three of the range are dual output units, with the facility to connect in series and parallel to effectively double the voltage or current ratings and all the outputs have a regulation of less than 0·5mV variation. With a ripple and noise figure of less than 0·5mV r.m.s.

Four of the units have an additional 5V (1 or 3A) output facility, allowing users to power logic circuits without connecting to the principal output terminals. The separate 5V feeds may be finely adjusted by an internally mounted trimpot.

Output voltage on all types is adjusted by a 10-turn potentiometer mounted on the front panel, and this allows setting to be carried out to within 5mV. Similarly, current trip adjustment is made using a single turn potentiometer. The moving-coil meters provide reading accuracy better than 2 per cent f.s.d., and on one model—the TPS 21D—these are replaced by l.e.d. digital readouts.

The prices of the TPS range are from £108·55 to £254·42 plus VAT and p&p.

Gresham Lion Limited, Gresham House. Twickenham Road, Feltham, Middlesex TW13 6HA. (01-894 5511).

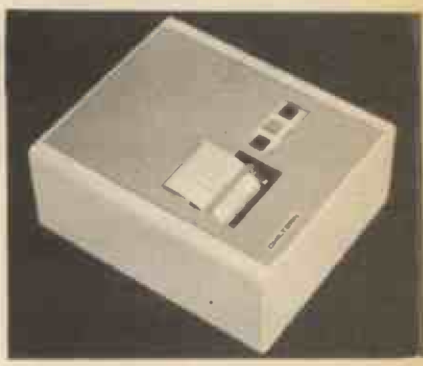
CASIO CALENDAR

The Calendar 200 from Casio is a liquid crystal quartz digital wristwatch that displays the time, date or calender page for any month of the year. The calendar display is a new idea from Casio whereby the information is presented like a conventional calender page accompanied by a large digit representing the number of the month and an indicator showing the position of the Sundays. Automatic leap year conversion is programmed in.

Recommended retail price is £84.95 including VAT. For further information contact **Casio Electronics Co. Ltd., 28 Scrutton Street, London, EC2A 4TY). (01-377 9087).**

CHILTERN IMPACT PRINTER

The new type 150 Numeric Impact Printer has been specifically designed for the digital instrument market. The instrument has eight active columns as standard with facility to expand to 15 columns if required. Each column has 12 characters with 0 to 9 with a dash and dot format and two extra columns have assorted symbols.



The standard interface is parallel TTL CMOS DTL compatible with optional inverted logic by selection and manual or remote control of all functions. An optional bit parallel character serial interface is available as is a line buffer giving up to four lines of storage.

There are optional clock/calendar and serial event counter cards available with the unit and for specialised print functions an IEEE/488 interface.

For further information contact **Chiltern Data Systems Ltd., Stoke Row, Henley-on-Thames, Oxon, RG9 5RB. (049-17 549).**

PLAY IT AGAIN CASIO

What more could you want a calculator to do than calculate, tell the time and ring alarms? Casio think a tune playing function may fulfil a need. Their Melody Card, M-80, is just slightly larger than their recent credit-card size series.

Digits 1 to 8 are labelled Do to Do, digit 9 gives one note above that octave, and the decimal and zero play the two notes below it. Thus you can play the one note samba and more.

A digit "key" will play its note as long as the key is pressed. Tunes of up to eight notes can be stored in memory. Even the timer alarms can be made melodious.

The recommended retail price of this threat to the Stylophone is £29·95. It can be bought by post at £25·95, inc. VAT and p&p. from **Timetron, The Beaumont Suite, 164–167 East Road, Cambridge CB1 1DB. (0223 67503).**

Microprocessor Evaluation System

PART TWO

D.S.COUTTS

THE complete development system was mounted into a 380 × 200 × 100mm case which was drilled as shown in Fig. 2.2. and then covered with fablon. The switches and l.e.d.s were fitted to the front panel taking care to place the anode pin of each l.e.d. at the top. The on/off switch, two DIN sockets, fuse holder and a grommet for the cable entry hole were fitted next with a 6BA earth tag fitted close to the grommet.

The outside positions of switches S4 to S19 were joined together using two 16 s.w.g. tinned copper wire bus bars with the anodes of D1 to D16 joined to the third bus bar via resistors R34 to R49. (Fig 2.1).

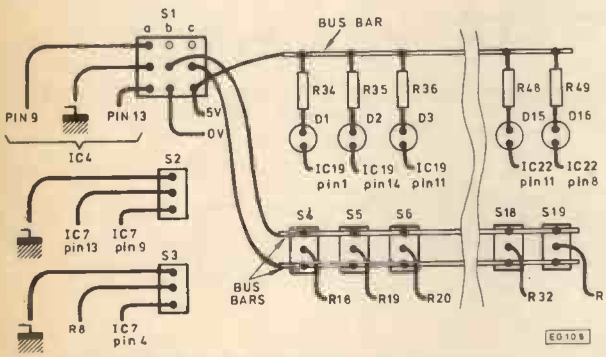


Fig. 2.1. Front panel wiring diagram

The track layouts for the double sided p.c.b. are shown in Figs. 2.3 and 2.4 with the component overlay in Fig. 2.5. After the board has been made it should be placed in the case along with the transformer. Check that the transformer is clear of the p.c.b. and then mark and drill the three p.c.b. mounting holes.

Extra holes should be drilled in the rear and bottom of the case for ventilation.

POWER SUPPLY UNIT

The circuit diagram of the p.s.u. is shown in Fig. 2.6 with the p.c.b. design and component overlay shown in Fig. 2.7 and 2.8. After the p.c.b. has been assembled and checked ensuring that the two regulators (IC25, IC26) are soldered with long leads, the p.c.b. should then be mounted on the rear of the case and the two regulators mounting holes drilled. Both regulators should then be mounted using the insulated mounting kits supplied with the devices.

An ohmmeter should be used to check that the regulators are not shorted to the case and then the p.s.u. can be wired up to the secondary winding of the transformer. The earth lead from the 0V of the p.s.u. should also be connected to 6BA solder tag under one of the mounting screws of SK1.

The mains cable to the primary of the transformer can be wired next via the fuse holder and mains switch. The mains earth lead should also be connected to the case.

Recheck the p.s.u. wiring and then switch on and monitor the output voltages. They should be approximately −3·3V, +5V and +11·2V. If the p.s.u. is functioning correctly switch off and disconnect the unit from the mains.

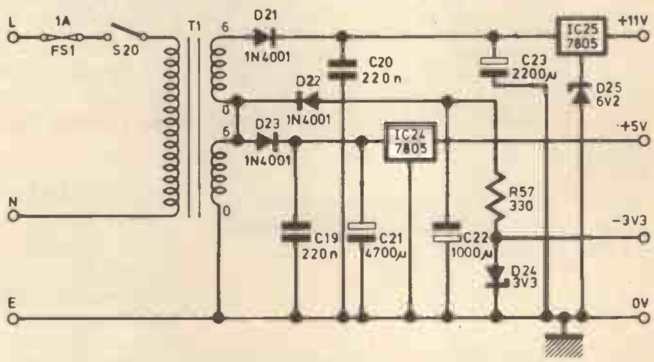
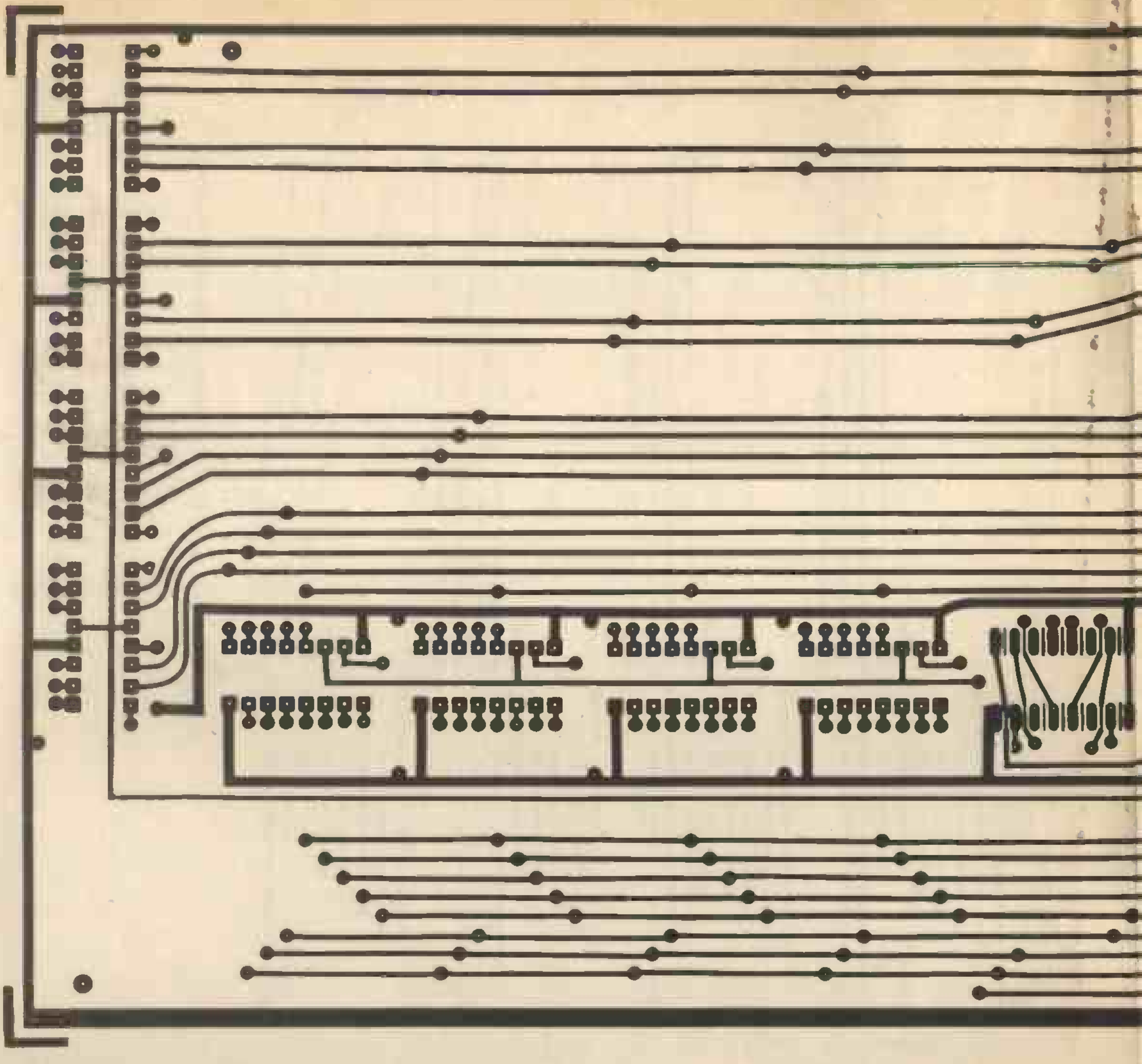


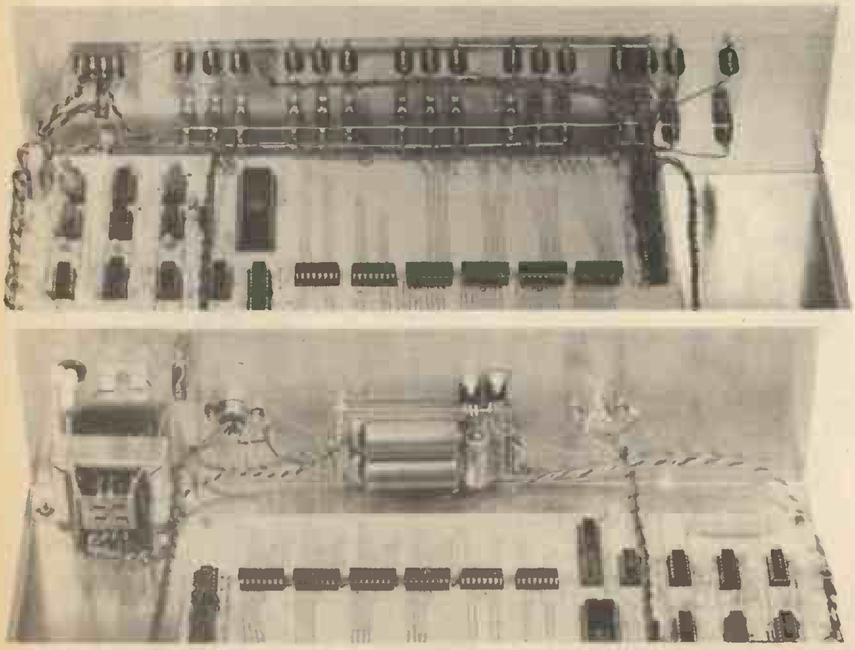
Fig. 2.6. Power supply circuit diagram

MAIN PRINTED CIRCUIT BOARD

The main processor board can be soldered next and it is strongly advised that i.c. sockets are used for all the integrated circuits. A suggested soldering sequence is to fit the i.c. sockets first, checking their orientation carefully, then the resistors and capacitors, TR1, TR2, D17, to D20 and 1MHz. crystal. Vero-pins can be used for the power input wires, S1-S19 and the l.e.d.s D1 to D16. Also fit pins for the five branch external output and input lines and fit pins for IC19 pins 9, 10, 15 and 16 (the 4 bottom Q lines of the output latches). Fit all the through board links, ensuring that they are soldered both sides. Also check that all capacitors and resistors are soldered both sides of the board where necessary. *Do not plug any i.c.s in yet.*

Clean the flux from the board and examine it very carefully for bad joints and solder bridges between tracks. At this point take an ohmmeter and check the p.c.b. out against the circuit diagram. An hour spent doing this could save many hours later.





PL1 (Output)

Pin	From	Signal
1	IC19 pin 16	O/P latch 2^0
2	IC19 pin 15	O/P latch 2^1
3	IC19 pin 10	O/P latch 2^2
4	IC19 pin 9	O/P latch 2^3
5	n.c.	
6	PSU +5V	+5V
7	GND	OV

PL2 (Input)

Pin	From	Signal
1	IC23 pin 25	EBCAØ
2	IC23 pin 24	EBCA1
3	IC23 pin 23	EBCA2
4	IC23 pin 22	EBCA3
5	IC6 pin 1	EBC1
6	PSU + 5V	+5V
7	GND	OV

TABLE 1

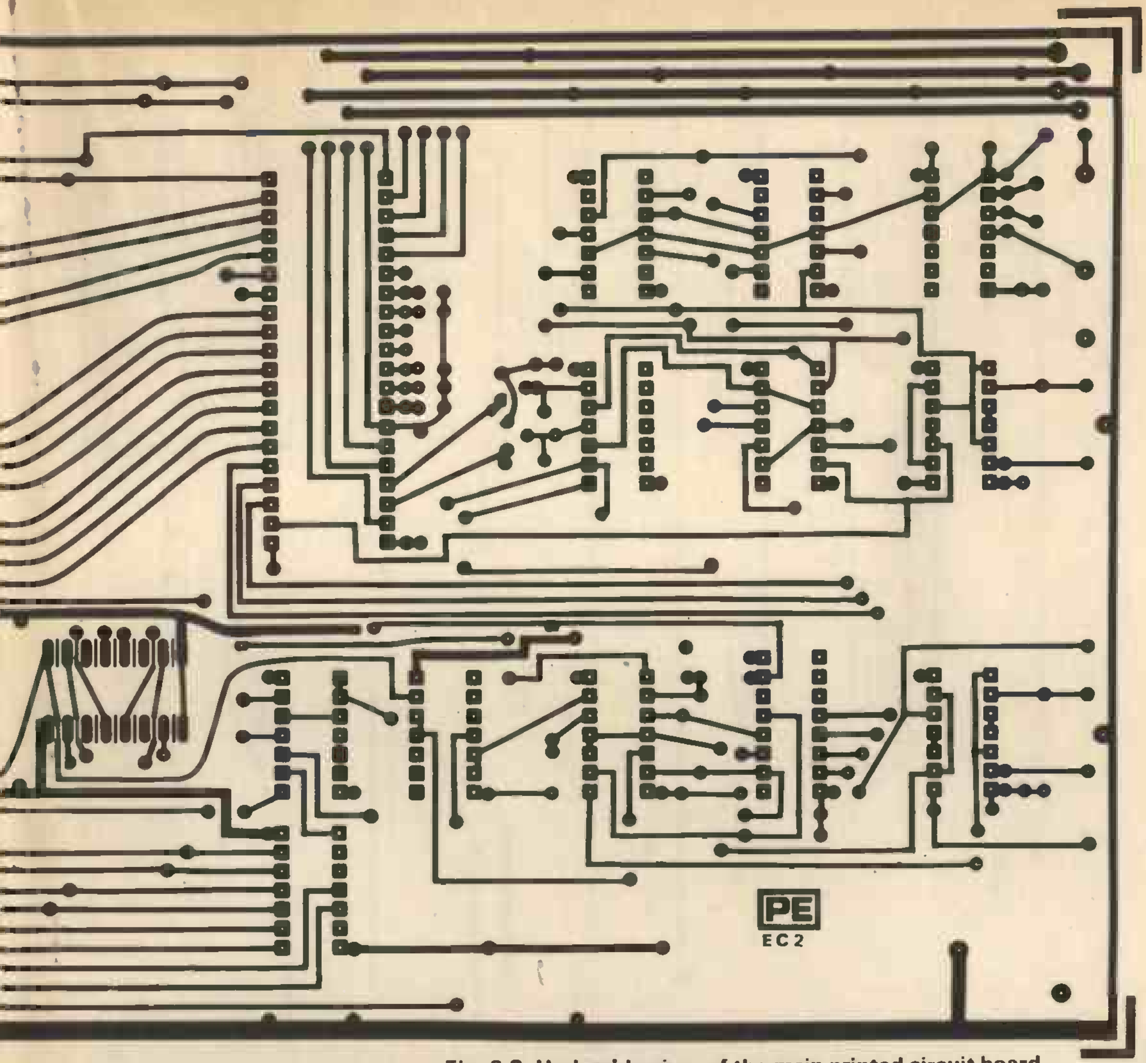
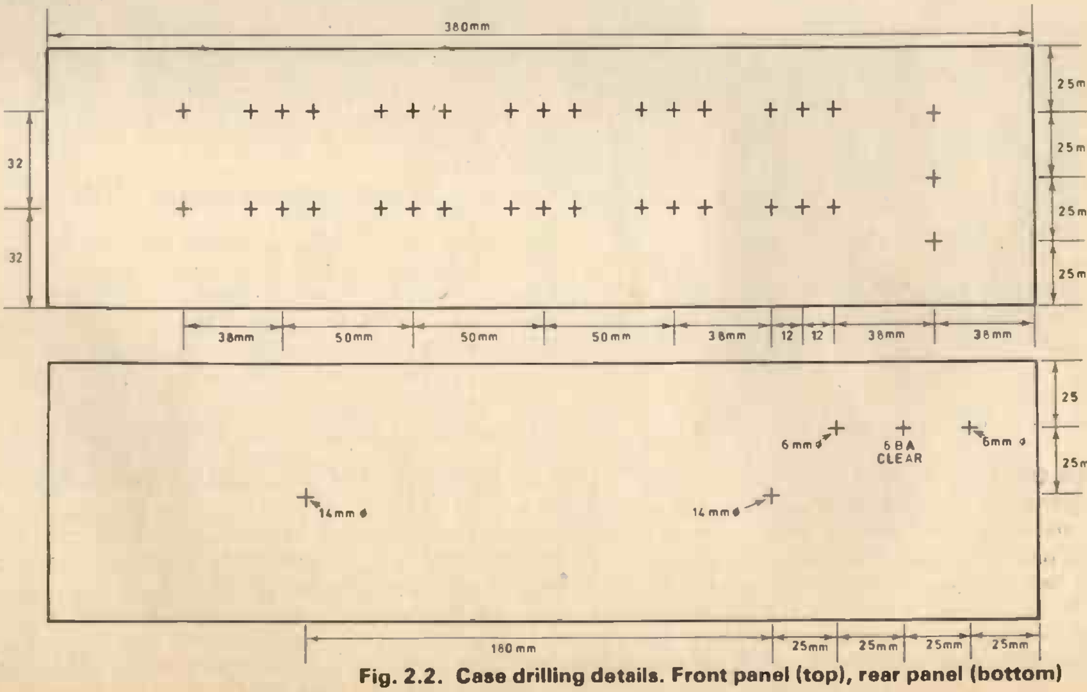


Fig. 2.3. Underside view of the main printed circuit board



EG107

Fig. 2.2. Case drilling details. Front panel (top), rear panel (bottom)

