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APRIL 1981

65p

PE DIGISOUNDER

SPEECH PROCESSOR

Adds talk power.... aids intelligibility

ULTRASONIC INTRUDER ALARM

Doppler shift system....easy installation

PRACTICAL
ELECTRONICS

VOLUME 17 No. 4 APRIL 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR MAY ISSUE WILL BE ON SALE FRIDAY, 10 APRIL 1981

(for details of contents see page 36)

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES

AA119	15
8A100	15
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

SCR's Thyristors

0·8A-100V	32
1A/200V	58
1A/400V	70
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

BRIDGE RECTIFIERS

(plastic case)	
1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	350
25A/200V	240
25A/600V	395
8Y164	56
VM18	50

ZENERS

Range 2V7 to 39V 400mW **8p each**

Range 3V3 to 33V 1·3W **15p each**

VARICAPS

MVAM2	165
MVAM115	158
8A102	30
BB105B	40
BB106	40

Noise Diode

Z5J	180

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

DIAC

ST2	25

SPEAKERS

8Ω 0·3W 2" 2¼" 2½" 3"	80
40Ω 2·5"	80
64Ω 2·5"	80
80Ω 2·5"	80
8×5" 8Ω 6W	
HF Cone	425
Piezo Tweeters Xovers etc. available.	

ALUM. BOXES

3×2×1"	65
4×2½×2"	85
4×2¾×2½"	103
5×4×2	105
5×2¾×1¾"	90
5×2¾×2¾"	130
5×4×1¾"	99
5×4×2¾"	120
6×4×2¾"	120
7×5×3"	180
8×6×3"	210
10×7×3"	275
12×5×3"	260
12×8×3"	295

VEROBOARDS 0·1"

	Clad	Plain
2½×3¾"	66p	47p
2½×5"	75p	—
3¾×3¾"	75p	—
3¾×5"	86p	72p
3¾×17"	290p	192p
4½×18"	390p	—
Pkt. of 100 pins		50
Spot Face Cutter		107
Pin Insertion Tool		147

VERO WIRING PEN and Spool **285p**
Spare Wire (Spool) **65p**; Combs **6p** ea.

FERRIC CHLORIDE
1 lb bag Anhydrous **195p** + 40p p&p

DALO ETCH RESIST
Pen + Spare tip 90p

ALFAC TRANSFERS
Etch Resist.
Full range available
35p a sheet

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SR8P 9·5"×8·5"
6"×6"	90p	110p	95p
6"×12"	150p	196p	

SOLDERCON PINS
100 pins **60p** 500 pins **275p**

OPTO ELECTRONICS
LEDS Plus. Clip

TIL209 Red 125"	13
TIL211 Green 125"	18
TIL212 Yellow	18
TIL220 ·2" Red	15
0·2" Yel, Grn, Amber Red, Green and Yellow Rectangular LEDS.	18
Triangular LEDs R&G	18
0·2" Flashing LED Red	48
0·2" Red/green LED	46
0·2" Red High Bright	49
2N5777 45; OCP71	120
OMP12	85
LD271 Infra Red (emit)	41
TIL38 Infra Red (emit)	58
SFH205 (detector)	91
TIL78 (detector)	60
7 Segment Displays	
TIL321 5" C.An	115
TIL322 5" C.th	115
DL704 3" C.Cth	99
DL707 3" C.Anod	99
DL747 6" C.Cathod.	180
8" Orange C.A.	250
FND357 or 500	120
3" Green C.A.	140
±1·3" Red or Green	150
Bargraph 10 seg. Red	225

Liquid Crystal Display
3½ digit **675p**; 4 digit **750p**
6 Digit LCD **850p**

'VO' Board **150p**
'DIP' Board **330p**
Vero Strip **144p**

PROTO-DECs

Veroblock	375p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	785p
Superstrip SS2	998p

VOLTAGE REGULATORS

1A	TO3	+ve	−ve	
5V	7805	**145p**	7905	**220p**
12V	7812	**145p**	7912	**220p**
15V	7815	**145p**	7915	**220p**
18V	7818	**150p**		—
1A	TO220 Plastic Casing			
5V	7805	**60p**	7905	**65p**
12V	7812	**60p**	7912	**65p**
15V	7815	**60p**	7915	**65p**
18V	7818	**60p**	7918	**65p**
24V	7824	**60p**		
100mA	TO92 Plastic Casing			
5V	78L05	**30p**	79L05	**65p**
6V	78L62	**30p**		—
8V	78L82	**30p**		—
12V	78L12	**30p**	79L12	**65p**
15V	78L15	**30p**	79L15	**65p**

CA3085	**95**		
LM300H	**170**	LM317K	**350**
LM305H	**140**	LM323K	**625**
LM309K	**135**	LM325N	**240**
78H05 5V/5A	**595p**	LM326N	**240**
78HG+5 to +24V 5A	**650p**	LM327N	**270**
		LM723	**39**
79HG −2·25V to −24V 5A	**850p**	T8A6258	**85**

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DPDT	13
4 pole 2-way	24

PUSH BUTTON
Spring loaded

Latching or Momentary 6A	
SPDT c/over	99
DPDT c/over	145

MINIATURE
Non Locking

Push to make	15p
Push break	25p

ROCKER: 5A, 250V. SPST **28p**
ROCKER: (white) 10A 250V SPDT changeover **38p**
ROCKER: With neon lights red when on 10A 250V. DPST **85p**
ROCKER: (White) 10A/250V DPDT **72p**

ROTARY: 'Make-A-Switch' Make your own multiway Switch as required. Shafting assembly has adjustable stop. Accommodates up to 6 Wafers **90p**
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way **65p**
Mains DPST Switch to fit **45p**
Screen & Spacers **6p**

ROTARY: (Adjustable Stop Type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **45p**
ROTARY: Mains 250V AC, 4 Amp **56p**

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

SUB-MIN TOGGLE

SP changeover	60
SPST on off	54
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	75
DPDT C/OFF	88
DPDT Biased	145
4 pole c/over	205

CRYSTALS

100KHz	300
455KHz	370
1MHz	295
1·008M	295
1·8432M	300
2·0MHz	305
2·4576M	305
3·2768M	290
3·57954M	150
4·0MHz	290
4·032M	290
4·194304M	270
4·433619M	150
5·0MHz	290
5·185M	300
5·24288M	390
6·0MHz	290
6·144M	295
6·5536M	290
7·168M	290
7·68MHz	300
8·0MHz	290
8·867237MHz	270
10·0MHz	290
10·7MHz	270
12·0MHz	290
14·31818M	320
16·0MHz	290
18·0MHz	290
18·432M	290
26·69M	290
27·648M	330
38·66667MHz	290
48·0MHz	270
100·0MHz	375

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- **SEIKOSHA GP80A** Unihammer dot-matrix Printer. Gives normal and double width characters as well as Dot resolution Graphics. **£225**
- **EPSON TX80** 80 column dot matrix printer available in tractor feed or friction feed. **£295**
- **VIDEO GENIE** based on TRS80 16K RAM NEW VERSION **Only: £289**
- **SOFTY.** Intelligent EPROM Programmer Kit **£99**
  Ready-Built & Tested **£120**
  PSU for above (Built) **£20**
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- **UHF MODULATOR** 6MHz **280p**
  UHF MODULATOR 8MHz **450p**
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DIL PLUGS (Headers)
14 pin **44p**; 24 pin **88p**
16 pin **49p**; 40 pin **295p**
(DIL Sockets on opp. page)

'D' CONNECTORS (Cannon type)

	Plugs	Sockets	Covers plastic
9 way	90p	118p	—
15 way	120p	167p	150p
25 way	180p	280p	170p
37 way	268p	390p	185p

DIL switches (SPST)

4 way	**85p**
6 way	**98p**
8 way	**115p**
10 way	**175p**
(SPDT)	
4 way	**190p**

EDGE CONNECTORS double type

	1	156
2×10 way	—	**82p**
2×15 way	—	**98p**
2×18 way	**140p**	**120p**
2×22 way	**150p**	**125p**
2×25 way	**165p**	**160p**
2×30 way	**188p**	—
2×36 way	**197p**	—
2×40 way	**205p**	—
2×43 way	**250p**	—

TRANSFORMERS (mains Prim. 220-240V)
6·0-6V 100mA; 9·0-9V 75mA; 12·0-12V 75mA **98p**
8VA type: 6V-5A 6V-5A; 9V-4A 9V-4A; 12V-3A 12V-3A; 15V-2·5A 15V-2·5A **220p**
12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2, 6V-1·2A 12V-·5A 12V-·5A **250p** (30p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-8A 15-8A; 20V-6A 20V-6A **310p** (44p p&p)
50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A **365p** (60p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A **820p** (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
Single ended DIP. 24" length Cable
14 pin **145p** 16 pin **165p;**
24 pin **240p;** 40 pin **380p.**

Length	14 pin	16 pin	24 pin	
6"	**185p**	**205p**	**300p**	**465p**
12"	**195p**	**215p**	**315p**	**490p**
36"	**230p**	**250p**	**375p**	**595p**

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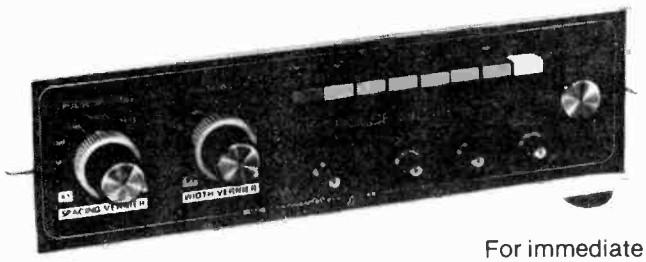
*£95 for 0·5Hz to 5MHz



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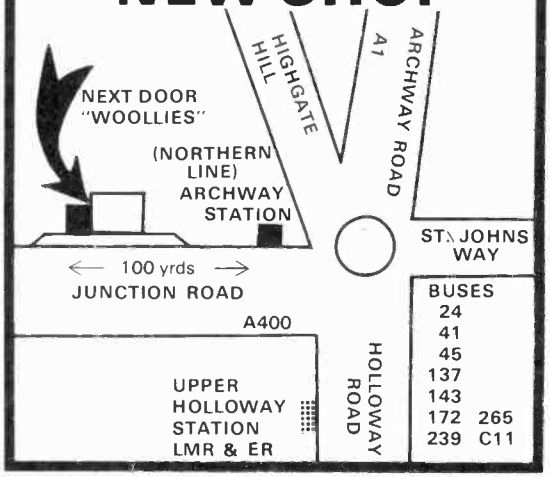

VIDEO GENIE

VIDEO GENIE based on TRS80

Utilises Z80, 12K level II Basic, Integral Cassette Deck, UHF O/P, 16K RAM, all TRS80 features.

£289

CASES

Available for U.K. 101, Superboard Nascom, Appx. DIM. 17" x 15" 435 x 384 mm

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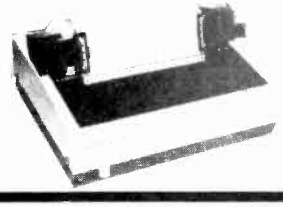
Post + Packing £1.50

UK101 P.P.I.

Built & tested. Interfaces TX80 printer direct, can be programmed to operate relays, motors, various other peripherals. "Centronics compatible". Plugs into IC socket. LED binary display. Fully documented. **£29.95**

PRINTERS



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No extras required

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Z80 2.5 Meg	7.95
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Z80A PIO	6.95
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6522	6.85
6532	8.50
6821	4.25
6850	3.60
6852	4.35
8212	1.95
8216	1.95
8224	2.75
8228	3.75
8251	4.95
8253	9.75
8255	4.50
TMS9901	13.16
TMS9902	11.18
TMS9904 (74LS362)	4.21
DM8123	1.75
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D. RAMS	£ p
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2102A	1.30
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2112A	2.75
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4035	1.07
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6810	3.50
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ROM

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I.C. SOCKETS

	D.I.L.	W/W
8 pin	.09	.25
14 pin	.11	.35
16 pin	.12	.42
18 pin	.16	.50
20 pin	.20	.62
22 pin	.22	.65
24 pin	.24	.70
28 pin	.30	.80
36 pin	—	.99
40 pin	.40	1.10

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81LS95	1.25
81LS96	1.25
81LS97	1.25
81LS98	1.25
SN74365	.52
SN74366	.52
SN74367	.52
SN74368	.52
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8T97	1.50
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TRANSISTORS

AC107	25	BC107B	11	BC173	09	BC549	11	BD200	99	BF163	30	BFR52	25	MPSA05	20	TIP30A	40	2N707	48	2N2714	22	2N3823	
AC125	30	BC107C	12	BC174	15	BC550	14	BD201	80	BF164	50	BFR62	24	MPSA06	20	TIP30B	42	2N708	14	2N2904	24	(FET)	60
AC126	22	BC108	10	BC175	35	BC556	14	BD202	80	BF165	50	BFR79	28	MPSA55	20	TIP30C	44	2N711	30	2N2904A	26	2N3903	12
AC127	22	BC108A	11	BC177	14	BC557	13	BD201/202		BF167	24	BFR80	28	MPSA56	20	TIP31	38	2N717	30	2N2905	24	2N3904	12
AC128	20	BC108B	11	BC178	14	BC558	13	M/P	1.70	BF173	24	BFW10	55	ND120	18	TIP31A	40	2N718	25	2N2905A	26	2N3905	12
AC128K	37	BC108C	12	BC179	14	BC559	14	BD203	80	BF176	36	BFX29	25	OC19	85	TIP31B	42	2N718A	50	2N2906	18	2N3906	12
AC132	26	BC109	10	BC180	12	BCY30	80	BD204	80	BF177	24	BFX30	30	OC20	1.85	TIP31C	44	2N726	29	2N2906A	20	2N4058	12
AC141	26	BC109A	11	BC181	10	BCY31	80	BD203/204		BF178	25	BFX84	24	OC22	1.50	TIP32	38	2N727	29	2N2907	20	2N4059	14
AC141K	40	BC109B	11	BC182	10	BCY32	85	M/P	1.70	BF179	30	BFX85	26	OC23	1.50	TIP32A	40	2N743	20	2N2907A	22	2N4060	14
AC142	26	BC109C	12	BC182L	10	BCY33	80	BD205	80	BF180	30	BFX86	26	OC24	1.35	TIP32B	42	2N744	20	2N2923	15	2N4061	12
AC142K	40	BC113	16	BC183	10	BCY34	80	BD206	80	BF181	30	BFX87	26	OC25	1.00	TIP32C	44	2N914	20	2N2924	15	2N4062	12
AC176	24	BC114	17	BC183L	10	BCY70	14	BD207	80	BF182	30	BFX88	26	OC26	1.00	TIP41A	44	2N918	30	2N2925	15	2N4220	
AC176K	40	BC115	18	BC184	10	BCY71	15	BD208	80	BF183	30	BFX90	55	OC28	90	TIP41B	46	2N929	20	2N2926G	10	(FET)	35
AC187	25	BC116	19	BC184L	10	BCY72	15	BD222	47	BF184	22	BFY50	20	OC29	95	TIP41C	48	2N930	18	2N2926Y	09	2N4284	28
AC187K	40	BC116A	20	BC186	15	BCZ10	70	BD225	47	BF185	22	BFY51	20	OC35	90	TIP42A	44	2N946	40	2N2926O	09	2N4285	28
AC188	25	BC117	20	BC187	18	BCZ11	70	BD232	85	BF186	26	BFY52	20	OC36	90	TIP42B	46	2N1131	24	2N2926R	09	2N4286	28
AC188K	40	BC118	17	BC207	11	BCZ12	70	BD233	65	BF187	26	BFY53	20	OC41	20	TIP42C	48	2N1132	24	2N2926B	09	2N4287	28
ACY17	50	BC119	29	BC208	11	BD106	50	BD234	55	BF188	32	BFY90	80	OC42	22	TIP2955	60	2N1302	25	2N3010	20	2N4288	28
ACY18	50	BC120	35	BC209	12	BD115	50	BD235	55	BF194	10	BIP19	38	OC44	24	TIP3055	50	2N1303	28	2N3011	20	2N4289	28
ACY19	50	BC125	25	BC212	10	BD116	50	BD236	58	BF195	10	BIP20	38	OC45	20	TIS43	22	2N1304	28	2N3053	22	2N4290	28
ACY20	50	BC126	30	BC212L	10	BD121	65	BD237	65	BF196	12	BIP19/20		OC70	24	TIS90	20	2N1305	28	2N3054	45	2N4291	28
ACY21	50	BC132	18	BC213	10	BD123	65	BD238	65	BF197	12	M/P	80	OC71	15	TIS91	22	2N1306	35	2N3055	42	2N4292	28
ACY22	50	BC134	18	BC213L	10	BD124	75	BD239A	50	BF198	15	BRY39	39	OC72	24	TIS92	22	2N1307	35	2N3402	21	2N4293	28
AD130	75	BC135	18	BC214	10	BD131	35	BD240A	50	BF199	16	BSX19	20	OC74	26	UT46	20	2N1308	40	2N3403	21	2N4B60	
AD140	70	BC136	20	BC214L	10	BD132	35	BD239A/		BF200	30	BSX20	20	OC75	30	ZTX107	10	2N1309	40	2N3404	29	(FET)	60
AD142	85	BC137	20	BC225	26	BD131/132		240A	1.00	BF222	90	BSX21	21	OC76	35	ZTX108	10	2N1599	35	2N3405	42	2N4923	65
AD143	85	BC138	28	BC226	36	M/P	80	BD240	45	BF224	20	BSY95	13	OC77	50	ZTX109	10	2N1613	28	2N3414	16	2N5135	10
AD149	70	BC139	32	BC237	13	BD133	40	BD241	45	BF240	17	BSY95A	13	OC79	40	ZTX300	12	2N1711	30	2N3415	16	2N513B	10
AD161	40	BC140	28	BC238	14	BD135	35	BD506	38	BF241	18	BU105	1.60	OC81	22	ZTX301	12	2N1889	45	2N3416	29	2N5172	14
AD162	40	BC141	28	BC239	15	BD136	35	BD508	38	BF244	28	BU105/		OC81D	24	ZTX302	16	2N1890	45	2N3417	29	2N5194	56
AD161/162		BC142	25	BC251	15	BD137	35	BDX32	2.20	BF257	30	02	1.95	OC82	24	ZTX303	16	2N1893	40	2N3614	1.00	2N5245	40
M/P	80	BC143	25	BC251A	16	BD138	36	BDY11	1.30	BF258	30	BU204	1.40	OC82D	30	ZTX304	20	2N2147	75	2N3615	1.05	2N5294	50
AF114	50	BC144	40	BC261	18	BD139	38	BDY17	1.80	BF259	35	BU205	1.40	OC83	26	ZTX330	15	2N2148	70	2N3616	1.05	2N5296	50
AF115	50	BC145	46	BC300	30	BD140	38	BDY20	80	BF262	60	BU208	1.90	OC84	38	ZTX500	13	2N2192	38	2N3646	09	2N5448	12
AF116	50	BC147	09	BC301	28	BD139/140		BDY55	1.40	BF263	60	BU208/		OC139	80	ZTX501	12	2N2193	38	2N3702	09	2N5457	
AF117	50	BC148	09	BC302	29	M/P	80	BDY56	1.60	BF270	36	02	2.25	OC140	80	ZTX502	16	2N2194	38	2N3703	09	(FET)	32
AF118	65	BC149	09	BC303	28	BD155	50	BF115	25	SF271	31	GP300	40	OC169	80	ZTX503	12	2N2217	25	2N3704	09	2N5458	
AF124	50	BC150	20	BC304	28	BD175	60	BF117	50	BF273	36	MJ480	95	OC170	80	ZTX504	25	2N2218	25	2N3705	09	(FET)	32
AF125	50	BC151	22	BC307	13	BD176	60	BF118	75	BF274	38	MJ4B1	1.05	OC171	80	ZTX531	25	2N2218A	28	2N3706	10	2N5459	
AF126	50	BC152	20	BC327	12	BD177	68	BF119	75	BF324	35	MJ490	95	OC200	46	ZTX550	25	2N2219	28	2N3707	10	(FET)	35
AF127	50	BC153	25	BC328	13	BD178	68	BF121	50	BF336	34	MJ491	1.15	OC201	95	2N388	36	2N2219A	30	2N3708	09	2N5551	36
AF139	38	BC154	19	BC337	13	BD179	75	BF123	60	BF337	34	MJ2955	90	OC202	1.20	2N388A	56	2N2220	20	2N3708A	09	2N6027	
AF239	42	BC157	10	BC338	13	BD180	75	BF125	50	BF338	38	MJE340	50	OC203	85	2N404	20	2N2221	20	2N3709	09	(P.U.T.)	34
AL102	1.90	BC158	10	BC384	14	BD185	68	BF127	60	BF371	26	MJE370	55	OC204	90	2N404A	24	2N221A	22	2N3710	10	2N6121	70
AL103	1.80	BC159	10	BC440	30	BD186	68	BF152	25	BF457	37	MJE371	60	OC205	1.15	2N524	40	2N2222	20	2N3711	10	2N6122	70
ASY26	50	BC160	26	BC441	30	BD187	75	BF153	25	BF458	37	MJE520	45	R2008B	2.50	2N527	50	2N2222A	20	2N3771	1.40	2N6289	70
ASY27	50	BC161	38	BC460	32	BD188	75	BF154	22	BF459	38	MJE521	65	R20108	2.60	2N598	40	2N2368	18	2N3772	1.60	2S301	50
ASY28	50	BC167	11	BC461	32	BD189	78	BF155	35	BF594	30	MJE2955	90	TIC44	29	2N599	46	2N2369	14	2N3773	2.20	2S302	43
ASY29	50	BC168	10	BC477	20	BD190	78	BF156	28	BF595	28	MJE3055	65	TIC45	35	2N696	24	2N2369A	14	2N3819		2S302A	43
AU104	1.90	BC169	10	BC478	20	BD195	90	BF157	28	BF596	28	MJE3440	52	TIP29	30	2N697	24	2N2411	25	(FET)	18	2S303	56
AU110	1.90	BC169C	11	BC479	20	BD196	90	BF158	28	BF839	24	MPB113	52	TIP29A	55	2N698	30	2N2412	25	2N3820		2S304	71
AU113	1.90	BC170	09	BC546	10	BD197	95	BF159	28	BFR40	25	MPF102	60	TIP29B	42	2N699	32	2N2646	47	(FET)	35	2S305	80
BC107	10	BC171	09	BC547	10	BD198	95	BF160	28	BFR42	25	MPF104	35	TIP29C	44	2N706	10	2N2711	22	2N3821		2S306	80
BC107A	11	BC172	09	BC548	10	BD199	99	BF162	24	BFR50	25	MPF105	35	TIP30	38	2N706A	12	2N2712	22	(FET)	60	2S307	80

DIODES

AA119	08	BB104	30	BY176	75	OA79	10
AA120	08	BAX13	07	BY206	30	OA81	10
AA129	09	BAX16	08	BY210/600	09	OA85	10
AAY30	09	BY100	22	BYZ10	45	OA90	07
AAZ13	15	BY101	22	BYZ11	45	OA91	07
AAZ17	15	BY105	22	BYZ12	40	OA95	07
BA100	10	BY114	22	BYZ13	40	OA182	13
BA102	20	BY117	22	BYZ16	41	OA200	08
BA144	09	BY126	11	BYZ17	36	OA202	08
BA148	15	BY127	12	BYZ18	36	IN34A	07
BA154	12	BY128	16	BYZ19	36	IN60	06
BA155	14	BY130	17	OA5	60	IN914	04
BA156	14	BY133	21	OA10	35	IN916	05
BA173	15	BY156	08	OA47	08	IN4148	04
BA248	16	BY164	51	OA70	08	IS44	05

74 SERIES TTL

7400	14	7437	30	7485	95	74153	65
7401	12	7438	30	7486	28	74154	1.00
7402	12	7440	15	7489	1.95	74155	70
7403	12	7441	60	7490	36	74156	70
7404	13	7442	60	7491	75	74157	70
7405	13	7443	1.00	7492	50	74160	90
7406	28	7444	1.00	7493	36	74161	90
7407	28	7445	90	7494	75	74162	90
7408	20	7446	90	7495	65	74163	90
7409	20	7447	65	7496	65	74164	1.00
7410	13	7448	65	74100	1.10	74165	1.00
7411	20	7450	15	74104	50	74166	1.00
7412	22	7451	15	74105	50	74167	2.30
7413	30	7452	15	74107	32	74174	90
7414	50	7453	15	74110	46	74175	80
7416	28	7454	15	74111	60	74176	85
7417	28	7460	15	74118	95	74177	85
7420	14	7470	32	74119	1.20	74180	90
7421	32	7472	28	74121	36	74181	2.30
7422	24	7473	32	74122	46	74182	85
7423	28	7474	30	74123	60	74184	1.35
7425	28	7475	44	74124	60	74190	1.00
7426	30	7476	35	74136	65	74191	1.00
7427	28	7480	48	74141	60	74192	95
7428	34	7481	95	74144	2.50	74193	1.00
7430	14	7482	70	74145	80	74194	90
7432	28	7483	68	74150	1.00	74195	90
7433	36	7484	95	74151	65	74196	95

CMOS

CD4000	18	CD4021	1.05	CD4042	78	CD4081	26
CD4001	19	CD4022	95	CD4043	88	CD4082	26
CD4002	20	CD4023	23	CD4044	88	CD4085	90
CD4006	92	CD4024	70	CD4045	1.50	CD4093	70
CD4007	22	CD4025	20	CD4046	1.10	CD4501	28
CD4008	80	CD4026	1.50	CD4047	95	CD4502	1.20
CD4009	40	CD4027	48	CD4048	65	CD4503	70
CD4010	48	CD4028	80	CD4049	45	CD4506	70
CD4011	22	CD4029	1.00	CD4050	45	CD4507	60
CD4012	22	CD4030	55	CD4052	80	CD4508	2.95
CD4013	45	CD4031	2.00	CD4054	1.25	CD4510	99
CD4014	84	CD4034	1.95	CD4055	1.25	CD4511	1.15
CD4015	84	CD4035	1.20	CD4056	1.35	CD4516	1.10
CD4016	42	CD4036	3.30	CD4066B	25	CD4518	1.00
CD4017	80	CD4037	95	CD4069	25	CD4520	1.00
CD4018	85	CD4038	1.15	CD4070	29	CD4528	1.10
CD4019	45	CD4040	95	CD4071	25	CD4531	1.50
CD4020	99	CD4041	78	CD4072	25	CD4561	1.00

VOLTAGE REGULATORS

MVR7805-NVR7824	all 58p Ea.
MVR7905-NVR7924	all 63p Ea.
78L05-78L24	all 28p Ea.
79L05-79L24	all 55p Ea.

LM309K 1.25
UA79MGHC 2.50
LM320 15v, 12v, 15v, 24v 95p Ea.

74 LS SERIES TTL

74LS00	13	74LS78	46	74LS165	1.20	74LS279	85		
74LS01	13	74LS83	68	74LS166	1.70	74LS280	2.40		
74LS02	15	74LS85	75	74LS168	1.80	74LS283	85		
74LS03	15	74LS86	38	74LS169	1.80	74LS290	90		
74LS04	15	74LS90	38	74LS170	2.50	74LS293	1.00		
74LS05	22	74LS91	1.10	74LS173	95	74LS295	1.90		
74LS08	21	74LS92	68	74LS174	95	74LS298	1.50		
74LS09	21	74LS93	58	74LS175	95	74LS299	3.50		
74LS10	20	74LS95	95	74LS181	2.70	74LS323	3.50		
74LS11	22	74LS96	1.10	74LS183	2.80	74LS324	1.90		
74LS12	26	74LS107	40	74LS190	95	74LS325	3.00		
74LS13	34	74LS109	70	74LS191	95	74LS326	3.20		
74LS14	50	74LS112	38	74LS192	95	74LS327	3.10		
74LS15	34	74LS113	68	74LS193	95	74LS348	1.80		
74LS20	18	74LS114	38	74LS194	95	74LS352	1.50		
74LS21	26	74LS122	68	74LS195	85	74LS353	1.50		
74LS22	32	74LS123	60	74LS196	1.00	74LS365	45		
74LS26	38	74LS124	1.60	74LS197	85	74LS366	55		
74LS27	35	74LS125	45	74LS221	1.00	74LS367	62		
74LS28	35	74LS126	45	74LS240	1.60	74LS368	80		
74LS30	18	74LS132	60	74LS241	1.60	74LS373	1.45		
74LS32	22	74LS136	50	74LS242	1.60	74LS374	1.45		
74LS33	34	74LS138	60	74LS243	1.60	74LS375	1.10		
74LS37	28	74LS139	68	74LS244	1.50	74LS378	1.20		
74LS38	28	74LS145	1.15	74LS245	2.20	74LS386	75		
74LS40	25	74LS147	2.00	74LS247	1.20	74LS393	1.10		
74LS42	55	74LS148	1.60	74LS248	1.20	74LS395	2.00		
74LS47	72	74LS151	70	74LS249	1.20	74LS398	2.70		
74LS48	80	74LS153	68	74LS251	1.20	74LS399	2.00		
74LS49	90	74LS155	65	74LS253	90	74LS490	1.40		
74LS51	24	74LS156	80	74LS257	90	74LS670	2.50		
74LS54	28	74LS157	60	74LS258	1.10				
74LS55	28	74LS158	60	74LS260	85	**COMPUTER I.C.'s**			
74LS63	1.40	74LS160	85	74LS259	1.50	2114 L-3	2.40		
74LS73	30	74LS161	75	74LS261	4.00	2708	3.50		
74LS74	30	74LS162	1.00	74LS266	72	2516/ 2716-5v	4.90		
74LS75	38	74LS163	90	74LS273	1.65	4116	2.25		
74LS76	42	74LS164	90	74LS275	3.50				

LINEAR I.C.'s

CA270BE	95	LM320/12v	95	72709	46
CA280Q	95	LM320/15v	95	709P	35
CA3011	98	LM320/24v	95	UA710C	40
CA3014	1.75	LM324N	48	72710	30
CA3018	65	LM337T	1.35	UA711C	32
CA3020	1.75	LM339N	65	72711	32
CA3028	80	LM348N	90	UA723C	45
CA3035	2.30	LM380	85	72723	45
CA3036	1.00	LM381	1.45	UA741C	24
CA3042	1.60	LM382N	1.20	72741	24
CA3043	1.85	LM384	1.45	741P	17
CA3046	70	LM1458	42	UA747C	60
CA3052	1.60	LM3900	58	72747	60
CA3054	1.10	LM3909N	70	UA74B	35
CA3075	1.50	LM3911N	1.20	748P	35
CA3080	65	LM3914N	2.20	SN76013N	1.60
CA3081	1.50	LM3915N	2.20	SN76023N	1.65
CA3085	95	MC1304	1.90	SN76110	1.50
CA3089	2.00	MC1310P	1.45	SN76115AN	1.90
CA3090	3.60	MC1312	1.70	SN76660N	90
CA3123E	1.50	MC1350	1.20	TAA550B	35
CA3130E	90	MC1352	1.40	TAA621	2.00
CA3140E	48	MC1469	2.70	TAA661B	1.50
LF351N	55	MC1496	90	TAD100	1.30
LF353N	88	NE555	20	TBA120B	70
LF356N	90	NE556	55	TBA540	1.40
LH0042CH	2.25	NE561	3.80	TBA641A	2.20
LM301A	25	NE562	4.00	TBA800	85
LM334	1.60	NE565	1.20	TBA810S	95
LM308	75	NE566	1.50	TBA820	70
LM309K	1.25	NE567	1.70	TBA920Q	2.50
LM317H	2.50	72702	46	TCA270S	1.40
LM318H	1.95	UA703C	25	ZN414	90
LM320/5v	95	UA709C	25	ZTK33B	15

SILICON RECTIFIERS

200mA		IS020 100v	10	IN5408 1000v	25
IS920 50v	06	IS021 200v	11	6 Amp	
IS921 100v	07	IS023 400v	13	BYX38-300	45
IS922 150v	08	IS025 600v	14	BYX38-600	60
IS923 200v	09	IS027 800v	16	BYX38-300R	45
IS924 300v	10	IS029 1000v	20	BYX38-600R	60
1 Amp		IS031 1200v	25	10 Amp	
IN4001 50v	04½			IS10/50 50v	30
IN4002 100v	05	3 Amp		IS10/100 100v	35
IN4003 200v	06	IN5400 50v	11	IS10/200 200v	40
IN4004 400v	06	IN5401 100v	12	IS10/400 400v	50
IN4005 600v	07	IN5402 200v	14	IS10/600 600v	60
IN4006 800v	07	IN5403 300v	15	IS10/800 800v	70
IN4007 1000v	08	IN5404 400v	16	IS10/1000	
		IN5405 500v	17	1000v	85
1·5 Amp		IN5406 600v	18	IS10/1200	
IS015 50v	09	IN5407 800v	22	1200v	95

BRIDGE RECTIFIERS

1 Amp RMS		2 Amp RMS		6 Amp RMS	
BR1/50v	20	BR2/50v	35	BR6/50v	75
BR1/100v	22	BR2/100v	40	BR6/100v	80
BR1/200v	25	BR2/200v	44	BR6/200v	88
BR1/400v	29	BR2/400v	50	BR6/400v	95
		BR2/1000v	65		

THYRISTORS

1 Amp – TO39 CASE					
THY1A/50v	34	THY5A/100v	45	THY5A/400vP	50
THY1A/100v	38	THY5A/200v	50	THY5A/600vP	60
THY1A/200v	42	THY5A/400v	57	THY5A/800vP	70
THY1A/400v	50	THY5A/600v	60		
THY1A/600v	65	THY5A/800v	75	10 Amp – TO48	
THY1A/800v	78	5 Amp – TO66		THY10A/50v	45
BT101/500R	80	THY5A/50v	36	THY10A/100v	50
BT102/500R	80	THY5A/100v	45	THY10A/200v	55
BT106	1.25	THY5A/200v	50	THY10A/400v	60
BT107	93	THY5A/400v	57	THY10A/600v	80
BT108	98	THY5A/600v	60	THY10A/800v	1.10
2N3228	70	THY5A/800v	75	16 Amp – TO48	
		2N3525	77	THY16A/50v	65
3 Amp – TO66		BTX30/50L	40	THY16A/100v	80
THY3A/50v	35	BTX30/400L	70	THY16A/200v	90
THY3A/100v	37	BT116	1.50	THY16A/400v	1.20
THY3A/200v	40	C106D	38	THY16A/600v	1.50
THY3A/400v	50	BTY79/400R	95	THY16A/800v	2.00
THY3A/600v	60				
THY3A/800v	75	5 Amp – TO220 PLASTIC		30 Amp – TO49	
		THY5A/50vP	35	THY30A/50v	1.30
5 Amp – TO64		THY5A/100vP	45	THY30A/100v	1.50
THY5A/50v	36	THY5A/200vP	47	THY30A/400v	2.95
				THY30A/400v	4.05
				THY30A/600v	4.20

TRIACS & DIACS

2 Amp – TO39		4 Amp – TO202		6 Amp – TO220	
TRI2A/100v	30	TRI4A/400v	55	TRI6A/100v	45
TRI2A/200v	42			TRI6A/200v	52
TRI2A/400v	50			TRI6A/400v	60
		8 Amp – TO220			
		TRI8A/400v	64	12 Amp – TO220	
				TRI12A/400v	70
10 Amp – TO48					
TRI10A/100v	55			DIACS	
TRI10A/200v	80	10 Amp – TO220 – PLASTIC		BR100	20
TRI10A/400v	90	TRI10A/400P	68	D32	20

ZENER DIODES

400W 1.3V-39V
1.3W 1.3V-100V
10W 1.3V-100V

all at 8p
all at 15p
all at 35p

LARGEST SELECTION – LOWEST PRICES

AERIALS

105	Adjustable Aerial Gutter Mount	3.00
106	C.B. Mobile Antenna	9.50
107	FM Indoor Ribbon Aerial	0.50
108	4 Section Car Aerial (Stainless)	2.16
109	4 Section Car Aerial (Chrome)	1.80
110	8 Section 1200mm Telescopic Aerial	2.00
111	8 Section 750mm Telescopic Aerial	2.60
112	5 Section 570mm Telescopic Aerial	2.64
113	Roof Mounting Aerial (Car)	3.80

AUDIO LEADS

114	5 pin – 3.5mm 3 & 5 connected	0.65
115	5 pin – 3.5mm 1 & 4 connected	0.65
116	Car Aerial Ext Lead	1.00
117	Mains Cassette Lead	0.48
119	2 × 2 pin Plug in In Line Stereo Jack Socket	0.74
120	Universal Car Adaptor Plug	0.52
123	20ft. Coiled Guitar Lead	1.50
125	5 pin to 5 pin DIN	0.65
126	5 pin to DIN to open ends	0.65
127	5 pin to DIN to 4 Phono Plugs	1.00
128	5 pin Plug to 5 pin socket	0.75
129	5 pin to 5 pin Plug (Mirror image)	0.72
130	2 pin Plug to 2 pin Line Socket 5 mtrs	0.55
132	2 pin Plug to 2 pin Line Socket 10 mtrs	0.85
133	5 pin Plug to 2 Phono Plug	0.65
136	Headphone ext lead 7 mtrs	1.50

A.B.S. PLASTIC BOXES

141	4" × 1" × 2"	1.08
142	4.4" × 1.22" × 2.44"	1.24
143	4.75" × 1.56" × 2.56"	1.30
144	6.00" × 2.00" × 3.15"	1.50
145	7.5" × 2.38" × 4.33"	2.64
146	2.8" × 4.37" × 1.63"	1.40
147	3.78" × 6.33" × 2.06"	1.92
148	5.63" × 4.14" × 2.19"	2.14
149	5.63" × 6.7" × 2.19"	2.62
150	6.65" × 4.98" × 2.76"	3.84
151	9.57" × 7.36" × 4.06"	5.82

VERO CASES

152	23/16" × 2" × 1" Black	0.47
153	23/16" × 2" × 1" White	0.47
154	Vero plastic case box	4.82

INSTRUMENT CASES

155	8" × 5 1/8" × 2"	1.70
156	11" × 6" × 3"	2.63
157	6" × 4 3/8" × 1 1/4"	1.64
158	9" × 5 1/4" × 2 1/2"	2.20

ALUM BOXES

159	5 1/2" × 2 1/2" × 1 1/2"	0.83
160	4" × 4" × 1 1/2"	0.83
161	4" × 2 1/2" × 1 1/2"	0.83
162	5 1/2" × 4" × 1 1/2"	0.93
163	4" × 2 1/2" × 2"	0.83
164	3" × 2" × 1"	0.57
165	7" × 5" × 2 1/2"	1.30
166	8" × 6" × 3"	1.68
167	6" × 4" × 2"	1.12
168	Sloping Box – Large	6.97
169	Sloping Box – Small	4.63

CASSETTES

301	Low Cost C60	0.36
302	Low Cost C90	0.45
303	Low Cost C120	0.65
304	30 Min Letter Tape	0.38
305	Empty Library Case	0.12

CAPS, CHOKES, TRIMMERS

327	Jackson Coupling	0.74
328	Jackson Slow Motion Drive	1.38
329	Jackson 300PF Dilecon	2.64
330	Jackson 500PF Dilecon	3.10
331	Jackson 01-365PF	2.86
332	Jackson 02-365PF Dual	4.34
333	Jackson 804 10PF	2.62
334	Jackson 804 25PF	2.88
335	Jackson 804 50PF	2.88
336	Jackson 804 100PF	3.42
337	Trimmer Cap 40PF	0.20
338	Trimmer Cap 250PF	0.25
339	Trimmer Cap 450PF	0.30
340	Trimmer Cap 750PF	0.34
357	Repanco CH1 2.5MH	0.44
358	Repanco CH2 5.0MH	0.50
359	Repanco CH3 7.5MH	0.50
360	Repanco CH4 10.0MH	0.56
361	Repanco CH5 1.5MH	0.44
362	Repanco CH6 5UH	0.38
363	Repanco DRX1 Coil	0.60
364	Repanco DRR2 Coil	1.00

CABLE

		per metre
390	Light Mic Cable	0.10
391	Twin Mic Cable	0.15
392	Fig. 8 Stereo Cable	0.12
393	4 Way SCR Cable	0.35
394	4 Way Ind. Screened Cable	0.18
395	Heavy Mic Cable	0.25
396	3 Amp 3 Core Mains Cable	0.16
397	Twin Oval Mains	0.10
398	Fig. 8 Speaker Cable	0.07
399	Low Loss Coax. 750ohms	0.20
400	Uniradio 76-50ohms coax.	0.30

ELECTROLYTIC CAPACITORS

430	470uF 50v	0.30
431	1000uF 25v	0.40
432	1000uF 63v	1.00
433	1000uF 100v	1.25
435	2200uF 25v	0.70
436	2200uF 40v	1.20
437	2200uF 100v	2.00
438	3300uF 100v	2.40
439	4700uF 25v	0.90
440	4700uF 63v	2.30

ENAM. COPPER WIRE 2oz

365	40 swg	1.00
366	38 swg	0.88
367	36 swg	0.90
368	34 swg	0.82
369	32 swg	0.80
370	30 swg	0.80
371	28 swg	0.76
372	26 swg	0.74
373	24 swg	0.66
374	22 swg	0.62
375	20 swg	0.60
376	18 swg	0.60
377	16 swg	0.52
378	14 swg	0.52

TINNED COP. WIRE 4oz

379	24 swg	0.94
380	22 swg	0.83
381	20 swg	0.86
382	18 swg	0.90
383	16 swg	0.78

HARDWARE IN PACKS OF 25

839	0BA 1" Bolt	0.70
840	0BA 1/2" Bolt	0.40
842	2BA 1" Bolt	0.35
843	2BA 1/2" Bolt	0.30
844	2BA 1/4" Bolt	0.32
845	4BA 1" Bolt	0.28
846	4BA 1/2" Bolt	0.20
847	4BA 3/4" Bolt	0.18
848	6BA 1" Bolt	0.24
849	6BA 3/4" Bolt	0.18
850	6BA 1/2" Bolt	0.20
851	0BA Solder Tags	0.20
852	2BA Solder Tags	0.16
853	4BA Solder Tags	0.14
854	6BA Solder Tags	0.12
855	0BA Full Nut	0.42
856	2BA Full Nut	0.26
857	4BA Full Nut	0.18
858	6BA Full Nut	0.18
859	0BA Washer	0.12
860	2BA Washer	0.09
861	4BA Washer	0.09
862	6BA Washer	0.09

FUSE HOLDERS

506	20mm Chassis Fuse Holder	0.14
507	1 1/4" Chassis Fuse Holder	0.14
508	1 1/4" Car in line Fuse Holder	0.12
509	20mm Panel Fuse Holder	0.26
510	1 1/4" Panel Fuse Holder	0.32

FUSES:

	Quick Blow 20mm:	
611	150mA	0.06
612	250MA	0.06
613	500MA	0.06
614	800MA	0.07
615	1 Amp	0.06
616	1.5 Amp	0.07
617	2.0 Amp	0.06
618	2.5 Amp	0.06
619	3.0 Amp	0.06
620	3.15 Amp	0.07
621	5.0 Amp	0.06
	Semi Delay: 20mm	
622	100MA	0.07
623	250MA	0.07
624	500MA	0.07
625	1 Amp	0.07
626	1.6 Amp	0.07
627	2 Amp	0.07
628	2.5 Amp	0.07
629	3.15 Amp	0.07
630	5.0 Amp	0.07
	Quick Blow: 1 1/4":	
631	250MA	0.06
632	500MA	0.06
634	800MA	0.06
635	1 Amp	0.06
636	1.5 Amp	0.06
637	2.0 Amp	0.06
638	2.5 Amp	0.06
369	3 Amp	0.06
641	4 Amp	0.06
642	5 Amp	0.06

KNOBS

1101	Black/Silver Knob	0.28
1102	Large Calibrated Knob	0.30
1103	Alli PA100 Knob	0.46
1104	Heavy Brushed Alli Knob 15mm	0.32
1105	Heavy Brushed Alli Knob 22mm	0.40
1106	Heavy Brushed Alli Knob 28mm	0.52
1107	Matt Black Knob 17mm	0.40
1108	Matt Black Knob 24mm	0.46
1109	Matt Black Knob 28mm	0.56
1110	All Metal Serated Edge Knob 15mm	0.34
1111	All Metal Serated Edge Knob 24mm	0.48
1112	All Metal Serated Edge Knob 30mm	0.60
1113	Black Plastic Metal Skirt	0.24
1114	Black Pointer Knob	0.22
1115	Black/Chrome Instrument Knob 22mm	0.32
1116	Alli Push Button Knob 11mm	0.14
1117	Black Plastic Slider Knob	0.12
1118	Chrome Slider Knob	0.14
1119	Chrome/Black Slider Knob	0.22

MICROPHONES etc.

1325	Crystal Desk Mike	3.30
1326	Cassette Mike 2.4mm - 3.5mm Plugs	1.46
1327	Dynamic Cassette Mike	1.86
1328	Dual Imp Dynamic Mike	10.50
1329	Dual Imp Condenser Mike	13.20
1330	Plastic Mike Holder	0.66
1331	Windshield Medium (Pair)	1.38
1332	Windshield Large (Pair)	1.92
1333	Gooseneck 320mm (Chrome)	2.60
1334	Gooseneck 515mm (Chrome)	3.50
1335	Mike Floor Stand	10.70
1336	Cassette Deck Mike 5K ohm	5.30
1337	Mike Boom Arm	8.80
1338	Crystal Mike Insert	0.52
1339	Two-Station Intercom	6.60
1340	Mobile or CB Mike 600 ohms	5.98
1341	Mobile or CB Mike 250 ohms	6.00

SEMICONDUCTOR HARDWARE

867	T0220		0.20
868	T03		0.20
869	S055	Insulating kits	0.20
870	T066	in packs of 5	0.20
871	T064		0.20
872	T048		0.20
873	T03 Single Heat Sink		0.26
874	T03 Double Heat Sink		1.35
875	Double Sided Heat Sink		2.65
876	T05/39 Heat Sink		0.15
877	T018 Heat Sink		0.15
878	T01 Heat Sink		0.10
879	T0220 Heat Sink		0.15
880	T066 Transistor Cover		0.14
881	T03 Transistor Cover		0.14

METERS

1305	2" Meter 2 Amps	2.88
1307	2" Meter 50UA	2.88
1308	2" Meter 100UA	2.88
1309	2" Meter 500UA	2.88
1310	2" Meter 1MA	2.88
1311	2" Meter 50 volts	2.88
1312	SWR and FS Meter	9.50
1313	SWR and Power Meter	11.90
1315	Test Meter 20,000 OPV	24.75
1316	Multi Tester RE185M	40.00
1317	Double VU Meter	3.25
1319	100-0-100 UA Meter 45mm	1.90
1320	Min Level Meter 23mm	0.95
1321	VU Meter 40mm	1.96
1322	Test Meter 1000PV	6.50
1323	Test Meter 20,000 OPV	11.40
1324	Test Meter 50,000 OPV	19.75

SWITCHES

1958	Min SPST Toggle Switch	0.70
1959	Min SPDT Toggle Switch	0.75
1960	Min DPDT Toggle Switch	0.80
1961	Min DPDT Centre Off Switch	0.95
1962	Push Button SPST	0.90
1963	Push Button SPDT	0.95
1964	Push Button DPDT	0.98
1965	1P 12W Rotary Switch	0.60
1966	2P 6W Rotary Switch	0.60
1967	3P 4W Rotary Switch	0.60
1968	4P 3W Rotary Switch	0.60
1973	Min DPDT Slide Switch	0.15
1974	Std Slide Switch	0.16
1975	SPST Toggle Switch	0.33
1976	DPDT Toggle Switch	0.46
1977	Rotary On-Off Switch	0.56
1978	Push to Make Switch	0.15
1979	Push to Break Switch	0.19
1981	SPST Rocker Switch (Black)	0.32
1982	SPST Rocker Switch (White)	0.32
1983	SPST Rocker Switch (Blue)	0.32
1984	SPST Rocker Switch (Yellow)	0.32
1985	SPST Rocker Switch (Luminous)	0.32
1986	Sub min SPST Toggle Switch	0.54
1987	Sub min SPDT Toggle Switch	0.58
1988	Sub min DPDT Toggle Switch	0.62
1989	Keyboard 24 way	1.50
1990	Keyboard 40 way	1.60
1991	Keyboard Switch	0.20
1992	Push to Make Switch (metal body)	0.32

BATTERY HOLDERS

200	Batt Holder 2 - HP7 short	0.18
201	Batt Holder 4 - HP7 short	0.19
202	Batt Holder 6 - HP7 short	0.20
203	Batt Holder 4 - HP7 long	0.19
204	PP3 Battery Clips	0.07
205	PP9 Battery Clips	0.12
206	Batt Holder 4 - HP11 long	0.25
207	Batt Holder 4 - HP11 short	0.25
208	Batt Holder 4 - HP2 long	0.30

ETCHANT AND PENS

1610	Dalo Etch Resist Pen	0.90
1611	Ferric Chloride 1/2lb pack	0.95
1612	Pentel Etch Resist Pen	0.65

SOLDERING EQUIPMENT

1925	12 volt soldering iron MLX	5.46
1927	Multicore solder 22 swg tube	1.00
1928	Multicore solder 22 swg reel	3.50
1929	Multicore solder 18 swg reel	3.50
1930	Desolder braid	0.75
1931	X25 Soldering Iron	4.20
1932	X25 1/4" replacement Bit	0.50
1933	X25 3/16" replacement Bit	0.50
1934	X25 3/32" replacement Bit	0.50
1935	X25 Replacement Element	1.80
1936	Desolder Pump	5.56
1937	Desolder Pump Nozzles	0.64
1938	SK1 Soldering Kit	7.00
1939	ST3 Iron Stand	1.60
1940	Horizontal IC Desoldering Bit	1.95
1941	Vertical IC Desoldering Bit	1.95
1942	Antex Heat Shunt	0.15
1943	CCN240 Soldering Iron	4.20
1944	CCN240 3/32" Replacement Bit	0.50
1945	CCN240 1/4" Replacement Bit	0.50
1946	CCN240 3/16" Replacement Bit	0.50
1947	CCN240 Replacement Eiement	1.90
1948	C240 Soldering Iron	4.20
1949	C240 3/32" Replacement Bit	0.50
1950	C240 1/4" Replacement Bit	0.50
1951	C240 3/16" Replacement Bit	0.50
1952	C240 Replacement Element	1.70
1953	G Soldering Iron	4.20
1954	Model G 3/32" Replacement Bit	0.50
1955	Model G 1/4" Replacement Bit	0.50
1956	Model G 3/16" Replacement Bit	0.50
1957	Model G Replacement Element	1.90

MAINS PLUGS AND SOCKETS

1618	13 Amp Rubber Plug	0.52
1619	13 Amp Plastic Plug	0.46
1620	13 Amp Free Socket	0.50
1621	13 Amp 2 way Free Socket	1.50
1622	13 Amp 4 way Free Socket	4.20
2019	2 Amp Terminal Block } 12 way	0.24
2020	5 Amp Terminal Block } 12 way	0.24

POTS

1831	1K	Lin Single Pots	29
1832	2K2	Lin Single Pots	29
1833	4K7	Lin Single Pots	29
1834	10K	Lin Single Pots	29
1835	22K	Lin Single Pots	29
1836	47K	Lin Single Pots	29
1837	100K	Lin Single Pots	29
1838	220K	Lin Single Pots	29
1839	470K	Lin Single Pots	29
1840	1M	Lin Single Pots	29
1841	2M2	Lin Single Pots	29
1842	4K7	Log Single Pots	29
1843	10K	Log Single Pots	29
1844	22K	Log Single Pots	29
1845	47K	Log Single Pots	29
1846	100K	Log Single Pots	29
1847	220K	Log Single Pots	29
1848	470K	Log Single Pots	29
1849	1M	Log Single Pots	29
1850	2M2	Log Single Pots	29
1851	4K7	Lin Dual Pots	88
1852	10K	Lin Dual Pots	88
1853	22K	Lin Dual Pots	88
1854	47K	Lin Dual Pots	88
1855	100K	Lin Dual Pots	88
1856	220K	Lin Dual Pots	88
1857	470K	Lin Dual Pots	88
1858	1M	Lin Dual Pots	88
1859	2M2	Lin Dual Pots	88
1860	4K7	Log Dual Pots	88
1861	10K	Log Dual Pots	88
1862	22K	Log Dual Pots	88
1863	47K	Log Dual Pots	88
1864	100K	Log Dual Pots	88
1865	220K	Log Dual Pots	88
1866	470K	Log Dual Pots	88
1867	1M	Log Dual Pots	88
1868	2M2	Log Dual Pots	88
1869			
1870	4K7	Lin switched pots	68
1871	10K	Lin switched pots	68
1872	22K	Lin switched pots	68
1873	47K	Lin switched pots	68
1874	100K	Lin switched pots	68
1875	220K	Lin switched pots	68
1876	470K	Lin switched pots	68
1877	1M	Lin switched pots	68
1878	2M2	Lin switched pots	68
1879	4K7	Log switched pots	68
1880	10K	Log switched pots	68
1881	22K	Log switched pots	68
1882	47K	Log switched pots	68
1883	100K	Log switched pots	68
1884	220K	Log switched pots	68
1885	470K	Log switched pots	68
1886	1M	Log switched pots	68
1887	2M2	Log switched pots	68
1888	100K	Log-Anti Log Dual Pot	88
1889	5K	Log pot 16mm switched	36
1890	5K	Log pot 17mm switched	48
1891	10 ohm wire wound pots		85
1892	22 ohm wire wound pots		85
1893	47 ohm wire wound pots		85
1894	100 ohm wire wound pots		85
1895	220 ohm wire wound pots		85
1896	470 ohm wire wound pots		85
1897	1K ohm wire wound pots		85
1898	2K ohm wire wound pots		85
1899	4K7 ohm wire wound pots		85

TOOLS CROC CLIPS ETC

2001	Insulated croc clips (Red)	0.06
2002	Insulated croc clips (Black)	0.06
2003	1 1/2 insulated croc clips (Red)	0.07
2004	1 1/2 insulated croc clips (Black)	0.07
2005	30 Amp croc clips 100mm **per pair**	0.74
2006	Test Leads	0.55
2007	Test Lead Kit	1.70
2008	4mm Test Lead Set	1.36
2009	4mm Test Prods Set	0.52
2010	Pincer Action Prod Set	1.40
2011	Cutters	5.50
2012	Pliers	5.20
2013	Croc clip test set	1.00
2014	Resistance sub box	4.30
2015	IC Extraction Tool	0.64
2016	Neon Mains Tester/Screwdriver	0.52

MIN PRESETS 9p EACH

1801	100 ohm	Horizontal
1802	220 ohm	Horizontal
1803	470 ohm	Horizontal
1804	1K	Horizontal
1805	2K2	Horizontal
1806	4K7	Horizontal
1807	10K	Horizontal
1808	22K	Horizontal
1809	47K	Horizontal
1810	100K	Horizontal
1811	220K	Horizontal
1812	470K	Horizontal
1813	1M	Horizontal
1814	2M2	Horizontal
1815	4M7	Horizontal
1816	100 ohm	vertical
1817	220 ohm	vertical
1818	470 ohm	vertical
1819	1K	vertical
1820	2K2	vertical
1821	4K7	vertical
1822	10K	vertical
1823	22K	vertical
1824	47K	vertical
1825	100K	vertical
1826	220K	vertical
1827	470K	vertical
1828	1M	vertical
1829	2M2	vertical
1830	4M7	vertical

TRANSFORMERS

2021	6-0-6v 100mA	0.90
2022	9-0-9v 75mA	0.90
2023	12-0-12v 100mA	1.15
2024	0-6v 0-6v 280mA	1.80
2025	0-12v 0-12v 150mA	1.80
2026	6-0-6v 1 Amp	2.40
2027	9-0-9v 1 Amp	2.00
2028	12-0-12v 1 Amp	2.50
2029	15-0-15v 1 Amp	2.75
2031	Multi tap 1/2 Amp	3.40
2032	Multi tap 1 Amp	4.80
2033	Multi tap 2 Amp	6.40
2034	0-35v 1.7 Amp	4.90
2035	0-55v 2 Amp	6.65
2036	0-17v 750mA	2.85
2037	Min audio output	0.25
2038	min audio driver	0.36
2039	0-20v 1 Amp	3.50
2040	0-45-55v 1.5 Amps	6.45
2041	0-55-65v 1 Amps	8.48
2042	0-25v 2 Amps	4.50
2043	15-0-15 150mA	2.40

2017
PICK UP FOR
ACOUSTIC GUITAR
£5.50

2018
TELEPHONE
PICK UP COIL
£0.66

170
QUICK TEST BLOCK 'KEYNECTOR'
£6.50

1617
T03 TRANSISTOR
SOCKET

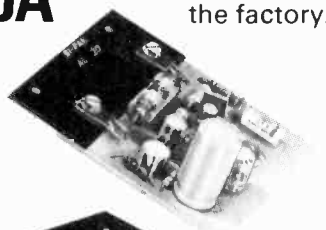
MAINS FUSES
13A PLUG TYPE

643	1A	**£0.12 each**
644	2A	
645	3A	
646	5A	
647	13A	

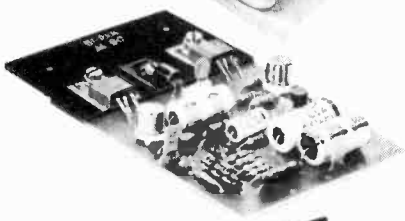
CHOOSE FROM OVER 20 TOP QUALITY MODULES

BI-PAK Audio Modules are famous for their variety, quality of design and ruggedness. For over 10 years BI-PAK have been suppliers to manufacturers of high quality audio equipment throughout the world – to date, well over 100,000 modules have been sold – this is why discerning amateur enthusiasts insist on using BI-PAK modules in their equipment. They know that every item is designed and tested to do the job for which it is intended before it leaves the factory. Whatever you are building, there is a kit or module in the BI-PAK range to suit your every need from 5 watts to 125 watts, from amplifiers to equalisers. AND if you cannot see what you require in this advertisement, just write or phone us – we are waiting to help you!

AL20A-30A
AUDIO AMPLIFIER MODULES

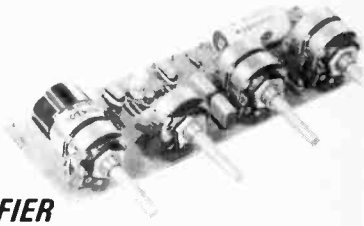


AL80
AUDIO AMPLIFIER MODULE 35 Watts RMS

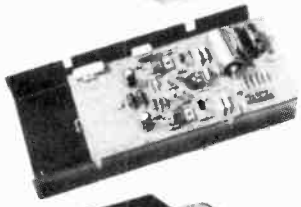


AL60
AUDIO AMPLIFIER MODULE 25 Watts RMS

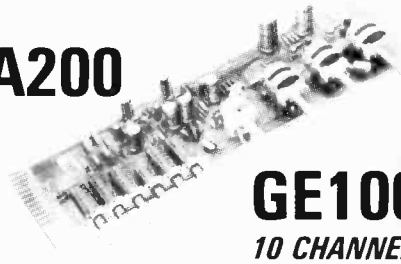
PA12
STEREO PRE-AMPLIFIER



AL120
AUDIO AMPLIFIER 50W RMS



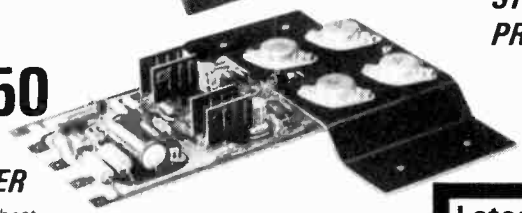
PA100 & PA200
STEREO PRE-AMPLIFIER



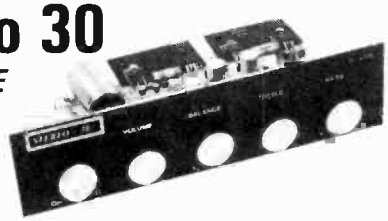
GE100
10 CHANNEL MONOGRAPHIC

AL250
POWER AMPLIFIER

With integral heat sink and short-circuit protection



Stereo 30
COMPLETE AUDIO CHASSIS



Latest addition

MM100 Suitable for disco mixer.
MM100G Suitable for guitar pre-amp-mixer.

£12.43 each

BI-PAK

COMPLETELY GUARANTEED

AMPLIFIERS

AL10. 3 watt Audio Amplifier Module 22-32v supply.	**£3.08**
AL20. 5 watt Audio Amplifier Module 22-32v supply.	**£3.57**
AL30A. 7-10 watt Audio Amplifier Module 22-32v supply.	**£4.16**
AL60. 15-25 watt Audio Amplifier Module 30-50v supply.	**£5.15**
AL80. 35 watt Audio Amplifier Module 40-60v supply.	**£8.07**
AL120. 50 watt Audio Amplifier Module 50-70v supply.	**£13.14**
AL250. 125 watt Audio Amplifier Module 50-80v supply.	**£19.60**

STEREO PRE-AMPLIFIERS

PA12. Supply voltage 22-32v input sensitivity 300mv. Suit: AL10/AL20/AL30.	**£8.55**
PA100. Supply voltage 24-36v inputs: Tape, Tuner, Mag P.U. Suit: AL60, AL80.	**£17.65**
PA200. Supply voltage 35-50v inputs: Tape, Tuner, Mag P.U. Suit: AL80/AL120/AL250.	**£18.24**

BI-KITS

STA5. 5 watts per channel Stereo Amplifier. Kit consisting of: 2×AL20 amplifiers, 1×PA 12 pre-amplifier, 1×PS12 power supply, 1×2036 transformer and necessary wiring diagram. **£19.52**

STA10. 10 watts per channel Stereo Amplifier. Kit consisting of: 2×AL30 amplifiers, 1×PA12 pre-amplifier, 1×PS12 power supply, 1×2036 transformer and necessary wiring diagrams. **£20.63**

STA15. 15 watts per channel Stereo Amplifier. Kit consisting of: 2×AL60 amplifiers, 1×PA100 pre-amplifier, 1×SPM80 power supply, 1×2034 transformer, 2×coupling capacitors for 8 ohms 470mfd 30v and necessary wiring diagram. **£36.76**

BI-KITS

STA25. 25 watts per channel Stereo Amplifier. Kit consisting of: 2×AL60 amplifiers, 1×PA100 pre-amplifier, 1×SPM120/45 power supply, 1×2040 transformer, coupling capacitors for 8 ohms 470 mfd 45v, 1×reservoir capacitor 2200mfd 100v and necessary wiring diagram. **£40.50**

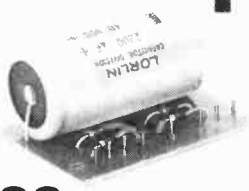
STA35. 35 watts per channel Stereo Amplifier. Kit consisting of: 2×AL80 amplifiers, 1×PA200 pre-amplifier, 1×2035 transformer, 2×coupling capacitors 470mfd at 50v for 8 ohms, 1×reservoir capacitor 2200mfd 100v and necessary wiring diagram. **£45.76**

BI-KITS

STA50. 50 watts per channel Stereo Amplifier. Kit consisting of: 2×AL120 amplifiers. 1×PA200 pre-amplifier, 1×2041 transformer, 2×coupling capacitors 1000mfd 63v, 1×SPM120/65, 1×reservoir capacitor 3300mfd 100v and necessary wiring diagram. **£59.89**

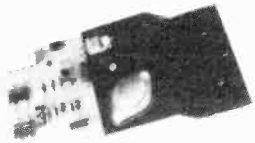
STA100. 100 watts per channel Stereo Amplifier. Kit consisting of: 2×AL250 amplifiers, 1×PA200 pre-amplifier. 2×SPM120/65 power supplies, 2×2041 transformers, 2×coupling capacitors 1000mfd 100v and necessary wiring diagram. **£84.68**

PS12
POWER SUPPLY MODULE

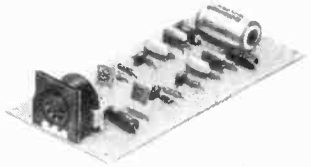


SPM80
STABILISED POWER SUPPLY

SPM120
STABILISED POWER SUPPLY

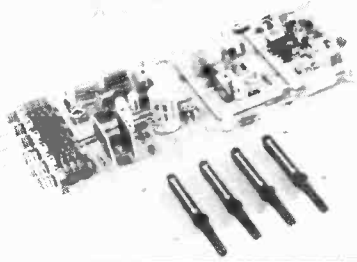


MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

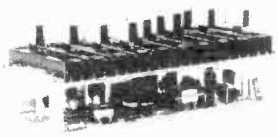


BP124
SIREN ALARM MODULE

S450
STEREO FM TUNER Fitted with phase lock-loop



Mk II
EQUALISER



Transformers are not included with power supplies.
SPM120 Range also require reservoir and output capacitors.

MONO PRE-AMPLIFIERS

MM100. Supply voltage 40-65v inputs: Tape, Mag P.U. Microphone Max output 500mv. **£12.43**

MM100G. Supply voltage 40-65v inputs: 2 Guitars. Microphones Max output 500mv. **£12.43**

POWER SUPPLIES

PS12. 24v Supply. Suit: 2×AL10, 2×AL20, 2×AL30 & PA12/S.450. **£1.65**

SPM80. 33v Stabilised supply. Suit: 2×AL60, PA100 to 15 watts. **£4.84**

SPM120/45. 45v Stabilised supply. Suit: 2×AL60, PA100 to 25 watts. **£6.38**

SPM120/55. 55v Stabilised supply. Suit: 2×AL80, PA200. **£6.38**

SPM120/65. 65v Stabilised supply. Suit: 2×AL120, PA200, 1×AL250. **£6.38**

SG30. 15-0-15 Stabilised power supply for 2×GE100MK11. **£3.80**

MISCELLANEOUS

MPA30. Stereo Magnetic Cartridge Pre-Amplifier – input 3.5mv Output 100mv. **£3.27**

S.450. Stereo FM Tuner Supply Voltage 20-30v – Varicap tuned. **£25.56**

STEREO 30. Complete 7 watt per channel Stereo Amplifier Board – includes amps, pre-amp, power supply, front panel, knobs etc – requires 2039 Transformer. **£21.09**

8P124. 5 watt 12v max. – Siren Alarm Module. **£3.85**

GE100MK11. 10 channel mono-graphic equaliser, complete with sliders and knobs. **£23.00**

VPS30. Variable regulated stabilised power supply 2-30v 0-2 amps. **£7.60**

PS250. Consists – 1 capacitor & 4 diodes for constructing unstabilised power supply for AL250 to 125 watts. **£2.90**

TRANSFORMERS

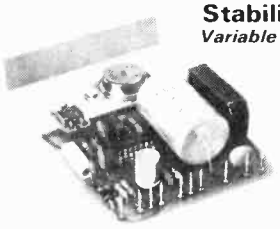
2034. 1.7 amp 35v. Suit SPM80. **£4.90**
2035. 2 amp 55v. **£6.65**
2036. 750mA 17v. Suit: PS12. **£2.85**
2040. 1.5 amp 0-45v-55v. Suit: SPM120/45, SPM120/55v. **£6.45**
2041. 2 amp 0-55v-65v. Suit: SPM120/55, SPM120/65v. **£8.46**
2039. 1 amp 0-20v. Suit Stereo 30. **£3.50**
2043. 150mA 15-0-15v. Suit: SG30. **£2.40**

ACCESSORIES

139. Teak Cabinet. Suit: Stereo 30, 320×235×81mm. **£7.00**
140. Teak Cabinet. Suit: STA15, 425×290×95mm. **£9.50**
FP100. Front Panel for PA100 & PA200. **£1.80**
BP100. Back Panel for PA100 & PA200. **£1.60**
GE100FP. Front Panel for one GE100MK11. **£1.75**
2240. Kit of parts including Teak Cabinet, Chassis, Sockets and Knobs etc. (To house STA15 Amplifier.) **£19.95**

Full data sheets are available FREE on request, please enclose a S.A.E.

VPS30
REGULATED VARIABLE STABILISED POWER SUPPLY



Stabilised Power Supply Kit
Variable from 2-30 volts and 0-2 Amps

Kit includes:
1 – VPS30 Module.
1 – 25 volt 2 Amp transformer.
1 – 0-50v 2" Panel Meter.
1 – 0-2 Amp 2" Panel Meter.
1 – 470 ohm wirewound potentiometer.
1 – 4K7 ohm wirewound potentiometer.

Wiring Diagram Included.

KIT £20 + V.A.T.

Access and Barclaycards accepted – just telephone our Orderline – Ware (STD 0920) 3182. All prices exclude V.A.T., add 50p. postage per order. Terms: C.W.O., cheques, Postal Orders payable to Bi-Pak.

BI-PAK – SATISFACTION OR YOUR MONEY BACK!