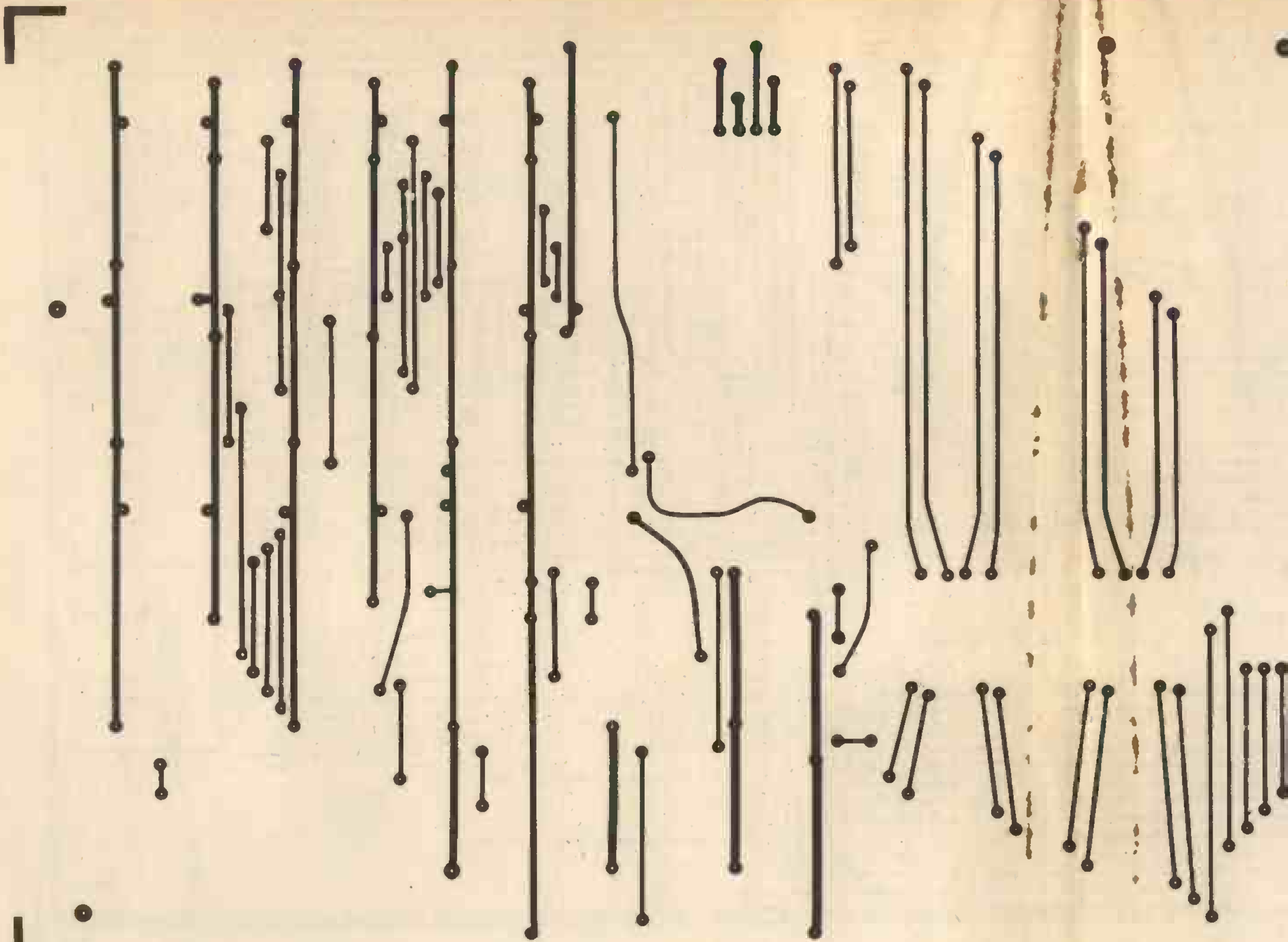


Fig. 2.4. Component side of the main printed c

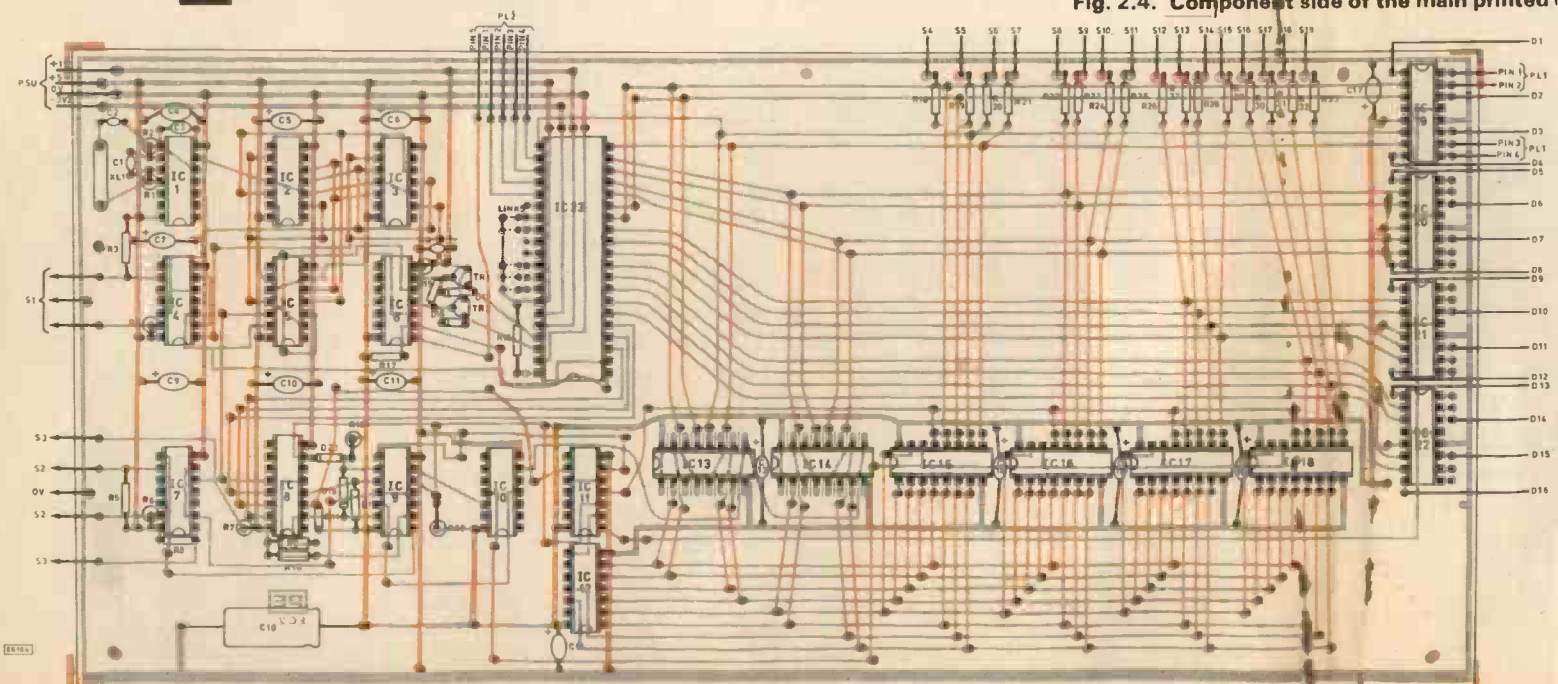
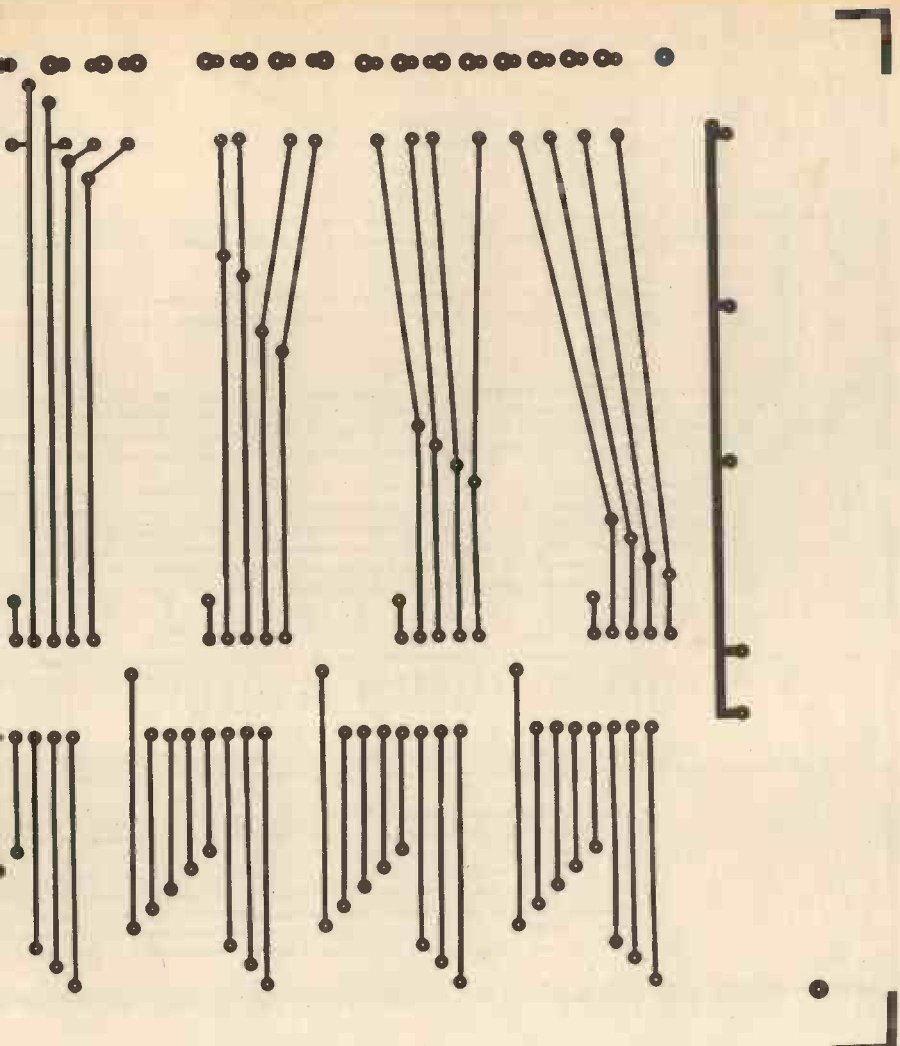
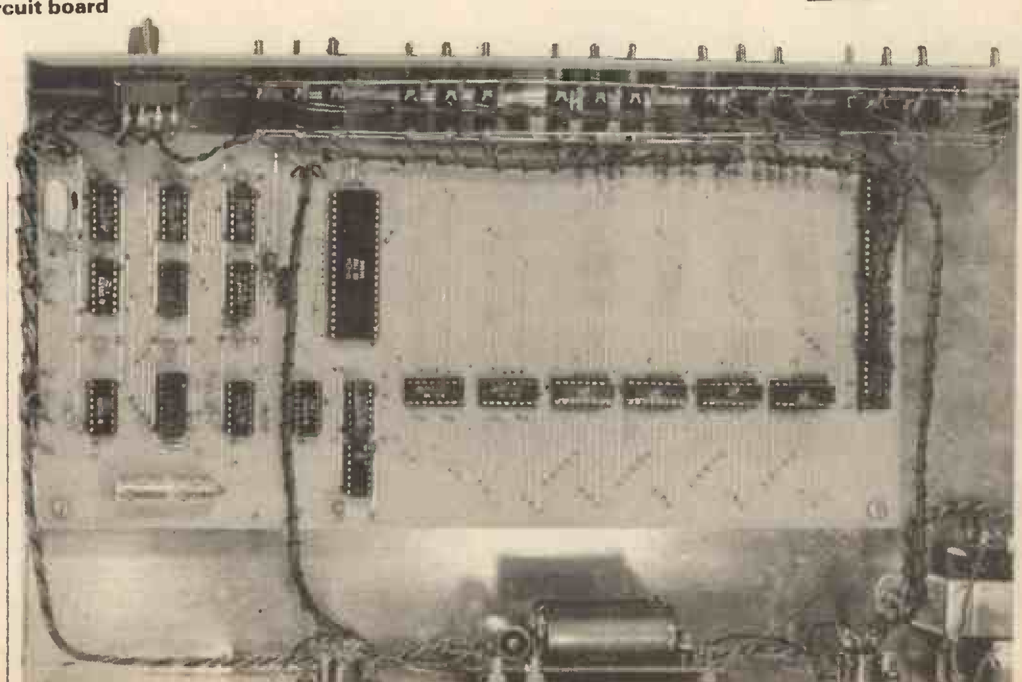


Fig. 2.5. Component overlay for the main printed circuit board



circuit board



INSTALLATION OF MAIN P.C.B. AND TESTING

Mount the processor p.c.b. back into the case with the three self-tapping screws and connect the power supply outputs to the board. Connect the unit to the mains, switch on and monitor the voltages on the main p.c.b. If they are correct the switches can be wired to the board. *Always remember to switch off at the mains before inserting i.c.s or adding wires to the board.*

Wire switches S1, S2 and S3, wire the bus connected to R34 to the +5V rail. Insert IC1, switch on, and check that the 1MHz clock appears at IC1 pin 6. Insert IC4 and check that when the run load switch is in the load position IC4 pin 8 is low and when the switch is in the run position pin 8 goes high. Fit IC2 and 3 and check that when S1 is in the run position pulses appear at IC2 pins 9 and 5 and IC3 pins 9 and 5. Fit IC5 and 6 and check that pulses appear at IC5 pins 6 and 8 when S1 is in the run position, at IC6 pins 4 and 6, and also at TR1 and TR2 emitters. When S1 is in the load position IC4 pin 3 should be low and when S1 is in the run position IC4 pin 3 should go high. Leave S1 in the load position.

Insert IC7. Check that IC7 pin 8 is high and goes low when S2 is pressed. Check that IC7 pin 6 is high and goes low when S3 is pressed. Insert IC8, 9, 10, 11, 13 and 14. IC13 pin 9 should go low and then high when S2 is pressed and released. IC11 pin 4 should be high and should go low when S3 is pressed. IC10 pin 11 should be high and should go low when S3 is pressed. Insert IC12, 19, 20, 21 and 22. Wire the centre connection of switches S4-S19 to the Veropins at the end of resistors R18 to R33, set all 16 switches to their centre off position and switch on the unit. Monitor IC19 pin 2 and check that it is floating (i.e. an open circuit TTL input). Check that when S4 is switched down ('O') the pin is switched to ground and when S4 is switched up ('O') the pin goes to +5V. Carry out this test on pins 2, 3, 6 and 7 of IC19, 20, 21 and 22 with switches S4 to S19, each switch control only one pin. Monitor IC11 pin 2, set the bottom eight switches S4 to S11 up at '1' and press S2.

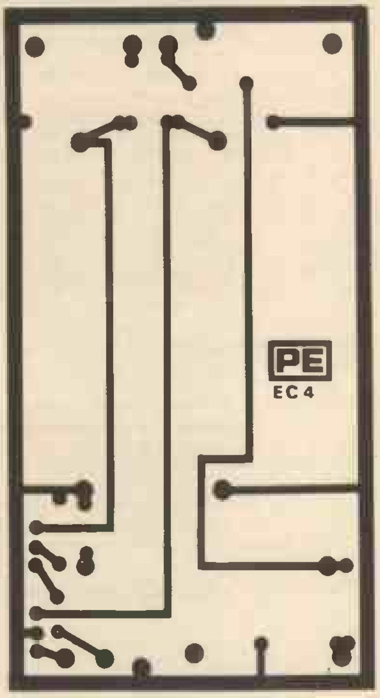


Fig. 2.7. P.c.b. design for the p.s.u

Address 377 octal should be loaded into the address latches IC13 and 14 and IC11 pin 2 should go low. Put S4 to 'O' and press S2, IC11 pin 2 should go high. Put S4 to '1' and press S2. IC11 should go low again. Put S5 to 'O' and press S2, IC11 should again go high. Repeat the above test for all eight bottom switches, only when they are all at '1' should IC11 pin 2 go low.

If everything is alright, wire the cathodes of l.e.d.s D1 to D16 to p.c.b. D1 goes to IC19 pin 1, D16 to IC22 pin 8 (Fig. 1.3). Also wire up DIN sockets 1 and 2 as shown in Table 1. Insert IC15, 16, 17, 18 and 23, check that S1 is in the load position and S4 to S19 are in their centre off position and switch the unit on. Check all the p.s.u. voltages again to check that they are alright under full load.

The processor can be tested by the short program shown below.

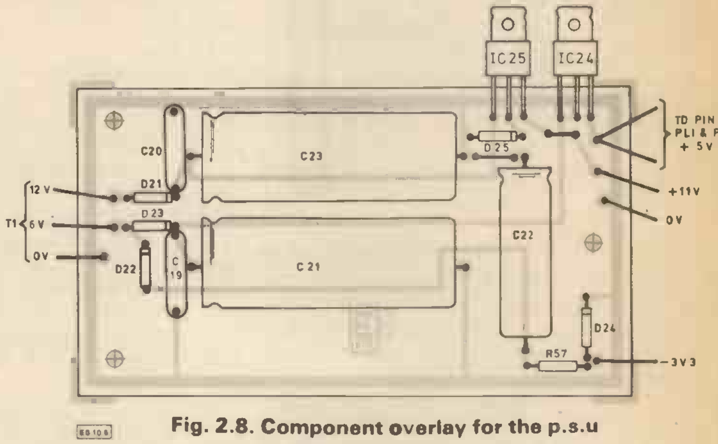


Fig. 2.8. Component overlay for the p.s.u

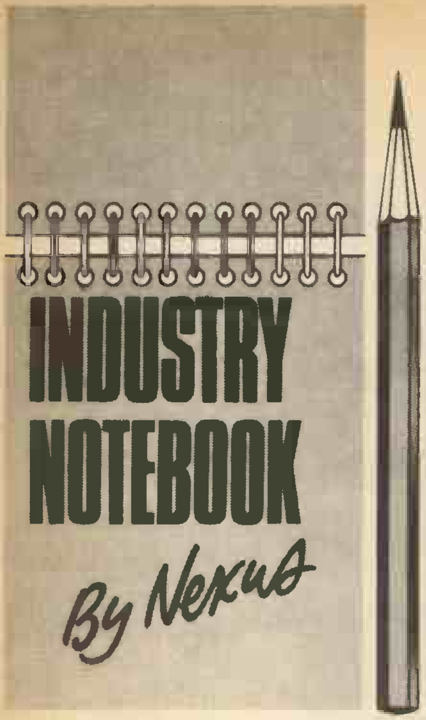
ENTERING A SIMPLE PROGRAM

Consider the following program to increment register 1 in the CPU and output its contents to the l.e.d.s:—

Octal Add	Binary Add	Octal Data	Binary Data	
0	0 000 000 000 000 000	711	0 000 000 111 001 001	Clear R1
1	0 000 000 000 000 001	11	0 000 000 000 001 001	Increment R1
2	0 000 000 000 000 010	1101	0 000 001 001 000 001	Output R1 to
3	0 000 000 000 000 011	377	0 000 000 011 111 111	Add 377
4	0 000 000 000 000 100	4	0 000 000 000 000 100	Jump to
5	0 000 000 000 000 101	1400	0 000 001 100 000 000	Add 1
6	0 000 000 000 000 110	1	0 000 000 000 000 001	
376	0 000 000 011 111 110	0	0 000 000 000 000 000	Write start add into location 376

1. Select Load/Run switch S1 to Load.
2. Set switches S4 to S19 to octal Ø.
3. Push Enter Add S2 to enter Add Ø into Add register.
4. Set switches S4 to S19 to octal 711.
5. Push Enter Data switch to enter 711 into Ø in RAM.
6. Set switches S4 to S19 to octal 1.
7. Push Enter Add switch to enter Add 1 into Add register.
8. Continue until the octal number 1 is entered into location octal 6 in the RAM.
9. Now select octal 376 on switches S4 to S19.
10. Push Enter Add switch, enter 376 into Add register.
11. Write octal Ø into this location using switches S4 to S19 and the Enter Data switch. This writes the start Add into location octal 376 (any spare location can be used for the start address).
12. Put switches S4 to S19 to centre (off) position.
13. Select Load/Run switch to RUN. The program should now commence and the l.e.d.s should increment.
14. It is important that the last entry into the Add register should be the start Add of the program.

NEXT MONTH: programming.



Training

Catch 'em while they're young seems to be the motto in France. I note with interest a press report that 10,000 microcomputers are being ordered for French schools and universities and that 150 teachers are to get a year's training on their use and another 1,500 teachers a shorter course. In parallel there is a big competition for ideas on how to use MPUs in which up to 1,000 young inventors are expected to submit entries. A similar scheme is in preparation for the UK with a funding of £12·5 million over five years, but is still in the paper and committee stage.

In the UK there are encouraging signs that science and engineering are regaining favour in schools and colleges as proper, even exciting, future careers. Salary structures have certainly improved over the past three years and the prospect, as seems certain, of a critical shortage of engineers over the next decade or so will at least give employment security and fine opportunities to all those who take the profession seriously. The latest salary survey shows that IEE members were averaging £7,240 p.a. in January this year compared with £6,210 p.a. in January 1978, an improvement well in advance of the cost of living. In the public sector electrical and electronic engineers' salaries on average were higher than in private industry so one assumes that public sector employees will keep quiet about comparability while those in the private sector might well start raising hell—a reverse of the general trend.

Results

The fickle wheel of fortune spares nobody. EMI's high-flyer, the EMI Scanner, so profitable in its early years is now almost a dirty word with losses this year estimated by City sources as £15 million or more, largely attributed to slumping sales in the USA and increasing competition in the market place. Budget-price brain scanners, for example, are expected from two Japanese manufacturers this year, Toshiba and Hitachi. But EMI can take comfort in having sold two top-price whole-body scanners to China for £500,000 and is clearly making further efforts to diversify its market outside the USA.

Plessey, despite increased business looks like having a standstill year as far as profits are concerned. In Plessey's case the problems are in the loss-making Liverpool plant making telephone exchanges, and Garrard making record players. Industrial disruption has also eaten into Plessey profits, one estimate being £800,000. So wonderful performance in some areas of Plessey activities are masked in the overall results by difficulties elsewhere, and by no means always the fault of the company.

Plessey, however, remains fundamentally strong with a record order book of over £800 million and with exports and overseas sales accounting for over half total turnover and a market in 131 countries.

GEC is forecast as pushing up profits this year to over £370 million and topping easily the £400 million mark in 1979/80. Profit growth will be led by GEC's electronic divisions, spearheaded by Marconi. The Formation of GEC-Fairchild in the UK has sparked off speculation that GEC has its sights on acquiring the whole of Fairchild Camera and Instruments in the United States.

The Racal Group, fastest growing in both turnover and profit in British electronics, is expected to have another good year. Recent tidying up operations include two name changes. Racal-Thermionic, the professional-quality tape-recording company in the Group has been re-named Racal Recorders Ltd and a base in the USA has been established as Racal Recorders Inc with sales and service initially from Rockville, Maryland, and Corena, near Los Angeles. These will be followed by other sales and service outlets later this year at Chicago and Houston. British Physical Laboratories, acquired by Racal in 1974 becomes Racal-BPL, the change coinciding with the entry of BPL into the digital panel meter field.

Among Racal's recent off-beat support activities are backing for Britain's first amateur scientific satellite being co-ordinated by the University of Surrey and the supply of radio equipment to the Transglobe Expedition which sets off from Greenwich next September on a three-year circumnavigation of the world by its Polar axis over land, sea and pack-ice. The Racal equipment is said to be worth over £130,000.

Hire

Hiring rather than buying instruments often makes good sense, especially if you need them only to meet short-term needs such as a small production run or in field-commissioning of a new installation. The UK instrument hire business has hitherto been shared by two companies, Livingston Hire and Labhire. Now there is a third entrant in the field, Leasemetrix. Not much of a threat, you might imagine, against two experienced and well-established companies. That is, until you look at the Leasemetrix management. At the top is David Rennie who set up Livingston Hire in the 1960s and was top man there until parting company in 1975. Rennie is joined by sales manager R. J. Mundy and laboratory manager Ray Keogan who both held the same positions at Livingston.

An intriguing situation for industry watchers. Will Leasemetrix come up from behind and scoop the pool? Will there be a price war? Rennie says there will be no price cutting. As for coming up from behind, Rennie thinks there will be a big expansion in instrument hire and there is room for a third company. Financial backing for Leasemetrix comes from the Small Business Capital Fund which is a venture capital operation of the Co-operative Insurance Society.

Show-Biz

Telecom 79, the giant telecommunications show to be held at Geneva in September will see Britain's biggest ever promotional exercise. Centre-piece will be a huge BPO/Industry joint stand covering 9,000 sq metres occupied by the Post Office, GEC, Plessey, STC, Marconi and Pye TMC. The commercial companies will also have their own individual stands as will 24 other British companies in the business. The operation is supported by the British Overseas Trade Board and the Electronic Engineering Association. Public Relations for the promotion on a day-to-day basis is headed by Peter Wymer, well-known in the industry for many years as publicity manager at Mullard and later as a publicity chief in the Post Office before becoming a private consultant.

Mini-LP

The shape of things to come in the hi-fi market could be the 4½in diameter LP record recently demonstrated in experimental form by Philips. A laser beam is used as a "pick-up" thereby eliminating record wear and giving a ten-year life with normal useage. Philips would clearly like its audio disc to become a world standard, following the path of the Philips tape cassette. The Japanese, however, are all working towards audio systems which will be compatible with videotapes. It could be the start of another damaging war in consumer electronics ending in another muddle of incompatible equipment. Philips say they will adopt a liberal licensing policy towards other manufacturers. If it goes ahead the Philips system should be commercially available by the mid-1980s. A big plus-point for the 4½in hi-fi disc is that it can be readily used in cars.

Automated Oven

In an attempt to capture a larger share of the microwave oven market, Toshiba has introduced an oven controlled by inserting a magnetic card which is encoded with the cooking instructions.

next month!

STROBOSCOPE...

Almost any rotating or vibrating system can be studied in motion using this strobe. Any irregularity is instantly revealed.

SWITCHED TONE TREBLE BOOST

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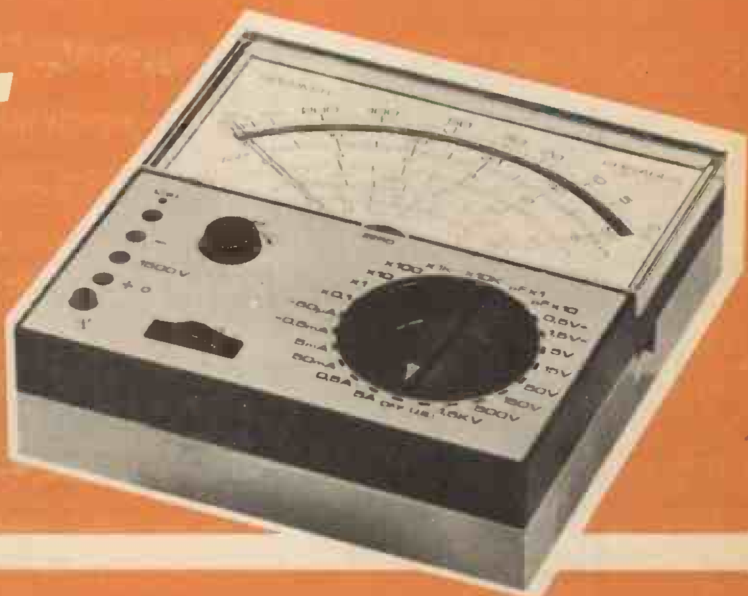


PRACTICAL
ELECTRONICS

OUR JULY ISSUE WILL BE ON SALE FRIDAY, 8 JUNE 1979

ULTRASONIC REMOTE CONTROL

M. PLANT & G. HALLAM

THIS project describes how ultrasonic transducers can be used in a control system for domestic use. Although this is not a novel application, TV manufacturers have used ultrasonic remote control systems for a number of years, many constructors should be able to find a number of interesting applications i.e. on/off control of mains operated appliances that might be of special interest to the aged or handicapped people. The control of garage doors and toys are two further possibilities. This system also has the facility for temporarily switching mains power on or off for a predetermined period of time which can be useful for lighting a path or porch light when returning home.

There are a number of methods that can be used when designing remote control systems and broadly these methods depend on either electromagnetic or sound waves.

The main problem in designing a system based on electromagnetic or sound waves as carriers of the control signal is to avoid the spurious triggering of the controlled element by artificial or natural signals having characteristics similar to the control signal.

One commonly used method is to modulate in a characteristic way the carrier signal from the control transmitter and to tune in the receiver to this characteristic. If infra-red is the carrier, an infra-red light emitting diode could be used to emit pulses of radiation at a frequency of say 20kHz, which the receiver detects via a photo diode rejecting all other frequencies. This same principle hold good for a radio control system.

TRANSDUCERS

In order to avoid having to build a tuned circuit when using electromagnetic waves, it has become popular to use ultrasonic transducers which are already "tuned in" to a fixed frequency (usually 40 kHz).

These transducers depend upon the piezoelectric effect for their action which means that if a periodically changing voltage of 40kHz is applied across their terminals they resonate at this frequency and emit a beam of ultrasonic sound. (Note that 16kHz is the highest frequency most of us can hear.) Since the receiver transducer is identical to that of the transmitter, upon receiving this beam it responds by producing a 40kHz voltage across its terminals. As the ultrasonic beam is of high frequency with a narrow band width it is reasonably insensitive to signals from other sources.

The transmitter is housed in a small plastic case and is activated by a push button switch.

The receiver has its own low voltage power supply derived from the mains supply or from an internal battery. The relay closes when the receiver detects 40kHz ultrasonic waves

Receiver and Transmitter

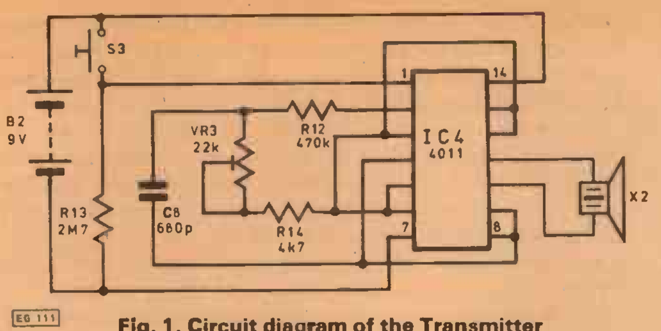


Fig. 1. Circuit diagram of the Transmitter

and mains power is then available to the appliance plugged into the 13A socket. The wattage of the mains power which can be controlled depends largely on the choice of relay (750W is the maximum for the one specified in the components list). Switches are provided for bistable (on/off), monostable (temporary on) and mains/battery operation. The battery supply can easily be dispensed with for it merely provides an on/off action via another pair of the mains relay contacts available at two sockets. The range of the control system for domestic use depends greatly on the type of furnishings in a room, but you should expect from 5 to 8 metres.

TRANSMITTER

The circuit diagram of the transmitter is shown in Fig. 1. A CMOS 4011 i.c. is used as a square wave oscillator to drive the ultrasonic transducer at a frequency of 40kHz. The oscillator is inactive until S3 is closed taking the voltage at pin 1 high. The 4011 contains four NAND gates, two of which are wired as an oscillator using R12, VR3, R14 and C8. The other two NAND gates are used as buffers to switch power to the transducer. The outputs, pins 10 and 11, of the second two NAND gates go high and low in a complementary way at a frequency of 40kHz. The variable resistor VR3 enables the frequency of the oscillator to be adjusted to the resonant frequency of the transducer.

RECEIVER

A combination of bipolar devices and CMOS integrated circuits is used in the ultrasonic sensitive receiver shown in Fig. 2. The function of the circuit may be understood by dividing it into its basic elements. Remember that the overall function of the circuit is to close the relay contacts RLA1 when the ultrasonic transducer receives the 40kHz sound waves.

Firstly the circuit operates from a nominal 10V d.c. supply derived from the mains via transformer T1, rectifier diodes D1 and D2, smoothing capacitor C1, and the series stabiliser components, TR1, R1 and Zener diode D4. For portable

Internal view of the Transmitter

operation of the circuit, S1 enables a 9V battery to be switched into the circuit.

Upon detecting an ultrasonic beam pulsed at around 40kHz, the ultrasonic receiver transducer generates a small sinusoidal voltage which the preamplifier, based on transistors TR2 and TR3, amplifies. The amplified signals at the collector of TR3 are rectified by D3 and appear as negative going pulses at pin 2 of IC1 which compares these voltage peaks with the voltage on pin 3. The latter voltage is set by R8 and the variable resistor VR1 which acts as a sensitivity control. Thus, when no signals appear at the collector of TR3, pin 2 is held high by R7 and the output voltage from the op amp is zero. When voltage pulses arrive at pin 2 and drive this voltage below that of pin 3, the output voltage suddenly switches positive, a condition which is made clear when D5 lights. Capacitor C4 provides a certain amount of integration of the pulses and avoids spurious operation of the op amp.

The signal from the op amp passes to pin 4 of IC2, a dual monostable CMOS i.c. The rising voltage on pin 4 triggers the first of these monostables, IC2a, producing a pulse from pin 6 the duration of which is fixed by the product of the R9 and C5 values. This monostable acts as a pulse shaper to provide reliable operation of IC2b and the CMOS flip-flop IC3.

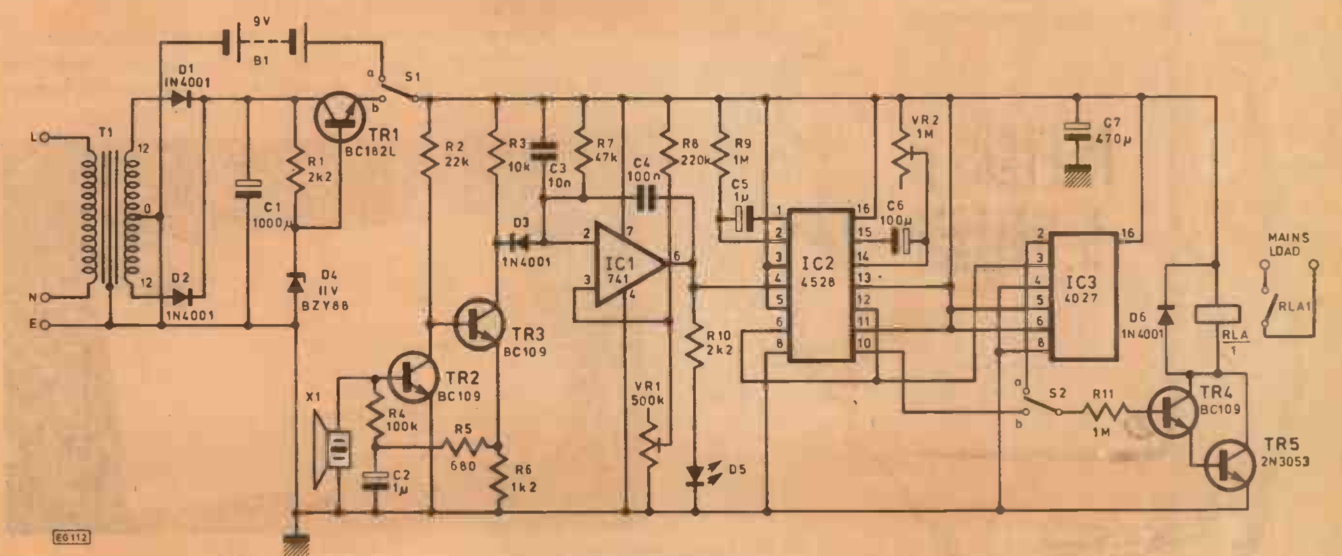


Fig. 2. Circuit diagram of the Receiver

The second monostable is triggered via pin 12 and produces a positive output voltage at pin 10 for a duration determined by the product of the VR2 and C6 values. The same trigger pulse from pin 6 of IC2a switches the flip-flop IC3 via pin 3. Each pulse operates the flip-flop so that its voltage at pin 2 goes alternately high and low. Switch S2 selects in position 'a' the flip-flop output and in position 'b' the monostable output. Either pulse passes to the Darlington pair current buffer transistors TR4 and TR5 to drive the relay RLA. Thus the circuit provides a stable (on/off) or monostable (temporary on) control of the relay. The monostable period is set by VR2. The mains relay contact RLA1 determines the mains current which can be switched and hence the power of the mains appliance which can be controlled.

CONSTRUCTION

The transmitter components are assembled on a small piece of Veroboard as shown in Fig. 3. One mounting hole on the Veroboard firmly fixes the circuit by means of a 6BA nut and screw to the inside of the plastic box shown in the photograph, in which the battery, transducer and switch are also fitted. Before screwing down the box lid, the variable resistor VR3 will need to be adjusted as explained under "setting up".

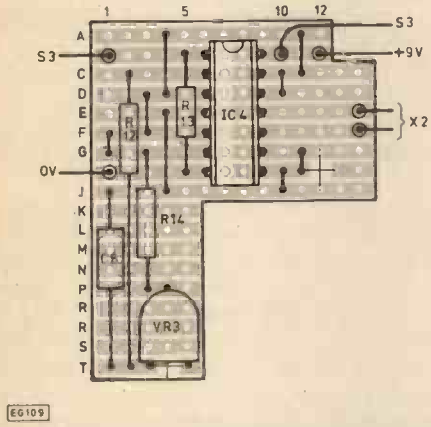


Fig. 3. Veroboard layout for the Transmitter

The receiver circuit is similarly assembled on the Veroboard as shown in Fig. 4. Note that this board also carries the rectifiers for the d.c. supply fed from the low voltage transformer windings. Decide if you want the battery facility. If not, S1a and S1b connections are not required. Double check all the spots where the Veroboard track needs to be cut away.

Note that diode D6 is wired directly across the relay contacts. One pair of the relay contacts (normally open) may be taken to a pair of 4mm sockets for control applications if the unit is to be operated from the internal battery.

SETTING UP

If a battery has been included in the design, switch to the battery mode using S1a position. Turn the sensitivity control VR1 fully clockwise and the red l.e.d. should light up. Turn back VR1 until the l.e.d. just goes out. As you do this, the relay may be heard to operate. Jangle some keys in front of the receiver transducer and the l.e.d. should momentarily light and the relay be heard to operate. This shows that the circuit is sensitive to ultrasonic noise from the keys. A similar procedure should be followed to check the circuit's operation from the mains.

Now check the function of the transmitter by pointing it towards the receiver from a distance of about one metre. Keep the button pressed and the l.e.d. on the receiver should light up. If it doesn't, use a small screwdriver to adjust VR3. The setting of VR3 is critical so take your time. The idea is to tune the transmitter to produce the maximum signal from the receiver transducer. If you have a multimeter, connect it across pin 6 to ground of the op amp and adjust VR3 in the transmitter until the maximum voltage is detected. Or an oscilloscope can be used connected across the receiver transducer to detect the maximum signal voltage swing. Plug in a table lamp to the receiver's 13A socket. Switch the

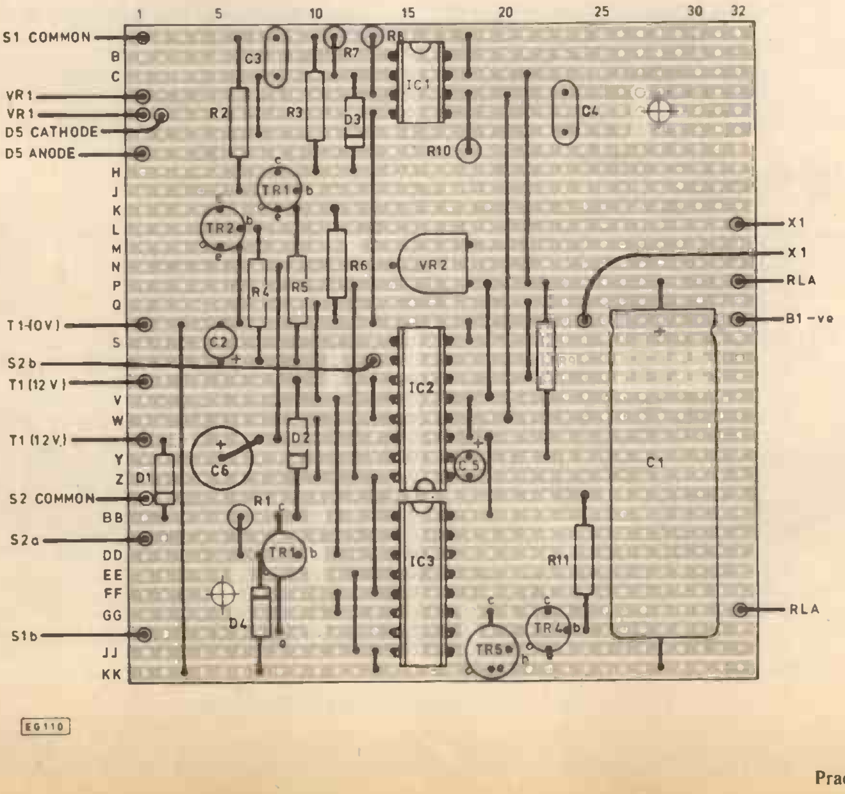


Fig. 4. Veroboard layout for the Receiver

COMPONENTS . . .

Resistors

R1, R10	2k2 (2 off)
R2	22k
R3	10k
R4	100k
R5	680
R6	1k2
R7	47k
R8	220k
R9, R11	1M (2 off)
R12	470k
R13	2M7
R14	4k7

All resistors ½W 5% carbon.

Potentiometers

VR1	500k lin
VR2	1M hor. preset
VR3	22k hor. preset

Capacitors

C1	1000µ 25V elect
C2, C5	1µ 16V elect (2 off)
C3	10n polyester
C4	100n polyester
C6	100µ 16V elect
C7	470µ 25V elect
C8	680p polystyrene

Semiconductors

D1, D2, D3, D6	1N4001 (4 off)
D4	11V BZY88 Zener
D5	TIL 209
TR1	BC182L
TR2, TR3, TR4	BC109 (3 off)
TR5	2N3053
IC1	741
IC2	4528
IC3	4027
IC4	4011B

Switches

S1, S2	s.p.d.t. min. toggle (2 off)
S3	push to make p.b. switch

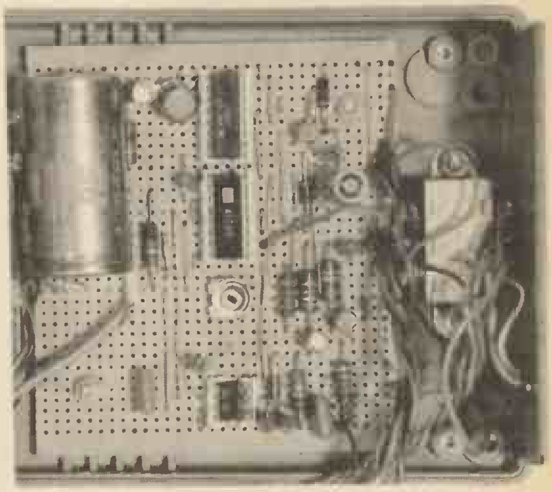
Miscellaneous

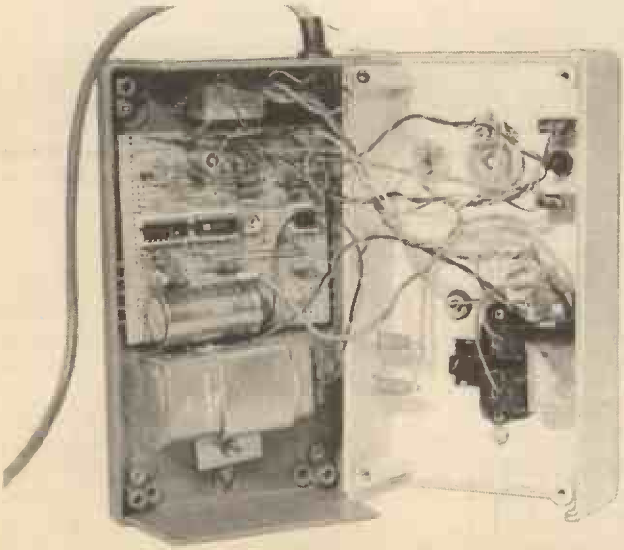
X1	Receiver 40kHz
X2	Transmitter 40kHz
B1	PP6 battery
B2	PP3 battery
RLA	12V 2 pole changeover 3A contacts

Battery clips
Mains 13A socket
Case type 301 (70 x 50 x 25mm) Maplin.
Case type 103 (188 x 110 x 60mm) Maplin.

mode switch S2 to the bistable mode and press the transmitter button pointing the transmitter at the receiver from a distance of about 2 metres. Remember that the ultrasonic beam is quite narrow (about 10°). One operation of the push switch (not too brief) will bring on the l.e.d. and the relay will be heard to operate and the lamp will go on or off. Practice the operation until you can reliably control the lamp, one push for on and the next push for off. You should get control over a distance of at least 5 metres.

Now check the operation of the monostable by switching S2 to this mode. The lamp will normally come on and remain on for a period of time determined by the setting of VR2. Wait for the lamp to go off and then use the transmitter to bring it on. Set VR2 to give the delay required—up to about 50 seconds with the values of VR2 and C6 given. The duration can be increased by increasing the value of C6. This





Internal view of the Receiver

monostable facility is provided if you want to turn on appliances such as a porch light for a limited period of time. In all these adjustments take great care when the receiver is being operated from the mains not to inadvertantly touch any bare mains connections within the unit. Note also that the maximum mains power which can be switched by the relay is determined by the current rating of the relay provided it is a 250V type, so check the wattage of the appliances.

If the receiver sensitivity control is set too high, the receiver might be triggered by noise which has an ultrasonic component. So beware of rustling papers, jangling keys, the click of a central heating thermostat and bats! You may have to turn down the sensitivity control to avoid unwanted triggering of the receiver circuit.

Finally, you might like to know that the ultrasonic beam from the transmitter can be reflected from objects in a room: the ceiling or the wall opposite the receiver, from a chair leg—or you. ★

R.F.I. SUPPRESSION for Power Supply Units

B.E.TAYLOR*

SCORES of very comprehensive articles have been written on the subject of suppressing (and filtering) conducted radio-frequency interference generated by switch-mode power supplies. Very few of these articles have been written with the non-specialist engineer in mind, and even fewer have been written that cover r.f.i. generated by linear regulators. This article attempts to show that the design of power supplies with good interference suppression can easily be achieved, provided that a few relatively simple rules are followed.

SOURCES OF RFI

The first, and most important rule, is to design the power supply with r.f.i. suppression as an integral part of the design. It is futile simply to try to filter the noise at the line input and/or output terminals after the noise has been generated. The interference should be reduced at source. To this end, one must first recognise these sources of interference, and all supplies—even linear ones—have one or more of these sources.

How can linear regulators be classed as generators of r.f.i.? It is only when the linear regulator is closely scrutinised that one recognises one of the first sources of r.f.i. for all supplies: that of large, line-pulse currents and their rates of change. One of the reasons for these large pulse currents is the line-frequency rectifier and the use of capacitor input filters. The reservoir capacitor forces the rectifier to conduct over very narrow conduction angles, and the sudden start and/or cessation of the resulting large current pulse that flows in line and neutral conductors—containing unwanted inductance (or the primary referred leakage inductance of the line transformer in a linear supply)—generates noise voltages that appear at the line and neutral terminals.

The effect of this rate of change of current is one of the major sources of interference over the 10kHz to 100kHz band, and is also a factor up to a few megahertz. One of the remedies for this source of interference is to connect as large a value of capacitor (as large as the relevant safety specifications will allow) as near as possible to the a.c. terminals of the rectifier bridge.

Another source of r.f.i. (this time appearing at the output terminals) can be attributed directly to sudden changes in current flow, and is generated in the output rectifiers in switch-mode supplies—whether they be Schottky-barrier devices or plain fast-recovery rectifiers. The usual solution for these devices is to connect RC snubbers across the rectifiers or across the transformer secondary.

Yet another source of interference from currents and their rates of change is the emission of magnetic fields around conductors, chokes and transformers.

Not all r.f.i. is due to current. Many sources also arise from the capacitive coupling of rapid changes in voltage. Unfortunately, the 'dabbing' of the odd capacitor or resistor will have little or no effect. To eliminate these generators of interference, one must revert to the principles of good electrical and mechanical design.