PLUGS AND SOCKETS

1625	2mm Plug RED	£0.16
1626	2mm Plug BLACK	£0.16
1628	2mm Socket RED	£0.16
1629	2mm Socket BLACK	£0.16
1634	4mm Plug BLACK	£0.16
1637	4mm Plug RED	£0.16
1640	4mm Socket BLACU	£0.16
1643	4mm Socket RED	£0.16
1652	2 Pin DIN Chassis Socket	£0.08
1654	5 Pin 180° DIN Chassis Socket	£0.12
1655	5 Pin 240° DIN Chassis Socket	£0.12
1656	2.5mm Chassis Socket	£0.10
1657	3.5mm Chassis Socket	£0.10
1658	Metal Std. Jack Chassis Socket (mono)	£0.18
1659	Metal Std. Jack Chassis Socket (stereo)	£0.24
1660	Single Phono socket	£0.09
1661	Double Phono Socket	£0.12
1662	Coax surface socket	£0.22
1663	Coax Flush Socket	£0.22
1664	Plastic Std. Jack Socket (mono)	£0.20
1665	Plastic Std. Jack Socket (stereo) for headphones	£0.32
1666	Car Aerial Chassis Socket	£0.18
1667	AC Chassis Socket	£0.16
1668	4 Way Phono Chassis Socket	£0.22
1669	Plastic Std. Jack Chassis socket stereo switched	£0.32
1670	AC switched non rev. socket	£0.32
1672	2 Pin DIN line socket	£0.10
1674	5 Pin 180° DIN line socket	£0.17
1675	5 Pin 240° DIN line socket	£0.20
1676	2.5mm Plastic line socket	£0.12
1677	3.5mm Plastic line socket	£0.12
1678	Std. jack plastic line socket (mono)	£0.17
1679	Std. jack metal line socket (mono)	£0.30
1680	Std. jack plastic line socket (stereo)	£0.22
1681	Std. jack metal line socket (stereo)	£0.38
1682	Phono lin line metal socket	£0.16
1684	Coax line socket	£0.34
1685	Coax back-back socket	£0.14
1686	AC linesocket (2 pin USA Type)	£0.18
1687	Phono in line plastic socket	£0.12
1688	Phono back-back socket	£0.20
1689	2 Pin DIN plug	£0.10
1692	5 Pin 180° DIN plug	£0.14
1693	5 Pin 240° DIN plug	£0.14
1696	2.5mm Plug (Metal)	£0.15
1697	3.5mm Plug (Plastic)	£0.12
1698	3.5mm Plug (Metal)	£0.16
1699	Std. Plastic Jack Plug (Mono)	£0.16
1700	Std. Metal Jack Plug (Mono)	£0.30
1701	Std. Metal Jack Plug (Stereo)	£0.35
1702	Plastic Phono Plug	£0.11
1703	Car Aerial Plug	£0.24
1704	Coax TV Plug	£0.22
1705	Right Angle Jack Plug (Mono)	£0.20
1706	2.5mm Plastic Plug	£0.12
1707	Std. Plastic Jack Plug (Stereo)	£0.22
1708	Metal Phono Plug	£0.14
1709	2.1mm DC Plug	£0.12
1710	2.5mm DC Plug	£0.12
1711	AC Plug (2 pin USA Type)	£0.16
1712	AM Aerial Plug	£0.17
1713	Cassette AC Input Plug	£0.15
1714	FM Aerial Plug	£0.13
1715	PL 259 Plug	£0.40
1716	SO239 Socket 4 hole fixing	£0.38
1717	SO239 Socket single hole fixing	£0.40
1718	PL258 Double Ended Female Coupler	£0.40
1719	NC555 Reducer for PL259 (Small)	£0.16
1720	NC556 Reducer for PL259 (Large)	£0.16
1721	M359 Right Angle Coupler PL259 SO239	£0.75
1722	M358 T Connector Female-Male-Female	£0.85
1723	NC563 Inline Coupler PL259 x 2	£0.60
1724	BNC15 50 ohm standard plug	£0.64
1725	BNC1502 Chassis mounting socket	£0.75
1726	BNC1503 Chassis mounting socket single hole fixing	£0.70
1727	BNC1520 BNC male to SO239 female	£0.85
1728	BNC1521 BNC female to PL259 male	£0.85
1729	Junction Box one in two out	£0.80
1730	Low loss splitter	£1.00

BREADBOARD

2195	EXP325	£1.84
2196	EXP350	£3.62
2197	EXP650	£4.14
2198	EXP300	£6.61
2199	EXP48	£2.65
2200	EXP600	£7.25

VEROBOARD

2201	2.5" x 5" .1 copper	£0.76
2202	3.5" x 3.75" .1 copper	£0.66
2203	2.5" x 17" .1 copper	£2.28
2204	3.75" x 5" .1 copper	£0.86
2205	3.75" x 3.75" .1 copper	£0.76
2206	3.75" x 17" .1 copper	£2.96
2207	4.75" x 17.9" .1 copper	£3.90
2208	2.5" x 1" 5 in pack	£0.92
2209	3.75" x 17" .1 Plain	£1.92
2210	3.75" x 2.5" .1 Plain	£0.48
2211	5.0" x 3.75" .1 Plain	£0.72
2212	vero pins Double sided .040mm .1" (in 100's)	£0.52
2213	vero pins Single sided .040mm .1" (in 100's)	£0.52
2214	DIP Breadboard	£3.26
2215	Vero Cutter	£1.06
2216	Insertion Tool .1	£1.46
2218	12 volt mini drill	£7.00
2219	Right Angle Bracket 1 1/2" x 1/2"	£0.07
2220	Right Angle Bracket 1/2" x 1/2"	£0.06

EARPIECES & BUZZERS

500	Solid State Buzzer 4-25v	£0.75
501	Crystal Earpiece	£0.42
502	8 ohm Earpiece 2.5mm Plug	£0.18
503	8 ohm Earpiece 3.5mm Plug	£0.18
505	200 ohm Earpiece 3.5mm Plug	£0.44

COMPONENT PACKS

C26	300 Preformed carbon resistors mixed 1/4-1/2w	£1.00
C27	50 2-10 watt wire wound resistors mixed	£1.00
C28	300 Approx Resistors mixed values (count by weight)	£1.00
C29	200 Approx Capacitors mixed values and types (count by weight)	£1.00
C30	60 Precision Resistors 1-5% tol.	£1.00
C31	100 Approx 1/8 watt min Resistors mixed values	£1.00
C32	6 Pieces Ferrite Rods	£1.00
C33	60 Metres Single strand wire assorted colours	£1.00
C34	15 Reed switches glass type	£1.00
C35	5 Micro switches assorted types including min.	£1.00
C36	6 Assorted Audio jack sockets and plugs	£1.00
C37	100 Disc ceramic caps mixed values	£1.00
C38	20 Assorted pots	£1.00
C39	40 C280 type capacitors metal foil	£1.00
C40	60 Electrolytics assorted	£1.00
C41	50 Assorted polyestor/polystyrene	£1.00
C42	60 Low voltage Electrolytics mixed values up to 10v.	£1.00
C43	15 Assorted slider pots	£1.00
C44	10 Dual gang pots log and lin assorted	£1.00
C45	1 Pack assorted Handware nuts/bolts etc.	£1.00
C46	10 Assorted switches slide/rocker/mains	£1.00
C47	3 Relays 24v coil	£1.00
C48	20 Assorted knobs push, screw and slider types	£1.00
C49	20 Assorted Tag strips and panels	£1.00
C50	4 Wave change switches rotary	£1.00
C51	1 Pack of assorted PVC sleeving and markers	£1.00
C52	100 1/4 watt resistors mixed values	£1.00
C53	35 Presets assorted type and values	£1.00
C54	40 Metres stranded wire assorted colours	£1.00
C55	10 Assorted Din/sockets/Coax/speakers/phono	£1.00
C56	10 Assorted plugs Din/coax/speakers/etc.	£1.00
C57	10 Metres assorted cable. Mains/speaker/coax/microphone	£1.00
C58	100 sq in copper clad board single side paper	£1.00
C59	75 sq in copper clad fibreglass board	£1.00
C60	15 Assorted IC sockets 8, 14, 16 pin	£1.00

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BUDGET STEREO HEADPHONES

BLACK WITH PADDED EARCUPS
IMPEDANCE 8 ohms
FREQUENCY RESPONSE
30-18,000 HZ
WEIGHT 300gms

£4.20

GOOD QUALITY STEREO HEADPHONES

DOUBLE PADDED HEAD BAND
CIRCULAR VENTED PADDED EARPIECES
BLACK AND ALUMINIUM FINISH
IMPEDANCE 8 ohms
FREQUENCY RESPONSE
20-19,000 HZ
WEIGHT 350gms

£8.25

SUPERIOR QUALITY STEREO HEADPHONES

WIDE BLACK PADDED HEAD BAND AND MATT ALUMINIUM EARCUPS
IMPEDANCE 8 ohms
FREQUENCY RESPONSE
15-25,000 HZ
WEIGHT 290gms

£15.85

LAST MINUTE ITEMS

We offer the following Fairchild Power Transistors at much reduced prices

TYPE	Pol.	£ p
2N3054	NPN	0.32
2N3713	NPN	0.35
2N3714	NPN	0.36
2N3716	NPN	0.36
2N3767	NPN	0.34
2N3789	PNP	0.45
2N4901	PNP	0.40
2N4903	PNP	0.42
2N4910	NPN	0.25
2N4911	NPN	0.27
2N4912	NPN	0.30
2N4913	NPN	0.30
2N4914	NPN	0.32
2N4915	NPN	0.34
2N5630	NPN	0.50
2N5631	NPN	0.60
2N5838	NPN	0.60
2N5886	NPN	0.60
2N6031	PNP	0.70
2N6123	NPN	0.25
2N6129	NPN	0.25
2N6130	NPN	0.30
2N6131	NPN	0.32
2N6133	PNP	0.32
2N6134	PNP	0.35
2N6487	NPN	0.35
2N6490	PNP	0.40
BD220	NPN	0.25
BD223	PNP	0.30
BD225	PNP	0.30
FT49	NPN	0.25
FT317a	NPN	0.28
FT417a	PNP	0.32
FT417b	PNP	0.34
FT423	NPN	0.40
MJ802	NPN	0.45
TIP61A	NPN	0.25
TIP61B	NPN	0.26
TIP62A	PNP	0.28
TIP62B	PNP	0.28
TIP110	NPN	0.30
TIP111	NPN	0.32
TIP112	NPN	0.35

BRIDGE RECTIFIERS

10 Amp RMS	
BR10/50v	1.40
BR10/100v	1.50
BR10/200v	1.60
BR10/400v	1.90
25 Amp RMS	
BR25/50v	1.85
BR25/100v	1.95
BR25/200v	2.05
BR25/400v	2.90
BY164	51

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THE BI-PAK OPTO SHOW

LED's

1501	TIL209 Red LED .125"	£0.10
1502	TIL211 Green LED .125"	£0.16
1503	TIL213 Yellow LED .125"	£0.16
1504	FLV117 Red LED .2"	£0.10
1505	FLV310 Green LED .2"	£0.16
1506	FLV410 Yellow LED .2"	£0.16
1507	2nd Grade LED pack 10 assorted	£0.80
1522	MIL32 Clear illuminating Red LED .125"	£0.12
1523	FLV111 Clear illuminating Red LED .2"	£0.12
1524	CQX21 Red Flashing LED	£0.65
1525	CQX95 two colour LED	£0.75

OPTO-ISOLATORS

1515	Opto-isolator IL74 Single	£0.55
1516	Opto-isolator ILD74 Dual	£1.18
1517	Opto-isolator ILQ74 Quad	£2.10

7 SEGMENT LED DISPLAYS

1508	BDL307 7 segment LED display .3"	£0.80
1509	BDL527 dual 7 segment LED display .5"	£1.80
1510	BDL707 7 segment LED display .3"	£0.98
1511	BLD747 7 segment LED display .6"	£1.75
1512	BDL727 dual 7 segment LED display .5"	£1.90

MISCELLANEOUS

1514	ORP12 Light Dependent Resistor	£0.60
1518	Photo transistor P20 NPN	£0.60
1519	Photo Darlington MEL11 NPN	£0.26
1520	Photo transistor OCP71 PNP	£0.40
1526	FPE100 Infra Red Emitter	£0.38
1527	CQY89 Infra Red LED	£0.38

Beginners Pak: No. 1

100 Transistors

A pack of well known transistors. As used in many popular projects. A must for beginners (and very useful to experienced constructors too).

10	BC107/B	T018	Metal	NPN
10	BC237	T092	Plastic	NPN
5	BC177/8	T018	Metal	PNP
5	BC251	T092	Plastic	PNP
10	BFY51-BC141	T039	Metal	NPN
5	BC160	T039	Metal	PNP
5	2N3055	T03	Metal	NPN
2	BD312/MJ2955	T03	Metal	PNP
5	TIP29-31	T0220	Plastic	NPN
2	TIP30-32	T0220	Plastic	PNP
10	OC71-76	Germanium		PNP
5	AC128-188	Germanium Metal		PNP
5	AC176	Germanium Metal		NPN
5	OC44-45	Germanium		PNP
5	TIS43-UT46	Unijunction Plastic		
5	2N3819	F.E.T.		
2	MEL11	Photo Transistor Plastic		
2	BD131	T0126	Plastic	NPN
2	BD132	T0126	Plastic	PNP
100	TOTAL			

All devices – brand new and full spec as per device coding. Data and lead out details included in pak.
Normal Retail Value **£23.00**
Our Special Offer Price **£15.00**

Beginners Pak: No. 2

100 Rectifiers, SCR's, Triacs, Diodes.

20	IN4001-IN4007 1Amp Silicon Rectifier
20	IN5401-IN5407 3Amp Silicon Rectifier
20	IN4148 Fast switch diodes Silicon
10	OA200 BAX13-6 General Purpose Diode Silicon
5	C106D Thyristor 400v TO202 Case
2	10Amp Triacs 400v TO220 Case Isolated Tab
2	4Amp Triacs 400v TO220 Case Non-isolated Tab
10	Assorted 3Amp Thyristors 50-600volts T064-T066 Case
5	Assorted 1Amp Thyristors 50-600volts T039 Case
6	OA81-91 General Purpose Germanium Diodes
100	TOTAL

All devices brand new and ful spec Data and lead out details included.
Normal Retail Value **£17.00**
Our Special Offer Price **£11.00**

UNTESTED SEMICONDUCTOR PAKS

U1	150 germ Gold Bonded Diodes OA47	£1.00
U2	150 germ point contact diodes OA81	£1.00
U3	150 Silicon G.P. 200mA Diodes OA200	£1.00
U4	150 Silicon Fast Switch Diodes IN4148	£1.00
U5	25 Stud type Silicon Rectifiers up to 10A	£1.00
U6	10 SCR's 5Am- T066	£1.00
U7	40 Sil Trans NPN T018 Case BC107/8/9	£1.00
U8	40 Sil Trans PNP T018 Case BC177/8/9	£1.00
U9	40 Sil Trans NPN T018 Case 2N706[	£1.00
U10	40 Sil Trans NPN T05/39 2N697/2N1711	£1.00
U11	40 Sil Trans PNP T05/39 2N2905/1132	£1.00
U12	30 Sil Trans NPN T039 BFY51-BC141	£1.00
U13	30 Sil Trans PNP T039 BC160-161 etc	£1.00
U14	10 Sil Trans NPN T03 2N3055	£1.00
U15	10 Sil Trans NPN T0220 TIP29-31-33	£1.00
U16	10 Sil Trans PNP T0220 TIP30-32-34	£1.00
U17	30 Sil Trans NPN T039 High Vlts. BF258/115	£1.00
U18	40 Sil Trans T092 BC237/B	£1.00
U19	40 Sil Trans T092 BC251	£1.00
U20	40 Sil Trans NPN T092 BC183-4	£1.00
U21	40 Sil Trans PNP T092 BC257 BC212L	£1.00

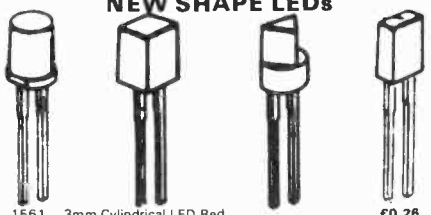
Code No's mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

ELECTROLYTIC PAKS

A range of paks each containing 25 first quality, mixed value miniature electrolytics.

EC1	Values from 46mFD-10mFD	£1.00
EC2	Values from 10mFD-100mFD	£1.00
EC3	Values from 100mFD-1000mFD	£1.00

NEW SHAPE LEDs



1561	3mm Cylindrical LED Red	£0.26
1562	3mm Square LED Red	£0.26
1563	3mm Triangular LED Red	£0.26
1564	5mm Rectangular LED Red	£0.26
1565	5mm Cylindrical LED Red	£0.26
1566	5mm Square LED Red	£0.26
1567	5mm Triangular LED Red	£0.26
1568	3mm Cylindrical LED Green	£0.28
1569	3mm Square LED Green	£0.28
1570	3mm Triangular LED Green	£0.28
1571	5mm Rectangular LED Green	£0.28
1572	5mm Cylindrical LED Green	£0.28
1573	5mm Square LED Green	£0.28
1574	5mm Triangular LED Green	£0.28
1575	3mm Cylindrical LED Yellow	£0.28
1576	3mm Square LED Yellow	£0.28
1577	3mm Triangular LED Yellow	£0.28
1578	5mm Rectangular LED Yellow	£0.28
1579	5mm Cylindrical LED Yellow	£0.28
1580	5mm Square LED Yellow	£0.28
1581	5mm Triangular LED Yellow	£0.28

CERAMIC PAKS

Containing a range of first quality miniature ceramic capacitors.

MC1	40 miniature ceramic capacitors: 5 of each value: 22pf, 27pf, 33pf, 39pf, 47pf, 56pf, 68pf, 82pf.	£1.00
MC2	40 miniature ceramic capacitors: 5 of each value: 100pf, 120pf, 150pf, 180pf, 220pf, 270pf, 330pf, 390pf.	£1.00
MC3	40 miniature ceramic capacitors: 5 of each value: 470pf, 560pf, 680pf, 820pf, 1000pf, 1500pf, 2200pf, 3300pf.	£1.00
MC4	35 miniature ceramic capacitors: 5 of each value: 4700pf, 6800pf, .01uf, .015uf, .022uf, .033uf, .047uf.	£1.00

SPEAKERS AND CROSSOVERS

1901	Dome Tweeter 3½" 8 ohms 50w	£3.20
1902	Dome Tweeter 3" 8 ohms 20w	£2.60
1903	Flared Horn Tweeter 8 ohms 30w	£3.80
1904	2 way crossover 15w 8 ohms	£1.24
1905	2 way crossover 40w 8 ohms	£2.70
1906	3 way crossover 60w 8 ohms	£3.50
1907	Piezo Tweeter	£5.20
1914	70mm 80 ohm speaker	£1.20
1915	70mm 8 ohm speaker	£0.95
1916	56mm 8 ohm speaker	£0.65
1917	2½" 8 ohm speaker	£0.75
1918	2½" 64 ohm speaker	£0.82
1919	5¼" whoofer 4 ohms 10w	£3.90
1920	5¼" whoofer 8 ohms 10w	£3.90
1921	5¼" Dual cone wide range 8 ohms	£5.80
1922	8" Dual cone long throw 8 ohms 15w	£4.84
1923	8" whoofer dual 4+8 ohms rubber edge 20w	£7.80

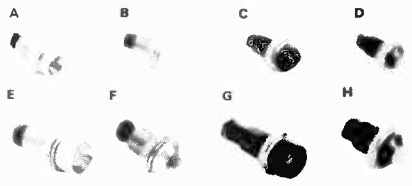
DIL SOCKETS

	1601	8 Pin	£0.09			
1602	14 Pin	£0.11	1606	22 Pin	£0.24	
1603	16 Pin	£0.12	1607	24 Pin	£0.28	
1604	18 Pin	£0.18	1608	28 Pin	£0.32	
1605	20 Pin	£0.20	1609	40 Pin	£0.36	

LATE ADDITIONS – High Current Transistors

	VCEO	VCBO	I.C. Max	
BFT32	60	80	3A	£0.60
BFT33	80	100	3A	£0.62
BFT34	100	120	3A	£0.65
BFT37	100	120	3A	£0.95
RPYY76A	Infra Red Detector			£0.65

LED CLIPS AND HOUSINGS



1548	LED Plastic clips .125"	£0.15
1549	LED Plastic clips .2"	£0.18
1550	LED Housing (nickel plated) .125"	£0.26
1551	LED Housing (nickel plated) .125"	£0.22
1552	LED Housing (matt black) .125"	£0.37
1553	LED Housing (matt black) .125"	£0.31
1554	LED Housing (nickel plated) .2"	£0.34
1555	LED Housing (nickel plated) .2"	£0.28
1556	LED Housing (matt black) .2"	£0.44
1557	LED Housing (matt black) .2"	£0.36

BULBS AND NEONS

1534	LES Bulb 6v 0.36w	£0.24
1535	LES Bulb 6.5v 1w	£0.24
1536	LES Bulb 14v 0.75w	£0.24
1538	MES Bulb Round 6v .04A	£0.24
1539	MES Bulb Round 6.5v .15A	£0.20
1540	MES Bulb Round 6.5v .3A	£0.20
1541	MES Bulb Round 12.0v .1A	£0.20
1542	MES Bulb Round 12.0v 2.2w	£0.20
1543	Neon Red Round 240v	£0.34
1544	Neon Red Rectangular 240v	£0.34
1545	Neon Orange Rectangular 240v	£0.34
1546	Neon Green Rectangular 240v	£0.34
1547	MES Batten Holder	£0.18

CARBON FILM RESISTOR PAKS

These paks contain a range of Carbon Film Resistors, assorted into the following groups:

R1	80 Mixed ¼w 100 ohms-820 ohms	£1.00
R2	80 Mixed ¼w 1K ohms-8.2K ohms	£1.00
R3	80 Mixed ¼w 10K ohms-82K ohms	£1.00
R4	80 Mixed ¼w 100K ohms-1M	£1.00
R5	60 Mixed ½w 100 ohms-820 ohms	£1.00
R6	60 Mixed ½w 1K ohms-8.2K ohms	£1.00
R7	60 Mixed ½w 10K ohms-82K ohms	£1.00
R8	60 Mixed ½w 100K ohms-1M	£1.00

TANTALUM BEAD CAPACITORS

401	0.1uf 16v	£0.11	414	47.0uF 16v	£0.55	
402	0.22uf 16v	£0.11	415	100uF 10v	£0.62	
403	0.33uf 16v	£0.11	416	.1uF 35v	£0.12	
404	0.47uF 16v	£0.11	417	.22uF 35v	£0.12	
405	0.68uF 16v	£0.11	418	.33uF 35v	£0.12	
406	1.0uF 16v	£0.11	419	.47uF 35v	£0.12	
407	2.2uF 16v	£0.12	420	.68uF 35v	£0.12	
408	3.3uF 16v	£0.13	421	1.0uF 35v	£0.12	
409	4.7uF 16v	£0.14	422	2.2uF 35v	£0.13	
410	6.8uF 16v	£0.15	423	3.3uF 35v	£0.15	
411	10.0uF 16v	£0.16	424	4.7uF 35v	£0.18	
412	22.0uF 16v	£0.28	425	6.8uF 35v	£0.30	
413	33.0uF 16v	£0.50	426	10.0uF 35v	£0.38	

FAIRCHILD/ DARLINGTONS

TYPE	Pol	VCEO	VCBO	I.C.	HFE	CASE	£ p
2N6052	PNP	−100v	−100v	12A	750-18K	T03	1.50
2N6282	NPN	60v	60v	20A	750-18K	T03	1.25
MJ3000	NPN	60v	60v	10A	1KMN	T03	1.00
SE9300	NPN	60v	60v	10A	1000	T0220	0.90
SE9031	NPN	80v	80v	10A	1000	T0220	0.95
SE9304	NPN	80v	80v	10A	1000	T03	0.95
SE9305	NPN	100v	100v	10A	1000	T03	1.00
SE9401	PNP	−80v	−80v	10A	1000	T0220	1.10
TIP115	PNP	−60v	−60v	2A	1A	T0220	0.40
TIP117	PNP	−100v	−100v	2A	1K	T0220	0.50
TIP120	NPN	60v	60v	5A	1K	T0220	0.60
TIP121	NPN	80v	80v	5A	1K	T0220	0.65
TIP122	NPN	100v	100v	5A	1K	T0220	0.68
TIP126	PNP	−80v	−80v	5A	1K	T0220	0.70
TIP127	PNP	−100v	−100v	5A	1K	T0220	0.72

POWER SUPPLIES

137	AC-DC Adaptor 6, 7½, 9 & 12 volts	£3.75
138	DC-AC Adaptor 6, 7½, 9 volts	£2.70

CABINETS

139	Teak 30 Case	£7.00
140	Teak 60 Case	£9.50

Access and Barclaycards accepted – just telephone our Orderline – Ware (STD 0920) 3182.
All prices exclude V.A.T., add 50p postage per order. Terms: C.W.O., cheques, Postal Orders payable to Bi-Pak at addresses below.

BI-PAK
SEMICONDUCTORS

Dept. PE4, P.O. BOX 6, WARE, HERTS.
Tel: Ware (STD 0920) 3442. Telex: 817861.
Giro No. 3887006.
Visit our shop at: 3, Baldock St, Ware, Herts.

BARCLAYCARD VISA

Buy it with Access

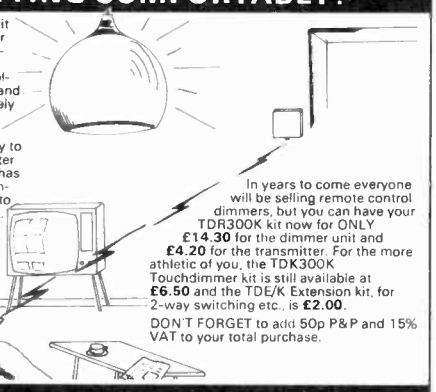
SPRING TIME IS SALE TIME

Closing date 31.4.81

6 x 555	1.00	**LEDs 0.2"**		15 x BC182	1.00
6 x 741	.90	10 each red, green, yellow	2.50	15 x BC212	1.00
IC Sockets		LM3915 + 10-element LED		4 x C106D SCR	1.10
15 x 8 pin	1.00	display	3.20	6 x CD4011 (CMOS)	1.00
12 x 14 pin	1.00	Liquid Crystal Display, 3½		**Voltage Regulators**	
10 x 16 pin	1.00	0.5" digits, d.i.l.	4.00	2 x 7805	1.00
8 x 18 pin	1.00	2 x TIC226D 8A/400V Triacs	1.00	2 x 7812	1.00
6 x 22 pin	1.00	2 x TIC236D 12A/400V Triacs	1.35	2 x 7815	1.00

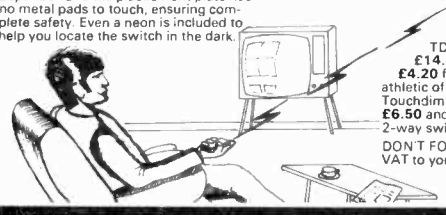
BONUS: A further 5% discount if you buy the lot. (£4.75 + VAT).

ARE YOU SITTING COMFORTABLY?



Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter.

The complete kit, which includes easy to follow instructions, will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.



In years to come everyone will be selling remote control dimmers, but you can have your TDR300K kit now for ONLY **£14.30** for the dimmer unit and **£4.20** for the transmitter. For the more athletic of you, the TDK300K Touchdimmer kit is still available at **£6.50** and the TDE/K Extension kit, for 2-way switching etc., is **£2.00**.

DON'T FORGET to add 50p P&P and 15% VAT to your total purchase.

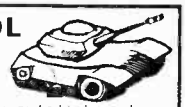
CT4000 CLOCK/APPLIANCE TIMER KIT

The CT4000 has been designed to preset the state (on or off) of four outputs at four times per day for up to 7 days in advance, enabling the unit to control tape recorders, appliances, central heating, lights, etc. The times are set on a 0.1" high red LED display by means of a keyboard and the output states are displayed on four LEDs. Each output can switch up to 20mA at 9V. For mains loads use our Solid State Relay Kit (MK2). The kit includes a PCB, keyswitches, I.C., 4 digit LED display, transformer, plus all other components and a screen printed and drilled box which can also accommodate up to 4 Solid State Relay Kits.

£25.25

Size: 10 x 12 x 4.5 cms.
Colour: Black.

THE REMOTE CONTROL STORY



ONCE UPON A TIME, if you wanted to control any equipment remotely you had to buy a dozen logic ICs, chase around the shops for crystals and expensive ultrasonic transducers and then spend a few days getting the unit to work. Then one day TK began stocking a new system. All you required was one IC, a couple of transistors, resistors and a keyboard for the transmitter and a couple of ICs plus a few capacitors for the receiver, to give you up to 16 on/off (digital) outputs or 10 channels plus three analogue (0-10V) outputs. The SL490 transmitter/encoder accepts inputs from a keyboard (up to 32 way) and encodes these into a pulse train which may be transmitted using infra red, ultrasonic, radio or even wire links. For the receiver you may use the SL480 pre-amplifier if you want an infra red link or a suitable pre-amplifier for ultrasonic or radio links, and one of the ML920 series decoders depending on the number and type of outputs required. The only adjustment you need to make is to set one preset by trial or with a 'scope, and that's all.

LD271	IR Emitting Diode	£0.36	**ML926**	16-channel receiver, 4 momentary binary outputs	£1.40
SFH205	Photodiode Detector	£0.90			
SL480	IC Pulse Amp	£1.70	**ML928**	16-channel receiver, 4 latched binary outputs	£1.40
SL490	32 Command Encoder/ transmitter	£2.40	**ML929**	16-channel receiver, 4 latched binary outputs	£1.40
ML922	10-channel receiver +3 analogue outputs	£4.20		Clip on Plastic Reflector for IR LEDs, increases range	£0.20

MEW ML925. A decoder designed for model/toy control, providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights, etc. **£2.10.**

To make things EVEN EASIER we have designed several new kits:–

MK6 Simple Infra Red TRANSMITTER. A pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery. **£4.20**

MK7 Infra Red RECEIVER. Single channel, range approximately 20 ft. Mains powered with a triac output to switch loads up to 500W at 240V ac, but can be modified for use with 5 to 15V dc supplies and transistor or relay outputs. **£9.00**

SPECIAL PRICE MK6 and MK7 together. Order as RC500K. **£12.50**

MK8 Code Infra Red TRANSMITTER. Based on the SL490, the kit includes 2 IR LEDs, measures only 8 - 2 x 1.3 cms. and requires a 9V (PP3) battery. **£5.90**

MK9 4-Way KEYBOARD. For use with the MK8 kit, to make a 4-channel remote control transmitter. For use with ML926 or ML928 Based Receivers. **£1.90**

MK10 16-Way KEYBOARD. For use with the MK8 kit, to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) Kit. **£5.40**

MK11 10 On-Off Channel IR RECEIVER with three analogue outputs (0-10V) for controlling such functions as lamp brightness, volume, tone, etc. Other functions include an on/standby output and a toggle output, which may be used for sound muting. Based on ML922 decoder IC. Includes its own mains supply. **£12.00**

MK12 16-Channel IR RECEIVER. For use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary, depending on whether the ML926 or ML928 is specified. Includes its own mains supply. **£11.95.**

MK13 11-Way KEYBOARD. For use with MK8 and MK11 kits. Transmits programme step + and - analogue + and - to normalise analogue outputs, and on/standby. **£4.35**

Now you can buy all the components you require for your infra red system or complete kits from one supplier, at unbeatable prices, and live happily ever after.

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD 50p P&P and 15% VAT TO TOTAL. OVERSEAS CUSTOMERS ADD £1.50 (Europe) £4 (elsewhere) for P&P.

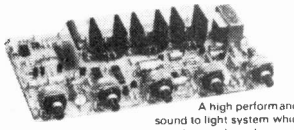
Send sae for price list and with all enquiries. Callers welcome 9.30-5.00 (Mon-Fri) 10.00-4.00 (Sat.).

TK Electronics

(P.E.), 11 Boston Road, London W7 3SJ. TEL. 01-579 9794

3 CHANNEL SOUND/LIGHT CHASER

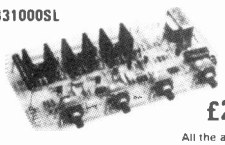
LB31000SLC **£32.70**



A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/channel. 5Hz to 70K. Controls bass/mid/treble/master sensitivity/chase speed.

3 CHANNEL SOUND/LIGHT

LB31000SL



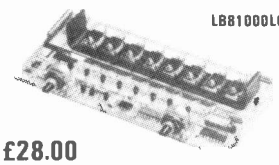
£22.70

All the advantages of the SLC without chase

Controls bass/mid/treble/master sensitivity

2/4/8 CHANNEL CHASER

LB81000LC

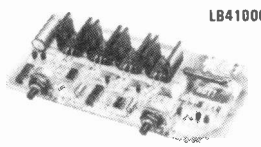


£28.00

An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswitch trigger and module cascading (16 24 32 channel, etc.), chase speed and re-cycle delay

4 CHANNEL SEQUENCER

LB41000LS

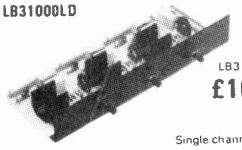


£19.20

A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls cross effect to provide settings between seconds and rapid burst

1 AND 3 CHANNEL DIMMERS

LB31000LD



LB31000LD **£16.20**

Single channel version LB11000LD **£7.20**

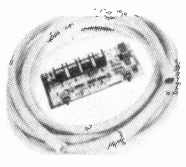
Power dimmer units for theatre/stage applications up to 1,000W per channel, with on board suppressing. The unit is also available without rotary pots for use with sliders —

LB31000LD (no pots) **£15.00** Sliders **75p** each

ROPE LIGHTS/DRIVER

LB41000LC-S

£24.20



24 feet ropes
Red/Yellow
Blue/Green

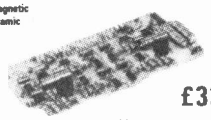
ROPE LIGHTS **£45.40**

A four channel chaser up to 1,000W per channel with a sound trigger facility. The music input signal modulates the speed of the chase giving an excellent sound/light effect. The unit will control up to 10 ropes with chase speed and trigger level control

STEREO DISCO MIXER/PREAMP

LBPA3

M – Magnetic
C – Ceramic



£33.70

Magnetic or ceramic deck versions – please state

All the requirements of a stereo disco preamp on one board. left and right deck mixers/tone controls/mic mixer/tones/mic auto fade over decks/and P.F.L. The unit can be used with either LB100/150/250.

Full set of pots — **£8.63**

LBPA2 **£17.20**

A four channel mixer and tone stage for mics guitars etc. Can be used with any LB amps. Set of pots £2.74.

LBPA1 **£19.50**

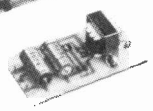
A stereo hi-fi preamp and tone stage for mag. p.u./tape/tuner etc. Set of pots £3.27.

3-WAY ACTIVE CROSSOVER

LBAC01

£17.90

LBPSU1 **£7.20**



Bass/mid/treble active crossover with stage booster! Available with crossover points of 200 or 300Hz and 2K or 3KHz (please specify) LBPSU1 supply for LBAC01. (1 or 2).

POWER AMPLIFIERS

Tough dealing power amps for use in sound systems. Open/short circuit protection and fused. Heavy gauge heatsinks and rugged o/p devices (all operate down to 4 ohms)

25W R.M.S.	100W R.M.S.	150W R.M.S.	250W R.M.S
20Hz to 60K	5Hz to 25K	5Hz to 25K	5Hz to 25K
0.07% THD	0.1% THD	0.1% THD	0.1% THD
96DB S/N	110DB S/N	110DB S/N	110DB S/N
LB25	LB100	LB150	LB250
£11.20	**£19.70**	**£29.20**	**£43.50**

Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering

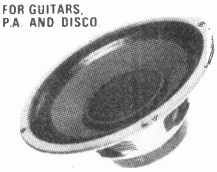
LBRLD1 **£6.20**

A.de thump unit for use with any LB power amps

POWER AMP POWER SUPPLIES

LB25PS	LB100PS	LB150PS	LB250PS
£11.20	**£16.20**	**£19.00**	**£26.50**
P/P £1.20	P/P £1.40	P/P £1.40	P/P £1.70

FOR GUITARS, P.A. AND DISCO



PIEZO HORNS **£5.75** P/P 50p

CELESTION LOUDSPEAKERS (ALL STANDARD CONE 8 OHMS)

G10-50	G12-65	G12-100	G15-100
(10 inch 50W)	(12 inch 65W)	(12 inch 100W)	(15 inch 100W)
£14.70	**£20.70**	**£26.45**	**£36.45**
P/P £1.70	P/P £1.70	P/P £1.70	P/P £2.00

NEW – MINI MODULES – NEW

Ingeniously designed mini pre-amplifier 'building blocks' for use in music and P.A. applications. You choose the type and number of units you require for your particular system and mount each module via its control direct onto your panel

LBMM1 Pre-amp for mics guitars etc
LBMM2 Mixer for up to 6 LBMM1/2/3/4/5
LBMM3 Bass/boost/cut for either LBMM1/2/3/4/5
LBMM4 Mid-boost/cut for either LBMM1/2/3/4/5
LBMM5 Treble boost/cut for either LBMM1/2/3/4/5
LBPSU1 ± 15V supply for up to 12 modules
LBPSU ± 15V regulated for up to 50 modules

MM1 £4.50; MM2 £5.20; MM3 £5.70; MM4 £5.70; MM5 £5.70; PSU1 £7.20; RPSU £14.50.