IDENTIFICATION AND ELIMINATION

At this point, it is best to identify some of these sources, to tabulate them and to look at some of the available means of elimination that may be employed:

(1) The first source of noise due to sharp edges in voltage waveforms is the capacitance between the cases of switching transistors and their heatsinks. Since the case of the transistor is usually tied to the collector (the isolated-case TO-3 transistor is not yet readily available, so its use cannot be freely advocated), and the heatsink is usually at ground potential, it is easy to see the capacitor so created as forming a potential divider with the capacitors to ground in the line input filter. Because the capacitors to ground in the input filter are limited to a maximum value (to minimise earth leakage currents) it is just not feasible to keep increasing their capacitances ad infinitum. The capacitance of transistor case to ground should be eliminated or at least drastically reduced. Reducing this capacitance is fairly easy; the use of aluminium oxide insulating washers in preference to mica or Melinex ones to increase dielectric constant is one method. The elimination of this capacitance, on the other hand, involves the use of one or other of the two most common ploys: the guard screen (the subject of a Gould patent) or the use of a heatsink electrically isolated from ground. The heatsink should be connected to the negative line rectified rail.

(2) One of the most easily recognised sources of noise is due to transformer inter-winding capacitance. The use of electrostatic screens should prove more than adequate in eliminating this source. On no account, though, should the screens be connected to ground, but to d.c. rails—one to each side of the transformer. The exception to this rule is the safety screen. Therefore, between primary and secondary, the screens should be in the following order:

(i) primary; (ii) guard screen connected to the positive line rectified d.c. rail; (iii) safety screen to ground; (iv) guard screen connected to the common output terminal; and (v) secondary.

(3) A third source associated with the transformer in switch-mode supplies, but one that is less easily recognised, is the capacitance between windings and the transformer core. The winding of greatest concern is the primary, which is usually found to be in close prox-

imity to the core (whether it is the innermost or outermost winding is largely immaterial). Once again, a guard screen between the winding and core may be used. On the other hand, it is easier simply to isolate the core electrically from ground. Whichever technique is used, care must be taken to ensure to connect either the guard screen or core electrically to the primary d.c. rail.

(4) A problem very similar to the transformer-winding/core capacitance is the capacitance between the winding and core of the output filter choke, especially if the 'hot' end of the winding happens to be nearest the core. A simple remedy is merely to transpose the connections if the current-carrying conductors are not made of copper strip. If transposition of connections is not possible, the measures described in the preceding paragraph are necessary.

THYRISTOR INTERFERENCE

One of the most insidious of sources of r.f.i. and one which covers both current and voltage generation, is the thyristor or triac used in many soft-start circuits to limit inrush current. Claims are made that zero-crossing triggering of thyristors virtually eliminates them as generators of interference. This most certainly is not the case; thyristors always generate interference. It is only the magnitude of the noise that varies. The lesson to be learned, therefore, is that, if they must be used, the devices must be inserted in one of the rectified lines and triggered by d.c.

ELECTROMAGNETIC FIELDS

Finally, it is worth looking, if only briefly, at r.f.i. generated by the emission of electric and magnetic fields. These fields emanate from devices and conductors handling pulse voltages and currents. The only viable approach to solving the problem is good layout. A few rules, if applied diligently, will be repaid handsomely; these may be stated as:

(a) Do keep cable lengths as short as possible.

(b) Do lump together all pulse-carrying conductors.

(c) Do not allow these conductors to come into close proximity to supply conductors.

(d) Do not route cables carrying supplies or outputs near to transformers, chokes and switch transistors.

CONCLUSION

If, in the final analysis, all the foregoing rules are applied, a clean supply is almost certain to be the outcome. The application of a relatively simple filter should then be all that is necessary to make virtually any supply comply with most existing specifications. ★

* *Gould Electronic Power Supply Division*

BOOK REVIEWS

HEAVY CURRENT ELECTRICITY IN THE UNITED KINGDOM

By Lord Hinton of Bankside,
Pergamon Press
79 pages, Price £5 Hard Cover; £2 Soft Cover

WHILST many of the readers of this magazine are probably aware of the salient milestones in the history and development of electronics throughout its various ramifications, beyond the power socket however, such knowledge is invariably lacking. This fascinating monograph will rectify any such deficiency as it provides a history of heavy current technology from its earliest development up to the time when the industry was nationalised in 1947.

The utilisation of electric power dates from Faraday's paper on electromagnetic induction in 1831 which precipitated the great change in world life style. Sadly, for this country, we lagged behind other industrial countries, both in the structure of an emerging electrical power industry and in the use of electricity.

We read of the stunting restrictions of central government that prevented a prosperous electrical manufacturing industry to be built up and which, no doubt, contributed to Edison's monopolistic incandescent light patent which funded a fortune for the inventor and spawned the giant General Electric corporation.

It was not until the 1926 Act had been passed that it became possible for Britain to have a forward looking electricity supply industry. That Act set up the Central Electricity Generating Board which had the job of creating and operating the national grid, the construction of which was not completed until 1933. However, although the C.E.B. had control over the grid retailing was still done by municipalities and by private companies. Nationalisation in 1947 established a new framework under the British Electricity Authority with ownership of all generating stations and subsequent rationalisation.

A pithy read that doesn't tax the mind. Highly recommended.

G.G.

April Fool? The 10–4 Newsletter is officially published *quarterly* but tends to appear every four months. So, the £1·50 subscription to C.B.A. entitles four issues. Apologies to all.

A.T.

News Briefs

FREQUENCY BY TIME

A HIGH resolution, fully autoranging frequency meter, is available from Orbit Controls of Cheltenham, which uses the reciprocal of time period to compute frequency.

Using a central processor, the 75C 501 TIC meter can measure down to 0·0001Hz, and faster than is possible by the more conventional approach. It can display the digital reading in any engineering units required.

TEACHERS TO STUDY

A ONE week course organised by the Department of Electrical Engineering at the University of Salford, is aimed at providing teachers who have some basic knowledge of electronics, with the opportunity to extend that knowledge. Running from July 16–20, 1979, the material covered will be adequate for the electronics option of the JMB "A" level physics syllabus, or other syllabi of comparable standard. It will cover operational amplifiers and integrated logic circuit applications, with approximately half the time being spent on experimental work. Details: The Administrative Assistant (Short Courses), Room 110, Registrar's Dept., University of Salford M5 4WT.

CUT PRICE WATCHES

WE HAVE received from Timetron, a revised price list giving details of some very significant recommended retail price reductions in Casio watches. An example is the 46CS-27B Alarm/Chronograph which in the April/May '79 price list has come down in RRP from £89·95 to £49·95. Timetron are selling this watch for £39·95.

OBITUARY

IT is with regret that we report the death of David Cohen of RT-VC. A well known character in the electronic retail business. David was the sort of straight talking business man with whom you always knew where you stood—we liked him a lot!

RT-VC will continue under the guidance of his son. We offer our sympathy to his family and friends.

WORKSHOP P.S.U

S. HOARE

ONE of the most useful pieces of test equipment for the workshop is a variable output supply for use in testing and setting up new circuits. The design featured in this article was developed to meet the author's requirements. Firstly the power supply should cover a wide range, 0 to 50 or 60V, and to avoid the need for a built-in voltmeter it should be possible to dial up any required voltage. Secondly, the output would have switchable current limiting, and a high maximum current—1A. The current limiting should protect the circuit the power supply is feeding—in this case the power supply switches to standby after excess current. Thirdly, it should be as difficult as possible to get an excess voltage on the power supply output. The fourth requirement is that the power supply should be unharmed by misuse and protected against overheating.

PANEL INDICATORS

The front panel layout is shown in the photograph. Upon switching on the circuit comes on to standby. After setting output conditions the "Output Connect" switch is turned on, and the reset button pressed. If all is well the output comes on and stays on. If not, the output current limits at the value selected, and the supply reverts to standby when the button is released. When changing voltage or working on the equipment being tested the "Output Connect" switch is turned off, completely isolating the output and switching the power supply to standby. If the output voltage is increased with the output connected, the supply again reverts to standby. If the power supply should overheat the warning light comes on and the power supply cannot be reset until the temperature has dropped.

The idea is to make the system "fail-safe", as this is the only way to avoid expensive accidents when setting up new equipment. In practice this arrangement has proved very convenient to use for testing and fault finding.

CIRCUIT ACTION

With the increased availability of cheap i.c.s it seemed obvious that the circuit should be built around one, and the 723 voltage regulator was chosen. The normal way of connecting this is shown in simplified form in Fig. 1. A part of the output voltage is compared with the reference voltage. If the ouput tends to be low the error amplifier output goes up so the output is maintained. However the 723 will only stand 40V input, giving a maximum of about 36V out.

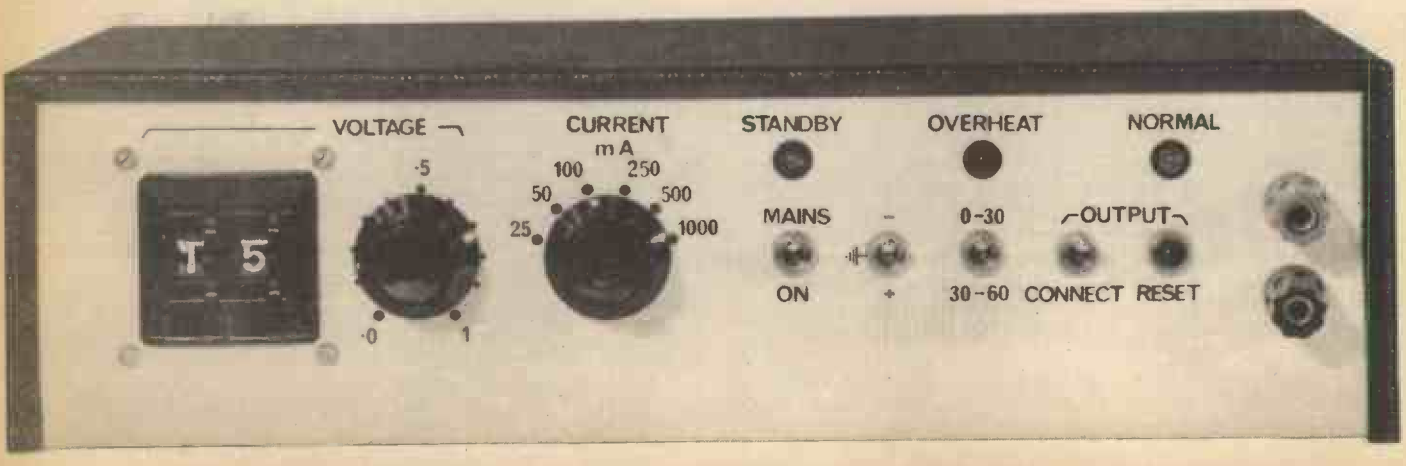
One way to get higher voltage outputs is shown in Fig. 2. There is a little fiddling to keep the error amplifier working in the correct range, but the only real complication is a separate power supply for the i.c. This, however can be very simple. In each case, the output can be reduced to zero by connecting the frequency compensation terminal to the i.c. negative line—this feature will be used for current limiting and overheating protection. Also, in each case the output voltage is proportional to the "Set Output" resistance, but in Fig. 1 the minimum output is the same as the reference voltage, whereas in Fig. 2 the minimum output is zero.

The V_z output on the i.c. is only provided on the 14 d.i.p. version of the 723, but a metal can 723 could be used with an external 8V Zener diode.

The complete circuit is shown in Fig. 4. Frequency compensation is provided by C1, and the emitter follower transistor (Figs. 1-2) becomes two transistors, TR4 and 5 to provide the required current gain.

As the reference voltage can vary between about 6·8 and 7·5V, preset potentiometers VR2 and 3 have to be provided.

Current limiting is provided by sensing the voltage drop across R12 and the resistor selected by the current limit switch, S3. To avoid wasting power, and to avoid an unnecessarily large heat sink on the output transistor a range switch, S8 is used to switch the input to the regulator to about 60 or 35V.



COMPONENTS . . .

Resistors

R1	1k
R2	4k7
R3	1k
R4	3k3
R5	3k
R6	270
R7	5k6
R8	5k6
R9	1k
R10	1k
R11	100
R12	47
R13	47
R14	15
R15	5·6
R16	4·7
R17	4·7
R18	1 2W
R19	220k
R20	47k
R21	2k2 2W
R22	22k
R23	100k
R24	100k
R25–R33	1k 2%
R34–R38	10k 2%

Unless otherwise specified all resistors $\frac{1}{4}$ or $\frac{1}{3}$ watt 5% high stability

Switches

S1	Push-button push to break
S2	2 decade thumbwheel edge switch (see text)
S3	2 pole 6 way rotary
S4	Single pole double throw toggle (EV Type S7101)
S5	Double pole double throw toggle (EV Type S7201)
S7	Double pole double throw toggle (EV Type S7201)
S8	Single pole double throw toggle (EV Type S7101)

Potentiometers

VR1	1k horizontal preset (Type PR15)
VR2	1k horizontal preset (Type PR15)
VR3	1k horizontal preset (Type PR15)
VR4	1k linear wirewound (see text)

Capacitors

C1	1n disc ceramic
C2	1µ 63V electrolytic
C3	47µ 63V electrolytic
C4	2,200µF 100V electrolytic
C5	470µF 25V electrolytic
C6	220p ceramic plate

Semiconductors

IC1	723, d.i.l. voltage regulator
TR1	OC81
TR2	BC184L
TR3	BC184L
TR4	2N5192
TR5	2N3055
TR6	BC184L
TR7	BC184L
D1	1N4148
D2	TIL209 Green
D3	TIL209 Red
D4	1N4002
D5	1N4002
D6	1N4002
D7	1N4148
D8	1N4148
D9	TIL209 Green
REC1	Diode bridge 2A 100V r.m.s.
REC2	Diode bridge 0·5A 40V r.m.s.
D10	33V 400mW Zener
D11	1N4148
D12	1N4148
D13	1N4002
R25	VA1100

Transformers

T1	0–25–40–50V 1A (EV Type GP501)	Mains
T2	6–0–6V 100mA (EV Type 606/1)	Mains

Heatsinks

(For TR4)	17°C/W (EV Type TV4)
(For TR5)	2°C/W (EV Type 10DN400)
(For TR1)	Clip type (EV Type A1031)

Fuses

FS1	500mA 20mm
FS2	1·5A 20mm

'EV Type' references refer to components available from Electrovalue Ltd., 28 St. Judes Rd., Englefield Green, Egham, Surrey, TW20 0HB.
The cabinet is a 'Norman', Type WB4, size 280 × 150 × 75mm approx.

Normally the difference between the input and output is less than about 33V, so TR7 is not drawing current, and the voltage at the base/emitter junction of TR6 plus D8 has to reach about 1·2V before TR6 draws any current, and makes the output fall. If the input is much more than 33V higher than the output, because the supply is set to high range and is current limiting (or incorrectly set to high range when a low voltage is selected) there is a risk of excessive power being dissipated in TR5. To avoid this TR7 switches on and shorts out D8, so that current limiting occurs when TR6 base is +0·6V, and the maximum current is halved.

CONTACT RESISTANCE

R18 is shown as 1 ohm rather than 1·2 because the wiring and switch resistance of the prototype was about 0·2 ohms. As the contact resistance of the current limit switch could be a problem in time it is a good idea to wire two switch sections in parallel on the 1A range as shown. (This is "fail-safe" as higher resistance will reduce the maximum current.)

Reference to the 723 published data will show that there is already a current limit transistor equivalent to TR6 provided to do the same job. However, the rating of this transistor is inadequate in this configuration so an external device is used.

STANDBY

In Figs. 1 and 4 the voltage at point "x" is 0 when the output is stabilised. This point is sensed in the circuit by TR3. If the output voltage drops, for example, due to the onset of current limiting the voltage at the base of TR3 goes positive. When it reaches 0·6V TR3 conducts and pulls down the output of the stabiliser, and D2 ("Standby") comes on.

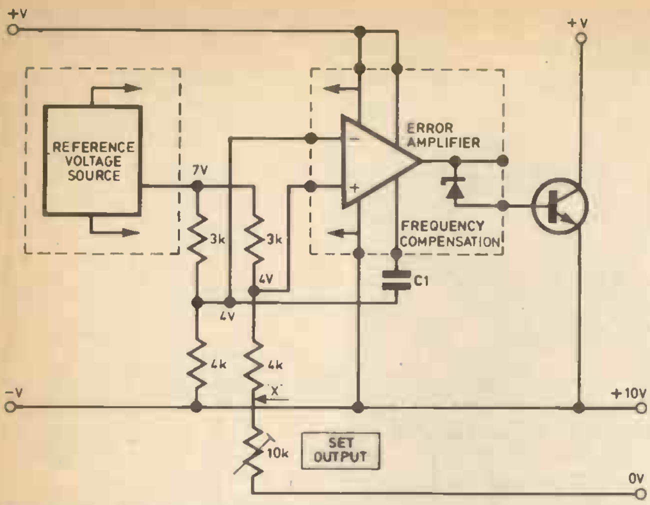


Fig. 1. Operation of the 723 voltage regulator. Area within dotted lines indicates i.c.

Once this has happened the output will stay low, and can only be reset by opening S1, the "Reset" button. In practice, R6 is included to make the normal voltage at "x" about 0·3V, so that the detection of lack of stabilisation is more sensitive. When S2 is operated it will often go open circuit as it switches. In this situation the voltage at "x" goes positive, and the stabiliser goes to "Standby", whereas in a conventional circuit the output would start to rise to full voltage. If the new setting is to a higher voltage "x" goes positive and the stabiliser goes to "Standby".

OVERHEAT

The "Overheat" circuit has a temperature sensor mounted on the heat sink of TR5. The author is not aware of any cheap universally available thermistor designed for this job, so a germanium output transistor, TR1, is used (OC81 in prototype).

The leakage current of a germanium transistor is enormously temperature sensitive, and in this case a vice can be turned into a virtue! Although transistors are obviously not designed for this job, general purpose germanium types should work in this circuit.

If in a given case the leakage is too low, the base can be left open circuit. The output of the overheat circuit is connected to pin13 of the i.c. after the "Reset" switch, so that in the event of overheating the output cannot be brought on.

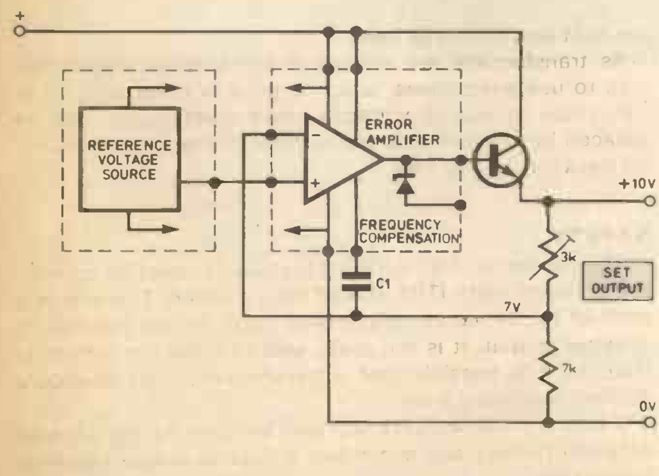


Fig. 2. High voltage operation of the 723 regulator

NORMAL INDICATION

The "Normal" diode D9 is connected to indicate actual output voltage, so D5 and 6 are needed to make sure that it comes on at 1V. Although the l.e.d. is not very bright below about 5V this was thought to be a useful indication of correct operation, and the extra complication of constant current circuits does not seem worth while. Incidentally D5 and 6 also protect the power supply against reverse voltages.

With the component values shown the output is 1V for every kilohm selected by S2. As shown this is a two decade thumb wheel edge switch, plus a 1 kilohm linear wirewound potentiometer for fine control. However, any desired alternative may be used.

Possibilities that come to mind are a 10 turn potentiometer, or a 12-way switch giving 3V steps, and a +30V switch, which could be the same switch as the range switch. However, a reasonably good quality switch should be used, as should it go permanently open circuit the stabiliser output could be reset to maximum. (An intermittent open circuit, which is much more likely, would merely put the output to standby).

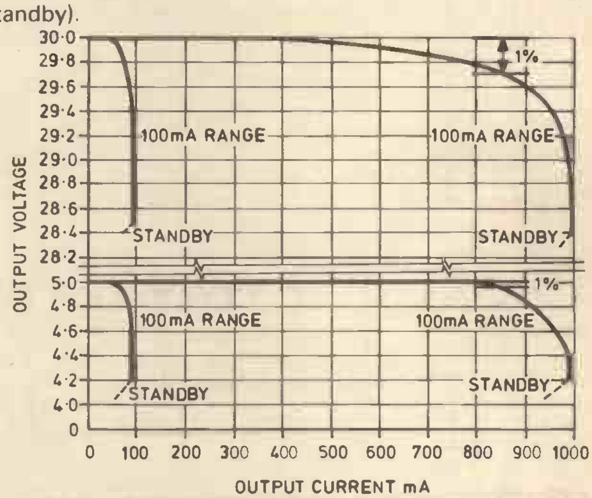


Fig. 3. Graphs showing workshop power supply unit's voltage regulation

The power dissipated by TR5 is the difference between input and output voltage, multiplied by the maximum current, and could be up to about 40W. To cope with this a heat sink with a thermal dissipation of about 2°C/W is indicated.

The maximum dissipation from the heat sink will only be achieved if the fins are mounted vertically in free air—that is, on the outside of the back panel.

It helps a little if the heat sink is painted matt black, and a smear of silicone grease must be used on both sides of the insulating washer for TR5. In practice the back panel of the case will dissipate some heat, and the prototype using the specified heat sink cut down from 4 to 3 inches runs quite cool, but it is not recommended to reduce the heat sink much more. TR4 runs at the power of TR5 divided by the h_{FE} of TR5—a maximum of about 2W. This power is comfortably dissipated by a small heat sink mounted on the circuit board.

The whole circuit depends on TR5 dissipating the necessary power with low leakage. The 2N3055 is not expensive, and to use a lesser transistor, or one of dubious origins, is asking for trouble.

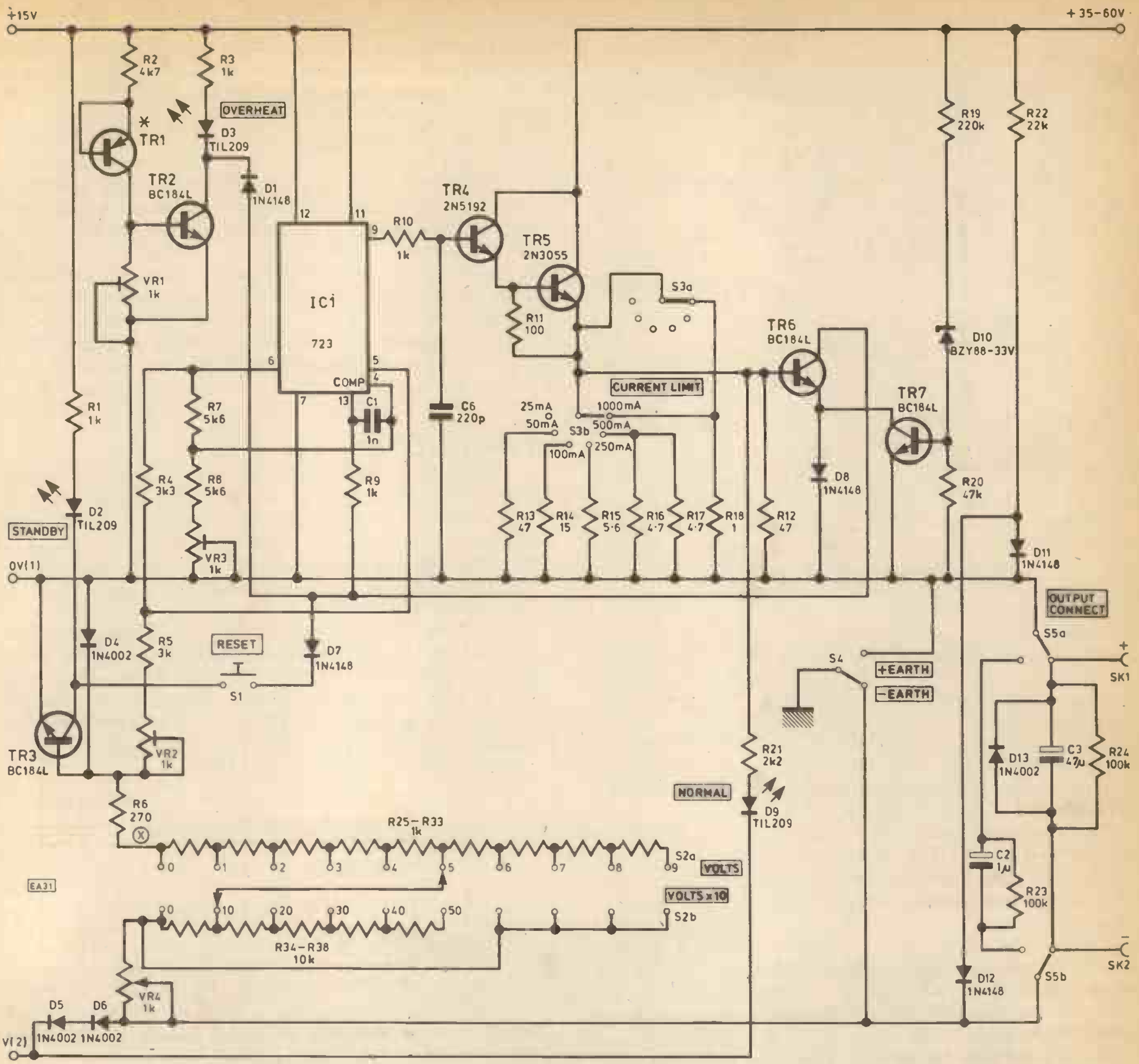


Fig. 4. P.s.u. circuit

RECTIFIER CIRCUIT

The stabiliser circuit is fed from the rectifier circuit of Fig. 5. Ironically, the compromises in the circuit have been made here, for the sake of specifying components that are universally available at a reasonable price. As the range switch is before the reservoir capacitor a thermistor is included to reduce the switching surge to reasonable proportions. However, this must increase the amount by which the power supply sags at high current.

The highest voltage rating of large electrolytic capacitors at a reasonable price is 63V, which is just above the 60V obtained at low loads using the 40V tapping of the specified transformer. However, at a continuous load of 100mA this drops to 56V, and at 1A to 45V. The maximum output voltage is about 3V less. As equipment to be tested will rarely demand continuous high current as well as high voltage, this compromise seems reasonable. However, for those who refuse to compromise, the alternative is to use a 2N3442 for TR5. Then the high range can use the 50V output of T1 which should be rated at 2A. In this case the full size heat sink should be used.

As transformers are expensive some constructors may wish to use alternatives, which is quite in order as long as the actual measured voltages prove suitable. T2 can be replaced by any available transformer giving a rectified output between 14 and 18V.

SAFETY

The cabinet and all exposed metalwork must be connected to mains earth (TR5 should have a cover). The output is earthed by S4 connecting mains earth to the positive or negative output. It is not really safe to allow the output to float, as it is possible that a transformer could develop a primary/secondary short.

If both transformers are replaced by types having a screen between primary and secondary a floating output becomes permissible,

The fuses are not made accessible from the outside as their failure would indicate a fault within the power supply.

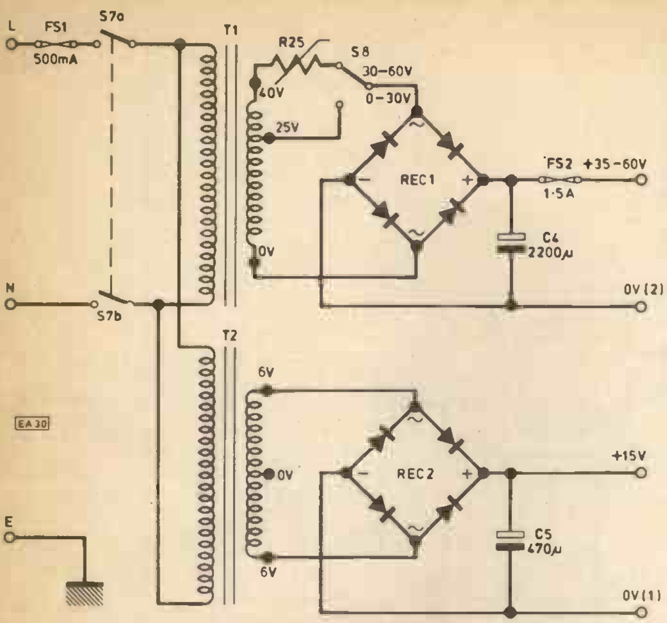


Fig. 5. Bridge supplies for main circuit

STABILITY

The inherent stability of the 723 regulator is very high (a fraction of 1% in most circumstances), so the accuracy achieved depends largely on the components used. The absolute value of R4–R8 is not important as long as they do not vary. Thus 5% high stability resistors are good enough for this application. The resistors R25–R33 for the 1V steps are critical, but a 5% error represents only 50mV, which is close enough for most purposes.

When a nine is dialled up, however, nine of these resistors are in series, giving a possible error of 450mV. Statistically the error in this case should be much less than 5%, but the extra expense of 2% resistors is probably worthwhile. The resistors R34–R38 for 10 volt steps should however normally be 2%.

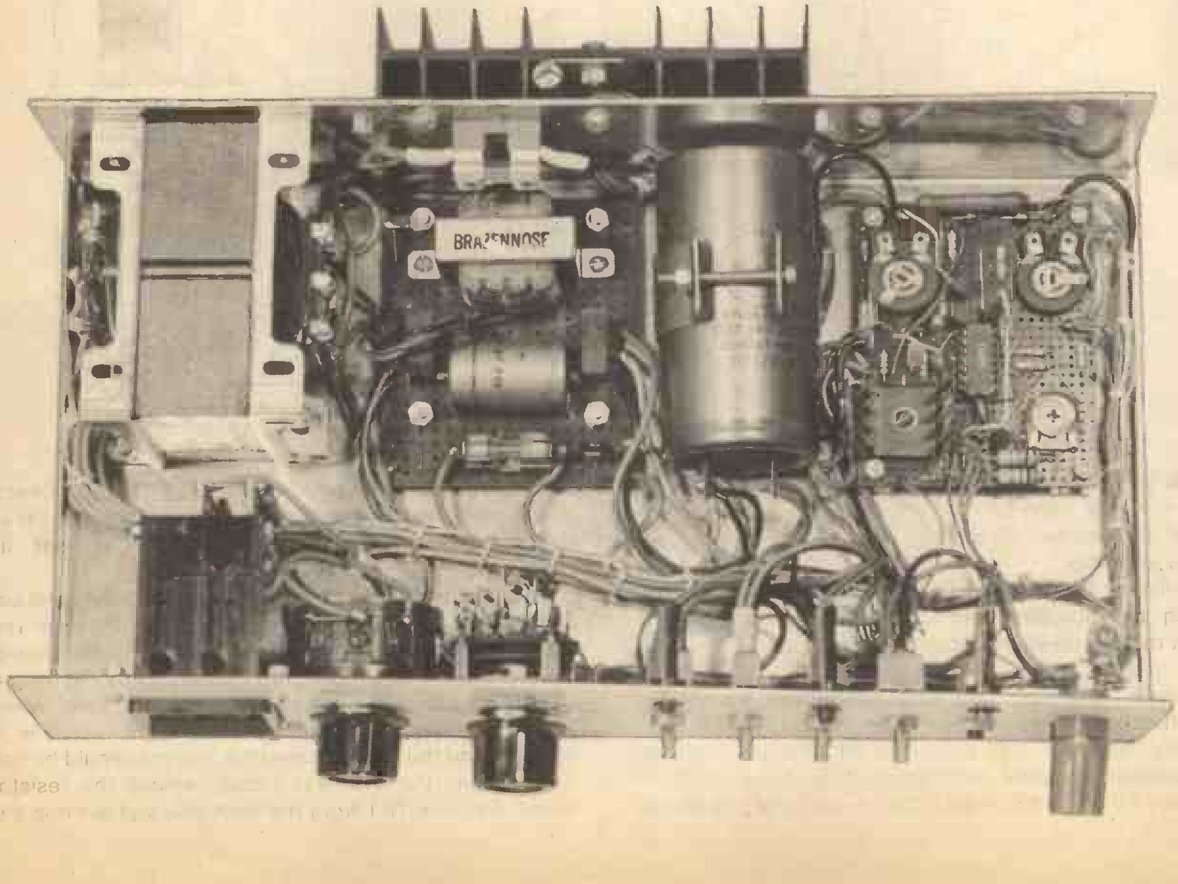
The preset potentiometers VR2 and 3 are a potential weak link, but they only make up a small part of the total resistance. If preferred they could be replaced by multiturn preset potentiometers.

For the minimum thermal drift in the i.c. the resistances seen by the inverting and non-inverting inputs should be equal. This is achieved at about 15V, but the unbalance at other voltages is not great enough to cause difficulties, as the i.c. does not dissipate enough heat to run at all hot.

CONSTRUCTION

The general construction of the prototype can be seen from the photographs. The circuitry is mounted mostly on two pieces of Veroboard corresponding to Fig. 6 and Fig. 7. The layout for the rectifier circuit is given in Fig. 7. Layout for the stabiliser, Fig. 4, is given in Fig. 6. This uses rather a large number of links, and could probably be improved upon, but the extra expense of a printed circuit board does not seem warranted. It is recommended that Veropins should be used for external connections, as this makes assembly easier and reduces the likelihood of short circuits between tracks. The construction must be of a high standard if expensive disasters are to be avoided. In particular beware of whiskers of solder or removed copper getting between tracks.

The i.c. should be mounted in a holder.



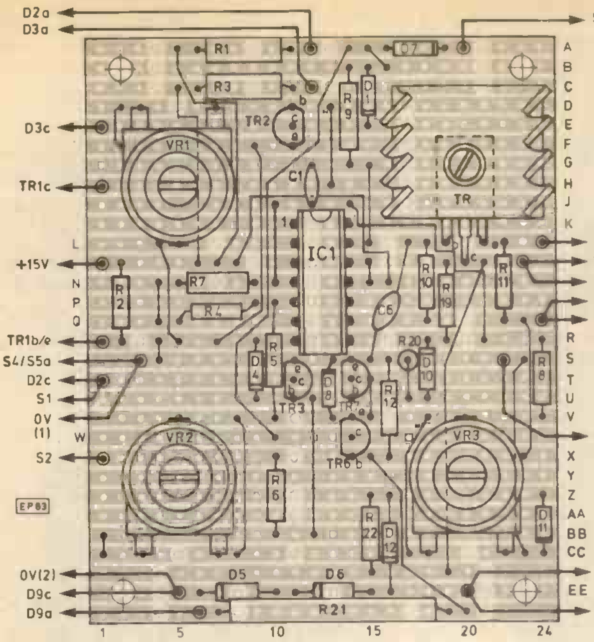


Fig. 6. Stabiliser circuit

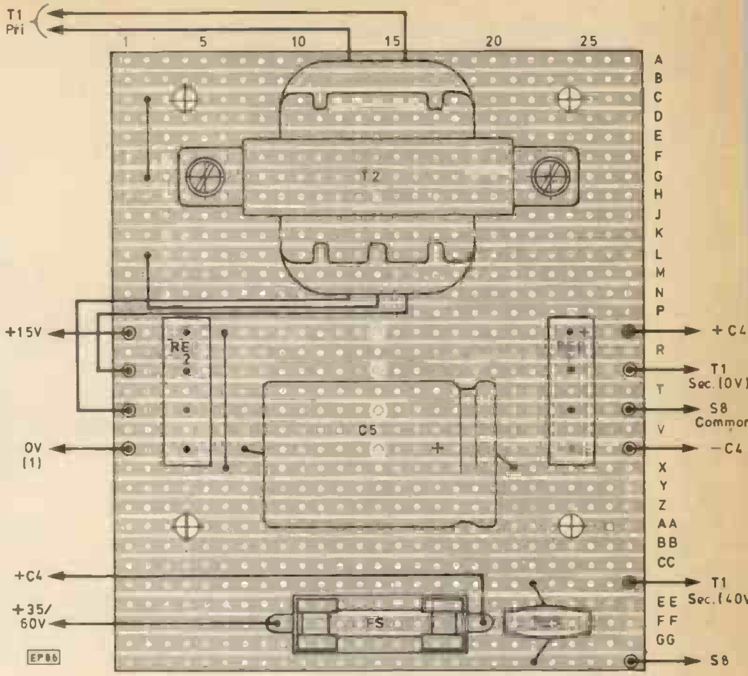


Fig. 7. Supply board T1 and C4 are elsewhere chassis mounted (see photograph)

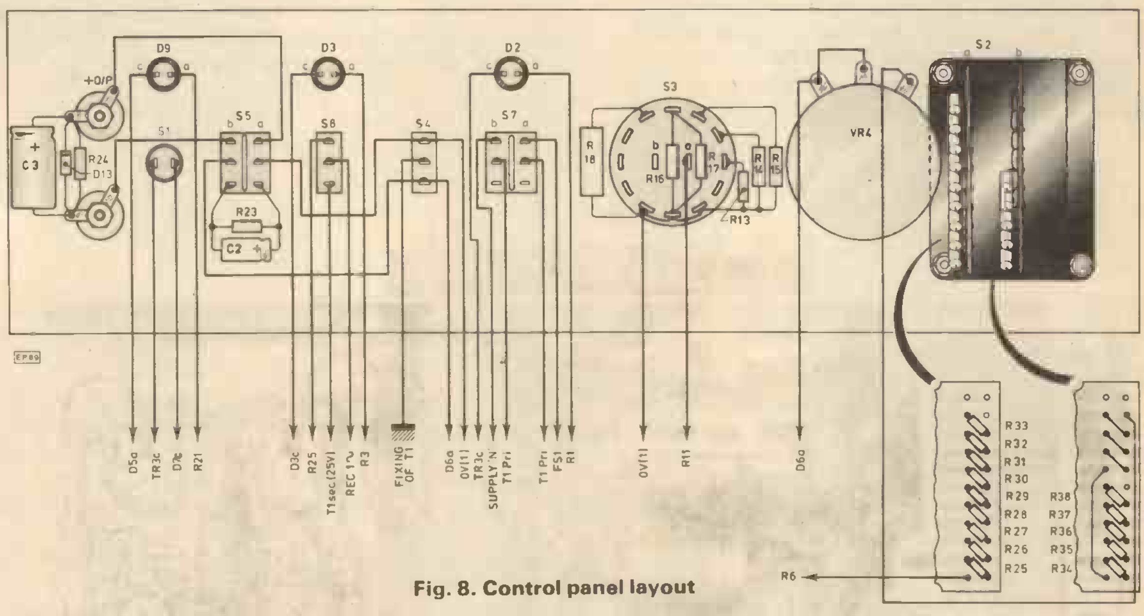


Fig. 8. Control panel layout

SETTING UP

If the unit has been built properly there should be no snags, but it is worthwhile testing methodically just in case something is wrong.

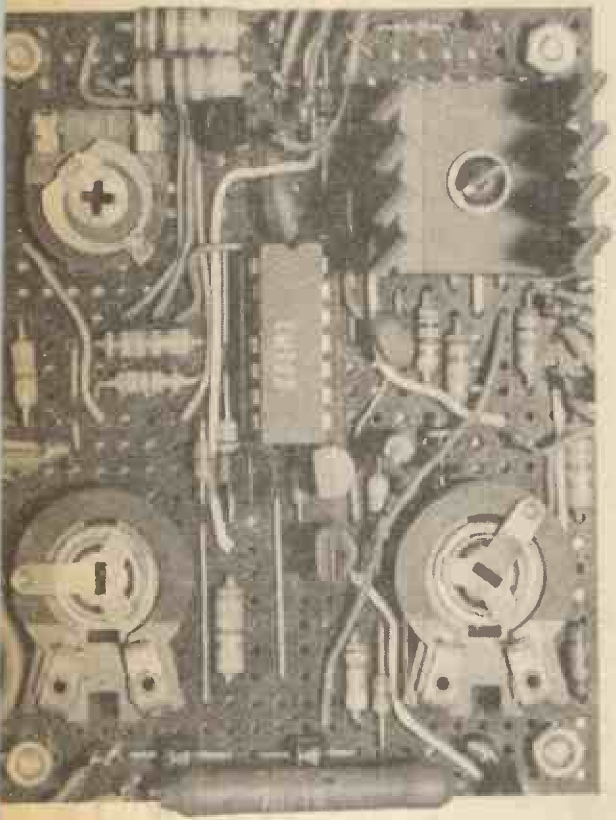
It is advisable to build and test the rectifier circuit before connecting the stabiliser circuit. Before connecting TR5 check that there is no short circuit to the heat sink.

Switch to 20V, 25mA, low range, "Connect" turned on, and connect a voltmeter to the output terminals. Switch on, and the standby light should come on. Press the reset button, and the "Standby" light should go off, "Normal" light on and the voltmeter should read about 20V. Adjust VR2 to correctly set 1V and VR3 to set 20V—repeat the process as necessary as the two controls interact. Check for overheating (at this point the overheat circuit is not set up, so if necessary adjust VR1 so that the "Overheat" light is off).

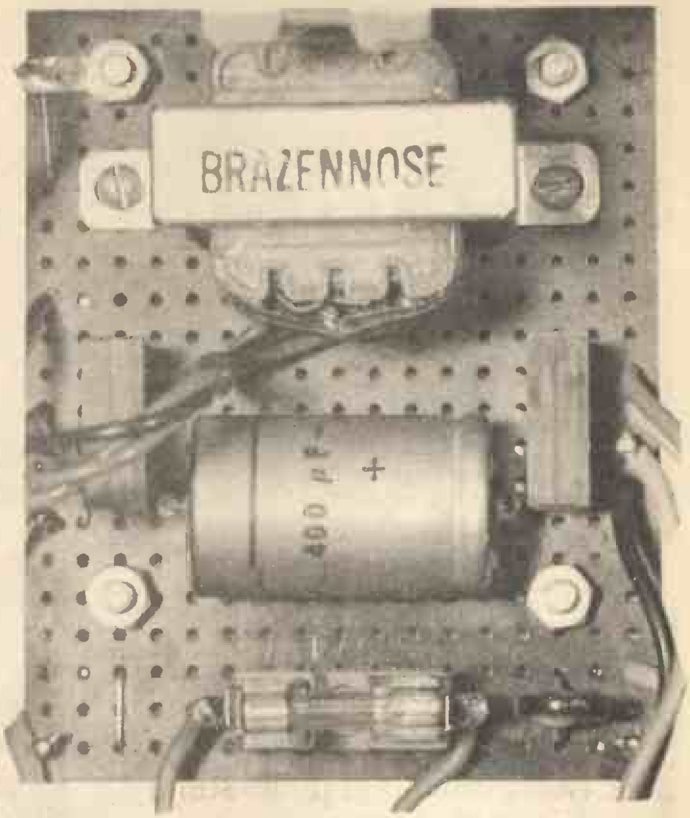
To check the current limit select 10V, 25mA, and connect a meter set to 100mA in series with a 220 ohm resistor. Press the "Reset" button—the "Standby" light should stay on, and the meter should read 25mA approx., as long as the "Reset" button is pressed, dropping to zero when the "Reset" button is released. If the range switch is set to 30–60V and the test repeated the current should be halved.

To set up the overheat circuit remove the resistor and meter. Remove TR1 from the heat sink and put it in a cup of

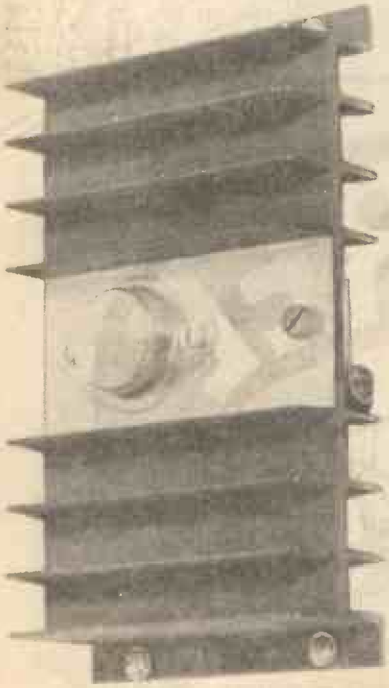
VIEWS INSIDE . . .



(a)



(b)



(c)

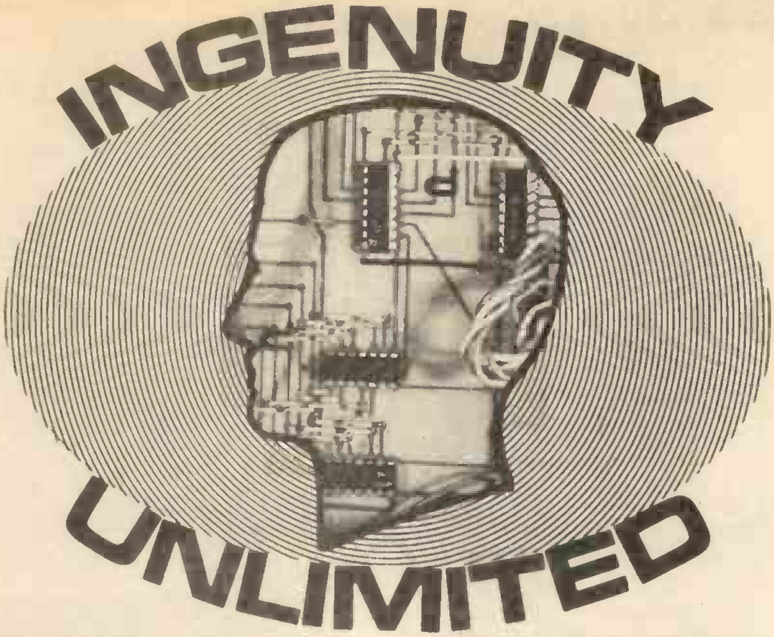
Fig. 9 (a) Stabiliser Veroboard (b) Supply Veroboard (c) Showing mounting of OC81 sensor below TR5's heatsink

almost boiling water (just dip the can of the transistor in the water, not the leads). Switch on and press the "Reset" button. Increase VR1 from minimum resistance until the "Overheat" light and the "Standby" light both come on. Check that the "Reset" button is inoperative. Switch off and reconnect TR1 to the heat sink.