Discount on MM1/2/3/4/5 10 to 24 – 20%, 25+ – 30%

Each module is manufactured from the highest quality components fully tested, supplied with a connection and circuit diagram and guaranteed for twelve months

All prices shown are VAT inclusive. Please include 50p post/packing except where individually stated. To mail order send cheque/P.O./registered cash or Access number. C.O.D. service £1 extra. For the new Autumn catalogue send 50p (Full spec. shown)

PLEASE NOTE THIS COMPANY HAS NO CONNECTION WITH LB ELECTRONICS OF HILLINGDON

L & B
ELECTRONIC MODULES

PROFESSIONAL ENGINEERING BY PROFESSIONALS

45 Wortley Road, West Croydon, Surrey CR0 3EB. Tel. 01-689 4138

We use advanced winding technology to make our toroidal transformers. They have only half the weight and height of their laminated equivalents and are appreciably more efficient. Our toroidals cost virtually the same as the older types which they are rapidly replacing. Induced hum is reduced by a factor of ten. *Supplied with rigid mounting kit with centre bolt, steel and neoprene washers.*

30VA
70mm dia. × 30mm Weight 0.45 Kg **£4.71** *(+£1.20 p.p. +0.89 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
1X010	6 + 6	2.50
1X011	9 + 9	1.66
1X012	12 + 12	1.25
1X013	15 + 15	1.00
1X014	18 + 18	0.83
1X015	22 + 22	0.68
1X016	25 + 25	0.60
1X017	30 + 30	0.50

50VA
80mm dia. × 35mm Weight 0.9 Kg **£5.19** *(+£1.30 p.p. +0.97 VAT)*

2X010	6 + 6	4.16
2X011	9 + 9	2.77
2X012	12 + 12	2.08
2X013	15 + 15	1.66
2X014	18 + 18	1.38
2X015	22 + 22	1.13
2X016	25 + 25	1.00
2X017	30 + 30	0.83
2X028	110	0.45
2X029	220	0.22
2X030	240	0.20

80VA
90mm dia. × 30mm Weight 1 Kg **£5.76** *(+£1.50 p.p. +£1.09 VAT)*

3X010	6 + 6	6.64
3X011	9 + 9	4.44
3X012	12 + 12	3.33
3X013	15 + 15	2.66
3X014	18 + 18	2.22
3X015	22 + 22	1.81
3X016	25 + 25	1.60
3X017	30 + 30	1.33
3X028	110	0.72
3X029	220	0.36
3X030	240	0.33

120VA
90mm dia. × 40mm Weight 1.2 Kg **£6.72** *(+£1.60 p.p. +£1.25 VAT)*

4X010	6 + 6	10.00
4X011	9 + 9	6.66
4X012	12 + 12	5.00
4X013	15 + 15	4.00
4X014	18 + 18	3.33
4X015	22 + 22	2.72
4X016	25 + 25	2.40
4X017	30 + 30	2.00
4X028	110	1.09
4X029	220	0.54
4X030	240	0.50

160VA
110mm dia. × 40mm Weight 1.8 Kg **£8.88** *(+£1.80 p.p. +£1.60 VAT)*

TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
5X012	12 + 12	6.66
5X013	15 + 15	5.33
5X014	18 + 18	4.44
5X015	22 + 22	3.63
5X016	25 + 25	3.20
5X017	30 + 30	2.66
5X018	35 + 35	2.28
5X028	110	1.45
5X029	220	0.72
5X030	240	0.66

225VA
110mm dia. × 45mm Weight 2.2 Kg **£10.59** *(+£1.90 p.p. +£1.87 VAT)*

6X014	18 + 18	6.25
6X015	22 + 22	5.11
6X016	25 + 25	4.50
6X017	30 + 30	3.75
6X018	35 + 35	3.21
6X026	40 + 40	2.81
6X028	110	2.04
6X029	220	1.02
6X030	240	0.93

300VA
110mm dia. × 50mm Weight 2.6 Kg **£12.27** *(+£2.00 p.p. +£2.14 VAT)*

7X016	25 + 25	6.00
7X017	30 + 30	5.00
7X018	35 + 35	4.28
7X026	40 + 40	3.75
7X025	45 + 45	3.33
7X028	110	2.72
7X029	220	1.36
7X030	240	1.25

500VA
140mm dia. × 60mm Weight 4 Kg **£16.35** *(£2.10 p.p. + £2.77 VAT)*

8X017	30 + 30	8.33
8X018	35 + 35	7.14
8X026	40 + 40	6.25
8X025	45 + 45	5.55
8X033	50 + 50	5.00
8X028	110	4.54
8X029	220	2.27
8X030	240	2.08

• I.L.P. TOROIDAL TRANSFORMERS ARE GUARANTEED FOR 5 YEARS

CHOICE OF 3 PRIMARY INPUTS

I.L.P. Toroidal Transformers are available in choice of 110V, 220V, 240V, coded as follows: (Secondaries can be connected in series or parallel)

For 110V Primary insert 0 in place of "X" in type number.
For 220V Primary (Europe) insert 1 in place of "X" in type number.
For 240V Primary (U.K.) insert 2 in place of "X" in type number

Example – 120VA 240V 15 + 15V. 4A = 42013.

*** CUSTOMER DESIGN ENQUIRIES INVITED. QUANTITY PRICE LIST AVAILABLE.**

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Simply address envelope to **FREEPOST** to address below. NO STAMP REQUIRED.

TO ORDER *Enclose cheque/Postal Order/Money Order payable to I.L.P. Electronics Ltd or quote your ACCESS or BARCLAYCARD account No. To pay C.O.D. add £1 extra to TOTAL value of order.* **Also available from ELECTROVALUE and MARSHALLS.**

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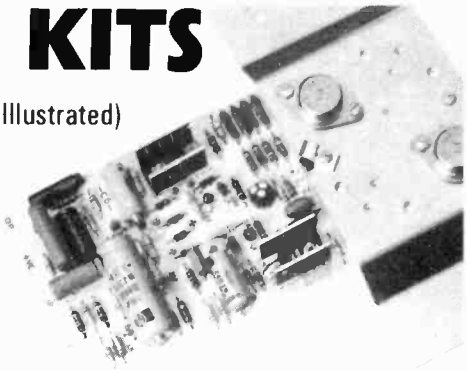
HIGH POWER MODULE KITS

125 WATT MODEL £10.50 plus £1.15 p&p (Illustrated)

200 WATT MODEL £14.95 plus £1.15 p&p



SPECIFICATIONS

Max. Output power	125 watt RMS
Operating voltage (DC)	50-80 Max.
Loads	4-16 ohms
Frequency response measured at 100 watts	25Hz-20KHz
Sensitivity for 100 watts	400mV @ 47K
Typical T.H.D. @ 50 watts 4 ohms load	0.1%
Dimensions	205 x 90 and 190 x 36 mm

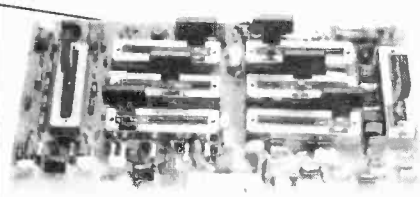
The P.E. power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chasis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

ACCESSORIES

Suitable LS coupling electrolytic for 125W model	£1.00 plus 25p p&p.
Suitable LS coupling electrolytic for 200W model	£1.25 plus 25p p&p.
Suitable Mains Power Supply Unit for 125W model	£7.50 plus £3.15 p&p.
Suitable Twin Transformer Power Supply for 200W model	£13.95 plus £4.00 p&p

MULLARD LP1183 STEREO PREAMP FREE!

Original listed price over £5.00. Suitable for ceramic and auxiliary inputs, when you purchase 2 power module kits.



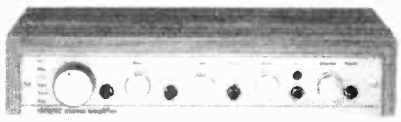
PRACTICAL ELECTRONICS CAR RADIO KIT (Constructors pack 7)

2 WAVE BAND MW LW
* Easy to build * 5 push button tuning
* Modern styling design * All new unused components
* 6 watt output * Ready etched & punched P.C.B.
* Incorporates suppression circuits * Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards
Complete with instructions. **£10.50** plus £2.00 p&p

CONSTRUCTORS PACK 7A

Suitable stainless steel fully retractable locking aerial and speaker (approx. 6" x 4") is available as a kit complete **£1.95** per pack. p&p £1.15



30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30 + 30 watts. RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14¾" x 10" approx.

READY TO PLAY £32.90 plus £3.80 p&p

HI FI STEREO AMPLIFIER MODULES

- Mullard LP1183 built preamplifier suitable for ceramic and auxiliary inputs. **£1.95** plus 70p p&p.
- Mullard LP1184 built preamplifier suitable for magnetic/ceramic and auxiliary inputs. **£4.95** plus 80p p&p
- Matching I.C. 10 + 10 Stereo Power amplifier kit. **£3.95** plus £1.15 p&p
- Matching power supply kit with transformer. **£3.00** plus £1.96 p&p
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes. **£1.70** plus 80p p&p.
- Complete with application notes.

£14.95 plus £2.90 p&p

10+10 WATT STEREO AMPLIFIER KIT

- Featuring latest SGS/ATES TDA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection.
- Mullard Stereo Preamplifier module.
- Attractive black vinyl finish cabinet. Size 9" x 8⅜" x 3⅝" approx.
- Converts to a 20 watt Disco amplifier.

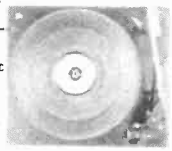
To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amplifier assembly kit and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs and contrasting ready made black vinyl finish cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.

SPECIFICATIONS

Suitable for 4 to 8 ohms speakers

Frequency responce	40Hz — 20KHz
Input Sensitivity	P.U. 150mV Aux. 200mV Mic. 1.5mV
Tone controls	Bass ± 12db @ 60Hz Treble ± 12db @ 10KHz
Distortion	1% typically @ 4 watts
Mains supply	220-250 volts 50Hz

BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge. **£8.50** plus £3.15 p&p when purchased with amplifier.
Available separately **£10.50** plus £3.16 p&p



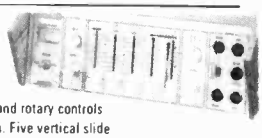
8" SPEAKER KIT 2 8" approx. twin cone domestic use speakers. **£4.75** per stereo pair plus £1.70 p&p when purchased with amplifier. Available separately **£6.75** plus £1.70 p&p

STEREO MAGNETIC PRE-AMP CONVERSION KIT. All components including P.C.B. to convert your ceramic input on the 10+10 amp to magnetic. **£2.00** when purchased with kit featured above. **£4.00** separately inc. p&p.

STEREO DISCO PREAMPLIFIER

matching above modules, suitable for twin deck mixing with P.F.L. output and Mic/Tape input.
Ready built, ready to play with circuit diagram and application notes to suit our power module kits. **£21.95** plus £1.72 p&p

100 WATT MONO DISCO AMPLIFIER



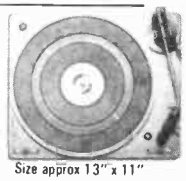
Brushed aluminium fascia and rotary controls
Size approx 14" x 4" x 10¼. Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level.
Output 100 watts RMS 200 watts peak. **£76.00** plus £4.60 p&p

50 WATT MONO DISCO AMPLIFIER

Size appox 13⅜" x 5¼" x 6¾" 50 watts rms 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

£30.60 plus £3.68 p&p

BSR Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco use.



£12.25 OUR PRICE plus £3.16 p&p Size approx 13" x 11"

PHILLIPS RECORD PLAYER DECK GC037

Size approx 15¼" x 12¼"

Hi Fi record player deck, 2 speed, damped cueing, auto shut-off, belt drive with floating sub chassis to minimise acoustic feedback. Complete with GP401 stereo magnetic cartridge—*LIMITED STOCK*.
UNBEATABLE OFFER AT
£27.50 complete plus £3.16 p&p

R T V C

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ACTON: Mail Order only. No callers

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For further information send for instructions 20p plus stamped addressed envelope.

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PE VOLUME 17 No. 4 APRIL 1981

A GOOD CASE . . .

THOSE of you who have already looked further into your copy will by now be aware that our May issue is a very special one (others turn to page 36—when you have finished this piece please!) When planning our free case one of our intentions was to present as wide a variety of digital projects to fit in the case as possible. Another factor that influenced our decision to go ahead with this rather expensive gift, in the face of the present recession, was the relatively simple construction of each project.

The use of what is probably the first of a new generation of panel meters has resulted in very high performance projects which are not expensive, are readily constructed and neatly housed. The free case was designed especially for PE by Lascar Electronics and, as far as we know, is the only case of this type available in the UK at the present time. Because you will get one free you will save over £2·00 on the project cost and our *DPM Special Offer* will save you a further £3·00 on the normal price.

Taking all these factors into account we believe that we can appeal to the widest possible range of readership and thus make the most of our primary intention—to sell more copies. Yes, it's a hard world and we do publish to make money, although we can easily lose sight of that fact in our enthusiasm for electronics and for PE in particular. Of course we believe PE is excellent value for money anyway, but on this special occasion it will be even more attractive, so please make sure of your copy by ordering it now.

. . . LAID BEAR!

Having just worked our way through that lot of (hopefully) logical thinking and confidently believing we can introduce some new readers to PE, we received the following letter trusted to the tender care of a Paddington Bear envelope:

"Dear Sir or Madam,

*In November 1974's Practical Electronics you published the "*PE Minisonic*" by G. D. Shaw.*

My dad has a collection of your magazines, but unfortunately has not got all the parts. So could you please send me the circuit diagram for this very good battery operated synthesiser.

I enclose a stamped addressed envelope for your reply.

Yours sincerely,
Robert Brooks.

PS. I am twelve years old."

Thank you Robert for an excellent letter, unlike many older readers you have given your name and address clearly—you'd be surprised how many people forget all, or part of it—supplied a stamped addressed (Paddington) envelope—without any marmalade on it—set out your letter clearly, kept to one subject and even given us a little praise—all others please follow Robert's example.

The only thing that worries us is why do we bother about easy to build projects to interest new readers if you are building the *PE Minisonic* at the age of 12? You have just messed up all that logical thinking!

We would be interested in hearing from other young readers, we cannot promise to answer all the letters, but why not tell us how you first started reading PE and what type of projects and articles you like.

Mike Kenward

PS. I'm not telling you my age.

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

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

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers
Copies of some of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders
Binders for PE are available from the same address as back numbers at £4·30 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £11·80 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

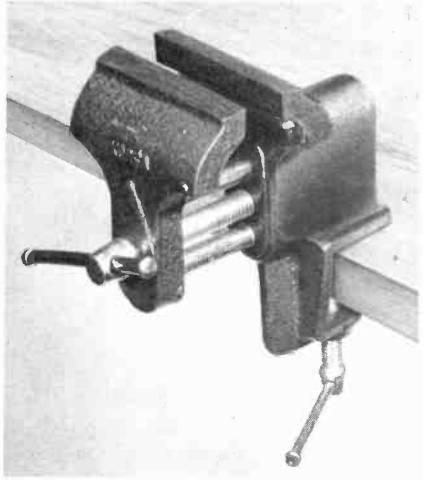
Market Place

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 David Shortland and Jasper Scott

BUDGET VICE

This portable bench vice, pictured below, is now available from Home Radio. The jaws open to a maximum of 32mm and it can be fitted to benches up to 24mm thick, so it should be suitable for most light constructional work.



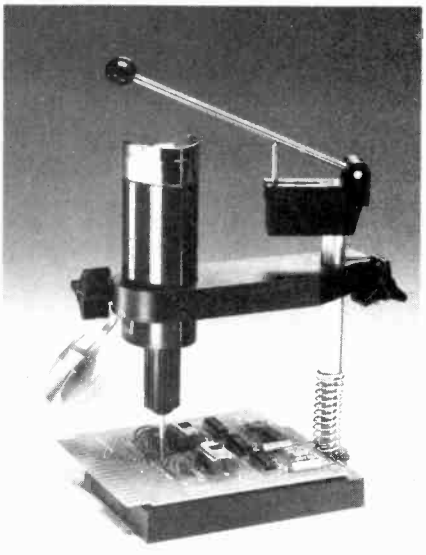
The price including VAT and p&p is £3·87.

Home Radio (Components) Ltd, PO Box 92, 215 London Road, Mitcham, Surrey (01-543 5659)

DRILLMASTER

Two new mini drills ideal for use with our minidrill p.s.u. are being marketed by Microflame together with a complete range of accessories which include a drill stand with a built in magnifying glass.

The junior model features a detachable chuck finger shield for close control and the chuck itself has four precision cut steel collets (0·6, 1·2, 1·8 and 2·4mm). An automatic 3-jaw chuck is available as an optional extra.



The senior model is supplied with an automatic 3-jaw chuck and a precision chuck with 5 collets is available as an optional extra (0·6, 1·2, 1·8, 2·4 and 3·2mm).

The price of the junior model is £10·00 and the senior model is £17·35. All prices exclude VAT and p&p.

Microflame (UK) Limited, Vinces Road, Diss, Norfolk (0379 4813).

SOAR DFM

Many people who consider digital frequency meters just too expensive to be considered for inclusion in their range of test equipment will be interested to hear about the Soar DFM. The importers of this Japanese instrument claim they have done so because of the non-availability of a low priced high quality UK meter.

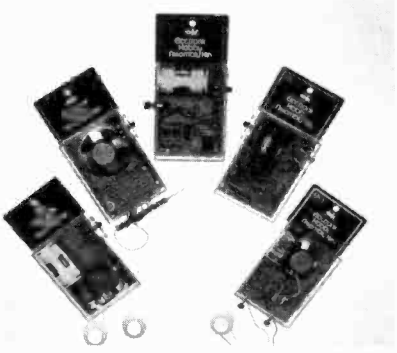
The unit which measures only 100×32×120mm has a frequency range of 10Hz to 50MHz and can measure up to 500MHz with a prescaler. Powered by either 4 penlight batteries or an external d.c. supply (8 to 11V) the instrument has a 4 digit display and a resolution of 10Hz/10kHz with a maximum input of 20V.

The DFM is priced at £39·99 including VAT. For £43·58 the DFM is available with batteries, input lead carriage and insurance.

Holdings, Mincing Lane, Darwen Street, Blackburn BB2 2AF (0254 59595).

KITS FOR BEGINNERS

A range of simple chip based hobby kits with step-by-step instructions has been introduced by OK Machine & Tool. OK say that the kits are suitable for 12 year olds upwards, with descriptions of the various terms and components used in electronics included in the instructions. Once assembled, the kits fit into their original plastic packaging containers.



Five kits are available, Quick Reaction (£5·80), Electronic Dice (£7·98), Digital Roulette (£8·60), Morse Code (£3·99) and Electronic Organ (£6·70). All prices include VAT and p&p and items are available by mail order or by placing a credit card order over the telephone. Prices do not cover batteries or tools.

OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA (0703 610944)

CATALOGUES

Howard Associates have just released a short form catalogue which covers a range of PE projects such as the Solid State Car Instruments, Speech Processor, 27/28MHz Converter, DFM, Sound Operated Switch and the Dynamic Semiconductor Tester.

Part kits are available and Howard can also provide individual component price lists.

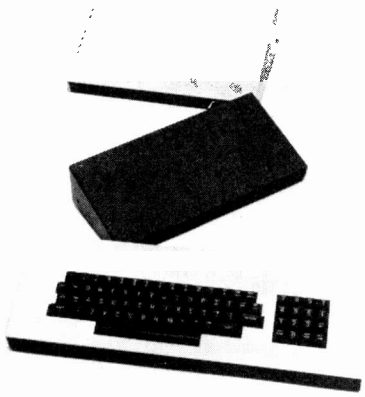
The catalogue is available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT13 9SU.**

Another shortform catalogue just available is from Lascar Electronics. It contains their complete range of digital panel meters, counter timers and portable instruments. Also listed is a 12/24hr clock module and l.c.d. and l.e.d. thermometers which will measure temperatures between −55° to +150°C with a resolution of 0·1°C.

Lascar Electronics, Unit 1, Thomasin Road, Basildon, Essex (0268 727383)

KEYBOARD CONSOLES

Boss Industrial Mouldings have recently introduced three medium sized keyboard consoles into their BIM 7400 range. This range now consists of six case sizes from 355 to 508mm wide by either 178 or 254mm deep and with a rear panel depth of 102mm. The front panel is inclined by 10 to 15 degrees for easier key operation.



The consoles are of all aluminium construction and incorporate ventilation slots in both rear and bottom panels with a gasket fitted between the panels to reduce vibration.

Prices for the range are from £16·05 to £26·33 excluding VAT.

Boss Industrial Mouldings Ltd., 2 Herne Hill Road, London (01-737 2383).

DRAUGHTING AIDS

Constructors who like to produce their own p.c.b.s will be interested in the latest range of etch resistance transfers from Ace Mailtronix. The transfers which include straight or curved tracks, transistor, d.i.l. solid, oval, square and terminal pads are available either in sets of five sheets of a type or a mixed bag of six sheets including an introduction sheet. The transfers which are printed on 115×105mm sheets are available in a 1:1 scale for use directly onto copper clad boards or in a 2:1 scale for those with photograpic reduction facilities, Ace can also supply black crepe paper track tape in various widths for constructors with UV light boxes.

For a free catalogue of the complete range send a stamped addressed envelope (9×4ins).

Ace Mailtronix Ltd., 3A Commercial Street, Batley, West Yorkshire, WF17 5HJ.

AUDIO-SAFE

The latest protection system for cars is the audio-safe unit which the makers claim makes the unauthorised removal of an in-car entertainment system virtually impossible.

The unit is a two part system: a base plate which replaces the usual dashboard trim plate and a cast aluminium cover that fits over the equipment and is secured to the replacement

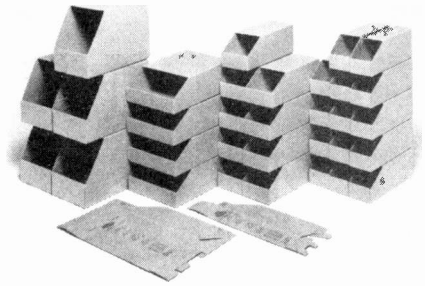
panel by means of an individual locking key.

When locked together access to the mounting nuts, securing the equipment, is prevented. In fact the equipment itself cannot be seen.

The audio-safe will sell for around £25·00 from retailers.

STORAGE CASES

A new range of component containers has been added to the large range already carried by Trade Aids. The containers which are made of laminated board are light, strong and easily folded flat for storage. They are available in four sizes from 380×100×133mm



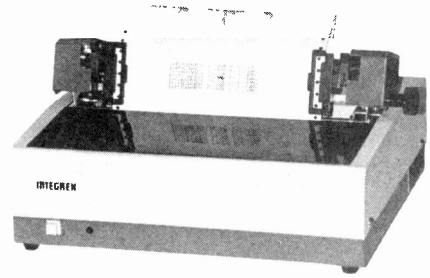
to 380×210×266mm with prices ranging from 24p to 50p ex. VAT and p&p.

Trade Aids, 54–56 Hawkes Road, Kingston upon Thames, Surrey, KT1 3FF. (01-549 2137)

COLOUR PRINTER

Integrex have recently announced the introduction of their new low cost impact Colour Matrix Printer, model CX80.

Printing in 7 colours (with simple control codes) and with 96 ASCII plus 64 graphics characters in ROM, the CX80 is fully dot ad-



dressable, has 15 user programmable characters together with double length and reverse character printing.

The retail price is £895 plus VAT, and further information is available from:

Integrex Ltd., Portwood Industrial Estate, Church Gresley, Burton on Trent, Staffs. (0283 215432)

FUELSTRETCHER

The latest in-car monitor is the Fuelstretcher Drive Computer which will give an instantaneous m.p.g. indication as well as helping with route planning, record keeping and trip scheduling.

The computer processes and stores information received from the fuel flow and speed sensors. This information which is given on a 4 digit l.e.d. display shows the driver how much fuel has been used, elapsed time and distance travelled on a particular trip or on a weekly or monthly basis.

The makers claim the unit is as easy to install as a car stereo and should take no more than two hours. All the motorist has to do is to fit the fuel sensor into the fuel line, speed sensor to the drive shaft and then connect both to the computer unit.

The computer, complete with wiring, optional mounting bracket, instruction manual, fuel flow and speed sensors can be obtained directly from EnviroSystems for just over £80·00.

EnviroSystems Ltd., Hampsfell Road, Grange-over-Sands, Cumbria, LA11 6BE (044 84 4233).

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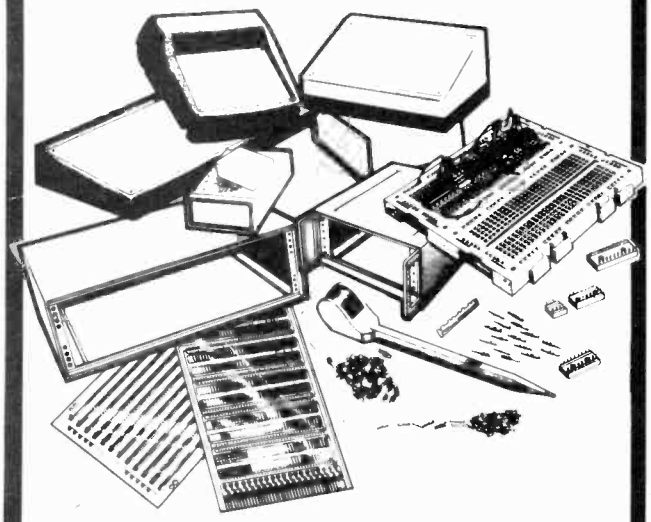

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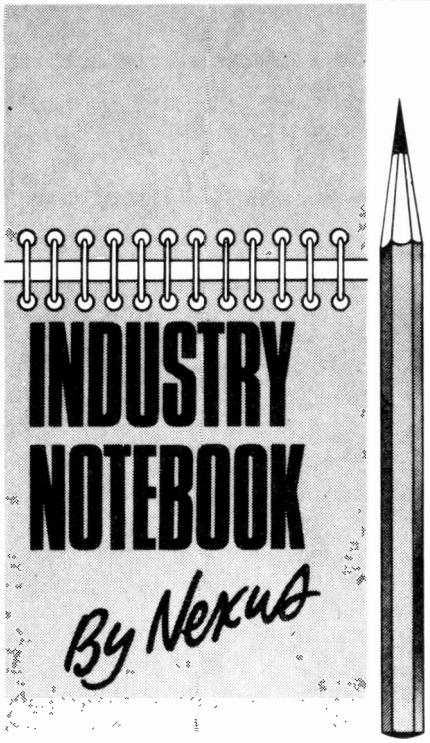


New Style Office

"- - - - - a transition to twentieth century from nineteenth century office technology is not easily or quickly achieved."

You might suppose the quotation above was taken from a text written, say, in 1905 and referring to then new-fangled ideas like the telephone. Actually, it was written in 1980 and published in January 1981 and is from a case history on the introduction of word processing. It implies that office methods haven't changed much in over 80 years and carries a stern warning of hazards ahead.

Word processing is now a boom area for manufacturers and equipment suppliers. But the potential user had better be wary. It is all too easy to stumble into the trap experienced by those bold enough to invest in data processing in the 1960s. In those days persuasive sales talk and extravagant claims for economy as well as efficiency only too frequently led to hasty installations, muddle, inefficiency and high costs. The jokes about computers all but disappeared as computer science attained maturity. Early hilarity has been supplanted by the menace of computer fraud—no laughing matter.

Now that we are all accustomed to, even conditioned to, data processing, a transition to word processing ought to be comparatively easy and painless. And, one would have thought, demonstrably so as an office has a well understood structure and purpose.

Not so, according to this case history. The authors went back to first principles and asked themselves what an office is and what it does. They found that in their own case that different departments organised their affairs quite differently and often to suit the personal needs of executives and secretaries as well as particular characteristics of the work undertaken.

There were more than 20 departments employing some 1,500 staff, half in London, originating over 1·2 million pages of text on A4 paper per year. When they looked at what people did they discovered that 150 person-years of time which should have been available for profit-earning professional tasks was being frittered away on internal administration. In fact the biggest savings would not be in reduction of secretarial costs but in gains of management time.

When it came to selecting a system it was found that over 30 suppliers offering over 50 different systems were available. Whittling these down to a short-list and final selection was no easy task.

The investment was eventually some £700,000 for the London office and an equal amount for the provincial offices, making a grand total of £1·4 million. The payback period was calculated as two years or less.

There is no space to describe all the development of software, training of staff, integration of the system with existing data processing facilities, or possible future expansion of the word processing system in terms of both size and newer technology as it becomes available. Or of how the system was progressively introduced, section by section, of 85 work stations without disruption of the daily work schedule.

The conclusion is that word processing is available now and is cost-effective. There is no mention of staff redundancy so that one assumes that payback in this case is added capacity for throughput which can only pay with an increase in business. In other words, while there are no immediate redundancies there should be no need to expand the staff for a long time ahead.

While this picture looks bleak for office workers, the other side of the coin is a huge new market for the electronics industry in manufacturing, installation, servicing and, eventually, a substantial replacement market, not to mention armies of software specialists.

Albert Einstein is recorded as having said: "If we look hopefully upon the shape of things to come, we can visualise automation as the greatest blessing mankind has ever known." I can only add that it seems a pity that the implementation of such a blessing is so painful.

Inertia

As a counterweight to the above an eminent engineer last year was remarking that although technology continues to advance it was slow in introduction and had had little real effect on our daily life pattern. As examples he quoted that people still commuted every day in great discomfort and read newspapers produced and distributed in the same manner as in the early part of the century.

How true! But he, too, is expecting big changes. What he was describing was that today there is practically no technical limitation to what can be achieved. The only real barrier to change is that people are conservative by nature.

Expansion

Ten years ago Aberdeen Airport was a busy terminal handling 30,000 aircraft movements per year of which 4,000 were helicopters. This year the projected movements are 130,000 including 53,000 helicopter movements. A new runway was laid down in 1977 and a new control tower added in 1979. Latest addition is a comprehensive CCTV system for monitoring apron parking, refuelling and baggage handling areas.

Such has been the impact of North Sea oil. The spin-off for the electronics industry is substantial and not only at Aberdeen.

Exploration, drilling, pumping, data logging, communications at sea are all huge markets benefiting the industry. It is interesting to note that in an analysis of the performance of the FT 30 Ordinary Share Index over the past three years that the oil giant BP is a notable high flyer with a gain of 90 per cent showing the strength of oils. But BP comes only third. Runaway winner is Plessey with a gain of 170 per cent since 1978 and GEC a creditable second-placer up 117 per cent.

There are some doubts on whether the government can maintain the promised level of defence spending and this could have an effect on both GEC and Plessey prospects with some major projects. But both these companies have a wide spread of activities and any programme reductions or delays are not likely to have a great effect.

In fact the outlook for electronics has never been brighter. One market analyst, Mackintosh, is forecasting an overall European growth rate of 12 per cent through to 1984 and that the UK will increase its market share.

The British Electrical and Allied Manufacturers' Association (BEAMA), which includes heavy electricals as well as electronics firms in membership, reported a 17 per cent rise in exports over the first nine months in 1980. In the same period, imports were up only 10 per cent.

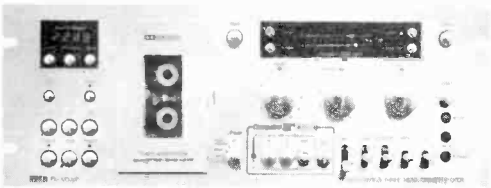
ATE.

Automatic test equipment (ATE) continues to thrive. Marconi Space and Defence Systems are supplying equipment for the Middle Eastern military base workshop. The contract is worth £2·5 million and the equipment supplied will be used to check out 150 p.c.b.s, sub-assemblies and other electronic units on main battle tanks.

On a more modest scale a Racal ATE worth £64,000 has gone into service with audio engineers Neve, who make sound mixing consoles for broadcasting and other high quality applications. Manual testing of a complex Neve p.c.b. takes as long as $3\frac{1}{2}$ hours. The Racal ATE does the same job in five minutes.

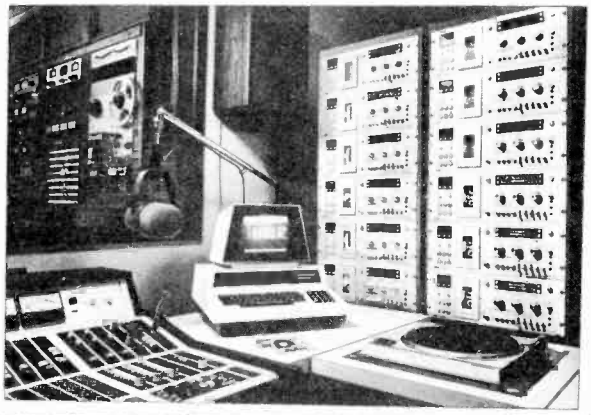
CONSUMER ELECTRONICS SHOW

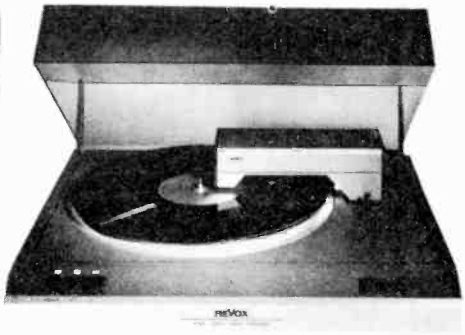
A gallery of impressions from the Consumer Electronics Show held in Las Vegas, January 1981.



Claimed to be the world's first computer connectable cassette deck, the Eumig FL-100. Built-in microprocessor enables on-tape indexing of sound tracks.

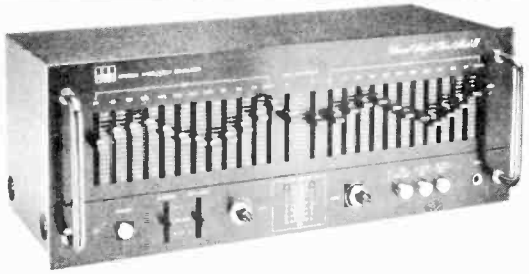
Twelve FL-1000s under computer control in an automated broadcast. *Photos courtesy of Eumig.*





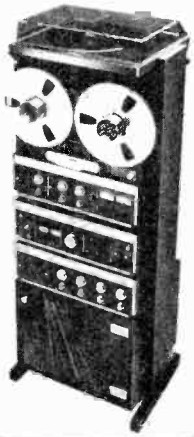
New Revox B795 direct drive turntable with Linatrak tangential tracking system. Motors are controlled by Hall effect sensors via quartz-referenced phase locked loops. *Courtesy Studer Revox America Inc.*

More conventional than the deck shown above—or is it? All operations are computer supervised, and controlled entirely at the fascia so that the dust cover stays down. The new FR–D45 turntable, *courtesy of Sansui.*



BSR's ADC Sound Shaper Two Mark III, with l.e.d. slide controls, each with defeat switch for individual on/off. Unit includes 12 frequency controls of 24dB range per channel. *Courtesy BSR (USA) Ltd.*

Not a two-faced grandfather clock, but the Revox Audio Rack. Galvanized steel to give strength, oak veneer to give finish. *Courtesy of Studer Revox.*



The world's most expensive stereo receiver, or so it is claimed, is the Revox B780. Incorporating a 70W per channel amplifier and quartz-controlled synthesizer FM tuner, the entire system is based on advanced technology. The unit also uses a microprocessor to manage the 18-station recall memory (with back-up battery). Specification is top line, and a Dolby FM circuit card can be user-installed. Suggested list: $2699.

Ultra-lightweight headphones by Mura. Weighing just 1·6 oz, the "Red Set" phones employ samarium-cobalt drivers. *Courtesy of Mura Corp.*

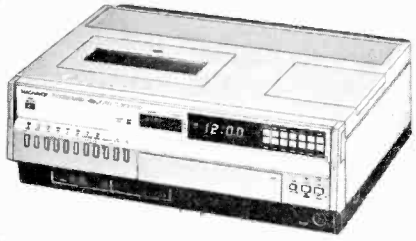
The Akai mini-component system, UC–3. The amplifier produces 45W of power per channel. *Courtesy of Akai America Ltd.*

Dimensions
UC-U3 mini-amp:
11 in. wide, 4 in. high, 10 in. deep
Cassette deck:
11 in. wide, 4 in. high, 10 in. deep
UC-S4 AM/FM
digital tuner:
11 in. wide, 2 in. high, 10 in. deep

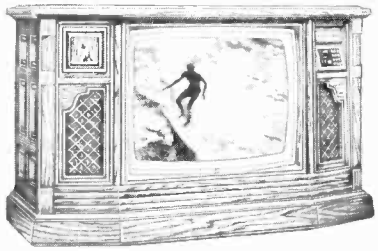
Put a tape of any oxide formulation into this cassette deck, and the on-board computer will have adjusted to correct bias, equalisation and sensitivity within seconds. Functions are solenoid (logic) controlled. The fluorescent bar meter allows for peak hold, and Dolby noise reduction is included in the GX-F95. *Akai America Ltd.*

Selling the concept of psychoacoustics, "Doc" Cavalier of Omnisonix Ltd. says of his Imager . . . "far more dramatic than the performance of a dynamic range expander". Shown here is the 801-A, intended for automobile hi-fi. *Courtesy of Omnisonix Ltd.*

The Bearcat 150 synthesised scanner, featuring 10-channel memory, fluorescent display and membrane keypad operation. Frequency ranges from 30 to 512MHz, covering 5 bands.