If all is well the unit can be tested at higher current. The hardest test is low output voltage at maximum current. If all is still well set to high range, where the hardest test is about 30V at maximum current. Also check that TR4 and the i.c. are not overheating.

Now test for leakage in TR5, which is shown by a voltage on the output, and thus a slight glow in the "Normal" light when the circuit should be in "Standby", especially on the high range. If all is well get TR5 hot by running at low output voltage, high current for some time until it is on the verge of overheating. Turn off the "Connect" switch, and check that the "Normal" light is completely off.

Give the power supply a good soak test, and if necessary slightly adjust VR2 to correct the output at 1V and VR3 to correct the output at 50V. Check that the output is correct at other voltages, and check the current limit on all ranges. ★



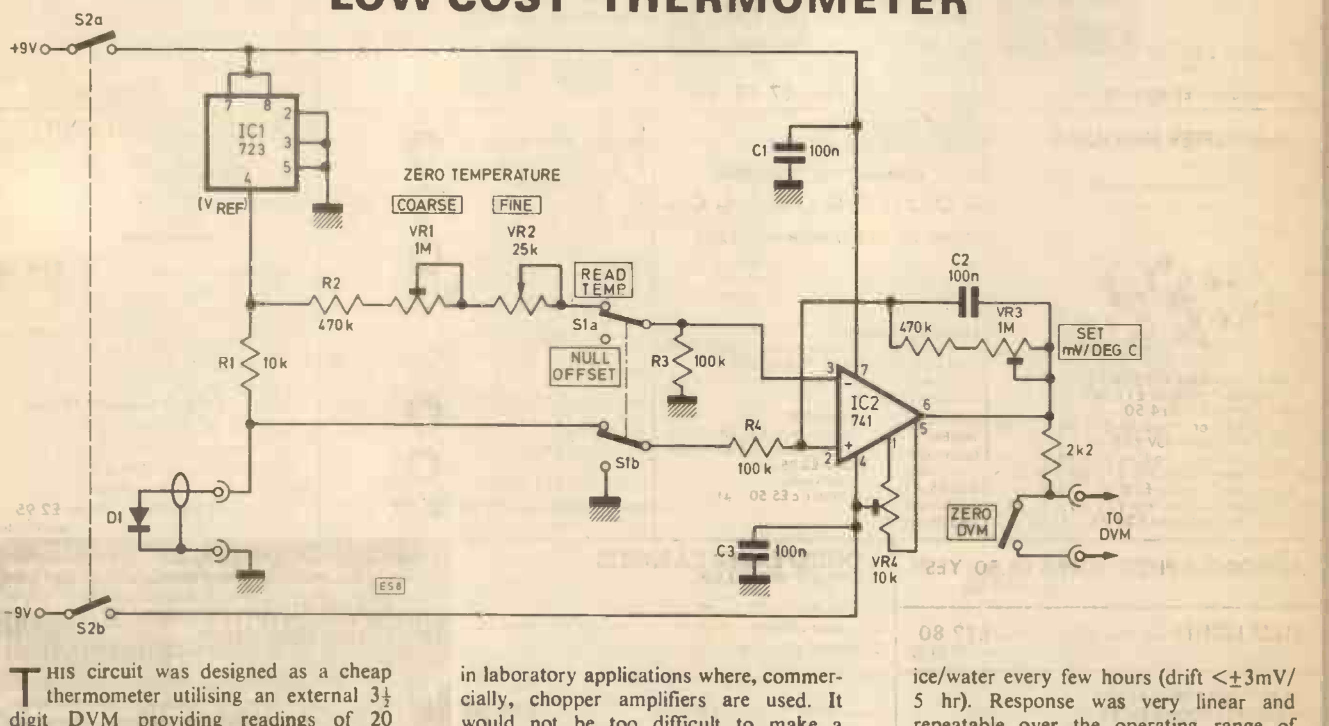
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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.

LOW COST THERMOMETER



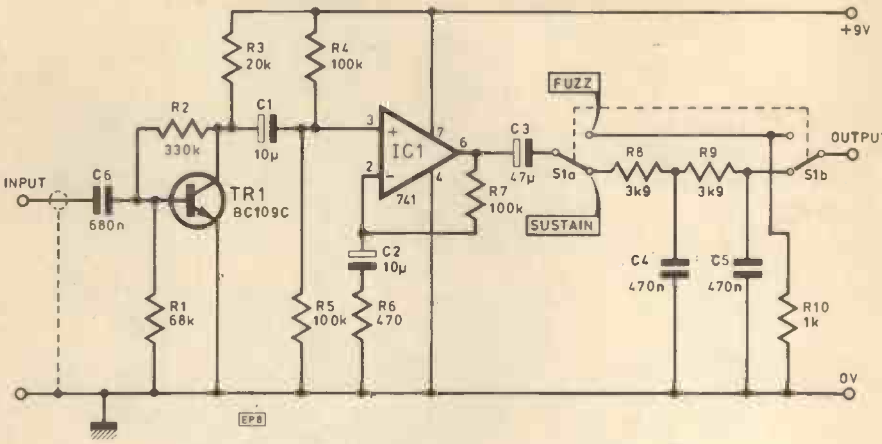
This circuit was designed as a cheap thermometer utilising an external 3½ digit DVM providing readings of 20 mV/°C. Whilst making no total claim for originality, I was impressed by the stability of a 741 used as a d.c. amplifier of fairly high sensitivity. The nearest commercial equivalent would have cost over £120, and would not have been very suitable (for an enzyme kinetics experiment).

On the basis of the success of this circuit, I might try extending the use of 741s in laboratory applications where, commercially, chopper amplifiers are used. It would not be too difficult to make a chopper-stabilised amplifier with 741s and analogue gates. D1 (any small silicon diode) was minimally insulated with epoxy resin, for good thermal conductivity. Once the 741 offset had been nulled at the appropriate ambient temperature (R3 and R4 maintain approximate offset current balance), it drifted by <1mV over several months.

The temperature was rezeroed in ice/water every few hours (drift <±3mV/5 hr). Response was very linear and repeatable over the operating range of 0–50°C, and accuracy was probably limited by the calibration (accurate to 0·1 deg C). D1 dissipates 300–400μW, and self-heating may not always be negligible. The +9V supply is a minimum safe value for the 723 for a stable V_{ref}.

B. J. Fowler,
Dept of Biochemistry,
Liverpool Polytechnic.

GUITAR FUZZ/SUSTAIN UNIT



COMMERCIAL guitar effects are usually very highly priced and therefore a circuit which offers two useful effects cheaply must be very appealing to most guitarists. The circuit shown is cheap to build and gives the ever-popular fuzz effect as well as sustain.

This design can be built either as a separate unit or is small enough to be inserted directly inside the guitar body.

A standard pre-amp consisting of TR1 enables even very low output guitars to be used successfully. The amplified signal is then fed to an op-amp IC1 via C1. Because of the high gain the waveform will be severely clipped. With S1 in the "fuzz" position the signal will be attenuated by R10 and taken to the output.

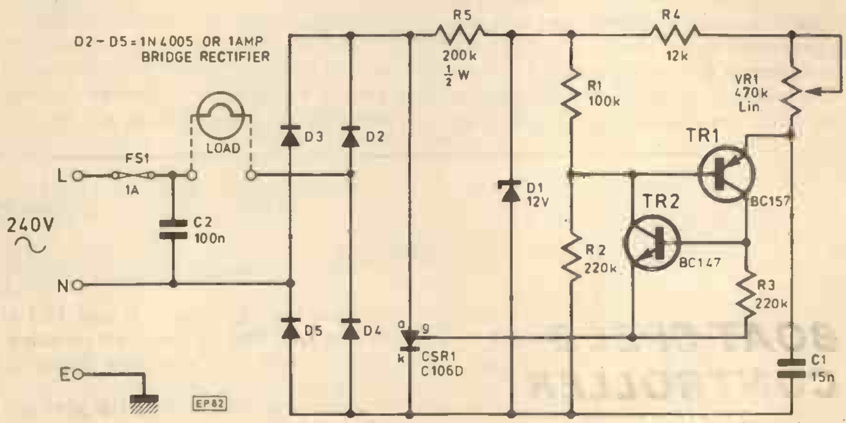
With S1 in the "sustain" position the output from IC1 will be attenuated and modified by the two stage RC network R8 C4 and R9 C5. This will remove most of the high order harmonics formed by the clipping to leave a sound more like the original. Sustain will be present because during the time clipping occurs the output level will remain constant independent of the input.

Should any residual fuzz sound at output be a nuisance then adjustment of the amplifier tone controls for maximum bass and minimum treble will eliminate it.

Battery drain is below 1mA so a PP3 battery would make a compact power source. The high gain of the circuit may cause several problems: the circuit should be laid out in a logical manner to avoid instability and positive feedback. The input lead should be screened to prevent hum and radio pickup. Owing to the increased sensitivity the guitarist should use his hand to damp the strings not being played. Guitar volume and tone controls should, of course, be left at maximum.

A. Niemiro,
Welwyn Garden City,
Herts.

LAMP DIMMER



MANY lamp dimmer circuits suffer from several drawbacks:

(1) Power consumption is too high for operation in a sealed box.
(2) High levels of r.f.i.
(3) Failure of a component may have disastrous results.
(4) Lamp flicker at very low light levels and hence the inability to turn the lamp off without a switch.

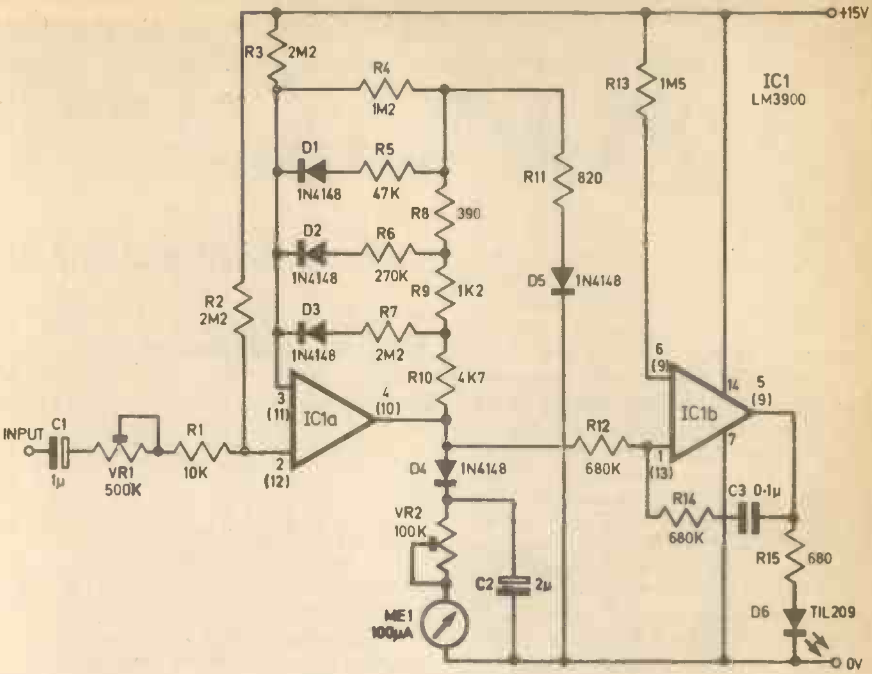
The circuit shown consumes a maximum of 0.25W and drives the lamp with a.c. using a thyristor and a bridge rectifier. The lamp is wired in series with the circuit which enables r.f.i. to be reduced using only one capacitor across the mains input giving an effective RC filter with the lamp. Failure of any one component will at worst only turn the lamp fully on or off.

TR1 and TR2 form a switch which operates when the voltage across C1 exceeds that set by R1 and R2. The energy in C1 fires the thyristor after a delay set by VR1.

The 12V Zener provides a working voltage to the circuit which falls to zero at the end of each half cycle reducing the base voltage of TR1 towards zero. The timing capacitor is thus discharged each half cycle which avoids lamp flicker due to charge being accumulated on C1 when VR1 is set for a delay longer than a half cycle. Triggering early in the following cycle is thus avoided enabling trouble free control at near zero light levels.

M. A. McCabe,
Bradford,
W. Yorks.

STEREO PEAK DETECTING PPM



One disadvantage of peak program meters (PPMs), apart from their usual cost and complexity, is their ability of hiding serious overloads. This is because the logarithmic response makes a large overload look like an insignificant one. It is for this reason that this simple inexpensive circuit for a PPM was designed to include a peak detection circuit which can detect a +1dB overload.

The circuit shows for one channel. The figures in brackets indicate the IC1 pin connections for the other channel. IC1 is a quad current differencing amplifier (CDA). The incoming signal is half wave rectified by IC1a, the gain of which is controlled as a function of the output voltage to give a logarithmic response. This response is tailored by switching in negative feedback as the output voltage increases. Four discrete linear slopes are combined to approximate the logarithmic response. Diodes D1, D2 and D3 are used as the switches. Diode D5 provides some temperature compensation. The output peaks charge C2 to give an attack time of about 1ms. The decay time is about 160ms. IC1b forms a comparator/monostable which will drive the l.e.d. overload indicator for 40ms periods if a +1dB signal persists for 1ms. A continuous overload will cause the l.e.d. to flash on and off.

The meter scale is linear and calibrated −35dB to +5dB. The meter zero is calibrated −35dB, although it is, of course, infinity, but this makes little difference.

Setting up is very simple, since the overload indicator provides a means of calibration. First, a signal is applied to the input which is just sufficient in amplitude to light the overload l.e.d. VR2 is then adjusted so that the meter reads +1dB. VR1 can then be adjusted so that a 0dB input deflects the meter to 0dB. This can be anywhere between 60mV and 2·8V r.m.s.

P. R. Williams,
Stevenage,
Herts.

BOAT SPEED CONTROLLER

A friend wanted to control the speed of a model boat without wasting valuable power across a power rheostat. This design evolved.

The on time (o/p high) is when C1 is being charged via R1 and D1.

The off time (o/p low) is when C1 is being discharged through VR1 and R2 to pin 7. This off time can be varied by ranging VR1 but the on time is not altered due to D1 bypassing R2 and VR1 on charge.

When the o/p at pin 3 is high TR1 is switched on. The o/p pulses are smoothed by C2 which also eliminates damaging back e.m.f.

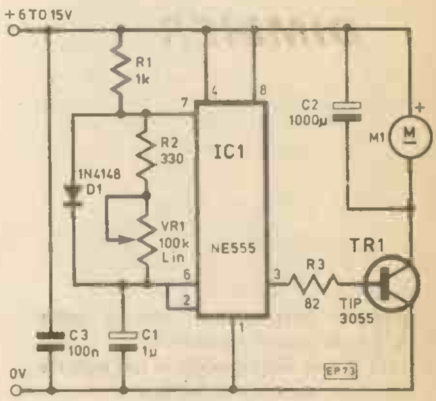
As the o/p transistor is a TIP 3055 and is saturated, no heatsink should be required.

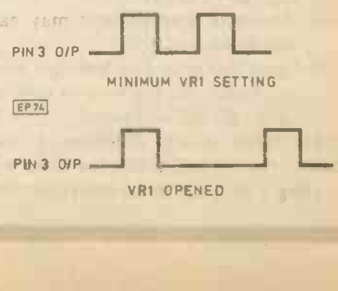
C3 is to remove spikes from the supply line.

A 100 kilohm potentiometer was used as the servo which moves this had only limited movement. The variation of the resistance required to be about 10 kilohms. A resistor can obviously be put in parallel with VR1 if the movement is too great.

The speed can be varied from full to very slow, smoothly.

S. H. Allsop,
South Anston,
Sheffield.





MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents 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 often come from readers working on their own systems, and payment will be made for any contribution featured.

THIS month's Micro-Bus looks at two activities that are normally considered extremely difficult for computers. The first is speaking, and a board which will provide speech output for a microcomputer is reviewed here; a program for generating random limericks used to evaluate the system is given in full, together with details for using it without a speech system to print limericks. The second activity, on a less serious note, is self-replication, and self-replicating programs in BASIC and M6800 assembler are given here.

MICRO TALKS

The speech channel is, for humans, the most fundamental means of communication, but it is still largely neglected as a means of communicating with computers, and HAL in "2001 A Space Odyssey" remains a creation of science fiction. However electronically synthesised speech was generated as long ago as 1951 by Walter Lawrence's PAT, or Parametric Artificial Talker, and although it is still difficult to produce very high-quality speech there are now simplified systems available for use with microcomputers.

One such system is the USA-produced Computalker board, designed for the S–100 bus and sold here for around £310 with software. Another product, the British-designed Microspeech board, has recently become available and Micro-Bus obtained one to review.

MICROSPEECH REVIEWED

The Microspeech board, shown opposite, is designed for use with the SS–50 bus as used in the South-West Technical Products MP–68 microcomputer which is based on an M6800 micro. At £295 including software it may seem rather expensive, but the circuitry is fairly complex containing some 38 i.c.s. The hardware and software were designed by Tim Orr and Richard Monkhouse respectively, both of whom formerly worked at Electronic Music Studios.

SYNTHESIS BY RULE

The Microspeech system uses a method of generating speech known as "synthesis by rule". The speech is stored in the most economical form of phonetic text, in which unique symbols are used to represent the different sounds from which the words are composed. Typically a minute of speech coded in this way can be stored in each 1K of memory.

Each speech sound is represented by an unambiguous one- or two-letter code; for example, "O" is the vowel sound in "hot" and "got", and "OO" is the vowel sound in "boot" or "true". The phrase "stupid computers" is rendered as "STYOOPIXD/KOMPYOOTETS. The "/" is used to separate words; a space gives a pause in the flow of speech. It is also possible to exert some control over the pitch of the voice, and this may be used to add intonation to make the speech sound more natural; for example "+" and "–" increase and decrease respectively the pitch of the voice by one unit, and these may be inserted between the phonetic codes at any point.

Two pieces of software provided with the system both convert the phonetic text into a series of parameter values which control the electronics of the synthesiser board. One, a stand-alone program, enables one to enter a piece of phonetic text and play it. The other program is a patch to SWTP 8K BASIC which makes it possible for a BASIC program to produce speech output. The phonetic text is printed to port 3; the speech software buffers it until an up-arrow is received, whereupon the text is spoken.

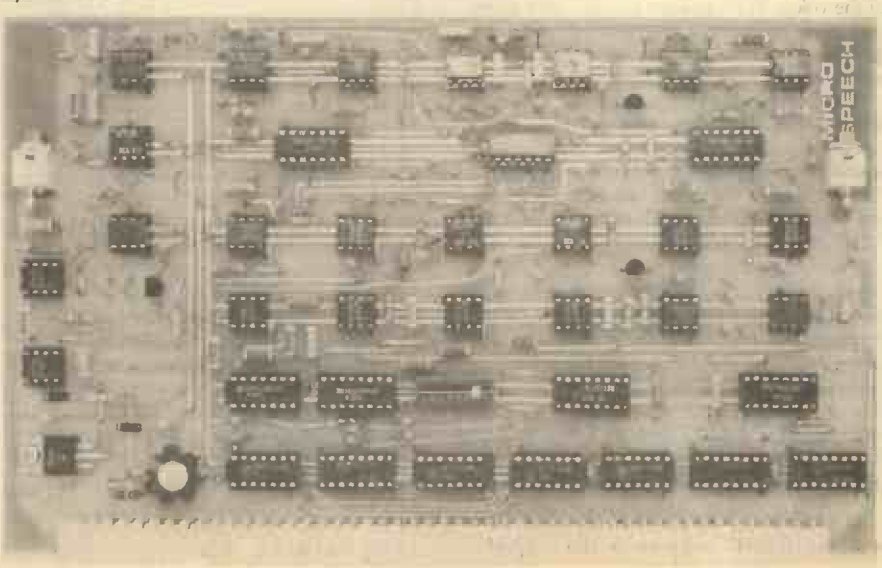
BLOCK DIAGRAM

Microspeech's electronic vocal tract is shown in block form in Fig. 1. The nine parameters on the diagram which control the different sections of the model are:

Frequencies:	**Amplitudes:**
F1—formant 1	AH—aspired sounds
F2—formant 2	AV—vowel sounds
F3—formant 3	AF—fricative sounds
FF—fricative formant	AN—nasal sounds
FV—voice oscillator	

To specify these parameters, nine 8-bit numbers are output to the Microspeech board by the controlling software. Each number is converted to an analogue voltage by a D/A converter and then steered to one of nine

The Microspeech board which will provide speech output from a microprocessor system.



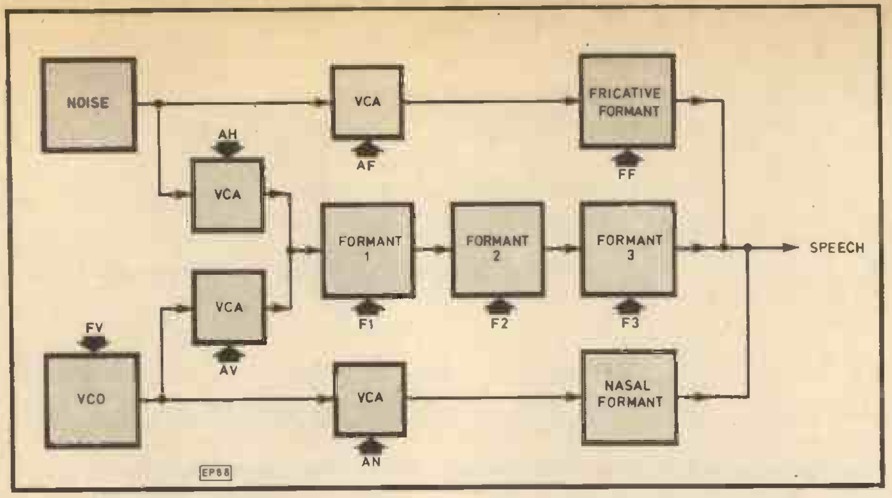


Fig. 1. Block diagram of the speech synthesiser electronics; the nine control voltages determine the speech sound produced.

sample-and-hold units by a multiplexer. The nine parameters are updated by the software at a rate of 50 times a second. The manipulation of these parameters enables the human speech sounds to be simulated as follows:

Vowels are generated by producing waveforms with maximum energies at certain specific frequencies known as the formants. The first three formant frequencies turn out to be the most important in determining the perceived vowel; for example, the "O" in "hot" has formants at 730Hz, 1kHz, and 2·4kHz, whereas the "OO" in "boot" has formants at 300Hz, 370Hz, and 2·2kHz.

Dipthongs, such as "AY" in "pay" and "OY" in "boy", are produced by gliding from one vowel sound to another. The vowel sounds are created electronically by passing the sawtooth waveform output from the VCO (Voltage Controlled Oscillator) through a line of three voltage-controlled bandpass filters, one for each formant (see Fig. 1).

A separate formant filter is used for nasals such as "M" in "man" and "NG" in "sing". Nasals, dipthongs, and vowels are all voiced sounds so that there is a pitch associated with them, and this pitch varies with the intonation of the voice. The unvoiced sounds, such as the fricatives "F" in "fat" and "SH" in "ship", are generated instead by passing the output of a noise generator through a bandpass filter.

The centre-frequency of the filter characteristic determines the speech sound heard; a frequency of about 4kHz will give an "F" sound whereas one of 2·5kHz will give an "SH" sound. If the sound includes some voicing these become the "V" in "vow" and the "ZH" in "azure" respectively.

Finally, stop consonants such as "D" in "dog" and "T" in "top" are generated by a period of silence followed by a gliding of the formants to the values determined by the vowel following the consonant. The difference between "D" and "T" is produced by the addition of a short burst of noise at the start of the latter sound.

RANDOM LIMERICKS

In order to try out the Microspeech system with the BASIC software a short BASIC program was written to make the micro compose its own random limericks, and read them out! The program is given in Fig. 2. A typical limerick produced by the program might be:

A vicious bland grocer from Spain
Once demolished some cakes on a train
He demolished so slow
That he demolished some dough
This vicious bland grocer from Spain.

Not up to Edward Lear perhaps, but with a cunning choice of words some of the limericks can turn out to be quite amusing.

The program of Fig. 2 works by choosing from among five alternatives at a particular point in the limerick; for example, the first adjective is chosen from : sordid, graceful, wily, vicious, and sparkling. These alternatives are specified, in phonetic form, in the DATA statements in lines 20 to 175 in the program. The subroutine at 7005 reads five strings from the DATA statements, chooses the one specified by the value of C (1 to 5), and prints it to the speech buffer.

If the subroutine is entered at 7000 the value of C is chosen at random, giving a random choice of one of the five strings. The subroutine at 6000 prints an up-arrow to the speech buffer, causing the strings to be vocalized. Rhyming is ensured by making the choice of the phrase at the end of the second line depend on the choice of word at the end of the first line; the same method ensures a rhyme between lines 3 and 4. The program would eventually be expanded with a greater number of alternative words at each point, but even with just five alternatives the results can be unexpected.

The program of Fig. 2 can just as well be made to produce printed limericks; the strings in the DATA statements should be changed to the written equivalents of the phonetic forms shown, and the PRINT statements should be altered to give printing at the terminal.

Fig. 2. BASIC program which composes random limericks and speaks them or, with modification, prints them.

```
0001 REM SPEAKING LIMERICKS
0010 GOTO 1000
0020 DATA SAORDIHD,GRAISFUHL
0025 DATA WIYLIH ,VIXSHETS
0030 DATA SPAHKLIHNG
0035 DATA GREEN,YUNG
0040 DATA VIYL ,BLAAND
0045 DATA OWLD
0050 DATA DUCHEHS,GROWSER
0055 DATA GLUTEN,FLAOTIHST
0060 DATA LAONDREHS
0070 DATA WEHMBLIH,SPAYN
0075 DATA CHAAD,SPEEK
0080 DATA KIXNGS
0085 DATA KAWNTEHD,FOLLOWD
0090 DATA NOWTIXSD,DEHMOLIXSHD
0095 DATA KOLLEHKTEHD
0100 DATA SUM STAAMPS
0105 DATA ET/STOWT,ET/NYOOD
0110 DATA SUM KAYKS,ET/FROG
0115 DATA AAND/FEHLT/TREHMBLIH
0120 DATA ON/ET TRAYN
0125 DATA AAND/WEHNT/MAAD
0130 DATA TWIYS ET WEEK
0135 DATA AAND/GROO/WIXNGZ
0140 DATA SHEE,HEE,SHEE
0145 DATA HEE,SHEE
0150 DATA KWIXK,SLOW,FYOO
0155 DATA HAHRD,LAIT
0160 DATA ET BRIXK,SUM DOW
0165 DATA ET SKROO
0170 DATA SUM/LAHRD
0175 DATA ET PLAYT
1000 DEF FNA(X)=INT(RND(0)*X)+1
1010 RESTORE
1020 PRINT #3,"AI ";
1030 GOSUB 7000:X=C
1040 GOSUB 7000:Y=C
1050 GOSUB 7000:Z=C
1060 GOSUB 8000
1100 GOSUB 7000:Q=C
1110 GOSUB 6000
1120 PRINT #3,"WUNS ";
1130 GOSUB 7000
1131  G$=C$
1140 GOSUB 7000
1150  C=Q:GOSUB 7005
1160 GOSUB 6000
1180  C=Z:GOSUB 7005
1190 PRINT #3,G$;"SOW";
1191  G$=C$+G$
1200 GOSUB 7000:A=C
1210 PRINT #3,"DHAAT";G$;
1230  C=A:GOSUB 7005
1240 GOSUB 6000
1250 RESTORE
1270 PRINT #3,"DHIXS";
1280  C=X:GOSUB 7005
1290  C=Y:GOSUB 7005
1300  C=Z:GOSUB 7005
1310 GOSUB 8000
1320  C=Q:GOSUB 7005
1330 GOSUB 6000
1340 GOTO 1000
6000 PRINT #3,"  ↑";:RETURN
7000  C=FNA(5)
7005 FOR M=1 TO 5:READ A$
7020 IF M=C THEN C$=A$
7030 NEXT M:PRINT#3,C$;
7050 RETURN
8000 PRINT #3,"FROM";:RETURN
```

```
                      NAM COPY
                *
0000 8D 00      HERE  BSR      *+2      PC ON STACK
0002 30               TSX
0003 31               INS
0004 31               INS
0005 EE 00            LDX      0,X      X=HERE+2
0007 09               DEX
0008 09               DEX
0009 C6 14            LDA B    £LAST-HERE+1
000B A6 00      MOVE  LDA A    0,X
000D BD EOCA          JSR      OUT2HS
0010 5A               DEC B
0011 26 F8            BNE      MOVE
0013 39         LAST  RTS
                *
     EOCA       OUT2HS EQU     $EOCA    IN MIKBUG
                      END
```

Fig. 3. (left) Self-replicating program for the M6800 micro will print a copy of itself at the terminal.

```
1000 FOR N=1000 TO 1040 STEP 10
1005 DATA FOR N=1000 TO 1040 STEP 10
1010 READ A$
1015 DATA READ A$
1020 PRINT N;A$
1025 DATA PRINT N;A$
1030 PRINT N+5;"DATA ";A$
1035 DATA PRINT N+5;"DATA ";A$
1040 NEXT N
```

Fig. 4. Self-replicating BASIC program which lists itself.

INTELLIGIBILITY

Just how good is the speech produced by the Microspeech board? To evaluate the system a piece of phonetic text was typed in, and on replaying it we were pleasantly surprised at the result. However we were in for a shock; we played the same speech to an unsuspecting volunteer, and they did not even identify it as speech, let alone understand it.

It seems fair to say that the speech produced is perfectly intelligible provided that you know what it is saying! Perhaps the best way of describing it is to say that it is like listening to someone with a very unfamiliar accent; after about half-an-hour's practice the speech is almost perfectly understood, especially if the sense is fairly predictable. It seems that human speech is a very difficult thing to simulate electronically; using the most sophisticated synthesis-by-rule systems people typically identify only 50 per cent of the words correctly unless very careful attention is paid to producing perfect timing and intonation.

In conclusion, the Microspeech board is great fun for use in non-serious applications where perfect intelligibility is not important; for example, for producing spoken output from games programs. It also has serious applications where experience with the speech it produces would overcome the problem of intelligibility; for example, dictation of the output from programs over the telephone, production of auditory alarms and warnings, and as a computer interface for the handicapped.

SELF-REPLICATING PROGRAMS

It is a fascinating, and by no means trivial, problem to write programs which will create an identical copy of themselves. Two examples are given here, but readers who find better solutions are urged to communicate these to Micro-Bus immediately. In assembler language for a particular micro the problem is fairly simple, even with the restriction that the program must work wherever it is placed in memory.

An example for the M6800 micro is shown in Fig. 3; when executed it prints a copy of itself to the terminal in hex. It assumes the existence of a subroutine, OUT2HS, which will print the byte pointed to by the X register as two hex characters, and then increment the X register. Alternatively the program can be made to put a copy of itself into memory by changing the instruction at $000D to A7, 14, 08.

A feature of this program deserving mention is the dummy subroutine call at $0000 which puts the program counter onto the stack so that it can be loaded into the X register. It is probably possible to write similar self-replicating programs for other micros; one for SC/MP appears in the Mk 14 programming manual.

Writing self-replicating programs in a high-level language such as BASIC poses a far trickier problem. One stumbling-block with BASIC is the difficulty of printing a quote character. Fortunately in SWTP BASIC, in which this problem was attempted, character strings in DATA statements may contain quotes provided that they do not contain commas or colons. The program in Fig. 4 when run, prints a copy of itself to the terminal To put it more graphically, the effect of typing RUN is the same as the effect of typing LIST! It is probably not possible to write self-replicating programs in all dialects of BASIC, and successful attempts or impossibility proofs are welcomed.

News Briefs

MORE FOR YOUR PET

TO QUOTE Commodore: "The PET family is here!" The 8K PET (2001-8) computer is now cheaper, at £594 inclusive. An upgradeable 4K version (2001-4) is also available at £497.

Two new bigger memory PETs are scheduled for release in May, the 2001-6N and 2001-32N, each with beefier typewriter style keyboards as opposed to PETs earlier calculator type. For 16K of RAM you pay £729, and for 32K RAM you will pay £858, but remember, in these versions there is no cassette deck! This is to make room for the larger keyboard.

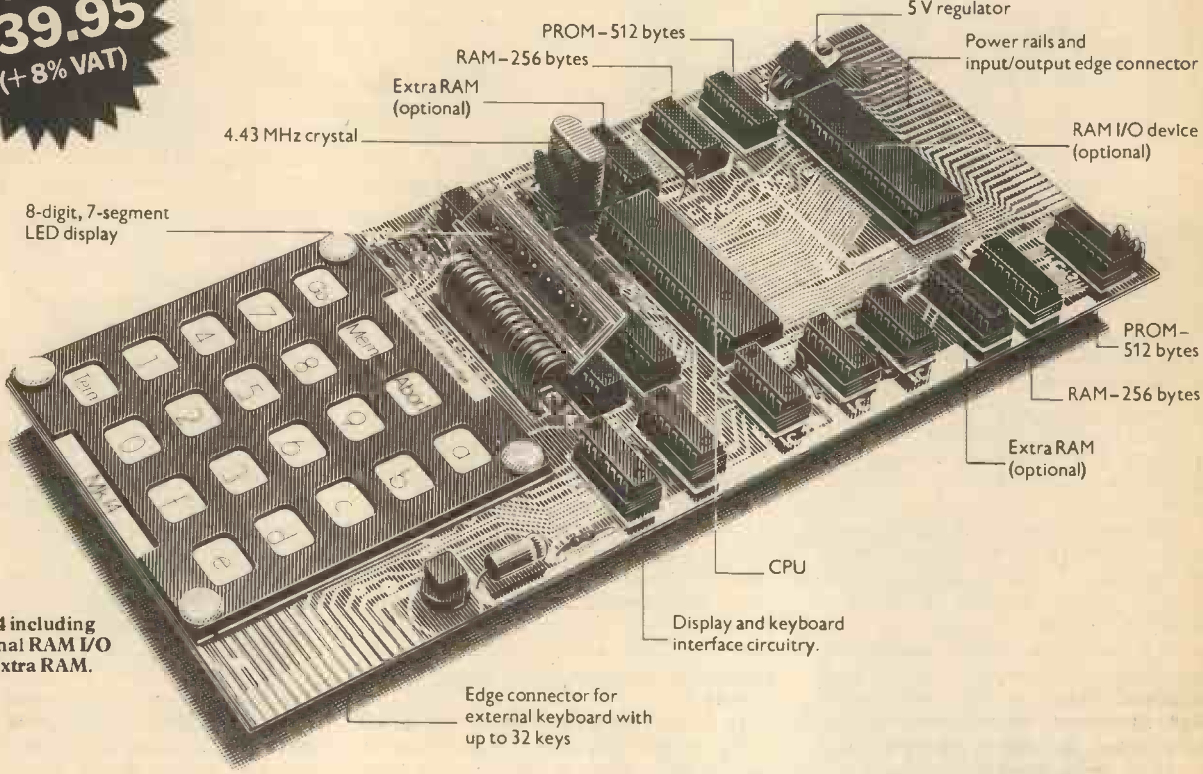
Two printers expected to be available from April, one of which is the 2023 which supercedes the previously announced 2020 printer. Capable of producing all PET graphics including reverse field and lower case, this 80 columns, 7 x 6 needle matrix impact printer can hammer along at an average of 93 chars/sec. It will also print double width capitals for document headings etc. For £594 you will be purchasing a software formattable microprocessor controlled hard-copy peripheral suitable for small business and engineering applications.

The 2022 is a higher quality tractor feed printer which can do everything the cheaper one can do, and naturally, more. How about up to four copies on $8\frac{1}{2}$ inch plain paper? Mailing labels, customised forms and even cheques for salaries! £696·60 inclusive.

May 1979 will also see the release of Commodore's 2040 Dual Drive Floppy giving a total of 360K bytes on two standard $5\frac{1}{4}$ inch disks. This peripheral uses two microprocessors of its own, plus fifteen memory i.c.s. Commodore claim to have eliminated all problems of double-tracking or double-density. The floppy disk operating system uses none of PETs user memory. Suitable for all models of PET and priced at £799·20 inclusive. Commodore Systems Division, 360 Euston Road, London NW1.

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only £39.95 (+8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

More memory – and peripherals!

Optional extras include:
1. Extra RAM – 256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB) giving further 128 bytes of RAM.
3. Low-cost cassette interface module – which means you can use ordinary tape cassettes/recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

• Hexadecimal keyboard • 8-digit, 7-segment LED display • 8 x 512 PROM, containing monitor program and interface instructions • 256 bytes of RAM • 4 MHz crystal • 5 V regulator • Single 8 V power supply • Space available for extra 256-byte RAM and 16 port I/O • Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

How to get your MK 14

Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

Science of Cambridge Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

Please send me the following, plus details of other peripherals:

☐ MK 14 Standard Microcomputer Kit @ £43.55 (inc 40p p&p.)
☐ Extra RAM @ £3.88 (inc p&p.)
☐ RAM I/O device @ £8.42 (inc p&p.)

I enclose cheque/money order/PO for £________ (indicate total amount.)

Name ________

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PE6 Allow 21 days for delivery.

Science of Cambridge

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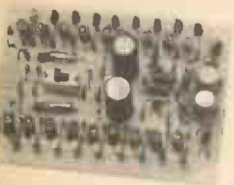
— WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS —

STEREO PRE-AMPLIFIERS

MC 1



CPR 1

CPR 1 – THE ADVANCED PRE-AMPLIFIER

The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably in the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV; distortion < .005% at 30dB overload 20kHz.
Following this stage is the flat gain/balance stage to bring tape, tuner, etc. up to power amp. signal levels. Signal to noise ratio 86dB; slew-rate 3V/uS; T.H.D. 20Hz – 20kHz < .008% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 130 × 80 × 20mm. Supply to be ±15 volts.

MC 1 – PRE-PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Send for details.

XO2: XO3 – ACTIVE CROSSOVERS

XO2 – two way. XO3 – three way. Slope 24dB/Octave. Crossover points set to order within 10%.

REG 1 – POWER SUPPLY

The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS

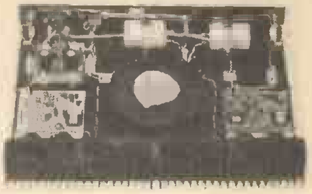
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification: T.H.D. typically .01% any power 1kHz 8 ohms; T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, -3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 × 80 × 25mm.

POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.



ACTIVE CROSSOVERS

XO2	£14·83
XO3	£23·06

POWER AMPLIFIER MODULES

CE 608 60W/8 ohms 35-035v	£16·30
CE 1004 100W/4 ohms 35-0-35v	£19·22
CE 1008 100W/8 ohms 45-0-45v	£23·22
CE 1704 170W/4 ohms 45-0-45v	£29·12
CE 1708 170W/8 ohms 60-0-60v	£31·90

TOROIDAL POWER SUPPLIES

CPS1 for 2 × CE 608 or 1 × CE 1004	£14·47
CPS2 for 2 × CE 1004 or 2/4 × CE 608	£16·82
CPS3 for 2 × CE 1008 or 1 × CE 1704	£17·66
CPS4 for 1 × CE 1008	£15·31
CPS5 for 1 × CE 1708	£22·68
CPS6 for 2 × CE 1704 or 2 × CE 1708	£23·98

HEATSINKS

Light duty, 50mm, 2°C/W	£1·30
Medium power, 100mm, 1·4°C/W	£2·20
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Fan mounted on two drilled 100mm heatsinks, 2 × 4°C/W, 65°C max. with two 170W modules.	£29·16

THERMAL CUT-OUT, 70°C . . . **£1·38**

POWER AMP KIT . . . **£32·40**

PRE-AMPS:
These are available in two versions – one uses standard components, and the other (the S) uses MO resistorts where necessary and tantalum capacitors.

CPRI	£29·49	CPRIS	£39·98
MCI	£18·50	MCIS	£29·49

POWER SUPPLY:
REGI . . £6·75 TR6 . . £1·75

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BDI . . . . £5·40

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Send SAE for complete list of components.

	74N	74LSN
7400	0.12	0.21
7401	0.12	0.21
7402	0.12	0.21
7403	0.12	0.21
7404	0.13	0.21
7405	0.13	0.21
7406	0.28	
7407	0.28	
7408	0.14	0.21
74S08	0.40	
7409	0.14	0.21
7410	0.13	0.22
7411	0.18	0.21
7412	0.21	0.21
7413	0.25	0.46
7414	0.54	1.05
7415		0.21
7416	0.27	
7417	0.27	
7420	0.13	0.21
7421	0.28	0.21
7422	0.17	0.21
7423	0.25	
7425	0.20	
7426	0.25	0.28
7427	0.25	0.30
7428	0.34	0.34
7430	0.13	0.21
74S30	0.30	
7432	0.24	0.31
7437	0.24	0.26
7438	0.24	0.26
7440	0.13	0.22
7441	0.52	
7442	0.55	0.70
7443	0.90	
7444	0.90	
7445	0.70	
7446	0.70	
7447A	0.60	0.94
7448	0.60	0.94
7449		0.94
7450	0.13	
7451	0.13	0.21
7453	0.13	
7454	0.13	0.21
7455		0.26
7460	0.13	
7470	0.28	
7472	0.22	
7473	0.26	0.36
7474	0.26	0.36
73S74	0.60	
7475	0.30	0.42
7476	0.26	0.39
7478		0.39
7480	0.45	
7481	0.90	
7482	0.75	
7483	0.72	0.97
7484	0.90	
7485	0.88	0.97

	74N	74LSN
7486	0.26	
74S86	1.50	
7489	2.00	
7490	0.35	0.95
7491	0.65	
7492	0.44	0.82
7493	0.40	0.95
7494	0.80	
7495	0.54	1.05
7496	0.60	1.30
7497	2.00	
74100	0.94	
74104	0.40	
74105	0.40	
74107	0.28	0.40
74109	0.45	0.40
74110	0.46	
74111	0.70	
74112		0.40
74113	0.30	0.40
74114		0.40
74116	1.60	
74118	0.82	
74119	1.25	
74120	0.82	
74121	0.26	
74122	0.40	
74123	0.50	0.59
74124		1.25
74125	0.40	0.46
74126	0.45	0.46
74128	0.62	
74132	0.68	0.82
74134	0.36	
74135	0.68	
74136	0.55	0.40
74137	0.94	
74138		0.62
74139		0.62
74141	0.58	
74142	2.00	
74143	2.00	
74144	2.00	
74145	0.64	1.20
74147	1.30	
74148	1.15	
74150	0.99	
74151	0.60	0.90
74153	0.60	0.56
74154	1.00	1.32
74155	0.63	0.98
74156	0.62	0.98
74157	0.63	0.60
74158	0.58	0.62
74159	1.70	
74160	0.80	1.30
74161	0.80	0.80
74162	0.80	1.30
74163	0.80	0.82
74164	0.89	1.20
74165	0.89	
74166	0.99	

	74N	74LSN
74167	2.70	
74169		2.10
74170	1.68	1.94
74172	4.00	
74173	1.18	1.12
74174	0.89	1.12
74175	0.68	1.12
74S175	3.25	
74176	0.80	
74177	0.82	
74178	1.20	
74179	1.10	
74180	0.90	
74181	1.76	3.38
74182	0.75	
74S182	2.30	
74H183	0.99	
74184	1.20	
74185A	1.20	
74186	7.20	
74188	2.70	
74189		3.60
74190	1.06	0.96
74191	0.99	0.98
74192	0.99	1.60
74193	1.05	1.50
74194	0.90	2.00
74195	0.84	1.40
74196	0.90	1.15
74197	0.90	1.15
74198	1.48	
74199	1.48	
74221	1.50	1.05
74247		0.80
74248		0.95
74249		0.95
74251	1.00	0.95
74253		1.10
74257		1.12
74258		1.15
74260		0.28
74261		3.25
74266		0.43
74273	2.15	1.80
74279	1.25	0.56
74283	1.70	1.06
74284	6.85	
74289		3.92
74290		0.95
74293	1.36	1.00
74298	1.92	1.40
74352		1.00
74353		1.06
74365		0.52
74366		0.52
74367		0.46
74368		0.52
74386		0.58
74390	1.92	
74393	2.00	
73670		2.30

LINEARS		
CA3045	–14	0.45
CA3046	–14	0.70
LM380N	–14	0.82
LM381N	–14	1.20
LM710N	–14	0.32
LM711N	–14	0.32
MC1310P	–14	1.50
NE555N	–8	0.30
NE556N	–14	0.65
NE25018	–14	2.00
SN72702N		0.50
SN75110N		0.50
SN76003N		1.95
SN76013N		1.35
SN76023N		1.35
SN76033N		1.95
TAA550B		0.35
TAA661B		1.40
TBA120S		0.64
TBA641A		1.88
TBA800		0.75
TBA810S		1.04
TCA270SQ		2.00
TDA2020		3.20
ZN414		1.00
OP AMPS		
CA3130	–T099	1.00
LM301A	–8	0.30
LM301A	–T099	0.46
LM348N	–14	1.00
LM709	–8	0.40
LM709	–14	0.42
LM709	–T099	0.50
LM741	–8	0.22
LM741	–14	0.20
LM741	–T099	0.45
LM747	–14	0.70
LM3900N		0.50
MC1458P	–8	0.42
VOLTATE REG		
LM300	–T099	1.00
LM309K	–T03	1.30
uA723	–14	0.40
7805	T0220	0.85
7812	T0220	0.85
7815	T0220	0.85
7824	T0220	0.86
7905	T0220	1.10
7912	T0220	1.10
7915	T0220	1.10
DIL SOCKETS		
8 pin		0.11
14 pin		0.12
16 pin		0.13
18 pin		0.23
20 pin		0.27
22 pin		0.29
24 pin		0.30
28 pin		0.44
40 pin		0.55

CMOS

4000	0.14	4067	3.50
4001	0.15	4068	0.24
4002	0.16	4069	0.17
4006	0.92	4070	0.17
4007	0.16	4071	0.17
4008	0.92	4072	0.17
4009	0.45	4073	0.17
4010	0.48	4075	0.17
4011	0.15	4076	1.05
4012	0.16	4077	0.46
4013	0.42	4078	0.22
4014	0.80	4081	0.17
4015	0.77	4082	0.20
4016	0.42	4085	0.72
4017	0.77	4086	0.76
4018	0.87	4089	1.55
4019	0.42	4093	0.65
4020	0.92	4094	1.80
4021	0.82	4095	1.10
4022	0.82	4096	1.10
4023	0.16	4097	3.50
4024	0.66	4098	1.12
4025	0.15	4099	1.90
4026	1.28	4404	1.00
4027	0.50	4412	0.30
4028	0.67	4428	0.80
4029	0.86	4445	1.50
4030	0.48	4449	0.30
4031	2.34	4501	0.17
4033	1.25	4502	0.88
4034	2.00	4507	0.50
4035	1.00	4508	2.25
4036	2.40	4510	1.05
4037	0.99	4511	0.98
4038	1.00	4512	0.92
4039	2.80	4514	2.85
4040	0.88	4515	2.80
4041	0.77	4516	1.02
4042	0.72	4518	0.99
4043	0.82	4519	0.50
4044	0.82	4520	1.05
4045	1.40	4521	2.00
4046	1.32	4522	1.35
4047	0.96	4527	1.60
4048	0.60	4528	0.92
4049	0.42	4529	1.10
4050	0.42	4536	3.56
4051	0.84	4553	4.20
4052	0.84	4555	0.85
4053	0.84	4556	0.85
4054	1.10	4558	1.25
4055	1.00	4566	1.40
4060	0.98	4583	0.75
4066	0.48	4585	1.03

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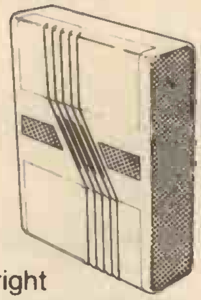

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TMS 1000N – MP0027A Micro-computer chip available separately if required. Full 24 tune spec device supplied with data sheet and fully guaranteed.