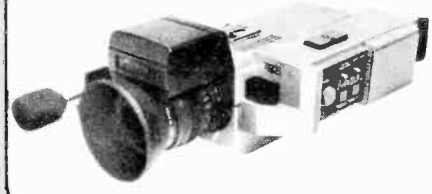


Magnavox 14-day programmable touch-tune VHS VCR, model 8340 portable. Features frame by frame advance, variable slow motion, stop action, fast motion and picture search; fascia or remote control.

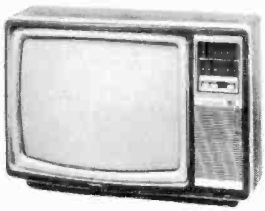


Leading edge technology concealed in a "Mediterranean" styled colour TV. Model 5056 in Pecan, by *Magnavox.*

Described as the *unconventional* colour video camera, Akai's VC-X1 features auto-focus, whereby the camera adjusts itself relative to the main subject matter. The equipment can handle close-up and low light level work. *Photo courtesy of Akai.*

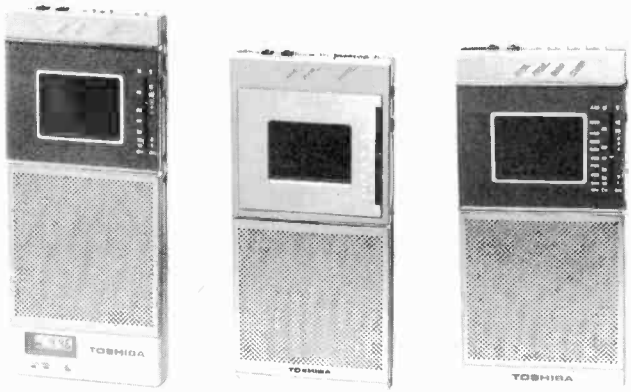


Magnavision laser-optical videodisc player. Forward, reverse, speed and search facilities, plus choice of bi-lingual-or-stereo, are built in. Video discs are immune to dust and scratches. *Courtesy of Magnavox.*



Today's look in television. The CB–954 is one of the latest family of 19 inch sets from Toshiba. Picture improvement results from the following: Electronic Noise Cancellor, Automatic Dark Picture Intensifier, and a White Detail Purifier. *Photo courtesy of Toshiba America Inc.*

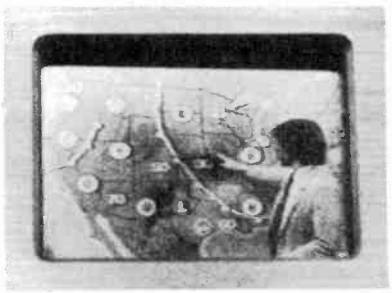
POCKET TELEVISION WITH LIQUID CRYSTAL SCREEN



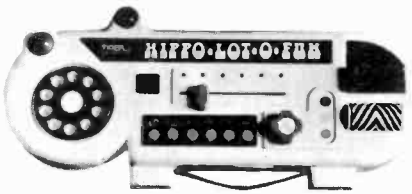
The star revelation at Las Vegas was undoubtedly three hand-held UHF–VHF TVs, whose monochrome pictures are produced on flat-screen l.c.d.s. Each unit measures an amazing 6·8 x 3·2 x 0·7 inches thick, and weighs just 10·5 ounces. The screen system used measures 1·2 x 1·6 inches (2 in. diagonal). One model incorporates a digital clock, and another, a radio. All three televisions can double the image size by zooming in on the centre area of the screen.

This is the way Toshiba describe the operation of their 'breakthrough': "The screen comprises a liquid crystal matrix panel filled with liquid crystal in a gap between the integrated circuit and the front glass. A picture is the end result of brightness differences on the crystal created by voltage differentials."

Photographs courtesy of Toshiba Consumer Electronics Divn.



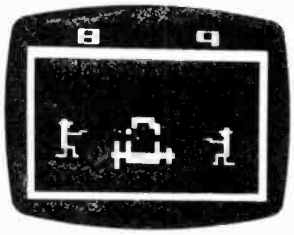
Computers disguised as animals aid development in thinking and co-ordination in the very young.



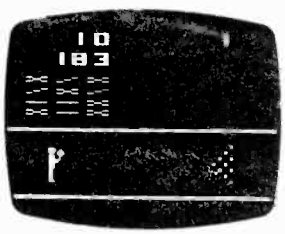
A unique three-dimensional game called Cosmos. In addition to what are described as "Holoptic" images, this sophisticated l.e.d. game incorporates novel sound effects.

Mattel Electronics, a pioneer of hand-held electronic games, is expanding in the computerised video games field. Some of these games are shown below.

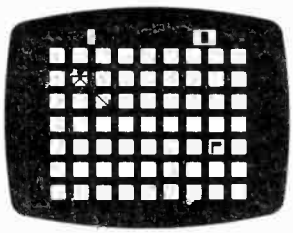
OUTLAW



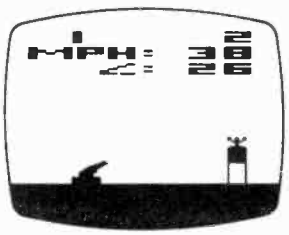
BOWLING



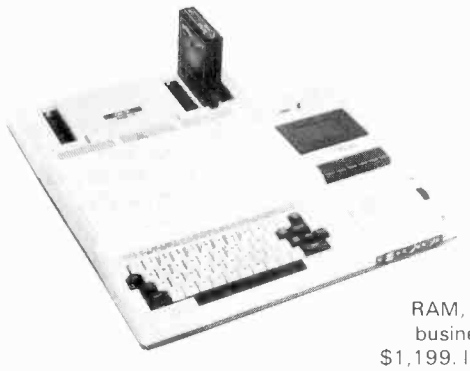
FLAG CAPTURE



HUMAN CANNONBALL



The EL-7001 Memowriter is an alphanumeric typewriter/calculator with 40 word-memories, by *Sharp*.



The Imagination Machine II with 27K RAM, 14K ROM, is a small business system with r.r.p. $1,199. It features up to eight video colours, sound synthesiser, BASIC or 6800 m/c, object orientated and point resolution graphics. Photo shows floppy interface module inserted. *Courtesy of APF Electronics.*

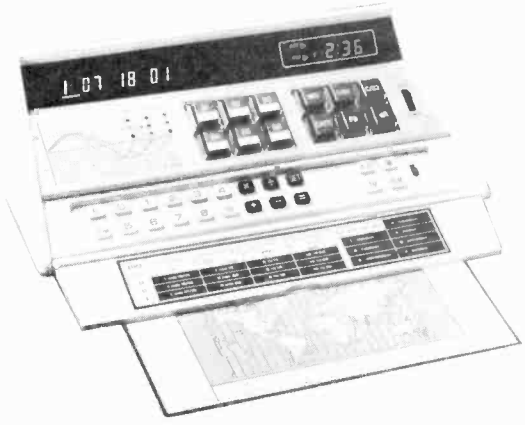
Praxis 35 portable electronic typewriter. Automatic correction of last ten characters via memory. *Courtesy of Olivetti.*

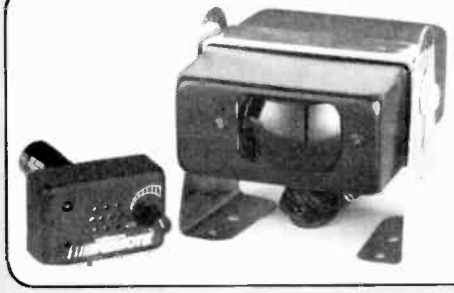
The "jewelry look" has come to calculators. This charcoal grey case with raised chrome numeral keys and l.c.d. display should suit some executives.

Mura claim this is one of the lowest priced digital VOMs. The LCD–200 features easy-to-read $\frac{1}{2}$ inch high digits, and is intended for hobbyists and engineers.

Banana plugs are used in preference to pin contacts, and *all* ranges are switched, obviating the need to change the probe leads from one socket to another, as is often the case with cheaper units. *Photo courtesy of Mura Corporation.*

The Kosmos biorhythm unit and world time clock will display data on six people. It also has a stopwatch. *Courtesy of Kosmos International of Atlanta.*

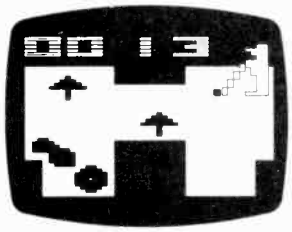




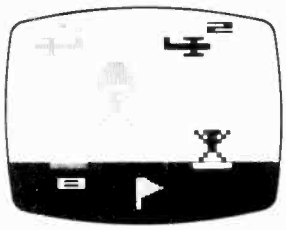
Fuzzbuster's radar detector for cars. The remote portion, utilising dielectrically coupled waveguide technology, fits behind the radiator grill. *Electrolert Inc.*

A few of the very many Atari games on offer. *Pictures courtesy of Atari Consumer Divn.*

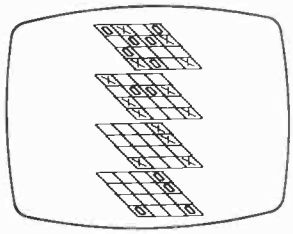
GOLF



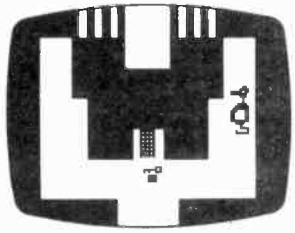
SKYDIVER



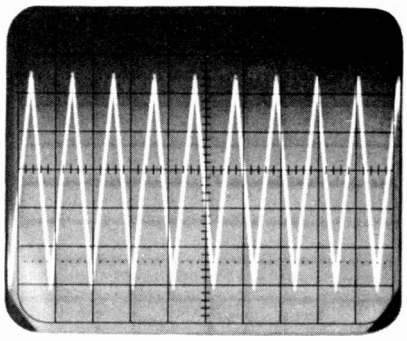
TIC–TAC–TOE



ADVENTURE



CONSUMER ELECTRONICS SHOW



Oscilloscopes ....HOW THEY WORK

Part One...The Cathode Ray Tube... by Ian Hickman

This two-part feature is taken from the last two chapters of a new book by this well-known author. Published by Newnes Technical Books the paperback is entitled *Oscilloscopes. How to use them. How they work.*

THE cathode-ray tube is the main component of an oscilloscope. A cathode-ray tube consists basically of an electrode assembly mounted in an evacuated glass vessel (Fig. 1). The electrodes perform the following functions:

1. A triode assembly generates the electron beam, originally called the "cathode ray". It consists of a cathode K heated by a filament F, a control grid G and the first beam-acceleration electrode (2).
2. An electrode (1) focuses the beam.
3. The beam is then further accelerated before reaching the deflection plates.
4. The vertical deflection plates change the direction of the beam in proportion to the potential difference between them. When this is zero, i.e. the two plates are at the same potential, the beam passes through undeflected. The vertical deflection plates are so called because they can deflect the beam in the vertical direction, so that it hits the screen at a higher or a lower point; they are actually mounted horizontally above and below the beam, as shown in Fig. 1. Similarly the horizontal deflection plates permit the beam to be deflected to left or to right.
5. The deflected beam then hits the fluorescent coating on the inner surface of the glass screen of the c.r.t. The coating consists of a thin layer of "phosphor", a preparation of very fine crystals of metallic salts deposited on the glass. The "spot" or point of impact of the beam glows, emitting light in all directions including forwards. Modern c.r.t.s are aluminised, i.e. a thin layer of aluminium is evaporated on to the rear of the coated screen. The electrons pass through this with little retardation, causing the phosphor to glow as before, but now the light emitted rearwards is reflected forwards, almost doubling the useful light output.

The potential at the focus electrode is adjusted to obtain a very small round spot on the end of the tube. Unfortunately, if no other control were provided, it would often be found that the focus control setting for minimum spot widths was different from that for minimum spot height. This is avoided by providing an astigmatism control. In the case of a simple cathode-ray tube this consists of a potentiometer that adjusts the voltage on the final anode and screen relative to the deflection plate voltages. Alternate adjustments of the focus and astigmatism controls then permit the smallest possible spot size to be achieved. With more complicated tubes using a high "post-deflection acceleration ratio" another electrode is often needed. This is a "geometry" electrode and is connected to another preset potentiometer, which is adjusted for minimum "pincushion" or "barrel" distortion of the display.

When an electron beam passes between two horizontal plates

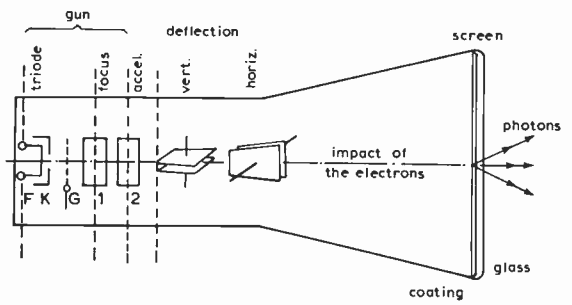


Fig. 1. Basic oscilloscope (electrostatic) cathode-ray tube *(courtesy Enertec Instrumentation Ltd.)*

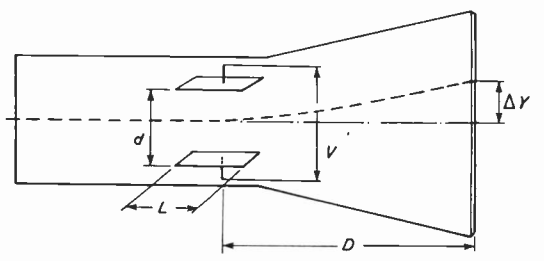


Fig. 2. Y-deflection sensitivity: see text *(courtesy Enertec Instrumentation Ltd.)*

that have a potential difference of V volts between them (Fig. 2) it is deflected vertically by an amount:

$$\Delta Y = \frac{KVLD}{2V_a d}$$

where L = length of the plates
D = distance between the plates and the point on the axis where the deflection is measured
d = distance between the plates
V_a = acceleration voltage applied to the beam at the level of the plates
K = a constant relating the charge of an electron to its mass.

The Y deflection sensitivity of a c.r.t. is defined by $\Delta Y/V$ and is expressed in cm/V. However, in practice the inverse relationship is normally used: $V/\Delta Y$, in V/cm, i.e. the differential deflection-plate voltage necessary to achieve a spot deflection of 1cm.

Brilliance or intensity modulation (also called Z modulation) is obtained by the action of a potential applied to the cathode or grid that controls the intensity of the beam. Generally, a change of 5V will produce a noticeable change of brightness, while a swing of about 50V will extinguish a maximum-intensity trace. The beam is normally extinguished during "flyback" or "retrace"; see Part 2. This may alternatively be achieved in some c.r.t.s by means of an auxiliary "blanking" electrode, which can deflect the beam so that it no longer passes through the deflection plates and hence does not reach the screen.

TUBE SENSITIVITY

The deflection plates of a c.r.t. are connected to amplifiers, which can be of relatively simple design when the required output amplitude is low; it is therefore desirable for the tube sensitivity to be as high as possible. To enable the amplifier to have a wide bandwidth, the capacity between the plates must be kept low, so they must be small and well separated. On the other hand, in order to obtain a suitably clear trace of a signal with low repetition frequency (or single-shot) the energy of the beam must be high. But the ideal tube must be:

1. Short (not cumbersome): D small
2. Bright (high acceleration voltage): V_a large
3. And with low deflection-plate capacity: L small, d large

This gives a tube with very low sensitivity, considering the formula:

$$\text{Sensitivity} = \frac{\Delta Y}{V} = \frac{KLD}{2V_a d}$$

The requirements for high sensitivity contradict the terms of the equation. Practical cathode-ray tubes are therefore the result of a compromise. However, techniques have been developed to improve a selected parameter without prejudice to the others. Post-deflection acceleration (p.d.a.) is one of these; see Fig. 3. To improve the trace brightness while retaining good sensitivity, it is arranged that the beam passes through the deflection system in a low energy condition (relatively low initial acceleration); post-deflection acceleration is then applied to the electrons. This is achieved by applying a voltage of several kilovolts to the screen of the c.r.t.

Spiral p.d.a., Fig. 4, is a development of the basic p.d.a. technique, and consists of the application of the p.d.a. voltage to a resistive spiral (500MΩ) deposited on the inner tube surface between the screen and the deflection system. The uniformity of the electric field is improved, which reduces distortion. In addition the effect of the p.d.a. field between the deflection plates is weaker, so the loss is sensitivity caused by this field is reduced.

The use of a field grid—Fig. 5a—avoids any reduction in sensitivity caused by the effect of the post-deflection accleration field. A screen is interposed between the deflection system and the p.d.a.; this makes the tube sensitivity independent of the p.d.a., a significant benefit. The screen must, of course, be transparent to the electrons and is formed from a very fine metallic grid. With this system we reach the domain of modern cathode-ray tubes.

The next development is the electrostatic expansion lens—Fig. 5b. By modifying the shape of the field grid (e.g. a convex grid) it is pósible to create, with respect to the other electrodes, an electric field that acts on the electron beam in the same way as a lens acts on a light beam. It is therefore possible to increase the beam deflection angle, for example by a factor of two, which improves the sensitivity by the same amount.

The field can also be formed by quadripolar lenses. So, for example, if the sensitivity of a spiral tube is 30V/cm in the X axis and 10V/cm in the Y axis, then the sensitivity of a lens-fitted tube, for the same trace brightness, may be 8V/cm in X and 2V/cm in Y or even better.

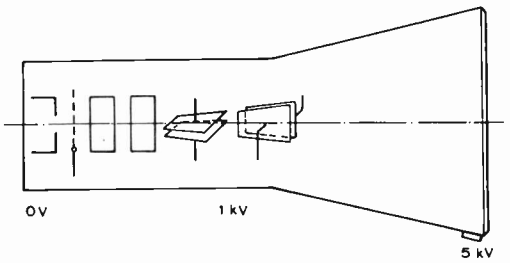


Fig. 3. Single-stage post-deflection acceleration *(courtesy Enertec Instrumentation Ltd.)*

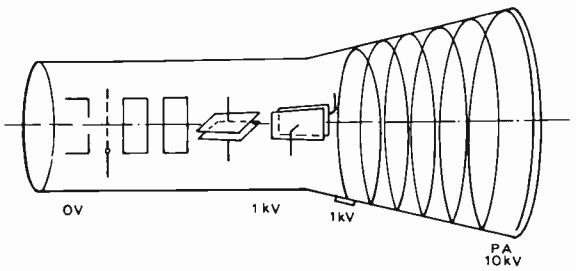


Fig. 4. Spiral p.d.a. *(courtesy Enertec Instrumentation Ltd.)*

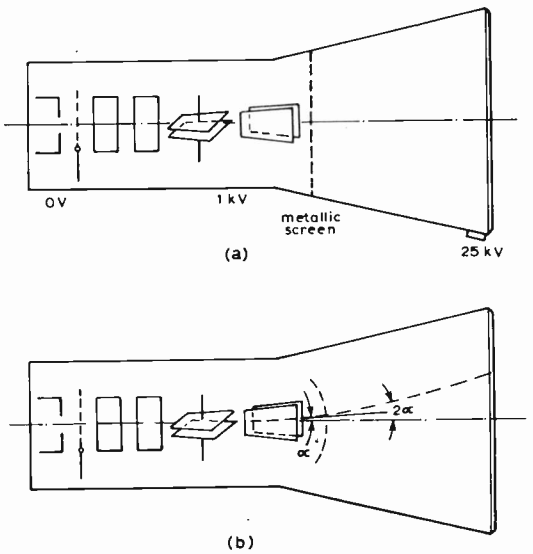


Fig. 5. (a) Mesh p.d.a.; (b) As (a) combined with expansion lens *(courtesy Enertec Instrumentation Ltd.)*

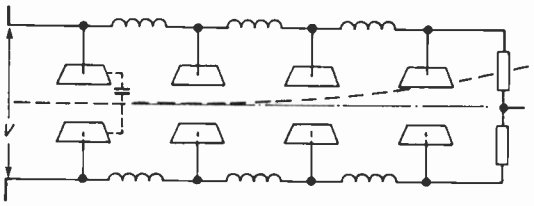


Fig. 6. Delay-line Y-deflection plates *(courtesy Enertec Instrumentation Ltd.)*

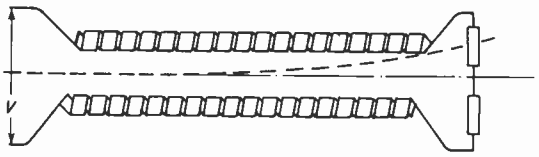
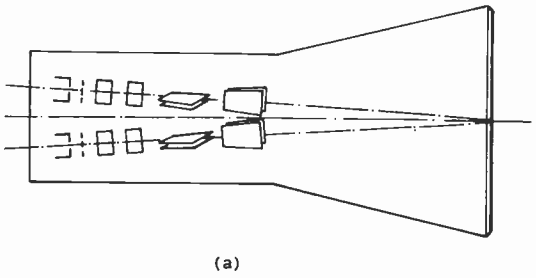
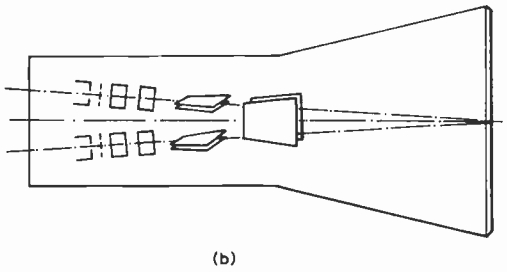


Fig. 7. Travelling-wave Y-deflection plates *(courtesy Enertec Instrumentation Ltd.)*



(a)



(b)

Fig. 8. (a) Dual-gun tube; (b) Dual-gun tube with common X- deflection plates *(courtesy Enertec Instrumentation Ltd.)*

To improve the sensitivity by modifying the deflection system it is necessary to do one of two things:

1. Reduce the distance between the plates, increasing the capacity between them; in addition it must be possible to deflect the beam without it striking them.
2. Lengthen the plates, again increasing the capacity; however, the transit time involved limits the application of this idea.

The transit time is the time taken for an electron to pass through the deflection system: $t_0 = L$/electron speed. Suppose that a sinusoidal voltage of period t_0 is applied to the deflection plates. An electron leaving the plates will be in the same position as one entering the system, because the instantaneous value of the voltage applied to the plates will be the same (one period between the input and the output) and there will be no deflection. To enable the beam to be deflected so as to trace the outline of the applied signal, the length of the plates must be small compared with the distance the electrons travel during the period of one cycle of the signal. So for high-frequency work the plates must be short, which again reduces the sensitivity.

This problem can be circumvented by the use of sectional plates (Fig. 6). To improve the sensitivity several plates are placed in series, connected by a delay line. As the propagation velocity of the line is made equal to the speed of the electrons in the beam, the deviation accumulates successively. On the other hand the parasitic capacitance of the plates is incorporated in the delay line, which must be terminated in its characteristic impedance. The design of the line is entirely determined by its stray capacitance and the propagation time. This brings us to delay-line deflection plates (Fig. 7). Here, the dimensions of the plates have been reduced and their number increased. Two flattened helices are used, each spiral acting as a deflection plate. The helix is constructed in such a way that its propagation velocity corresponds to the speed of the electron beam. These deflection systems, together with field grids or quadripolar lenses (or both), permit the construction of very high-performance tubes.

OTHER TUBE CHARACTERISTICS

To be suitable for use at high frequencies a c.r.t. must, as already discussed, have a highly developed deflection system. But this alone is not sufficient when it is required to observe and photograph fast pulses with low repetition rates or single-shot phenomena. The brilliance of the display must also be adequate. This is why "writing speed" is an important feature in these conditions. Writing speed is defined as the maximum speed at which a spot, passing once across the tube face, can be photographed under specified conditions (camera, aperture, image/object, film sensitivity).

On the occasions when it is necessary to compare several fast, single-shot phenomena occurring simultaneously, the only solution is to use an oscilloscope equipped with a c.r.t. with several beams. There are a number of different types available:

1. Multi-gun tubes. Fig. 8a shows a c.r.t. with several cathode-ray assemblies mounted in a single tube. Fig. 8b shows a tube where each gun or triode assembly has its own vertical deflection system but shares common horizontal deflection plates. All phenomena are displayed with the same sweep speed.

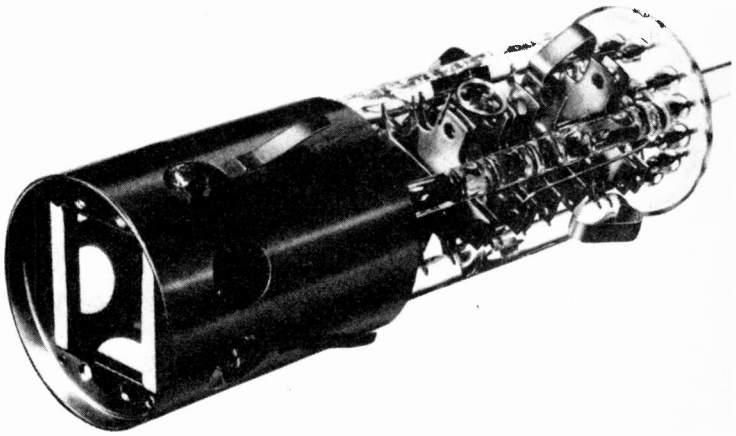


Fig. 9. Electrode assembly of Brimar mesh p.d.a. c.r.t. type D13–51GH *(courtesy Thorn Brimar Ltd.)*

2. Multi-beam tubes. There is a single electron gun for the different deflection systems, typically two. The beam is shared between each deflection system by means of a splitter plate. This type of tube is more economical because there is a single gun assembly. However, there is reaction between the two systems, and the brilliance of the displays cannot be adjusted separately.

CONSTRUCTION

The construction of the electrode assembly of a mesh p.d.a. cathode-ray tube is shown in Fig. 9. The deflection plates are within the cylindrical shield and the mesh covers the square opening at the end. The wires of which the mesh is woven are so fine that it is invisible; this also ensures that it is transparent to the beam of electrons. Fig. 10 shows a high-performance oscilloscope c.r.t. with side connectors to the deflection plates for minimum capacitance, spiral p.d.a., internal graticule, bonded implosion guard and light guide for graticule illumination.

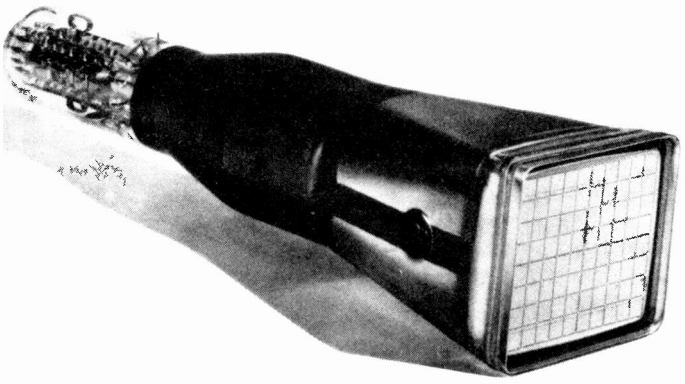


Fig. 10. Brimar spiral p.d.a. c.r.t. type D14–210GH/82 with internal graticule *(courtesy Thorn Brimar Ltd.)*

All the measures to maximise the bandwidth of a c.r.t. mentioned previously—p.d.a., delay-line deflection plates, scan expansion lenses—have been put together in the cathode-ray tube used in the Tektronix type 7104 oscilloscope. This instrument boasts a 1GHz real-time bandwidth, this limit being set by the Y amplifier rather than the c.r.t. itself. The latter could display signals up to 2·5GHz, were it possible to design suitable wideband drive circuitry. Also, notwithstanding the conflict, explained earlier, between tube design parameters for optimum bandwidth and maximum writing speed, this tube achieves the remarkable writing speed of 20,000cm/μs, using ASA 3000 film without fogging. (In fact, single-shot events at that speed can also be seen comfortably with the naked eye.) The secret is revealed in Fig. 11, which shows that in addition to the measures already mentioned, the c.r.t. incorporates a microchannel electron multiplier plate. This consists of thousands of short parallel tubes, each coated internally with a high-resistance film. Each individual tube acts as an electron multiplier by virtue of secondary emission, resulting in 10,000 electrons hitting the phosphor for each electron in the beam. Owing to the small spacing between the microchannel plate output side and the aluminised phosphor, together with the high potential difference between them, there is negligible spreading of the output of each microchannel tube, maintaining a small sharp spot size.

NEXT MONTH: the oscilloscope circuitry.

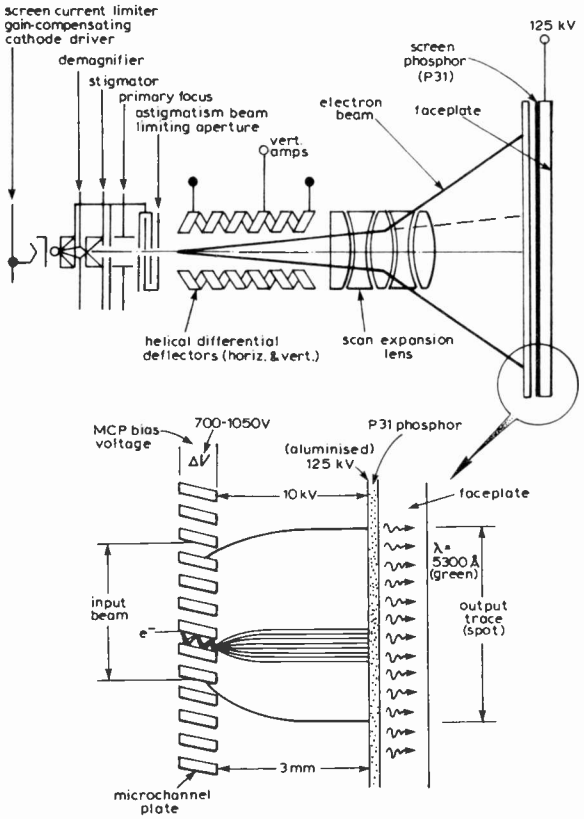


Fig. 11. Cathode-ray tube used in Tektronix oscilloscope type 7104 *(courtesy Tektronix UK Ltd.)*

PE DIGISOUNDER PART 1

BRIAN CURRIE

THE PE Digisounder is a digital depth gauge suitable for all types of small vessels. The l.c.c. read-out gives a clear unambiguous display, drawing only a small operating current. This makes it particularly suitable for sailing boats where power is often at a premium. The 'Digisounder' also includes an internally pre-settable alarm which gives an audible warning if the depth of water below the hull drops under a certain level.

Assuming sufficient interest a synthesised speech board will be featured in a future issue. This will utilise a small loudspeaker and actually call out the depth indicated on the Digisounder. This facility will be particularly useful to single-handed sailors or when sailing at night. It will fit inside the 'Digisounder' case and outputs are provided ready for it.

The 'Digisounder' can be constructed at a fraction of the cost of similar commercial equipment and will replace the 'Seafarer' type fitted in many boats, as it utilises the same ultrasonic transducer.

'DIGISOUNDER' BASICS

The principle is similar to radar in that a pulse is transmitted, and the time taken for the reflection to return is proportional to the distance the pulse has travelled. With radar the pulse is electromagnetic and travels at 300,000km per second approximately. The Digisounder uses an ultrasonic pulse of usually 150kHz, which travels approximately 1·5Km per second in water. So typically, we will expect time durations in the order of tens of milliseconds.

Conventional depth sounders usually have a rotor with an l.e.d. or neon, which flashes as the pulse is transmitted and flashes again when it is received. By this time, the rotor has moved further round the clock face scale, giving an approximate indication of depth. This system, besides being sometimes hard to read, is very wasteful of power as the rotor consumes power as it turns, and to give an apparently continuous display, the pulse must be transmitted and l.e.d. flashed several times a second.

The Digisounder only transmits one pulse of 500 microseconds duration per second and the l.c.d. display consumes negligible power, so the overall consumption from a 9V battery is around 7mA, compared with 250mA for the conventional type.

The overall operation can be seen from the block diagram, in Fig. 1.1. Although the circuit contains certain extra

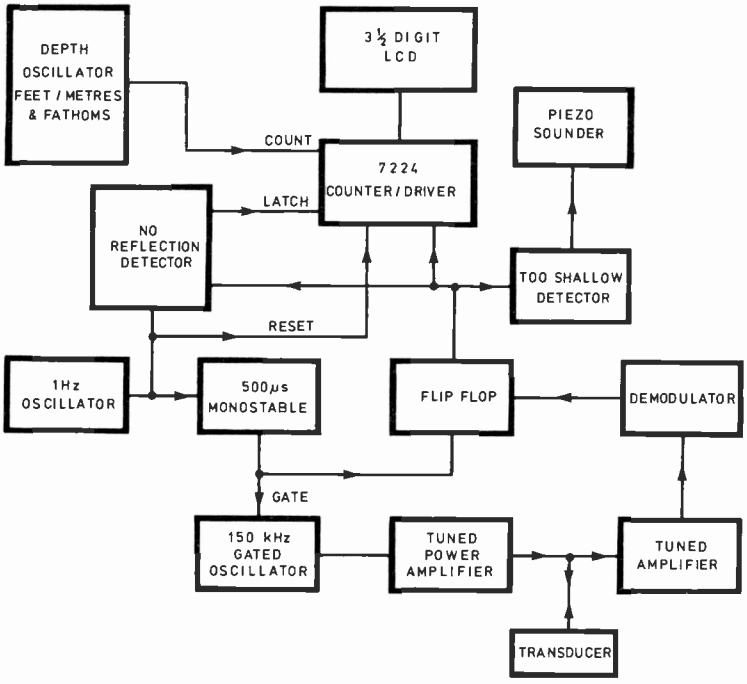
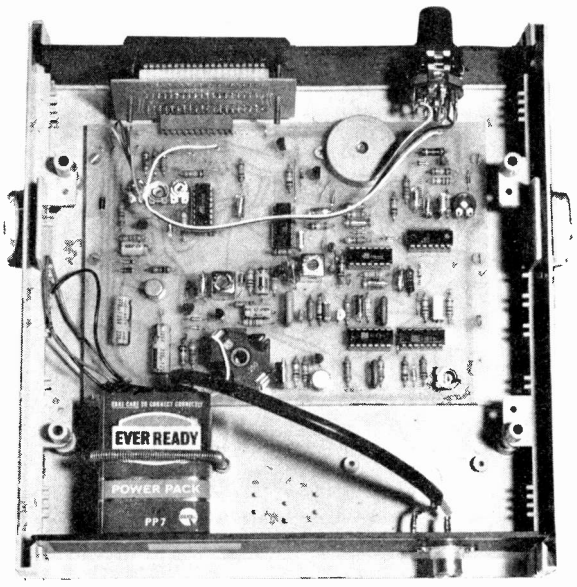


Fig. 1.1. Block diagram of the Digisounder



Internal view of the Digisounder

features, the basic operation is to pulse an electronic transducer. At the same time, a counter is reset to zero and the counter input is held open. An oscillator input is fed into the counter, which will commence to count. The counter is stopped and the resultant count displayed on receipt of the transmitted pulse. This count is dependant on the depth of water below the transducer. Varying the oscillator frequency means that the read-out can be in feet, metres or fathoms.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Digisounder is shown in Fig. 1.2. The 1Hz oscillator IC1d, e, f controls the timing of the circuit. It initiates the cycle of firing the 500µs monostable IC2e, IC2f which gates the 150kHz oscillator IC1a, IC1b, IC1c, "on" (for 500µs). The tuned power amplifier TR3, TR4, TR5 amplifies this 9V pk-pk square wave to about 400V pk-pk. The waveform at this stage is approximately sinusoidal because of the tuning. When this 400V signal is applied to the transducer, the crystal turns the electrical signal into an acoustic one, which travels down to the seabed where it is reflected. On returning to the transducer, it is converted back to an electrical signal (typically tens of microvolts).