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(Only present 24 tune repertoire currently available.)

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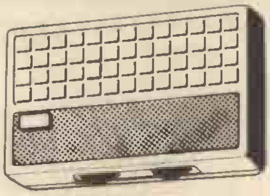

This easy to build kit includes:

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VT04 LCD Chronograph as VT07 but with solar assisted panel (not rechargeable).

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L.E.D.S. 0·2" Red **10p.** 0.2" Green **12p.** 0.2" Clear **15p.**

MINIATURE MAINS TRANSFORMERS. 240v AC Primary. 6–0–6v 100ma, 9–0–9v **75ma.** 12–0–12v 50ma all **73p** each. 12–0–12v 100ma **92p.** 0–6, 0–6v 280ma, **£1.20.** 12v 500ma **95p.** **PULSE TRANSFORMERS.** Miniature P.C. board mounting 1:1 Plus 1 **55p.** Larger type 1:1 **30p.**

NEW LOW PRICED POCKET MULTIMETERS. KRT100 1,000 ohms per volt, 1,000 volts AC/DC, 100K resistance, 150ma DC current, mirror scale range selector switch **£4.65. KRT101** As above but range selection Is via Prod Tip Insertion **£3.75.**

MINIATURE TOGGLE SWITCHES. SPST 8 x 5 x 7mm **49p.** DPDT 8 x 7 x 7mm **53p.** DPDT centre off 12 x 11 x 9mm 78p. **PUSH SWITCHES.** Push to make 16 x 6mm **14p,** push to break version **15p.**

TOOLS. Good quality side cutters 5" insulated handles **£1.35.** Matching snub nosed pliers also **£1.35.** Neon mains tester screwdriver 8" long **44p. PRECISION TOOL KIT.** Supplied in plastic hinged case consists of 5 spanners 4 to 6mm, 5 Hex. nut drivers 3 to 5mm, 3 small screwdrivers, 2 Phllips screwdrivers, 1 awl, 3 Alan Keys **£3.35. TEST LEAD JUMPER SET.** 10 leads wlth various coloured croc clips each end **80p.**

CASSETTE HEAD REPLACEMENTS. Mono cassette **£1.30.** Stereo cassette **£3.00. TAPE HEAD DEMAGNETISERS.** 240v AC **£2.00.**

TERMS CASH WITH ORDER (OR OFFICAL OROERS FROM SCHOOLS ETC) POSTAGE 30p. (OVERSEAS POST AT COST) VAT INCLUSIVE, SAE FOR ILLUSTRATED LISTS.

PROGRESSIVE RADIO, 31 CHEAPSIDE, LIVERPOOL L2 2DY.

TOPS THE PACK!

ACE

COMPONENTS	–	Now over 1,000 types in stock!
KITS	–	See the new range of low-cost 'ELEKITS'.
SERVICE	–	1st Class same day despatch.
QUALITY	–	All guaranteed products.
PRICES	–	Many reductions!
MAGAZINE PROJECTS	–	Trouble-free!

S.A.E. for list of PE projects

ACE MAILTRONIX LTD
Dept PE Tootal Street
Wakefield, W. Yorkshire WF1 5JR

I enclose 30p*, please send catalogue.

Name ____

Address ____

***Refundable with future orders over £5.00.**

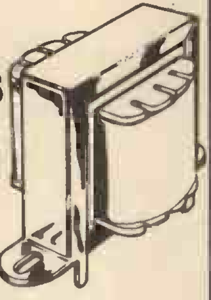
STEVENSON
Electronic Components

REGULATORS

78L05	30p	7805	60p	79L05	70p	7912	80p
78L12	30p	7812	60p	79L12	70p	7915	80p
78L15	30p	7815	60p	7905	80p	LM723	35p

HARDWARE

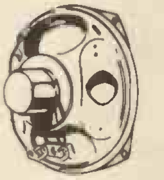
MINIATURE TRANSFORMERS



240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of:
6 - 0 - 6, 9 - 0 - 9 and
12 - 0 - 12. 92p. each.

LOUDSPEAKERS

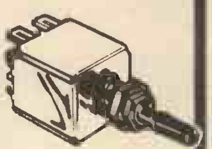


56mm dia. 8 ohms 70p
64mm dia. 8 ohms 75p
64mm dia. 64 ohms 75p
70mm dia. 8 ohms 100p
70mm dia. 80 ohms 110p

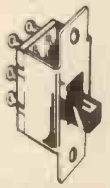
TERMINALS

Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . . 22p

SWITCHES



Subminiature toggle. Rated at 3A 250V.
SPDT 70p SPDT centre off 75p
DPDT 80p DPDT centre off 95p



Standard toggle
SPST 34p DPDT 48p

Wavechange switches.
1P12W, 2P6W, 3P4W or 4P3W all 43p ea.

Miniature switches (non-locking)
Push to make 15p Push to break 20p

Slide switches (DPDT)
Miniature 14p Standard 15p

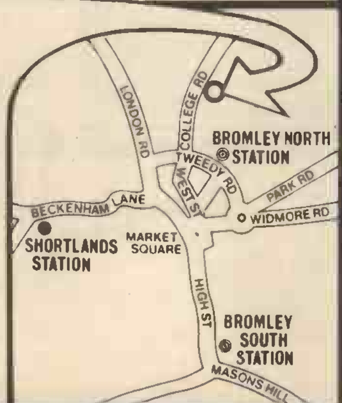
CONTROL KNOBS

Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black. 14p

WHY NOT VISIT OUR

NEW SHOP

We welcome callers at our new premises at the address below (5 mins. from High St.) We are open Mon - Sat, 9am - 6pm. Special offers available.



Express telephone order service. Orders received before 5pm. are shipped first class on that day. Contact our Sales Office now!
Tel: 01-464 2951/5770.

ORDERS DESPATCHED BY RETURN POST

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

BARCLAYCARD & ACCESS WELCOME.

Mail orders to: STEVENSON (Dept PE)

TRANSISTORS

AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC148	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214L	10p			2N5459	32p
BC477	19p			2N5777	50p
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

1N914 3p 1N5401 13p
1N4001 4p BZY88ser. 8p
Full spec. product.
1N4148. £1.40/100. £11/1000

LINEAR

THIS IS ONLY A SELECTION!

709	28p	CA3140	38p	NE555	21p
741	16p	LM301AN	26p	NE556	50p
747	40p	LM318N	85p	NE565	85p
748	30p	LM324	45p	NE567	170p
CA3046	55p	LM339	45p	SN76003	200p
CA3080	70p	LM380	75p	SN76013	140p
CA3130	90p	LM382	120p	SN76023	140p
		LM1830	150p	SN76033	200p
		LM3900	50p	SN76477	220p
		LM3909	65p	TBA800	70p
		MC1496	60p	TDA1022	650p
		MC1458	32p	ZN414	75p

CAPACITORS

TANTALUM BEAD (each)

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

MYLAR FILM

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

POLYESTER

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

CERAMIC

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

RADIAL LEAD ELECTROLYTIC

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

CONNECTORS

JACK PLUGS AND SOCKETS

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

DIN PLUGS AND SOCKETS

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

1mm PLUGS AND SOCKETS

Suitable for low voltage circuits, Red & black.
Plugs: 6p each Sockets: 7p each.

4mm PLUGS AND SOCKETS

Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each

PHONO PLUGS AND SOCKETS

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

74LS

LS00	13p	LS73	25p	LS156	60p
LS01	13p	LS74	25p	LS157	48p
LS02	13p	LS75	30p	LS164	65p
LS03	13p	LS76	25p	LS174	48p
LS04	13p	LS78	35p	LS175	48p
LS08	15p	LS83	35p	LS190	62p
LS10	13p	LS85	70p	LS192	60p
LS13	28p	LS86	30p	LS193	60p
LS14	45p	LS90	36p	LS196	60p
LS20	13p	LS93	38p	LS251	50p
LS30	13p	LS95	45p	LS257	50p
LS32	16p	LS123	70p	LS258	50p
LS37	24p	LS125	38p	LS266	30p
LS40	17p	LS126	38p	LS283	60p
LS42	40p	LS132	60p	LS290	60p
LS47	90p	LS136	28p	LS365	40p
LS48	70p	LS138	50p	LS366	40p
LS54	15p	LS139	50p	LS367	40p
		LS151	50p	LS368	40p
		LS153	50p	LS386	35p
		LS155	55p	LS670	140p

TTL

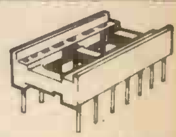
7400	10p	7454	12p	74132	45p
7401	10p	7473	20p	74141	55p
7402	10p	7474	22p	74148	90p
7404	12p	7475	25p	74150	55p
7408	12p	7476	20p	74151	40p
7410	10p	7485	55p	74156	40p
7413	22p	7489	135p	74157	40p
7414	39p	7490	25p	74164	55p
7420	10p	7492	30p	74165	55p
7427	20p	7493	25p	74170	100p
7430	10p	7494	45p	74174	50p
7442	38p	7495	35p	74177	50p
7447	45p	7496	45p	74190	50p
7448	50p	74121	25p	74191	50p
		74122	38p	74192	50p
		74123	38p	74193	50p
		74125	35p	74196	50p
		74126	35p	74197	50p

CMOS

4001	12p	4018	55p	4050	25p
4002	12p	4023	12p	4066	35p
4007	12p	4024	40p	4068	18p
4011	12p	4026	90p	4069	12p
4013	28p	4027	30p	4071	12p
4015	50p	4028	48p	4081	13p
4016	30p	4029	50p	4093	45p
4017	48p	4040	60p	4510	65p
		4042	50p	4511	65p
		4046	90p	4518	65p
		4049	25p	4520	60p

FULL DETAILS IN CATALOGUE!

SKTS



Low profile by Texas

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

Soldercon pins: 100:50p. 1000:370p

OPTO

LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	8p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

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

RESISTORS

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

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

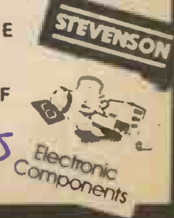
Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

METAL FILM RESISTORS

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

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

PLEASE WRITE FOR YOUR FREE COPY OF OUR NEW 64 PAGE CATALOGUE OF COMPONENTS. CONTAINS OVER 2500 STOCK ITEMS.



76 College Road, Bromley, Kent, England

TRANSFORMERS EX-STOCK

PRICES INCLUDE VAT. SAME DAY DESPATCH

12 OR 24 VOLT OR 12-0-12V
PRIMARY 220-240 VOLTS

Ref	Amps 12V	Amps 24V	£	P & P
111	0·5	0·25	2·38	0·49
213	1·0	0·5	2·85	0·84
71	2	1	3·79	0·84
18	4	2	4·35	1·04
85	5	2·5	4·86	0·85
70	6	3	6·78	1·04
108	8	4	8·02	1·23
72	10	5	8·77	1·23
116	12	6	9·71	1·43
17	16	8	11·58	1·43
115	20	10	15·10	2·25
187	30	15	19·36	2·25
226	60	30	39·03	OA

30 VOLT RANGE
Pri 220/240V Sec 0-12-15 20-24 30V. Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V, 15V 0-15V.

Ref	Amps	£	P & P
112	0·5	2·85	0·84
79	1·0	3·86	1·04
3	2·0	6·23	1·04
20	3·0	6·70	1·23
21	4·0	8·63	1·23
51	5·0	10·66	1·43
117	6·0	12·06	1·57
88	8·0	16·15	1·77
89	10·0	18·63	1·99
90	12·0	20·70	2·11
91	15·0	23·72	2·25
92	20·0	31·81	OA

50 VOLT RANGE
Pri 220/240V Sec 0-20-25-33-40-50V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V, 25V-0-25V.

Ref	Amps	£	P & P
102	0·5	3·68	0·84
103	1·0	4·94	1·04
104	2·0	7·73	1·23
105	3·0	9·24	1·43
106	4·0	12·32	1·62
107	6·0	16·26	1·77
118	8·0	21·88	2·25
119	10·0	26·98	OA
109	12·0	31·21	OA

60 VOLT RANGE
Pri 220/240V Sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V or 24V-0-24V, or 30V-0-30V.

Ref	Amps	£	P & P
124	0·5	4·19	1·04
126	1·0	6·38	1·04
127	2·0	8·21	1·23
125	3·0	11·88	1·43
123	4·0	13·52	1·99
40	5·0	17·11	1·99
120	6 0	19·50	1·99
121	8·0	27·60	OA
122	10·0	31·91	OA
189	12·0	36·78	OA

MAINS ISOLATORS (SCREENED)
Pri 120/240V SEC 120/240V (C. Tapped)

Ref	VA (Watts)	£	P & P
07*	20	4·75	0·85
149	60	7·24	1·04
150	100	8·23	1·23
151	200	12·05	1·62
152	250	14·34	1·99
153	350	17·74	1·99
154	500	22·11	2·32
155	750	31·38	OA
156	1000	40·18	OA
157	1500	55·49	OA
158	2000	66·75	OA
159	3000	93·59	OA

*Pri 0-220-240 Sec 115 or 240V State volts required

AUTD TRANSFORMERS

Ref	VA (Watts)		£	P & P
113	15	0-115-210-240	2·68	0·77
64	75	0-115-210-240	4·33	1·04
4	150	0-115-200-220-240	5·78	1·04
69	250		7·60	1·23
67	500	0-115-200-220-240	11·87	1·77
84	1000	0-115-200-220-240	20·26	2·25
93	1500	0-115-200-220-240	25·14	OA
95	2000	0-115-200-220-240	37·61	OA
73	3000	0-115-200-220-240	63·95	OA
80S	4000	0-10-115-200-220-240	83·01	OA
57S	5000	0-10-115-200-220-240	96·66	OA

HIGH VOLTAGE ISOLATORS
Prim 200/220V or 400/440V
Sec 110/120V CT or 200/240 CT

Va	Ref	£	P & P
60	243	7·24	1·43
350	247	17·74	1·99
1000	250	45·10	OA

CASED AUTO TRANSFORMERS
240V cable in & 115V USA 2 pin outlet

VA	£	P & P	Ref
20	6·43	1·04	56W
75	8·35	1·23	64W
150	10·81	1·23	4W
200	12·01	1·57	65W
250	13·15	1·57	69W
500	20·70	1·77	67W
1000	30·11	OA	84W
1500	35·48	OA	93W
2000	53·97	OA	95W

SCREENED MINIATURES

Ref	mA	Volts	£	P & P
238	200	3-0-3	2·78	0·59
212	1A, 1A	0-6, 0-6	3·08	0·84
13	100	9-0-9	2·31	0·41
235	330, 330	0-9, 0-9	2·15	0·41
207	500, 500	0-8-9-, 0-8-9	2·99	0·77
208	1A, 1A	0-8-9, 0-8-9	3·81	0·84
236	200, 200	0-15, 0-15	2·15	0·41
214	300, 300	0-20, 0-20	3·02	0·84
221	700 (DC)	20-12-0-12-20	3·68	0·84
206	1A, 1A	0-15-20-0-15-20	5·00	1·04
203	500, 500	0-15-27-0-15-27	4·31	1·04
204	1A, 1A	0-15-27-0-15-27	6·52	1·04
239	50	12-0-12	2·78	0·41

TEST METERS
U4315 Budget Meter 20,000 ohm/V Ranges 1000V AC/DC 2.5A AC/DC 500K resistance in steel robust case **£17·12**

AVO8 Mk5 **£95·15**
AVO71 **£38·88**
AVO73 **£52·60**
EM272 **£62·42**
MM5 minor **£35·59**
DA116 AVO digital **£117·61**
P&P all at £1·24

TT169 in circuit transistor tester **£42·69**
Megger BM7 Battery type **£55·90**
Wee Megger (crank) **£80·19**
Ever Ready Leather Case for Avo 8 **£24·55**

Full range of AVO's, Megger's and Cases.

MINI-MULTIMETER
DC-1000V AC-1000V DC-100mA Res 150kΩ 1000Ω/V Bargain **£7·78** P & P 67p

20,000 ohm/V Multimeter, mirror scale. Ranges AC/DC to 1000V, DC currents to 250mA. Resistance to 3 Megs. 5" x 3½" x 1¼" **£14·44** P & P £1·13

ISOLATOR – *Special Price*
0-200-220-240V, 0-240V Centre Tap, 250VA. Ref. 62 **£5·62** P & P £1·04

ELECTROSIL TR4 5% **£2·15/100**

ELECTRONIC CONSTRUCTION KIT
Home electronics teacher. Start simply and progress to a TRF radio or electronic organ. No soldering, all parts included in presentation box. Full instructions. **Price £8·95** P & P £1·04

PANEL METERS

43mm x 43mm Ref.	£	82mm x 78mm Ref.	£	
0·50μA	6·70	0·50μA	7·24	Carriage P & P 70p
0·500μA	6·43	0·500μA	7·24	
0·1mA	6·43	0·1mA	7·24	
0·30V	6·43	0·30V	7·24	

	£
VU Ind Edge 90mm	3·63
VU Ind Edge 54mm	2·81
VU Ind Panel	2·81

SEND 15p STAMPS FOR CATALOGUE

Prices correct 1.12.78. PE1.

COMPONENT PACKS
65 ¼w Metal Oxide Resistors
65 ½w Metal Oxide Resistors
150 Mixed Value Capacitors
10 Read Switch.
60 Wire Wound Resistors,
10 Caps 3000mf 30v.
25 assorted Presets.
50 Wire Wound Resistors,
Hardware B.A. nuts, bolts, washers etc.
10 mixed value electrolytic capacitors from 32μf to 2,000 μf

79p PER PACK 43p P & P

BE9 Miniature Transformer
Pri 0-240V Scr 28 x 26 x 20mm Sec. 12-0-12V 50MA **97p** P & P 41p

NEW RANGE TRANSFORMERS
Pri 0 220-240V 2 Amp. 45-36-0-36-45 **£12·14** P & P £1·40
Sec. 0 36-48 twice. To give 36 0 36. 48-0 48 72V or 92V.
Pri 0 120 or 220-240V.

Ref.		£	P & P
2 amp		13·11	1·51
3 amp		15·88	1·60
4 amp		20·27	1·99
5 amp		28·77	2·32
171		2·26	0·49
172	Centre	3·20	0·84
173	Tapped	3·88	0·84
174		4·05	0·93
175		6·19	1·04

S-DECS Solderless bread boarding

Ref.	£	
S Dec	3·35	
T Dec	4·70	P & P
U Dec A	4·86	43p
U Dec B	7·55	

ANTEX SOLDERING IRONS

Ref.	£	
15W	4·05	P & P
25W	4·27	50p
Stand	1·71	

BRIDGE RECTIFIERS

Ref.		£	
100V	25A	2·36	
200V	2A	0·51	P & P
400V	4A	0·96	16p
400V	6A	1·41	
500V	12A	3·08	

AMPLIFIER MODULES

Ref.	£	P & P
10W (AL30)	4·58	0·38
25W (AL60)	5·57	0·38
35W (AL80)	8·76	0·38
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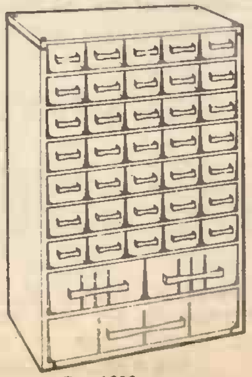

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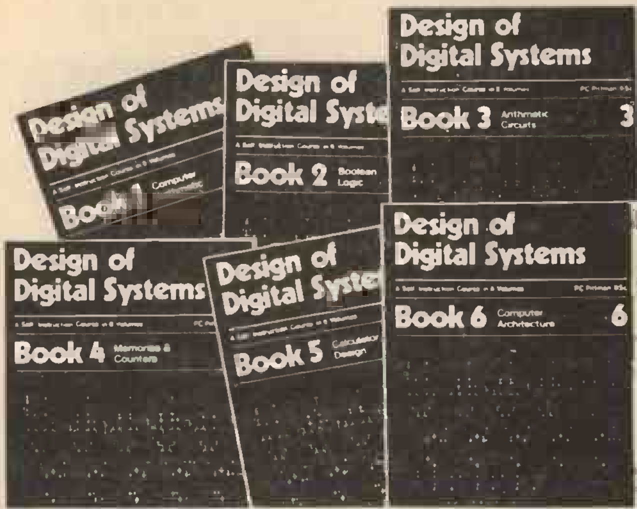

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(*Author of System Design with Microprocessors, Academic Press, 1978).

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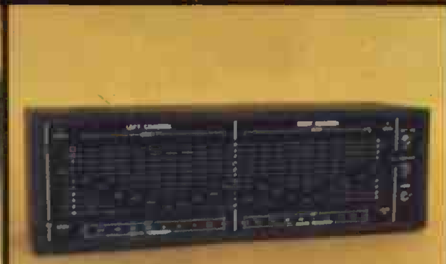

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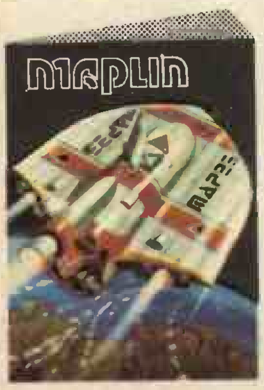

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