The tuned amplifier TR8, TR10 has a time dependant automatic gain control TR6, TR7. The 1Hz oscillator turns the gain down during transmission and raises it again over the following 30 milliseconds. As the transducer is fired, a positive going pulse appears at the output of IC3b, switching on TR7, discharging C9. Which then charges exponentially through R15, R16 and this changing level is fed via emitter follower TR6 to supply the first tuned stage of the receiver, TR9. The purpose of this is to reduce the risk of a false reflection from air bubbles or debris, which if they are near the transducer can cause large receiver signals and hence an incorrect depth reading. As the gain of the tuned amplifier is very high, it is susceptible to all sorts of interference, hence the need to turn the 150kHz oscillator off by D2 when it is not driving the transducer (if it were not turned off, some small amount of 150kHz might get through and saturate the amplifier).

COUNTER

The heart of the unit is the main counter, which receives pulses from the oscillator. The gate of the counter is held open from the moment the transmitter is fired until the returned pulse 'disables' the counter, and operates the latch, updating the display. The time the gate is held open is proportional to depth of water and the frequency of pulses fed in during this time determines the ultimate displayed figure. Therefore, by feeding in different frequencies, the counter will display feet, metres or fathoms. As an example, the 'feet' oscillator is exactly six times the frequency of the 'fathoms' input. This automatically converts the reading into fathoms.

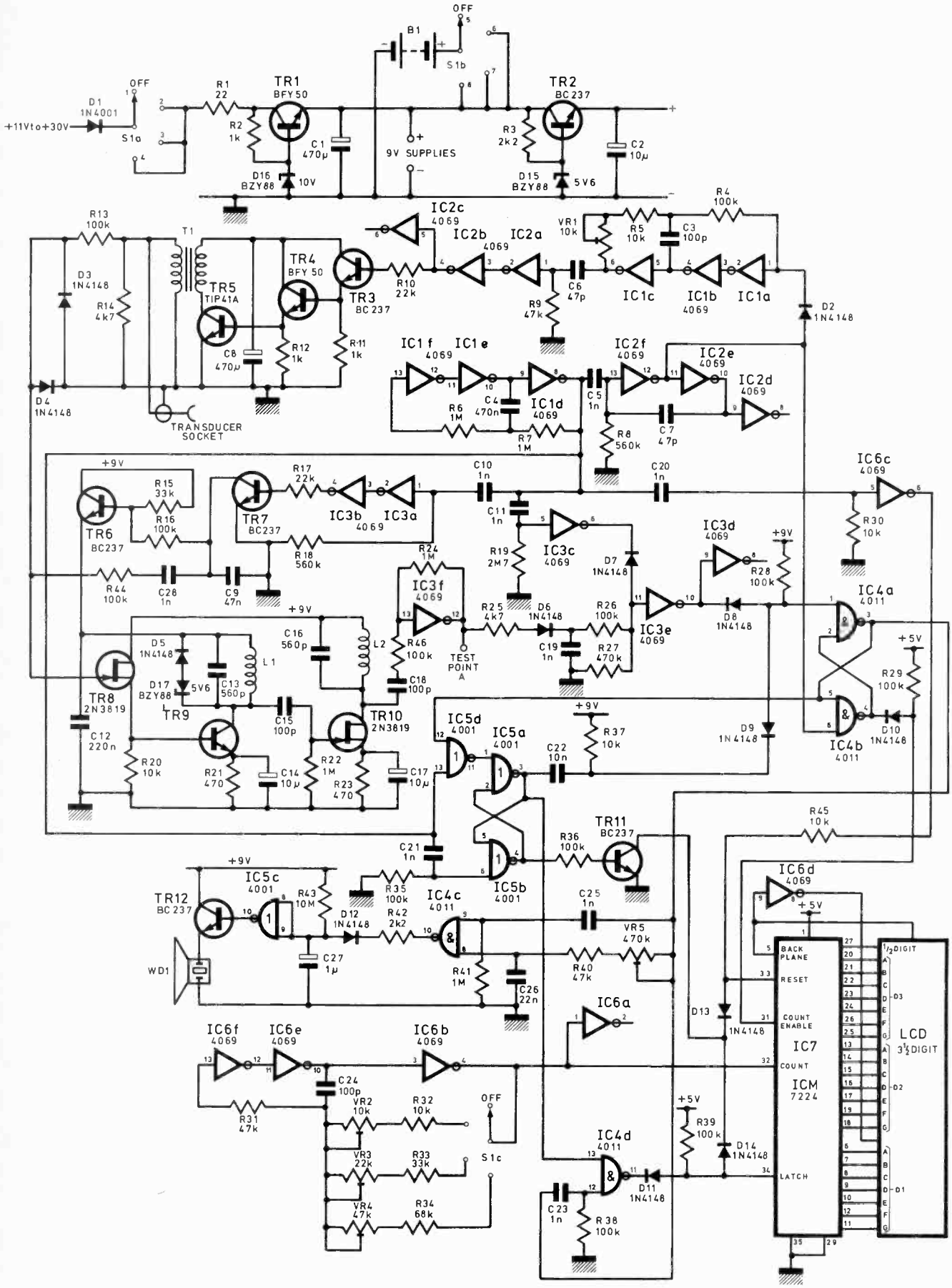
The counter used is the Intersil 7224, a $4\frac{1}{2}$ digit counter that will drive an l.c.d. directly. Although $3\frac{1}{2}$ digits are sufficient, this i.c. was chosen as being the most convenient method of implementing the required function. It features low power operation, direct 7-segment l.c.d. drive, latch and reset inputs and a count inhibit (enable/disable) control.

"NO REFLECTION" DEFLECTION

The flip-flop IC4a, IC4b is set by the 1Hz oscillator at the beginning of the transmit pulse and reset by the demodulator IC3e when a reflection is detected (so the output is high for a time proportional to the depth of the water, and this signal is used to 'enable' the 7224 counter). If the bottom has soft mud or substantial weed growth, it is possible that no reflection will be detected. IC5a, IC5b another flip-flop is set on transmission, and stays in this position as long as reflections are received. If, however, after approximately 0·5 seconds, no reflection is received, IC5d resets it. IC5a output goes low, which resets the main flip-flop (IC4a, IC4b) and prevents the latch pulse being transmitted by IC4d. TR11 turns on, and pulls the reset and latch inputs of the 7224 low. This makes the display show a zero reading indicating that no reflection has been received. As soon as a correct reflection arrives, normal operation recommences.

DEPTH OSCILLATOR

By varying the rate of the oscillator IC6b, IC6e, IC6f applied to the count input of the 7224, it is possible to arrange the display to show the depth in any desired unit — feet,


+11Vto+30V
D1 1N4001
OFF
S1a
R1 22
R2 1k
TR1 BFY50
C1 470µ
D16 BZY88 10V
B1
S1b
9V SUPPLIES
TR2 BC237
R3 2k2
D15 BZY88 5V6
C2 10µ
R4 100k
R13 100k
T1
D3 1N4148
R14 4k7
TR5 TIP41A
TR4 BFY50
TR3 BC237
C8 470µ
R12 1k
R11 1k
D4 1N4148
TRANSDUCER SOCKET
IC2c 4069
IC2b 4069
IC2a
R10 22k
R9 47k
C6 47p
VR1 10k
R5 10k
C3 100p
IC1c
IC1b 4069
IC1a
D2 1N4148
IC1f 4069
IC1e
R6 1M
C4 470n
IC1d 4069
R7 1M
C5 1n
IC2f 4069
IC2e 4069
IC2d 4069
R8 560k
C7 47p
+9V
R15 33k
R16 100k
TR6 BC237
R17 22k
TR7 BC237
IC3b 4069
IC3a
R18 560k
C10 1n
C11 1n
C20 1n
IC6c 4069
R30 10k
R44 100k
C28 1n
C9 47n
R24 1M
IC3f 4069
R19 2M7
IC3c 4069
D7 1N4148
IC3d 4069
R28 100k
+9V
D8 1N4148
R25 4k7
D6 1N4148
R26 100k
R27 470k
C19 1n
IC3e 4069
TEST POINT A
IC4a 4011
+5V
R29 100k
D5 1N4148
D17 BZY88 5V6
C13 560p
L1
C16 560p
L2
R46 100k
C18 100p
TR8 2N3819
TR9
TR10 2N3819
C15 100p
C12 220n
R20 10k
R21 470
C14 10µ
R22 1M
R23 470
C17 10µ
IC5d 4001
IC5a 4001
C22 10n
R37 10k
D9 1N4148
IC4b 4011
D10 1N4148
R45 10k
TR11 BC237
R36 100k
C21 1n
IC5b 4001
IC5c 4001
R43 10M
R35 100k
IC4c 4011
C25 1n
TR12 BC237
D12 1N4148
R42 2k2
VR5 470k
WD1
C27 1µ
R41 1M
R40 47k
C26 22n
IC6d 4069
+5V
IC6a
D13 1N4148
IC6f 4069
IC6e 4069
IC6b 4069
C24 100p
R31 47k
VR2 10k
R32 10k
OFF
VR3 22k
R33 33k
S1c
VR4 47k
R34 68k
IC4d 4011
C23 1n
R38 100k
D11 1N4148
R39 100k
D14 1N4148
BACK PLANE
RESET
COUNT ENABLE
COUNT
LATCH
IC7 ICM 7224
LCD 3½DIGIT
½DIGIT
D3
D2
D1

COMPONENTS . . .

Resistors

R1	22
R2, R11, R12	1k (3 off)
R3, R42	2k2 (2 off)
R4, R13, R16, R26, R28, R29, R35. R36, R38, R39, R44, R46	100k (12 off)
R5, R20, R30, R32, R37, R45	10k (6 off)
R6, R7, R22, R24, R41	1M (5 off)
R8, R18	560k (2 off)
R9, R31, R40	47k (3 off)
R10, R17	22k (2 off)
R14, R25	4k7 (2 off)
R15, R33	33k (2 off)
R19	2M7
R21, R23	470 (2 off)
R27	470k
R34	68k
R43	10M

All resistors $\frac{1}{4}$W 5% carbon

Potentiometers

VR1. VR2	10k per min. (2 off)
VR3	22k per min.
VR4	47k per min.
VR5	470k per min.

Capacitors

C1, C8	470µ 16V (2 off)
C2, C14, C17	10µ 16V (3 off)
C3, C15, C18, C24	100p (4 off)
C4	470n
C5, C10, C11, C19, C20, C21, C23, C25, C28	1n (9 off)
C6, C7	47p (2 off)
C9	47n
C12	220n
C13, C16	560p (2 off)
C22	10n
C26	22n
C27	1µ

Semiconductors

D1	IN4001
D2–D14	1N4148 (13 off)
D16	BZY88 10V Zener
D15, D17	BZY88 5V6 Zener (3 off)
TR1, TR4	BFY50 (2 off)
TR2, TR3, TR6, TR7, TR9, TR11, TR12	BC237 (7 off)
TR5	TIP41A
TR8, TR10	2N3819 (2 off)
IC1, IC2, IC3, IC6	4069 (4 off)
IC4	4011
IC5	4001
IC7	ICM7224

Miscellanous

3 pole 4 way switch
$3\frac{1}{2}$ digit l.c.d.
PP7 battery and connector
15 way p.c.b. plug and socket
Case Pac Tec 60119-1
UHF socket
Rm10 (AL250) pot core kit (RS228–242)
YXNS 30450NK 2mH choke (2 off)
22 s.w.g. enamelled wire
36 s.w.g. enamelled wire
Ultrasonic transducer
Soldercon pins
WD1 Piezo-Electric Sounder

Constructor's Note

A complete set of parts for the Digisounder is available from **Lascar Electronics, Unit 1, Thomasin Road, Basildon, Essex (0268 727383).** Price £69·80 (transducer extra)

metres, fathoms, inches etc. For the purpose of this design, the first three are used.

Those who know the ICM 7224 will, no doubt, realise that it is a $4\frac{1}{2}$ digit counter, but here it is only being used to drive a $3\frac{1}{2}$ digit display. This is because there is little point in measuring to an accuracy of 0·01 feet ($\frac{1}{8}$th of an inch) when the boat will be moving up and down substantially more than that, due to the movement of the water. A $3\frac{1}{2}$ digit display is easier and cheaper to obtain with larger digits for the same glass size.

"TOO SHALLOW" DETECTOR

As the current consumption is so low, there is no reason why the instrument should not be left on all the time, in which case the shallow water detector IC4c comes into its own. If there are three consecutive readings below a preset level (adjustable by altering resistor VR5 on the p.c.b.) an alarm sounds, so you can sleep in confidence that if the tide goes out, you will be woken up before it is too late! Three consecutive readings are required, as you might get an occasional low reading from a fish or piece of debris near the transducer. The output from IC4a is taken low when the transmitter fires and stays low until the flip-flop is reset by the returning signal. When the output first goes low, C26 discharges at a rate set by VR5. If the main flip-flop is reset before the voltage on C26 is below the CMOS threshold (approximately 4·5V) due to shallow water, then a negative going pulse on the output of IC4c partially discharges C27. This is normally being charged via R43. However, the circuit is arranged so that three consecutive 'low level' readings discharge C24 to the point where IC5c switches on TR12, activating the alarm. VR5 allows setting of any depth between 2–3 feet and 25 feet.

If the depth sounder is to be used on a boat with an engine, it is imperative that the engine is properly suppressed, otherwise it will produce interference, giving random depth indications.

POWER SUPPLY

The instrument operates from a 9V supply, from which is derived a 5V supply for the logic circuitry. The 9V supply can be from the internal PP7 battery, or external in the range 12V to 30V. The external input is regulated down to approximately 9V by D16, TR1. D15 and TR2 regulate the 9V input down to 5V. Diode D1 protects against reverse polarity connection of external supply.

The instrument can be powered from either a supply in the range 12V to 30V or an internal 9V battery, but not both at the same time, because the 9V battery may leak corrosive chemicals as a result of having charge pushed into it. If external supply is used, the internal 9V battery should be removed.

NEXT MONTH: Construction, Testing and Installation

P.E. COMPUTER SPEECH PROJECT

See P.E. Nov. '80 and Dec. '80 for relevant articles.

ADD VERBAL OUTPUT TO A COMPUTER OR LOGIC SYSTEM OF ANY KIND.

Modus Systems Ltd can now supply a range of fixed-vocabulary speech synthesiser boards to aid in the evaluation and addition of speech to any computer or logic device. The words available are basic and revolve around numerical words such as "two", "thirty", "pounds", etc. The units of particular interest, produced by Telesensory Systems Inc (TSI) are the 24 and 64 English units, consisting of a controller chip and one or two 2K ROM's, respectively.

Interfacing depends upon three main systems: logic, power and audio sections. Modus Systems have developed a General Interface Board which includes all of these aspects and permits easy interfacing to your logic system. Two levels of power supply are required. One (+5 Volt) is expected to be supplied from the microcomputer. The other is supplied from a power supply on the interface board, which also includes all necessary interfaces to the computer. The board also has an edge socket in which the speech board sits, and a plug and socket for ribbon cable connection to a computer. A small 10 to 15 Volt transformer is required for power and an 8 Ohm speaker for the voice output.

A computer is by no means necessary to use the speech board. Any device (even a bank of switches!) which gives a 6-bit word to signify which word is to be spoken, along with a start signal will control the unit. Applications include speaking clocks, telephone answering, games, calculators, audio readout in industrial control applications, etc, etc.

Vocabularies and prices:

S2A (**£44.95** + 80p PP + VAT: SPECIAL INTRO OFFER).
24 – Calculator type words: 0-9, +, –, ×, etc.

S2B (**£69.50** + 80p PP + VAT) 64 words.
As for S2A plus "ten", "twenty", etc, "pounds", "cm", "ounces", etc.

S2C (**£69.50** + 80p PP + VAT) 64 words.
Full ASCII set – each ASCIII Coder verbalised in sequence.

Interface Board (Kit) (£14.95 + 80p PP + VAT).
S2A, B, C board plugs into on-board socket. This PCB contains latches, audio filter, PSU, audio amplifier, 1/0 plug and socket.

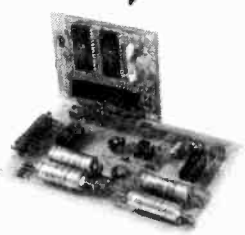
★★ UNLIMITED SPEECH NOW AVAILABLE

Modus Systems can produce customised speech fonts to suit individual applications. Vocabulary generation costs will depend on the specific words required, but they are not likely to exceed £150 pounds per new English word.

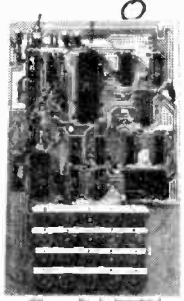
★★ COMING SOON

Series III speech board containing 119 words and all interfacing necessary on a single PCB (requires a single +5V supply only). Spare ROM socket may be used for a custom vocabulary.

LOW COST SYNTHESISED SPEECH



LOW COST EDUCATIONAL MICRO-COMPUTER



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THE EDUKIT

you can even make it talk with our speech board!

FULL KIT: £36.95 + 80p PP + VAT

Designed by Dr. A. A. BERK
(see P.E. review (April edition) & P.E. special offer May and June)

TECHNICAL SPEC.

** CMOS 1802 Processor (RCA) – excellent MPU for control.
** 256 bytes of RAM – plenty for learning machine codes.
** Hexadecimal display – large and readable.
** Full hex keyboard – positive 'click" type switches.
** Full manual – starts at soldering, ends with control circuits.
** Loudspeaker output – simple audio experiments.
** Excellent for all ages from secondary school level upwards.

The EDUKIT has proven a great success providing an excellent introduction to silicon chip technology from the bottom upwards. Many schools and colleges are using the kit, and sales now extend world wide. The machine is **not** mean to form the basis of a large and expandable personal computer system. The EDUKIT teaches all those things which a purely BASIC running machine cannot. I.e. the basis of hardware electronic control, down-to-earth Bits and Bytes, Machine Code etc. – and all this at a really throw away price. The manual is written by Dr. A. A. Berk to impart educational understanding from the beginning.

1802 USER'S MANUAL (essential for full understanding of MPU used in EDUKIT) **£4.75** + 50p PP.

FULL SOCKET SET for EDUKIT: **£2.99** + VAT (PP included).

EPROM PROGRAMMER P.C.B. £8.95 (fully inc.)

(For 2708's & multi supply 2716's)

See P.E. Dec. '79 and Jan. '80 for full description of programmer, along with interface to COMPUKIT.

TRANSFORMERS

CONTINUOUS RATINGS
All voltages are at full load.
+ VAT 15%

30 VOLT RANGE (2x15V SECS)
Pri 0-220-240V Sec Volts available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12-0-12V or 15-0-15V.

Ref.	Amps 15V	Price	P&P
112	.5	2.90	1.00
79	1	3.93	1.00
3	2	6.35	1.20
20	3	7.39	1.44
21	4	8.79	1.60
51	5	10.86	1.60
117	6	12.29	1.72
88	8	16.45	1.96
89	10	18.89	1.84
90	12	21.09	O.A.
91	15	24.18	O.A.
92	20	32.40	O.A.

50 VOLT RANGE (2x25V SECS)
Pri 220/240V. Volts out 5, 7, 8, 10, 13, 15, 17, 20, 33, 40V or 20-0-20V or 25-0-25V.

Ref.	Amps 50V	25V	Price	P&P
102	.5	1	3.75	1.20
103	1	2	4.57	1.20
104	2	4	7.88	1.44
105	3	6	9.42	1.60
106	4	8	12.82	1.72
107	6	12	16.37	1.84
118	8	16	22.29	2.20
119	10	20	27.48	O.A.
109	12		32.88	O.A.

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

Ref.	Amps 60V	30V	Price	P&P
124	5	1	4.27	1.20
126	1	2	6.50	1.20
127	2	4	8.36	1.60
125	3	6	12.10	1.72
123	4	8	13.77	1.96
40	5	10	17.42	1.84
120	6	12	19.87	2.04
121	8	16	27.92	O.A.
122	10	20	32.51	O.A.
189	12	24	37.47	O.A.

CASED AUTO TRANSFORMERS
240V cable in 115V USA flat pin outlet.

VA	Price	P&P	Ref.
20	6.55	0.95	56W
75	8.50	1.20	64W
150	11.00	1.44	4W
250	13.39	1.44	69W
500	20.13	2.04	67W
000	30.67	2.20	84W

12 OR 24V OR 12-0-12V
Pri 220-240 volts

Ref.	Amps 12V	24V	Price	P&P
111	0.5	0.25	2.42	0.95
213	1.0	0.5	2.90	1.00
71	2	1	3.86	1.00
18	4	2	4.46	1.20
85	5	2.5	6.16	1.20
70	6	3	6.99	1.20
108	8	4	30V 6	1.44
72	10	5	8.93	1.60
116	12	6	9.89	1.60
17	16	8	11.79	1.72
115	20	10	15.37	1.84
187	30	15	19.72	2.04
226	60	30	40.41	O.A.

SPLIT BOBBIN Pri 0.240-Sec
12-15-20-24-30V Volts out 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12-0-12 or 15-0-15V.
Ref 009 – 1 Amp **£2.98**, P. & P. £1.10.
Ref 010 – 2 Amp **£4.65**, P. & P. £1.10
open frame fixing. Other types available.

AUTO TRANSFORMERS
Voltages available 105, 115, 190, 200, 210, 220, 230, 240.

Ref.	VA	£	P&P
113*	80	4.41	1.00
64	75	5.89	1.20
4	150	5.70	1.20
53	350	10.08	1.44
67	500	12.09	1.84
84	1000	20.64	2.20
93	1500	25.61	O.A.
95	2000	38.31	O.A.
73	3000	65.13	O.A.
80S	4000	84.55	O.A.
57S	5000	98.45	O.A.

*0, 115, 220, 240.

15V ct Range (7.5-0-7.5)

171 500mA	2.30	0.52
172 1A	3.26	0.92
173 2A	3.95	0.90
174 3A	4.13	0.99
175 4A	6.30	1.10

MAINS ISOLATORS (SCREENED)
Pri 0-120; 0-100-120V (120, 220, 240V) Sec 60-55-0-55-60V twice to give 55, 60, 110, 115, 120, 125, 175, 180, 220, 225, 230, 235, 240V.

Ref	VA	Price	P&P
*07	20	4.84	1.20
149	60	7.37	1.20
150	100	8.38	1.44
151	200	12.28	1.72
152	250	14.61	2.04
154	500	22.52	2.20
155	750	32.03	O.A.
156	1000	40.92	O.A.
157	1500	56.52	O.A.
158	2000	67.99	O.A.
159	3000	95.33	O.A.

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

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	2.83	0.50
212	1A 1A	0-6 0-6	3.14	1.00
13	100	9-0-9	2.35	0.50
235	330 330	0-9, 0-9	2.19	0.60
207	500 500	0-8-9, 0-8-9	3.05	0.95
208	1A 1A	0-8-9, 0-8-9	3.88	1.20
236	200 200	0-15, 0-15	2.19	0.60
214	300 300	0-20, 0-20	3.08	1.00
221	700(DC)	20-12-0-12-20	3.75	1.00
206	1A 1A	0-15-20 twice	5.09	1.20
203	500 500	0-15-27 twice	4.39	1.20
204	1A 1A	0-15-27-0 twice	6.64	1.20
239	50	12-0-12	2.88	0.50
234	500	6-0-6	2.19	0.44

TRANSFORMERS END OF LINE OFFERS

M616 – 240V: Scr 1) 13-0-13 1A. 2) 12V 150ma **£1.50**
M708 – 6K to 3Ω matching transformer 5W **90p** 40p
B7 – 0-110-120-240V, Sec 20V 1A **£1.80** 66p
M679 – 120V + 2: 36V 1·6A **£3.00** 78p
M865 – 100V Line to 4Ω 10 watts **£1.90** 60p
M1020 – 0-240V 12-0-12V 50ma **75p** 41p
M1126 – 120/240V: 9-0-9V 1A **£1.79** 71p

UK Postage only. Overseas post extra.

AVO TEST METERS

Avo 8 MK5 latest model	£106.40
71 Electronic & TV Service	£43.10
73	£58.60
MM5 minor 89 x 139 x 38	£36.90
Wee Megger 500V	£87.00
DA211 L.C.D. Digital	£47.00
DA212 L.C.D. Digital	£67.00
Avo DA116 Digital L.C.D.	£108.90
Avo TI169 in circuit transistor tester	£45.00

All Avos Meggers and accessories available. P&P £1.32. 15% VAT

OTHER PRODUCTS

U4315 Budget Meter
20KΩ/V Ranges to 1000V. 2·5A AC/DC 500K Res. In steel case **£15·85** P&P £1·32

SPECIAL OFFER Multimeter (20KΩ/V) with combined audio/I.F. test oscillator at 1KHz, and 465 KHZ. AC/DC to 1000 volts. DC current to 500 MA resistance to 1M size 160 · 97 · 40mm **£8·50**. P&P £1·00. VAT 15%

ABS Plastic Boxes: inset brass nuts, slots to take P.C. cards (boards) flush fitting lid.

		P&P
PB1 –	80mm x 62 x 40	80p
PB2 –	100mm x 75 x 40	90p
PB3 –	120mm x 100 x 45	£1.04
PB4 –	215mm x 130 x 85	£2.68

50p + VAT

Bridge Rectifiers

100V	25A	£1.80
100V	50A	£2.20
200V	2A	.52
200V	4A	.75
400V	1A	.25
400V	4A	.98
400V	6A	£1.44
500V	12A	£3.60

P&P 20p VAT 15%

NEW RANGE TRANSFORMERS
0-36-48 twice to give 36-0-36 48-0-48V, 60V, 72V, 84V, 96V.

Amps	Ref	Price	P&P
0·5	430	4.88	0·76
1	431	8.12	0·99
2	432	13.35	1·31
3	433	16.17	1·40
4	434	20.65	2·11
5	435	29.30	2·47
6	436	36.69	O.A.
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SPACEWATCH

FRANK W. HYDE

THE NEXT DECADE

The Calendar for the next decade is a very full one. It is hoped that it will begin with the first trials of the Space Shuttle, Columbia. This issue of *Spacewatch* should be in your hands for the date set for the launch, which is the 17th of March 1981.

At the present time of writing Columbia is set up on its launch platform at the Kennedy Space Centre in Florida. The vehicle was powered up from the ground using ground based power. Engineers have since January 5th been making the final inspections and the exhaustive check of the systems.

On January 6th the prime team of astronauts, John Young and Robert Crippen together with the back-up crew practised the escape routines. The back-up team are Joe Engel and Richard Truly. There are complete safeguards for the crew from the moment of count-down. A quick exit is possible during the final hours of count-down if an emergency should arise.

The first orbital flight will last for 54 hours. During this flight the crew will test all the systems including the opening and the closing of the 59 feet long doors which cover the payload bay (where the spacecraft to be launched will be carried) and the space which is provided for other instruments.

The Shuttle with its boosters will be launched vertically and will later re-enter the atmosphere to glide in an un-powered condition to the NASA Dryden Flight Research centre in Edwards, California. If an emergency should arise the crew can also land in Florida or at the White Sands Missile Base near Las Cruces, Mexico.

PROSPECTS FOR THE NEXT DECADE

August 1981 will see the encounter with Saturn by Voyager 2. Plans are already being finalised for this event. The success or otherwise is dependent on the state of the vehicle when it arrives in the area of Saturn, before going on to Uranus.

The Soviet Union have a planetary programme which will involve four Venus probes. Venera Nos. 13 and 14 will be launched in November this year with an encounter date in the spring of 1982. Two more Venera craft nos. 15 and 16 will be launched around June or July 1985.

The missions will be "landers" and will very likely be similar to the Viking landers used by NASA on Mars. The two vehicles 13 and 14 will land March/April 1982 to examine the surface of Venus and, no doubt will be making the details of the project available. The 1984 mission will be a joint mission with France. Venera 15 and 16 will carry two balloons and two landers. These balloons at present being developed will carry instruments for the study of the Venusian atmosphere at a height of 56 km over a period of about six days. The landers will be carrying out observations from the surface at the same time. It is not known at present whether the vehicles themselves will orbit or flyby, but one will leave for an encounter with Halley's comet. This will be in 1986. This vehicle will be equipped with a specially developed camera supplied by the French.

The European Space Agency is preparing the Exosat which will be an additional satellite to cover the X-ray spectrum. At the moment this is the province of the Einstein satellite of NASA. An additional booster will be added to the Ariane launcher in order to get the required power to lift the Exosat to its eccentric orbit, taking it some 200,000km above the North Pole. The vehicle is equipped to study the position, structure and spectra of the sources emitting X-rays in the energy range up to 1·5keV. This satellite will operate as an observatory so that the groups of observers can share the time. The date set for the launch is November 1981.

A joint European/United States venture for the launching of an astronomical Satellite in August 1982 will go ahead, but at a higher cost due to certain technical problems. Its task is to study the infra-red wavelengths, which cannot be done satisfactorily from ground based telescopes, because of the carbon dioxide and water in the Earth's atmosphere. This satellite is the IRAS.

Another joint NASA/ESA venture will be the Space Telescope. This is due to be launched by the Space Shuttle in December 1983. The exact date of launch will of course depend on the progress and time table of the Shuttle programme. The telescope will have a primary mirror of 2·4m diameter, and will carry a number of instruments for the task to be undertaken. The benefit of this telescope will be that it will be some 500km above the atmosphere and will in consequence produce results of the order of 10 times greater than the largest of the earth based instruments.

In 1984, during March, the Galileo probe is due to be launched. This vehicle has also had a number of difficulties due to the financial troubles that have beset NASA. The plan is to send a probe deep into the atmosphere of Jupiter and an orbiter to go round the planet. The orbiter would be sent ahead of the probe and will circle the the planet for 20 months make close observations of the conditions of the atmosphere. The probe will study the atmosphere down to a level where the pressure is more than 10 times that of the Earth. Both vehicles will encounter the planet in July 1987.

Still another joint mission is the International Solar Polar Mission. The object of this mission is to explore that part of the solar system away from the ecliptic. It will be the first time that any spacecraft explore that part of the solar system about which we know nothing. The orbit will be over the poles of the Sun. Two spacecraft will be despatched toward Jupiter and "flicked" round in the planet's gravitational field toward the Sun. They will be launched in such a way that they pass over each of the solar poles, that is, they will travel in opposite directions.

Their task is to study the high energy particles of the solar wind and study the solar magnetic field. This is a most important mission to which the European space agency has already allocated £30 million.

In 1986 the Venus Orbiting Imaging Radar mission will be launched from the Space Shuttle. The object, as its name implies, will be to obtain radar pictures of the surface of Venus. The system of imaging that has been successfully developed will enable distances down to 150m to be resolved through the thick cloud cover. This vehicle will be dispatched in May or August depending on which trajectory is chosen. It will arrive at Venus in December of the same year.

Another special mission is that of Giotto. This is to be launched by an Ariane vehicle in July 1985 on a trajectory to intercept Halley's comet in March 1986. Attempts will be made to obtain imaging of the nucleus and measure the gas and dust of the coma. There is a great deal at stake in this mission, for an accurate knowledge of the composition of comets is very necessary to qualify present theories of cosmology.

The United States will carry out a plan to extend Gamma-Ray astronomy. The observatory will be launched in August 1985. The Shuttle will also be the vehicle for this mission. The observatory will examine, from an orbit 400–500km above the Earth, the very short wavelengths below 10^{-13}m. It is hoped that these observations will help to provide clues as to the nature of Pulsars, Quasars and Supernova.

To make a new map of the sky a special satellite, Hipparcos, is to be launched in 1986/1987. This was put back in favour of Giotto to ensure that at least one spacecraft was able to rendezvous with Halley's comet. Hipparcos' mission is an extremely important one for the same reasons that Giotto was important: further accurate knowledge of the universe.

Hipparcos will measure the positions and motions of 100,000 stars with an accuracy that is not possible from Earth. The measurements will also provide better evidence of the quasars and sources near the edge of the observable universe.

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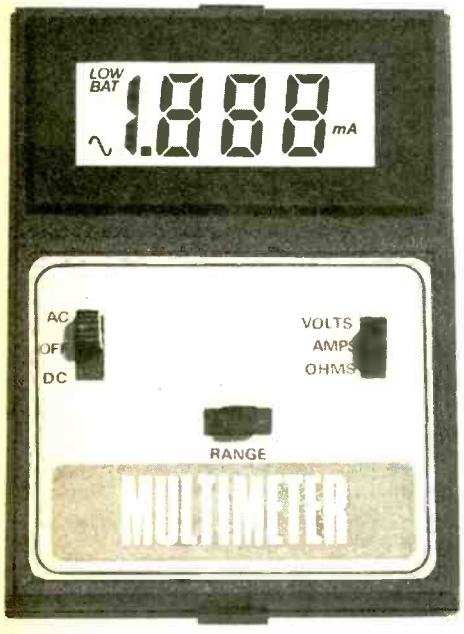

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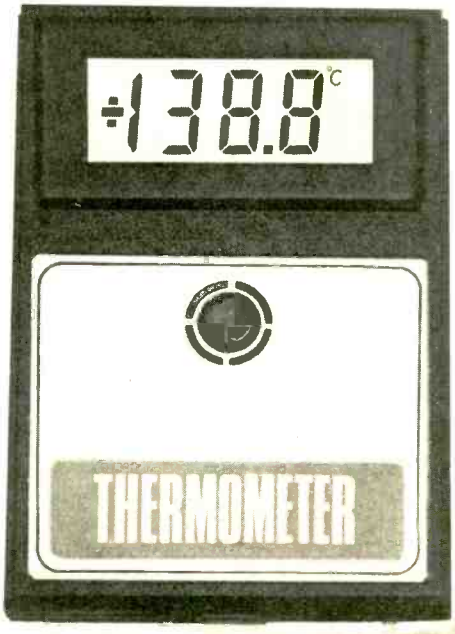

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PRACTICAL ELECTRONICS

MAY ISSUE ON SALE FRIDAY 10 APRIL 1981

Simple Speech Processor

Michael Tooley B.A.
David Whitfield B.A.M.Sc.

A SPEECH processor is essentially a device which improves the intelligibility of a voice signal. This is particularly important where the wanted signal is contaminated by noise or where the signal varies over a wide range. Several different types of processor are possible and these vary considerably in complexity and effectiveness.

The unit to be described not only provides an increase in signal level but also reduces the dynamic range of the signal. It is therefore eminently suited to applications where a consistently high level of output is required from a signal which varies in amplitude. The unit employs an active limiter and therefore avoids some of the time constant problems associated with dynamic speech compressors. Active filter techniques further enhance the output signal by reducing noise and harmonic distortion.

The circuit uses only one integrated circuit, a FET input quad operational amplifier, and may be readily inserted in the signal path of such equipment as public address amplifiers, tape recorders, transmitters and transceivers.

SPECIFICATIONS

Maximum limiting 3dB change in output for 20dB change in input
Input signal range 2mV to 2V peak-peak
Output signal range 20mV to 6V peak-peak
Minimum input signal for onset of limiting 6mV peak-peak
Input impedance 10k typical
Output impedance 150R typical
Supply 6 to 9V at 12 to 20mA

CHARACTERISTICS OF SPEECH

Very large variations in instantaneous signal are present in speech waveforms. This can often be an important consideration in the design of equipment for use with voice signals including public address amplifiers, transceivers etc. The 'peak factor' is defined as the ratio of peak to RMS sound pressure over a specified bandwidth. For unfiltered speech the peak values exceed the RMS values by typically some 10dB or more over a time which is equivalent to the length of an average syllable. Over a longer period of time, however, this value is greatly increased and the peak factor is typically some 20dB. Thus, if a public address amplifier is producing, for example, an average power of 1W from a given source it must be capable of a peak power of around 100W if the signal is to be reproduced faithfully.

In many applications, however, the important consideration is intelligibility rather than accuracy of reproduction. Here we are concerned not with the absolute signal power but more with the ratio of signal to noise power. This can be increased by either reducing the transmission channel bandwidth or by raising the average level of the signal whilst the noise in the transmission medium or recording system remains constant. The latter technique has the effect of reducing the dynamic range of the signal or, to put it in simple terms, making the quieter sounds louder whilst the louder sounds stay loud!

A further consideration is that, for a given system, there is often a maximum signal level that should not be exceeded. This is important in, for example, such applications as broadcast transmitters where overmodulation of the carrier results in a signal having an excessive bandwidth.

SPEECH PROCESSING TECHNIQUES

The two principal methods for restricting the dynamic range of a signal are amplitude limiting or clipping and dynamic compression. The former method has the advantage that it is simple and fast to act, but has the disadvantage that harmonic distortion is introduced by the limiting action. Dynamic compressors are relatively distortion free but are somewhat more complex. They also have considerable drawbacks associated with attack and decay time constants of the AGC system employed; the compressor may not operate quickly enough to respond to a rapid transient and, furthermore, may be slow to recover once the compression action has been started. Fig. 1a shows the general block schematic of an amplitude limiter whilst, for comparison, Fig. 1b shows the arrangement of a dynamic compressor.

The circuit described in this article uses an active limiting arrangement. As with all limiters some distortion is inevitable. This is primarily due to the generation of harmonics caused by the non-linearity of the transfer characteristic. Harmonics of the lower frequency components (say below 1kHz) of the input signal are more significant because they

fall within the frequency range of the speech signal. At middle and high frequencies (say above 2kHz) the harmonics generated fall outside the speech signal frequency range and can be attenuated by means of a suitably designed filter.

The transfer characteristics for various degress of amplitude limiting are shown in Fig. 2. 'Hard-limiting' occurs very abruptly, there being no perceptible increase in the output signal amplitude beyond a certain input level. 'Soft-limiting', as its name implies, is somewhat more gentle and the slope of the transfer characteristic is made to fall progressively as the input signal amplitude increases above

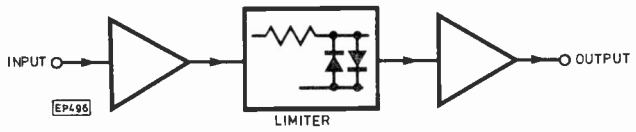


Fig. 1a Amplitude limiter block schematic

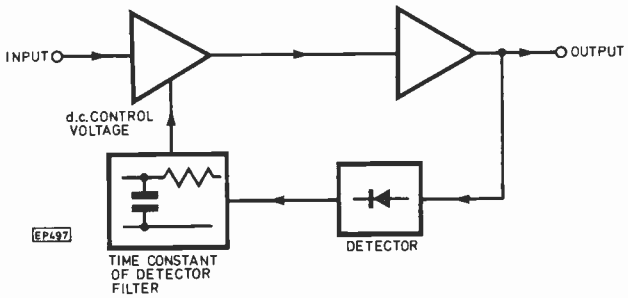


Fig. 1b Dynamic compressor block

a certain threshold level. 'Soft-limiting' offers some advantages over 'hard-limiting' as regards the generation of unwanted harmonics of the input signal. These are considerably reduced with the result that the output signal is less harsh and consequently more pleasant to listen to. Also, due to the reduction in harmonic content, less stringent requirements are imposed on the subsequent filter stage. Typical signal waveforms obtained with 'hard' and 'soft-limiting' are shown in Fig. 3.

The degree of limiting employed depends largely upon the particular application. A change in output of, say, 3dB for a change in input of 20dB may be eminently suitable for voice communications over a noisy radio channel, however, for public address and tape recording of speech signals a somewhat less severe 6dB change in output for a 12dB change in input will be more suitable. An essential requirement, therefore, of a general purpose speech processor employing amplitude limiting techniques is that the degree of limiting should be adjustable over a wide range. In practice, and since the input signal level may vary from one source to another, this means that the signal level both preceeding and following the limiter stage must be made variable. By careful adjustment a wide range of limiting can be achieved and a variety of input and output signal levels can be catered for.

The block schematic of the speech processor is shown in Fig. 4. The first stage is an amplifier with a voltage gain which is adjustable from approximately 1 to 100. The limiter stage which follows has a fixed voltage gain of 2 for small signals and this falls dramatically as the signal level increases. The active low pass filter has an upper cut-off frequency of approximately 4kHz and significantly reduces the harmonic content of the output signal from the limiter. The final stage is another amplifier, the gain of which may be adjusted over the range of 0·05 to 4·5.

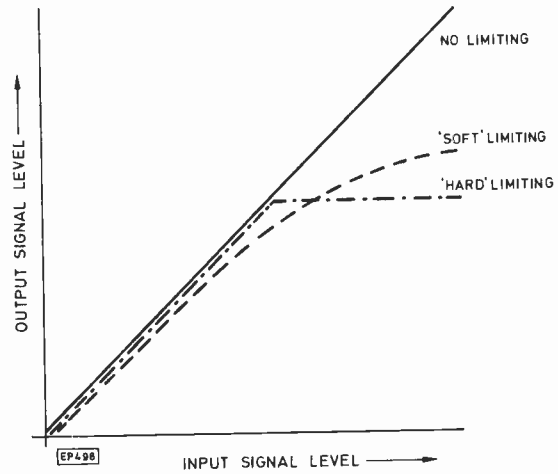


Fig. 2 Transfer characteristics for various degrees of amplitude limiting

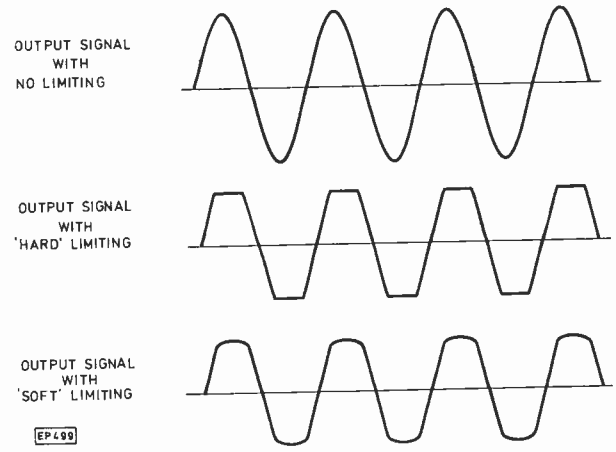


Fig. 3 Effect upon signal waveforms of the limiting characteristics depicted in Fig. 2

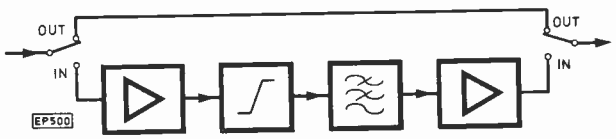
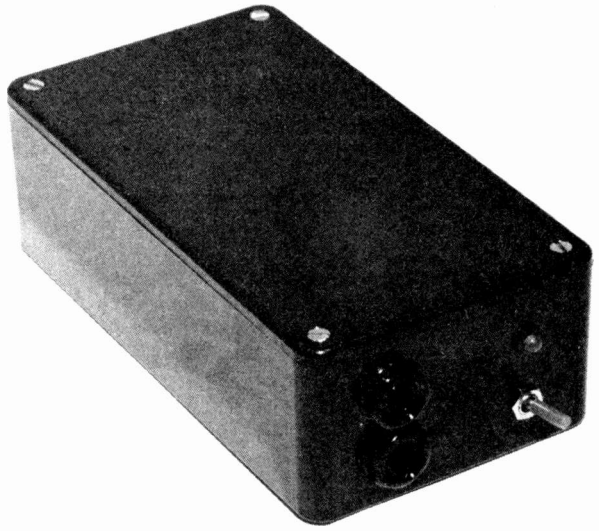


Fig. 4 Block schematic of the Speech Processor



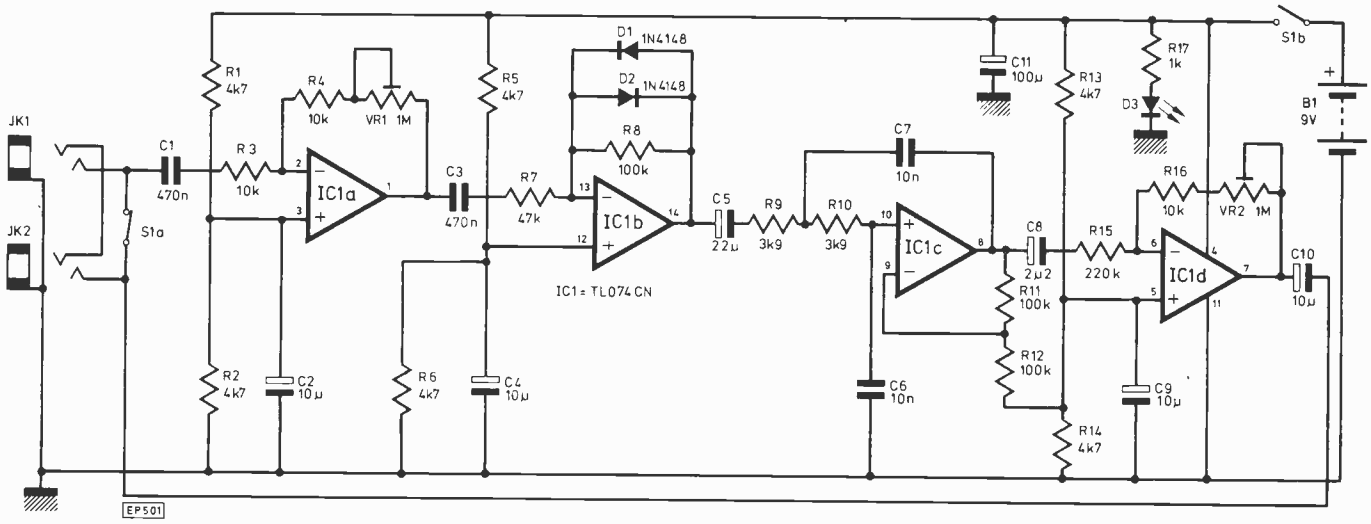


Fig. 5 Circuit of Speech Processor

COMPONENTS.

Resistors

R1	4k7
R2	4k7
R3	10k
R4	10k
R5	4k7
R6	4k7
R7	47k
R8	100k
R9	3k9
R10	3k9
R11	100k
R12	100k
R13	4k7
R14	4k7
R15	220k
R16	10k
R17	1k

All fixed resistors ¼W 5% carbon

Potentiometers

VR1	1M miniature horizontal preset
VR2	1M miniature horizontal preset

Semiconductors

IC1	TL074CN
D1	1N4148
D2	1N4148
D3	l.e.d.

Capacitors

C1	470n polyester
C2	10µ 16V tantalum
C3	470n polyester
C4	10µ 16V tantalum
C5	22µ 25V tubular
C6	10n polyester
C7	10n polyester
C8	2µ2 35V tantalum
C9	10µ 16V tantalum
C10	10µ 16V tantalum
C11	100µ 16V p.s. mounting tubular

Miscellaneous

Printed circuit board plastic case measuring approx. 150 x 80 x 50 mm DPDT miniature toggle switch, sockets (2 off) 3-pole jack or similar, battery connector—snap fit to PP3 battery, low profile 14-pin DIL socket

Components and p.c.b. available from **Howard Associates, 59, Oatlands Avenue, Weybridge, Surrey.**

CIRCUIT DESCRIPTION

IC1a operates as a conventional inverting voltage amplifier, the gain of which is controlled by the negative feedback resistor, VR1. The voltage at the non-inverting input is set by means of R1 and R2 at approximately half the supply voltage with C2 providing decoupling at signal frequencies. A similar arrangement is used for setting the non-inverting input on each subsequent stage. The active limiter is formed by IC1b, D1, D2 and associated components. Since D1 and D2 are silicon devices, a peak-peak voltage of approximately 1·2V at pin 14 of IC1 will cause D1 and D2 to conduct on alternate half-cycles and this will, in turn, provide a low impedance shunt path across the feedback component, R8.

IC1c and associated entry circuit forms a low-pass Sallen and Key filter. This is a simple, yet effective, second order filter, and cut-off frequency being determined by R9, R10 and C6, C7. The ratio of R9 to R10 and C6 to C7 being kept constant to provide fixed filter characteristics. The final stage, IC1d, is an inverting voltage amplifier, similar in configuration to IC1a. VR2 and R16 set the voltage gain of this stage, the values being chosen so that the stage can provide attenuation as well as amplification. S1a provides a direct signal path between input and output when S1b is in the 'off' position. A conventional LED and current limiting resistor is used to provide visual indication that the processor is in use.

CONSTRUCTION

The speech processor is built on a single sided p.c.b., the copper foil layout of which is shown in Fig. 6. The components are arranged on the top side of the p.c.b., as shown in Fig. 7.

It is recommended that IC1 be mounted in a low-profile 14-pin DIL socket and that, as far as possible only miniature components are used. The completed p.c.b. should be carefully checked and then mounted in a small plastic case using stand-off pillars. The layout of the input and output sockets, on/off switch and l.e.d. being entirely a matter for the individual constructor's preference. The connections to the p.c.b. together with associated wiring are shown in Fig. 8.

INITIAL TESTS AND ADJUSTMENTS

Connect a suitable battery (PP3, PP6 or similar) and check the supply current. This should be in the region of 12 to 20 mA. Set VR1 and VR2 to mid-position and connect a microphone to SK1. The output signal should then be checked using an amplifier or tape recorder connected to

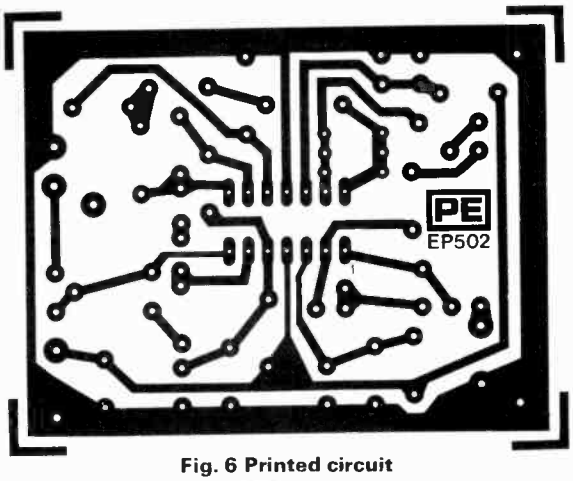


Fig. 6 Printed circuit

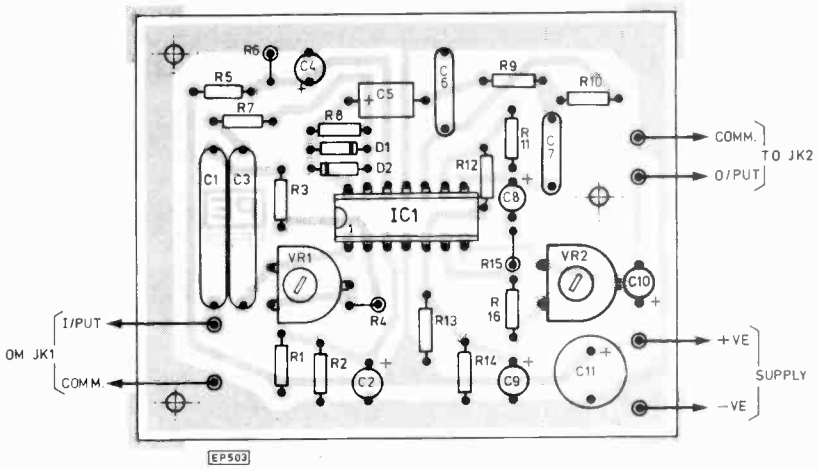


Fig. 7 Component layout

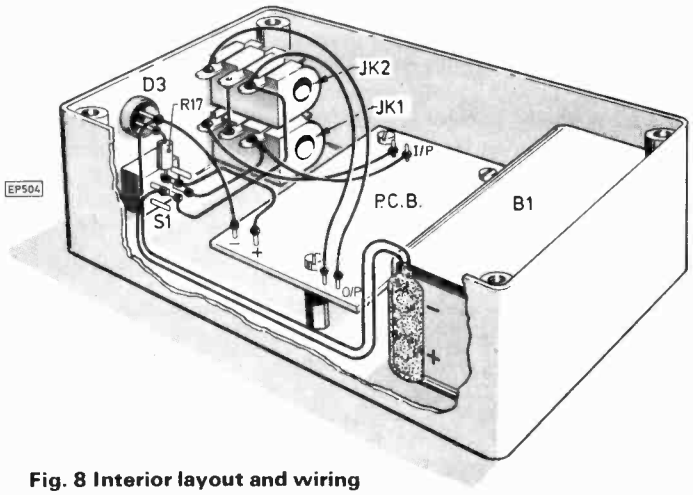


Fig. 8 Interior layout and wiring

SK2. The effect of varying the settings of VR1 and VR2 should be noted. If VR1 and VR2 fail to have any effect, or if the output signal is not obtained, the p.c.b. should again be carefully checked and, if this does not reveal any errors, d.c. voltages should be measured and reference made to the table of test voltages.

When experimenting initially with the speech processor it is recommended that VR1 and VR2 be set almost fully clockwise. This will produce similar input and output levels when using a low impedance dynamic microphone and limiting should occur when 'close-talking' into the microphone. Where an appreciable amount of gain is required, as would be the case when speaking at some distance from the microphone, the settings of both VR1 and VR2 may be increased to around mid-position.

Note that this may have the undesirable side-effect of amplifying unwanted extraneous noises to such a level that their presence is annoying. The settings of VR1 and VR2 are best determined by experiment in conjunction with the actual microphone or signal source which is to be used. It is then a fairly easy matter to determine the optimum settings for any particular application.

APPLICATIONS

Radio transmitters/transceivers

The addition of a speech processor will enhance the performance of most transmitters and transceivers. The extra "talk-power" often making the difference between a signal which is readable and one which is lost in noise. Air tests under marginal conditions show an effective 3 to 4dB increase over a signal without speech processing. The device is suitable for use with most types of transmitter and transceiver and, being merely inserted in the microphone connection, requires no internal modifications whatsoever. The processor may be switched in and out as required; a direct path from microphone to transceiver being provided in the latter case. Since processed speech tends to be somewhat less pleasant to the ear this facility is useful for restoring normal operation for local contacts; the speech processor being primarily intended for chasing DX! When used with mobile equipment the speech processor will allow

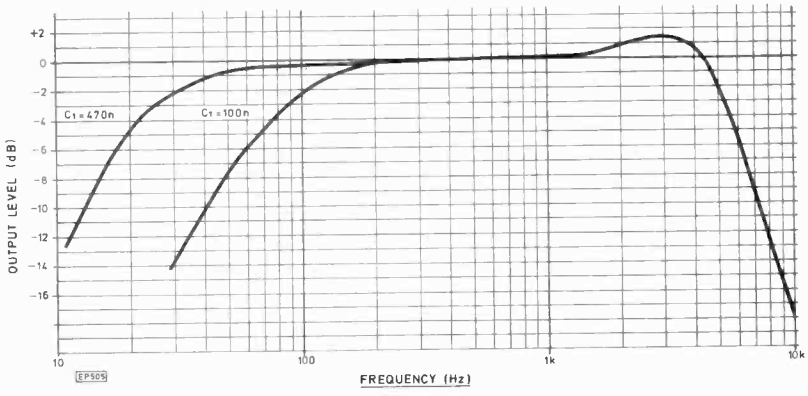


Fig. 9 Frequency response of the Speech Processor with C1 = 470n and 'rolled-off' at LF below 200Hz with C1 = 100n

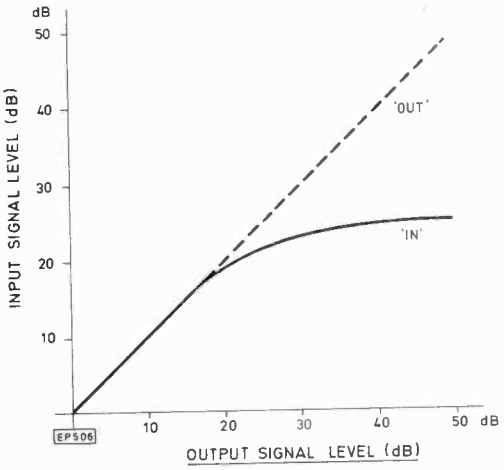
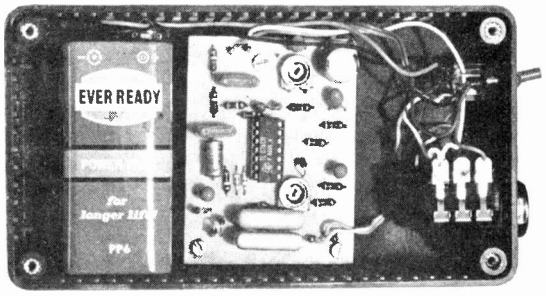


Fig. 10 Transfer characteristic

Test voltages

IC1 pin	1 4·5V	8 4·5V
	2 4·5V	9 4·5V
	3 4·5V	10 4·5V
	4 9·0V	11 0V
	5 4·5V	12 4·5V
	6 4·5V	13 4·5V
	7 4·5V	14 4·5V

All the above voltages were measured with a 10mΩ input d.c. voltmeter. The d.c. supply was 9V.



the operator to talk at some distance from the microphone thus permitting the use of a gooseneck or tie-clip microphone. This is much safer in use than the usual hand-held microphone!

Public address

The speech processor is particularly useful as a means of compensating for the variation in signal level which is often experienced when a fixed microphone (on either a floor or table stand) is employed. The processor then allows the speaker to vary his position relative to the microphone without appreciable loss of amplification.

Tape recording

The speech processor may be used to replace the AGC system used on some cassette tape recorders when recording speech. There is no annoying 'recovery time' and the processor is useful in clarifying signals contaminated by noise as would be the case when recording from short wave receivers. The unit is also suitable for dictation, freeing the user from the need to hold the microphone and allowing him or her to talk at some distance from the recording machine.

And finally, although the processor is not generally suitable for music (the distortion introduced being quite noticeable) it may prove to be of some interest to those who wish to experiment with musical effects. The speech processor makes a very effective "fuzz-box" with VR1 and VR2 suitably adjusted! ★

Countdown

BEX March 25-26. Metropole, Brighton. **K**
The Northern Electronic Test & Measurement Exhibition March 31–April 2. Wythenshawe Forum, Manchester. **T**
Laboratory April 1–2. Glasgow.**I**
BEX April 8–9. Centre Hotel, Liverpool. **K**
Laboratory April 8–9. Manchester. **I**
London Computer Fair April 14–16. North London Polytechnic **B5**
All Electronics Show April 22–24. Grosvenor House, Park Lane, London. **F1**
Computer Graphics April 28–30. The Barbican Centre, London. **O**
BEX April 29–30. Dragonara Hotel, Leeds. **K**
Entertainment May 9–17 (weekday mornings trade only). NEC, Birmingham. **B2**
The European Consumer Electronics Show May 10–13. Nuremberg, West Germany. **I**
BEX Train May 11–22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. **K**
Defence Components Expo May 12–14. Brighton Metropole. **I**
East Suffolk Wireless Revival May 24. Sports ground of Ipswich Civil Service Sports Association, Straight Road, Ipswich. **V1**
Scotelex June 2–4, Royal Highland Exhibition Hall, Ingliston, Edinburgh. **A1**
Semlab June 2–5, Grand Hall, Olympia, London. The international scientific educational, medical and industrial laboratory equipment exhibition. (Trade). **I**
Transducer Tempcon June 9–11. Wembley Conf. Centre, London. **T**
Components (Electronics Components Industry Fair) June 9–12. Earls Court, London. **I**
International Word Processing Exhibition & Conf. June 23–26. Wembley Conf. Centre. London. **Z**
BEX—Portsmouth June 24–25. Centre Hotel. **K**
Solar Energy Exhibition Aug. 23–28, 1981. Brighton. **M**
Laboratory Sept 8–10.Grosvenor House, Park Lane, London. **I**
International Business Show Oct. 20–29. NEC. Birmingham. **A2**
BEX—Southampton Nov. 4–5. Polygon Hotel. **K**
Electronics 82 (Sub-titled International Electronics Control and Instruments Exhibition) May 24–28, 1982. NEC. **I**

I Industrial Trade Fairs. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Road, Bournemouth
M Montbuild. ✆ 01-486 1951
O Online Conference. ✆ 0895 39262
T Trident International Exhibitions. ✆ 0822 4671
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V1 Jack Tootill, Ipswich. ✆ 0473 44047
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DR. ✆ 01-439 8556
B2 Brintex Exhibitions Ltd., 178–202 Great Portland Street, London W1N 6NH. ✆ 01-637 2400
B5 Dept. Electronic & Communication Eng., Polytechnic of N. London.

POINTS ARISING

27/28MHz CONVERTER *(March '81)*

The following coil winding details were omitted from Fig. 6:
L1 3 turns 26 s.w.g. wound over L2.
L2 15 turns 30 s.w.g. close wound.
L3 & L4 12 turns 30 s.w.g. close wound.
L5 18 turns 30 s.w.g. close wound.
In Fig. 5, D5 Anode should be connected to C21 which is non elect.

MICROBUS *(Feb '81)*

There was an error in one of the ZX80 programs. See *Readout* on page 64.

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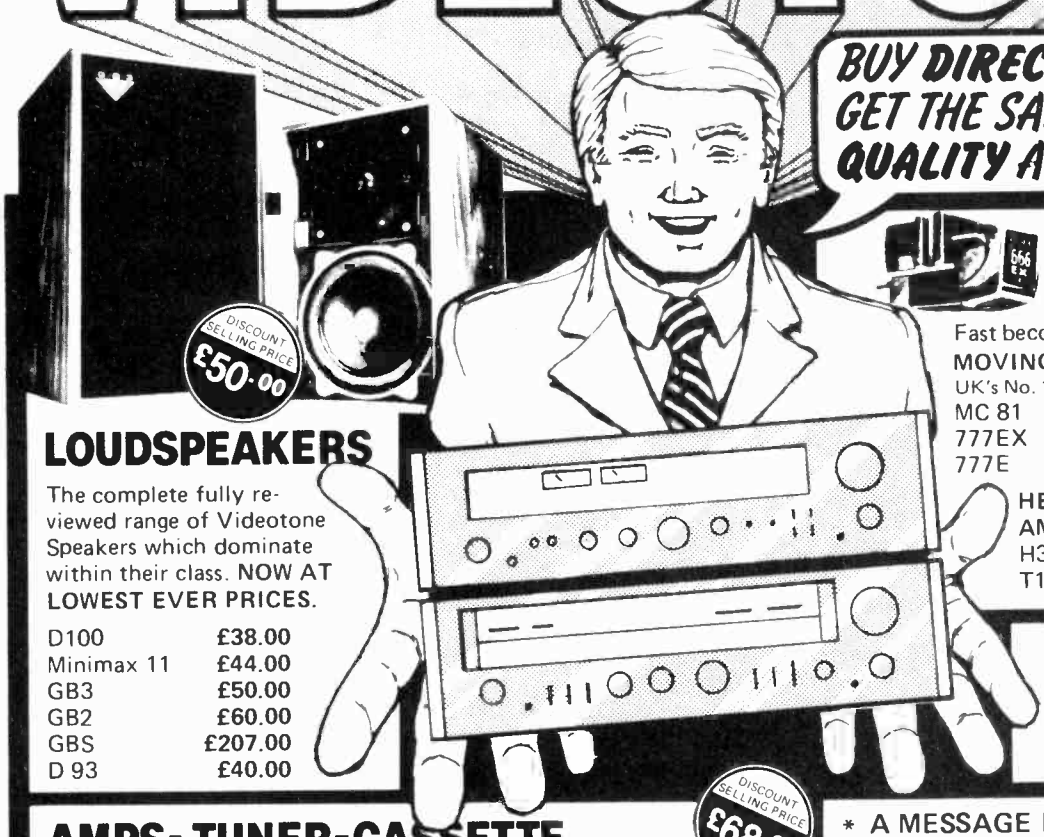

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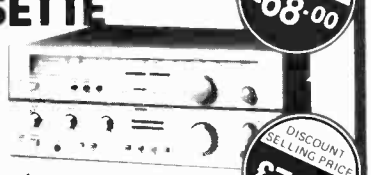

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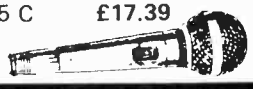

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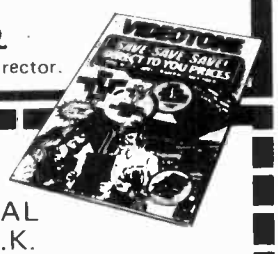

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PE

P.s.u. and controller design for mini-drills employing p.w.m. to vary the speed

NEARLY everyone who regularly produces printed circuit boards at home will own a miniature drill of some sort. These drills normally require a power supply of 14 volts, capable of giving 2–3 amps. The supply will allow the drill to give a better performance if it is regulated, since the 14 volts will be maintained when the drill is under load. Also, if the drill is to be used for other purposes than drilling (which should always be done at the fastest possible speed) a variable speed power supply/controller is desirable. The most notable time when a slower speed is required is when using a burr bit to scratch out a p.c.b. track, at full speed the burr tends to skid or bite making the job very difficult. The design presented here is for a suitable power supply and controller, employing pulse width modulation to give the variable speed capability.

PULSE WIDTH MODULATION

The easiest way to control the speed of a small d.c. motor (as are most drills) is to vary the power supply voltage. However, the torque developed by the motor falls off very quickly as the supply is reduced, making the slower speeds useless. This problem can be overcome by using a square wave drive with variable 'on' and 'off' time. (Fig. 1). When the 'on' time is a small percentage of the 'off' time the motor will obviously run more slowly since less energy is supplied, but since the motor is pulsed by a full power surge the torque remains fairly high. Obviously the speed is increased by increasing 'on' time. It is usual to keep the frequency of the system constant and vary the width of the 'on' pulse, hence the name of pulse width modulation.

THE CIRCUIT

The circuit is shown in Fig. 2. The power supply is fairly conventional, except that a great deal of decoupling is employed. This should not be omitted because the drill generates a lot of spikes which will cause faulty operation of the timing circuit. It is important that all the power supply components are rated to sufficient current.

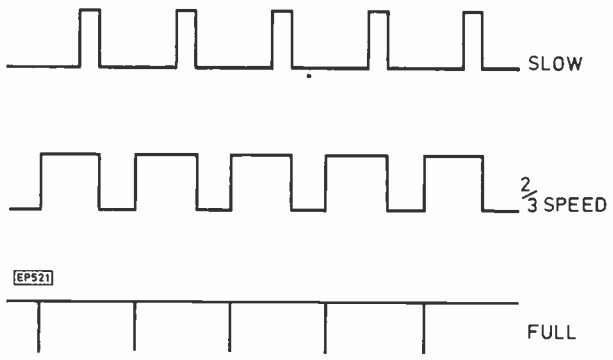


Fig. 1. Pulse width speed control

A 20 volt transformer was used in the prototype to give plenty of spare capacity. The output from this transformer is fed to C2 via a 6 amp bridge. Transistor TR1 and R1, D1 form a simple series regulator for the timing circuit. The voltage generated by this supply also determines the final output voltage and thus should be chosen to suit the drill concerned. A 15 volt Zener was used in the prototype, when reduced by three base/emitter drops the resultant 13·2 volt final drive is ideal for a 14 volt drill.

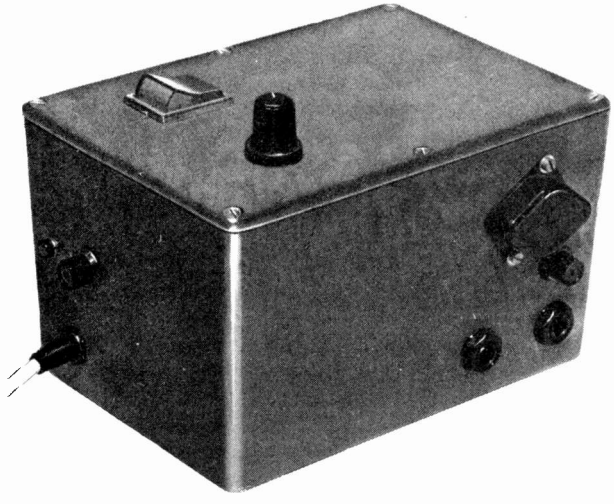
The timing is generated by two 555 timers in a double package (556). The first timer is connected as an astable, of 60Hz frequency. However, the output from this is in the form of a short pulse, this being ensured by making R2 much greater than R3. The pulse output is used to trigger the second 555, which is connected in monostable mode. C8 and R4 act as a pulse differentiater which increases the noise immunity of the circuit.

The monostable period can be varied by VR2, between short and long periods. Since the maximum period required is just less than the frequency of the first 555 VR3 is included to allow this period to be accurately set; similarly VR1 sets the shortest time available—or the slowest speed. A footswitch facility is provided by using the reset of the monostable; this simply inhibits its operation.

The output from the monostable is fed to a Darlington pair, of which the 2N3055 should be mounted on a heatsink. The output from the 2N3055 is fed directly to the drill, although considerable decoupling in the form of C11, C12 and R10 should be added.

mini drill P.S.U.

CHRIS LARE



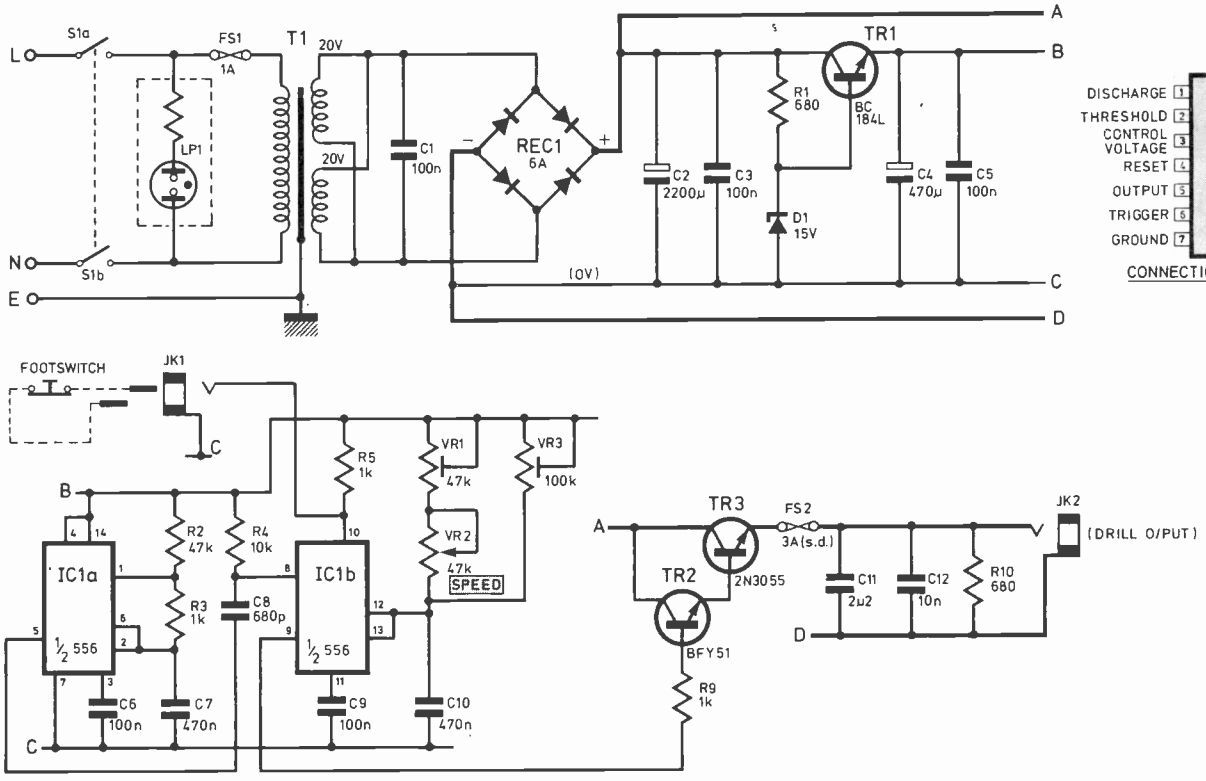


Fig. 2. Circuit diagram

COMPONENTS . . .

Resistors

R1, 10	680R
R2	47k
R3, 5, 9	1k
R4	10k
VR1	47k miniature preset
VR2	47k potentiometer
VR3	100k miniature preset

Capacitors

C1, 3, 5, 6, 9, 12	0·1µ Mullard C280
C2	2200µ 63 Volt electrolytic
C4	470µ 25 Volt electrolytic
C7, 10	0·47µ Mullard C280
C8	680p polystyrene
C11	2·2µ Mullard C280
C12	0·01 disc ceramic 750V

Semiconductors

D1	15V 400mW Zener
TR1	BC184L
TR2	BFY51
TR3	2N3055
IC1	556

Miscellaneous

REC1–6A bridge; T1–20V transformer 2·4A; double pole single throw illuminated switch; 1A fuse & holder; 3A fuse & holder (optional); 2 mono jack sockets; plugs; die cast aluminium box; p.c.b.; footswitch (Watford PB12); insulation kit for 2N3055; cover for 2N3055; nuts, bolts etc.; sticky feet; mains supply neon (optional).

CONSTRUCTION

The physical construction is not critical, but the wiring diagram should be closely adhered to so as to avoid noise problems.

The prototype circuit was built on a printed circuit board, produced with an etch-resist pen. Veroboard is not recommended due to the possible noise problems. The circuit board, together with the other parts was housed on a large die-cast aluminium box, chosen for its good heatsink properties. The 2N3055 transistor was mounted on the box part and fitted with a cover to prevent accidents with wandering screwdrivers. A double pole illuminated switch for the mains supply and the speed control were mounted on the lid of the box.

Standard quarter inch jack sockets were used to connect the drill and footswitch. Note that the footswitch should have closed contacts when released. Most footswitches are connected the other way round, but the one used in the prototype had a standard changeover micro switch inside,

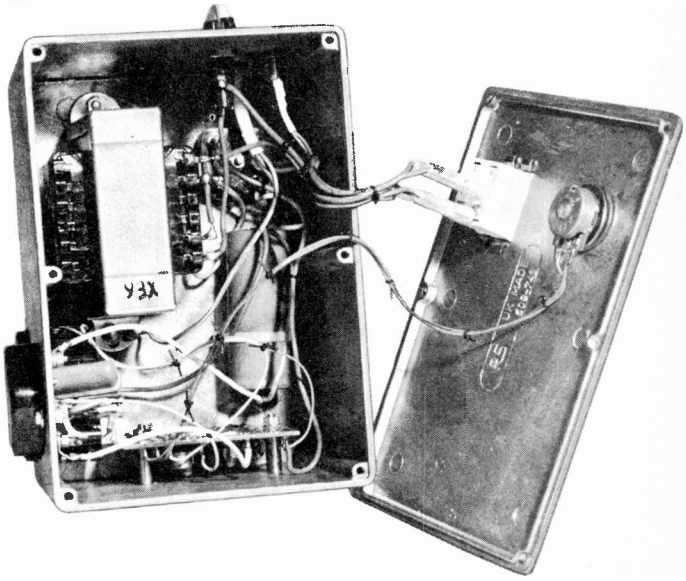
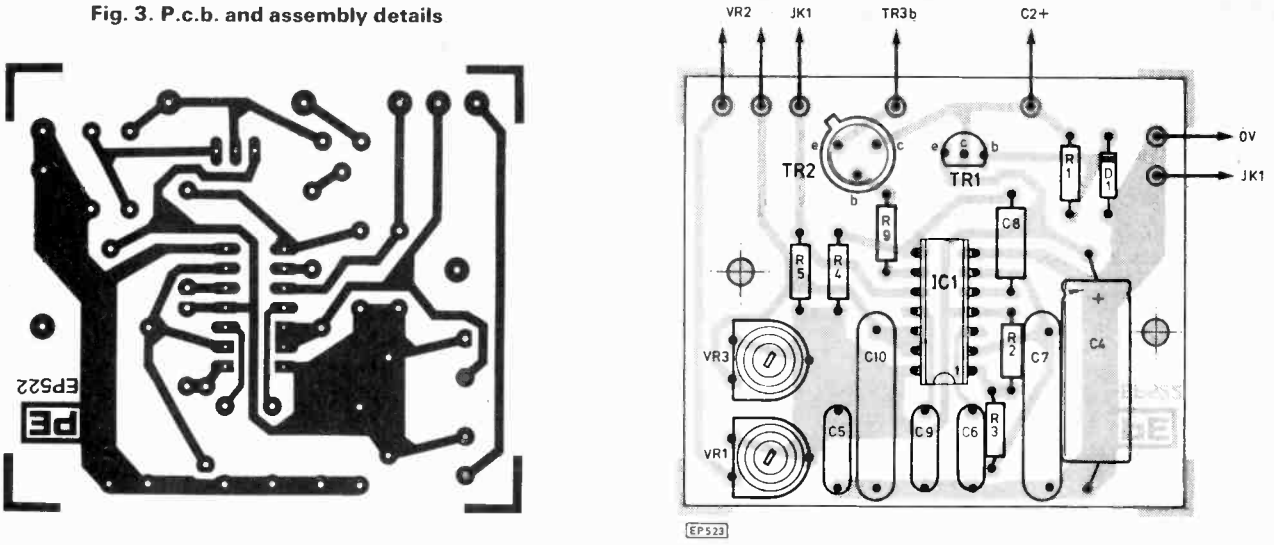


Fig. 3. P.c.b. and assembly details



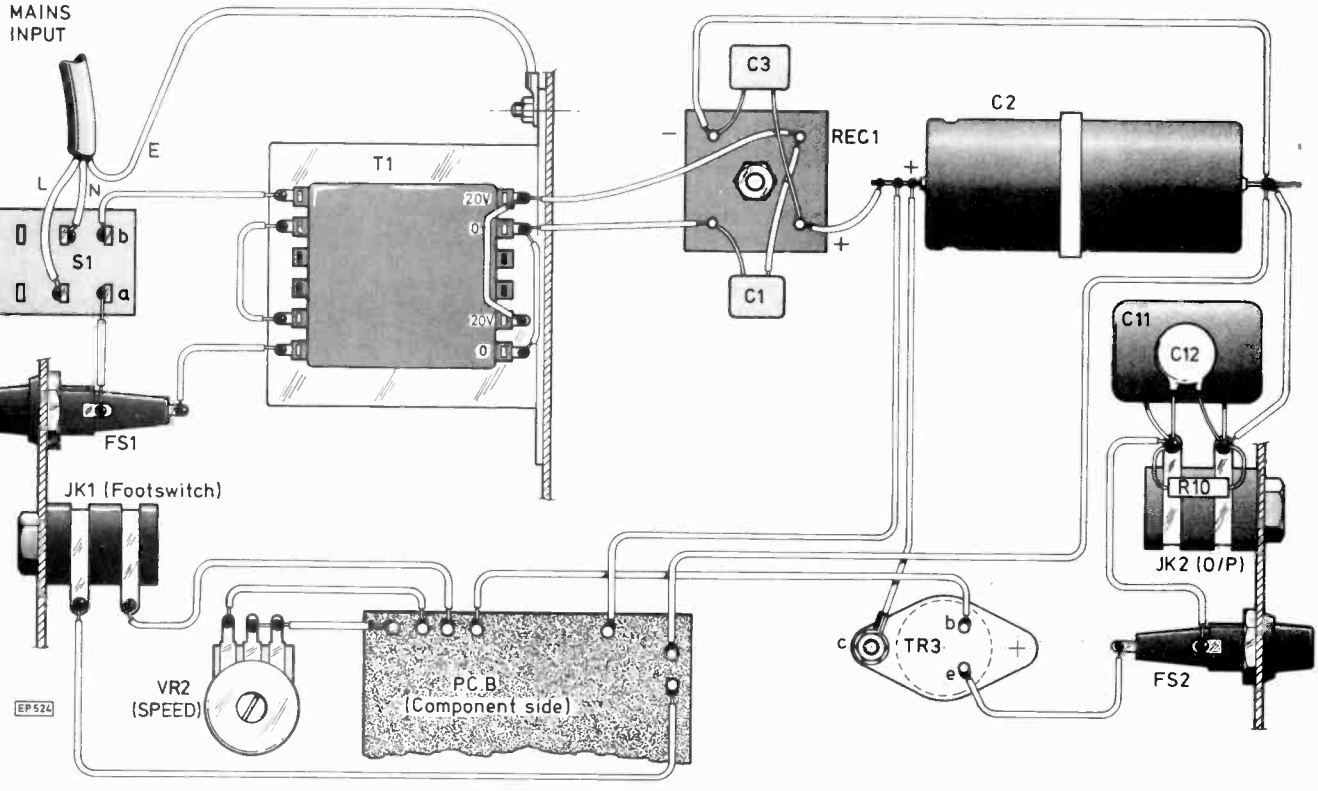


Fig. 4. Interwiring detail

and it was a simple matter to alter the connections. The main capacitor and bridge were mounted on the bottom of the box, and the output decoupling components were mounted directly on the output jack socket.

Four stick on plastic feet completed the unit.

TESTING

If an alternative current limited supply is available it is a good idea to test the board with that, since a major failure will almost certainly destroy TR1 and probably D1 as well. Set the supply for about 17 volts. After re-checking the wiring switch on. Check the regulator works. Check that a pulse output is present on pin 5, and also on pin 9. Set both presets to half travel and connect a drill up and it should run. Increase the speed control to full, and the drill should speed up. If it starts to run roughly, and slows down, do not worry—it is simply the monostable over running. Adjust VR3 with the speed control at maximum until the motor runs at its fastest. Turn the speed control to minimum and adjust VR1 until a suitable speed is obtained, then re-adjust VR3 with the speed control at maximum.

IN USE

All drilling should be performed with the speed control at maximum. Slow drilling will wear the drill bits out more quickly, as well as taking longer. For other uses, burring, polishing, etc. the best advice is trial and error, but around half speed seems to be the best.

The footswitch is a definite improvement. It is particularly useful if the drill stalls because the drive can be released quickly, and when drilling over a centre point because the drill can be positioned and then started. ★

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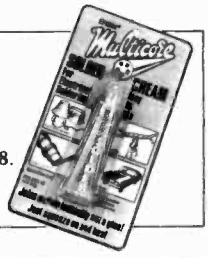

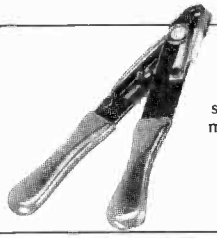

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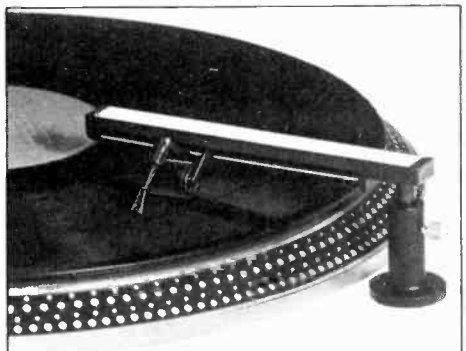

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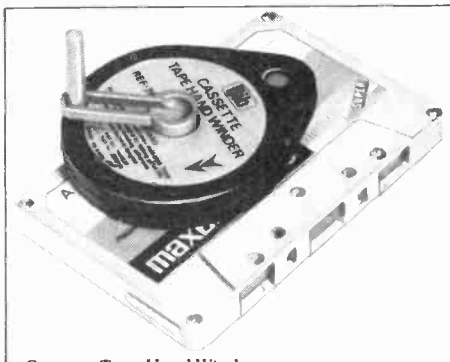

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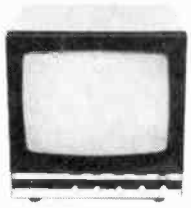

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			J47	10 0.125 yellow LEDs	150p
E26	10 100K min. presets	70p	J72	20 0.125 LED clips	60p
E31	10 1u 63V electrolytics	50p	J75	1 FND500 CC display	100p
E33	10 4u7 63V radial elec.	50p	K5	5 741 op amps.	90p
E34	10 10u 25V radial elec.	50p	K20	5 CA3140 op amps.	225p
E37	10 100u 25V radial elec.	75p	K30	5 LM301A op amps.	140p
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R.W. Coles

DIGITAL 555

Probably the most universally useful and successful integrated circuit ever made is the ubiquitous 555 timer. You find them in the most unlikely places, often doing unlikely jobs which the manufacturers never dreamed of when they introduced the design back in the early 'seventies. First came useful dual and quad versions in 14 and 16 pin packages, and more recently came the CMOS versions, all helping to expand the area of application, but never really eclipsing the original design with its cheap, simple and robust reputation. All of the "improved" 555 devices have been covered in this column over the years, and this month I am able to report on yet another device intended to replace 555s in certain timing applications.

One area where all previous 555 circuits have run out of steam has been in the construction of simple timers capable of long delay periods of seconds or even minutes duration. The trouble is that the 555 relies on a single CR period to set time duration, and this means going to large electrolytic capacitors when long time-outs are needed. The use of electrolytic capacitors brings the usual bogies of poor tolerance, high leakage, and temperature sensitivity, and for critical applications the solution has been to run the 555 as a higher frequency astable and follow it with a multi stage binary counter such as the CMOS 4040.

To make the job of constructing long duration timers and low frequency oscillators easier, Intersil have introduced the ICM 7242 which puts the oscillator and the counter all in one 555-like 8 pin package. A single external resistor and capacitor set the basic oscillator frequency, and the oscillator output is fed to the internal 8 stage binary divider chain whose final stage therefore gives an output frequency 1/256th that of the oscillator. Also in the package is a control flip-flop which is set by a TRIGGER input, and starts the count sequence, and reset by a RESET input which stops the count and zeroes the counter chain. With the RESET line disconnected the 7242 can be used as an LF oscillator, with the RESET line connected to the final count stage output the 7242 works like a monostable or timer.

For additional flexibility the basic RC oscillator output is brought out, as is the first stage of the count chain which gives a symmetrical square wave at half the oscillator frequency. This is a very useful device for those occasional long time/low frequency applications, but it won't replace the 555, take my word for it!

ROBOT MUSCLE

Robots, like people, need muscles to enable them to move their "arms". Animal muscles can be precisely controlled, are efficient, and are very complex. The poor old robot, on the other hand, has to rely on electric motors, gears, and drive belts, not to mention feedback pots, servo amplifiers, and power supplies.

Really useful muscle analogues seem as far away as ever, but perhaps a new chip set from SGS-ATES can at least help to streamline existing d.c. servomotor "muscle" technology to make it more efficient and compact. With the addition of a d.c. motor and an optical position encoder, and under the control of a microprocessor, the L290, L291 and L292 trio make up a compact and powerful servo system for position control in robots or any other industrial machine. The L290 comes in a 16 pin plastic d.i.p. and contains the circuitry to interface the optical position encoder to the microprocessor by means of derived position and velocity signals. This chip also provides a compensated reference for the L291, which accepts parallel binary data from the microprocessor and converts this into an analogue servo demand signal using a D to A converter. This chip also contains a position amplifier, mode/direction switches, and is housed in another 16 pin d.i.p. The L292 is the motor driver, able to handle up to 2 amps at 36 volts using an overload protected bridge circuit. The L292 operates in the "switched" mode, and in keeping with the application, it is housed in a 15 lead Multiwatt power package.

When interconnected, the servo components operate in two modes. In order to slew rapidly to a new demanded position the servo loop can initially employ velocity control only, but as the target position is approached, a change to precise position control is made.

PUTTING THE BYTE ON

If you are shovelling together a new microprocessor system and can't make up your mind what to do about memory, it's probably time you had a look at the "Bytewyde" concept championed by Mostek.

Bytewyde is not a reference to a single memory device, but is the name given to a whole family of devices, including some you will already be very familiar with, like the 2716 EPROM. What makes the concept special is the plug-in interchangeability of ROM and RAM memory devices in the same socket by utilising the pin configuration made standard by 24 pin UV erasable EPROMs and compatible masked ROMs. To launch the concept, Mostek introduced the 4118, a 1K x 8 static RAM in a 24 pin package which would have been a useful hunk of memory even *without* EPROM compatibility! Things didn't stop there however, and now there are bigger chips and several new manufacturers joining in. Mostek have introduced another 1K x 8, the 4801 which is faster than the 4118, and are now offering the 4802 which is faster and has a 2K x 8 capacity to boot. The Mostek chips are all NMOS, but in the land of the rising sun they are turning out CMOS memories in the Bytewyde mould, such as the MSM 2128-1 from OKI Semiconductor, another 2K x 8 device.

If you adopt Bytewyde, you can lay your boards out with standard 24 pin sockets and then by changing links to just two of the pins, you can plug in your choice of 1K x 8, 2K x 8 or 4K x 8 EPROMs, or 1K x 8 or 2K x 8 RAMs. If you use 28 pin sockets instead, you will be ready for all of the above plus the new generation of 8K x 8 EPROMs and those giant RAM chips which are just around the corner!

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. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THIS month's Micro-Bus presents an automatic program loader for the ZX80, and a three-dimensional plotting program for the Acorn ATOM. But first here are three ingenious programs for the ZX80 devised by *Lars Silen* of Finland. They provide ways of concatenating strings, transferring the last character from one string to another, and reading from the ZX80's keyboard.

CONCATENATING STRINGS

The ZX80 has no built-in function for concatenating two strings; so you cannot, for example, add the two strings A$="STUV" and B$="WXYZ" by writing A$=A$+B$ as you can on some BASICs. The routine shown in Fig. 1 overcomes this limitation by providing a way of concatenating any two different string variables, and it is called as follows:

```
LET A$=A$
LET B$=B$
GO SUB 1000
```

With the examples given above A$ would end up with the value "STUVWXYZ" and B$ would have the value "" (the null string). The references to A$ and B$ in the two seemingly redundant LET statements may be changed to any two different string variables that are to be concatenated. Note that no variables should be used between these two LET statements and the subroutine call, as this may cause the interpreter to hang up.

```
1000 REM STRING ADDER
1010 LET AD=PEEK(16394)+256*PEEK
(16395)-3
1020 LET AD=AD-1
1030 IF NOT PEEK(AD)=1 THEN GO T
O 1020
1035 LET TP=PEEK(AD+1)
1040 POKE AD,0
1050 POKE AD,PEEK(AD+2)
1060 LET AD=AD+1
1070 IF NOT PEEK(AD+2)=1 THEN GO
 TO 1050
1080 POKE AD+1,TP
1090 POKE AD,1
1100 RETURN
```

Fig. 1. Program to concatenate two strings on the ZX80

PROGRAM OPERATION

The program depends, for its operation, on the way strings are assigned in the ZX80; when a string variable is assigned to, the old version is deleted and a new version is created at the end of the list of variables. The two LET statements above have the effect of moving the strings A$ and B$ to the end of the list of variables, so that they are positioned in memory as shown in Fig. 2 (a).

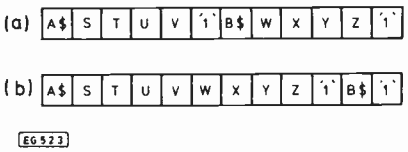


Fig. 2. Diagram showing two strings (a) before and (b) after running the String Adder program of Fig. 1

Locations 16394 and 16395 contain the address of the top of the list of variables; the program reads backwards from this address, through string B$, until the terminating byte '1' is found at the end of A$ (lines 1020 to 1030). Then the characters of B$ are shuffled down onto the end of A$ (lines 1050 to 1070), and finally B$ is recreated as a null string (lines 1080 to 1090). The result is shown in Fig. 2 (b).

TR$ FOR THE ZX80

The following routine is very much like the ZX80's TL$ function, but instead of cutting off the leftmost character from a string, it cuts off the rightmost character; it could therefore be called TR$. The routine is shown in Fig. 3, and uses much the same technique as the program to concatenate strings. Again, the routine is called by executing:

```
LET A$=A$
LET B$=B$
GO SUB 1000
```

The effect is to cut off the last character from A$ and add it as the first character of B$. Thus if initially A$="STUV" and B$="WXYZ" the result would be A$="STU" and B$="VWXYZ". B$ may initially be a null string.

```
1000 REM TR$
1010 LET AD=PEEK(16394)+256*PEEK
(16395)-3
1030 LET AD=AD-1
1040 IF NOT PEEK(AD)=1 THEN GO T
O 1030
1050 POKE AD,PEEK(AD+1)
1060 POKE AD+1,PEEK(AD-1)
1070 POKE AD-1,1
1080 RETURN
```

Fig. 3. Program for the ZX80 moves the last character from one string to another

ZX80 KEYBOARD ROUTINE

One shortcoming of the ZX80 is that the keyboard and display are effectively dead during execution of a program. However, with the help of the following simple machine-code routine it is relatively easy to read keys at any desired time:

```
IN A, 0    ; read port 0 into accumulator
LD L,A     : save result in LSB of HL
LD H, 0    ; zero MSB of HL
RET :      return to BASIC, result in HL
```

Since there is always a risk that a machine-code routine located in the ZX80's RAM will be overwritten by the display file, the routine is written into a string which must not therefore be used elsewhere in the program. The program of Fig. 4 sets up the machine-code routine, and is called using the USR function:

```
LET K=USR(O)
```

where K is given the value of the key pressed. Note that this function, and lines 20 to 90 in the program, refer to the variable "O", *not* the digit zero.

```
  10 REM READER
  20 LET O$="XXXXXX"
  30 LET O=PEEK(16392)+256*PEEK(
16393)+1
  40 POKE O,219
  50 POKE O+1,0
  60 POKE O+2,111
  70 POKE O+3,38
  80 POKE O+4,0
  90 POKE O+5,201
```

Fig. 4. Program sets up a machine-code routine to read the ZX80's keyboard

AUTOMATIC PROGRAM LOADER

It is often convenient to record a large number of seldom-used programs onto one cassette, but then it can be a lengthy business retrieving the particular one you want. The following system automatically searches a tape for the correct program, by skipping the correct number of earlier programs on the tape. It was developed by *Trevor Toms* of Phipps Associates, for use with the cassettes of programs that accompany their excellent "ZX80 Pocket Book", and they have kindly given permission for it to be included in Micro-Bus.

The automatic loading is performed by a header program, stored at the beginning of

each tape. This is loaded first, and it prints out a list of all the other programs on that tape. All you need to do is type the number of the program you want, and the header program will locate it and load it.

MACHINE-CODE ROUTINE

The first stage in writing the header program is to create a machine-code routine that will skip past a program on the tape. This is best done using a BASIC program, as in Fig. 5. First, line 2 reserves 100 bytes for the machine-code by dimensioning an array C, and the address of this array is calculated and stored in the variable C (line 10). To avoid having to write the entire cassette routine from scratch, the ZX80's LOAD subroutine is copied out of the relevant part of the monitor ROM in lines 30 to 70, and then "patched" to do the required task by modifying certain bytes. The patches are as follows:

Lines 110 to 230 converts the routine into a subroutine, rather than part of the main command-entry loop, and make it read program bytes from tape until a byte containing 128 (or 80 in hex) is detected. This byte denotes the end of the program and program variables. Lines 240 to 260 make the routine ignore the system variables, which are stored as 40 bytes before the program text and program variables. Finally, the routine is patched so that if the BREAK key is pressed the USR function will return a value of −1 (lines 330 to 390). Any other value returned indicates that a program has been successfully skipped over.

```
  1 REM CREATE CASSETTE HEADER
  2 DIM C(50)
 10 LET C=PEEK(16392)+PEEK(1639
3)*256+2
 20 LET Y=C+1
 40 FOR X=504 TO 597
 50 POKE Y,PEEK(X)
 60 LET Y=Y+1
 70 NEXT X
100 REM PATCH LOAD SUBROUTINE
110 POKE C+1,21
120 POKE C+2,32
130 POKE C+3,5
140 POKE C+4,126
150 POKE C+5,254
160 POKE C+6,128
170 POKE C+7,22
180 POKE C+8,1
190 POKE C+9,0
200 POKE C+10,0
210 POKE C+11,32
220 POKE C+12,28
230 POKE C+13,201
240 POKE C+14,6
250 POKE C+15,40
260 POKE C+25,57
270 POKE C+35,42
280 POKE C+36,8
290 POKE C+37,64
300 POKE C+38,35
310 POKE C+39,35
320 POKE C+40,80
330 POKE C+49,33
340 POKE C+81,24
350 POKE C+82,174
360 POKE C+83,33
370 POKE C+84,255
380 POKE C+85,255
390 POKE C+86,201
400 STOP
```

Fig. 5. Program to set up a machine-code routine to skip a program on tape

Having typed in the program of Fig. 5, and saved it on tape in case it crashes, run it to create the machine code in array C. Now delete every line in the program, being extremely careful to avoid pressing RUN or CLEAR which would destroy the contents of array C. Now type in the header program of Fig. 6; this contains, in lines 100 to 200, a list of the programs to be saved on the tape, and these lines should obviously be altered to suit the programs to be stored. Line 20 calculates the address of the skip subroutine created earlier, which still exists in memory although there is no longer any reference to it. The subroutine is called by the function USR(C+14).

```
  1 REM ***   "GOTO 1"   ***
  2 REM *** DO NOT "RUN" ***
 10 LET MAXPROGS=3
 20 LET C=PEEK(16392)+PEEK(1639
3)*256+2
 30 PRINT "PROGRAM SELECTION:"
 40 PRINT
100 PRINT "1. MASTERMIND",,"1K"
100 PRINT "2. HANGMAN",,"1K"
120 PRINT "3. HUNT THE WUMPUS",
"3K"
200 PRINT
210 PRINT "REWIND TAPE, ENTER S
ELECTION"
220 PRINT "PRESS PLAY/NEWLINE T
OGETHER"
300 INPUT N
310 IF N<1 OR N>MAXPROGS THEN G
OTO 1
320 IF N=0 THEN LOAD
330 IF USR(C+14)=-1 THEN GO TO
400
340 LET N=N-1
350 FOR Y=1 TO 400
360 NEXT Y
370 REM SMALL SETTLE LOOP 4 SEC
S
380 GO TO 320
400 PRINT "BREAK..."
9999 STOP
```

Fig. 6. Header program for the ZX80 loads a specified file from a tape

Having entered the header program, save it at the start of the tape, and you are then ready to fill up the tape with programs you wished to archive. Note that about 10 seconds of blank should be allowed after recording the header program, so that it can be updated and re-recorded if more programs are added to the end of the tape at a later stage.

USING THE PROGRAM

In use, the header program is first loaded from the start of the cassette, and executed using "GOTO 1" since RUN would destroy array C containing the machine-code routine. Having selected a program from the menu, and entered its number, the tape is rewound and played again, while typing NEWLINE. The automatic loader will then skip the header program, and all the intermediate programs, finally loading the program that was chosen.

3-D PLOTTING

The simple program in Fig. 7 plots a three-dimensional curve using high-resolution graphics. It is designed for an Acorn Atom with a floating-point extension. The program avoids plotting lines that would be hidden by the perspective from which the curve is being viewed; see Fig. 8.

The program uses a mixture of integer and floating-point variables; the floating-point variables are prefixed by a "%" sign, and are

```
  5 REM 3-D PLOT
 10 CLEAR4
 20 A=128;B=A*A;C=96;D=96
 30 FOR X=0 TO A
 40 S=X*X
 50 %P=SQR(B-S)
 60 %I=-%P
 65 DO
 70 %R=SQR(S+%I*%I)/A
 80 %Q=(%R-1)*SIN(24*%R)
 90 %Y=%I/3+%Q*D
 95 FIF %I=-%P %M=%Y;GOTOb
100 FIF %Y>%M %M=%Y;GOTOa
105 FIF %Y>=%N GOTOc
110b%N=%Y
115a%Y=C+%Y
120 PLOT13,(A-X),%Y
130 PLOT13,(A+X),%Y
135c%I=%I+4
140 FUNTIL %I>=%P
145 NEXT X
150 END
```

Fig. 7. Three-dimensional plotting program for Atom BASIC with floating-point

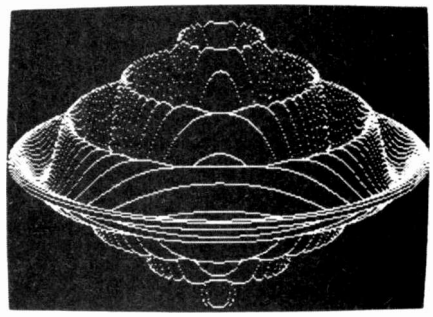


Fig. 8. High-resolution graphics curve produced by 3-D Plot program

totally separate from the normal integer variables. A second version of the IF statement, FIF, is provided for floating-point comparisons; similarly the integer DO . . . UNTIL loop, which gives repeated execution of a section of statements until the condition in the UNTIL statement is satisfied, has as its counterpart the floating-point DO . . . FUNTIL loop. The lower-case letters are labels, used by the GOTO statements instead of line numbers.

The graphics command 'CLEAR 4' sets up the display for 256 × 192 points, and the statement 'PLOT 13,X,Y' plots a point at coordinates X,Y. Hidden-line removal is performed by keeping a record of the highest point plotted, in %M, and the lowest point plotted, in %N; only points greater than %M and less than %N are plotted. Line 90 determines the perspective at which the curve is viewed. The function for evaluation is given in line 80, as the height %Q in terms of the radius %R, and this line can be changed to give plots of other functions.

ULTRASONIC INTRUDER ALARM

GILBERT DAVIES

THIS Ultrasonic Intruder Alarm is an updated version of the design published in *PE December 1979*. Modifications to the original circuit include the use of a sensitivity control which will also preset the detection range and a steady alarm output. The complete unit has been redesigned to fit onto a single p.c.b.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Intruder Alarm is shown in Fig.1. The 555 timer (IC2) is connected as a 40kHz square wave generator which can be fine tuned by VR1. The square wave output is filtered by R22 and C16 before being used to drive the ultrasonic transmitter X1. The 40kHz signal sets up a sound pattern in the protected room and if an object moves within the field a frequency shift occurs (due to the Doppler effect) to the waves which are reflected from the moving object. The transducer X2 will receive two different frequencies (40kHz and the shifted frequency which can be higher or lower than 40kHz); these will combine to produce a beat note. The frequency of this audio or sub-audio beat note will be the difference between the two ultrasonic frequencies. This beat frequency is then amplified filtered and used to operate the alarm. The received sound from X1 feeds the 40kHz amplifier IC3 the gain being determined by VR2, R6 and C6. VR2 adjusts the voltage gain from 1 to X100.

The output of this stage is fed to the envelope detector to remove the 40kHz signal and detect the Doppler frequencies from the received signal. IC4 forms a Doppler frequency amplifier the gain being set by R10, R9, and C8 this increases the signal sufficiently to drive the diode pump detector C9, D7, D8, C10 and R11 to convert the Doppler frequency into a d.c. level.

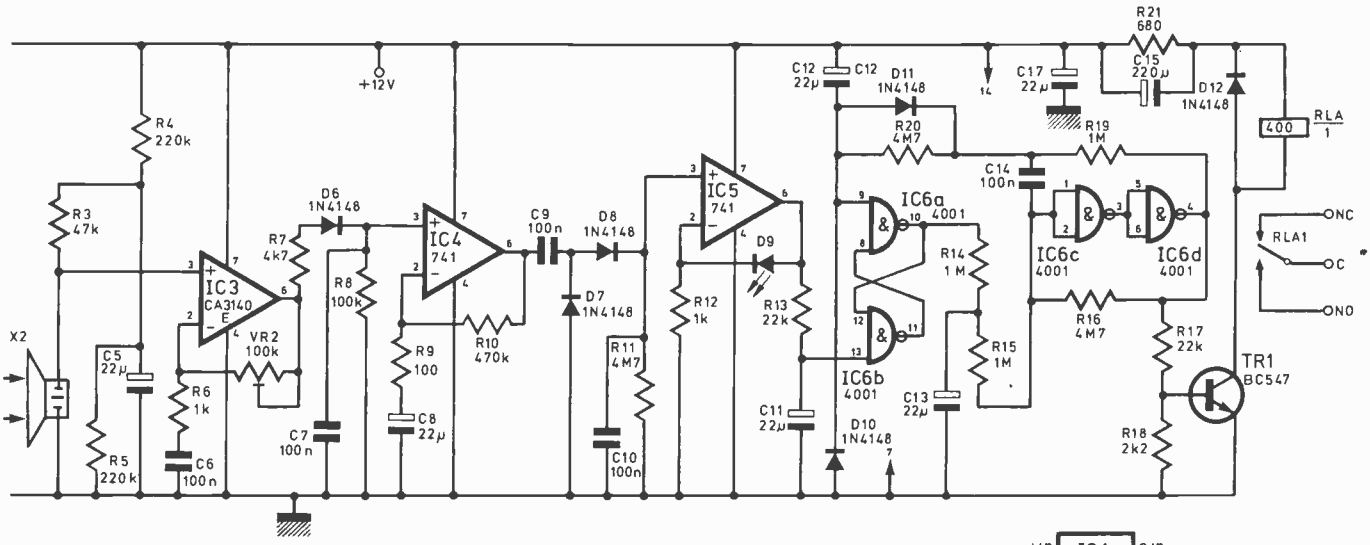
This d.c. level feeds the unit 'on' and 'movement' indicator formed by IC5, D9 and R12. The diode D9 glows when the unit is on and increases in brightness as a movement is detected, the brightness being dependent upon the voltage at the output of IC5 which causes current to flow though D9 and R12. The diode D9 also acts as a 1·2V level shifter for better matching to the next stage.

The d.c. level from IC5 is filtered by R13 and C11 (to form a 1 second invalid movement delay to prevent false triggering) before feeding IC6a and b which form a bistable reset at switch on by C12, D11 and R19 (D10 forms a discharge path at switch off for C12). When the bistable is triggered by pin 13 going high the output of pin 10 goes high charging C13 via R14. When the voltage across C13 reaches the upper threshold of the Schmitt trigger formed by IC6c and d, R15 and R16 the output of pin 4 goes high driving TR1 via resistor chain R17 and R18, the collector of TR1 drives RLA and D12. Resistor R21 and C15 provide sufficient current to energise the relay with a low holding current to minimise the power taken by the relay. When pin 4 is high C12 is discharged by R19 and R20 causing the voltage at pin 9 to rise, which resets the bistable causing pin 10 to go low discharg-

FEATURES

(1) Screw connections for 240V a.c. supply and remote alarm sounder.
(2) 1BV battery back up option in case of mains failure. Ni-cads can provide up to 5 hours of protection.
(3) Internally preset detection range (normally preset to 15 feet with built and tested alarms)
(4) Half second system test at switch on—acts as an alarm on reminder for the user
(5) Twenty seconds delay at switch on—to allow the building to be left without sounding the alarm.
(6) Twenty second delay on entry—to allow the alarm to be cancelled without sounding.
(7) One second invalid movement delay—to prevent false alarms by plants etc.
(8) Two minute self cancelling alarm—to provide repeated protection whilst away for long periods.

The alarm is most sensitive to moving objects in front of the unit and towards the unit. A red lamp glows on the front of the unit when power is connected and increases in brightness as movement is detected.



ing C13 via R14 and when the lower threshold of the Schmitt trigger is reached pin 4 goes low turning off TR1 and de-energising RLA. If relay RLA is removed and R21 linked TR1 can drive a low power high efficient piezo sounder such as the ITT U250-RHA which requires 12V d.c. at 18mA to produce a 105dB 2·7kHz at 1 metre.

R1 and D5 form a suitable charging circuit for ni-cad battery back up. If dry cells are used the charge resistor R1 should be removed. The mains power to the unit and battery feed should both be switched.

The power supply consists of T1, D1, D2, D3, D4, smoothing capacitor C1 i.c. regulator IC1 and decoupling capacitors C2 and C17.

The switch on test is provided by C14 causing pins 1 and 2 of IC6 to go high whilst charging through path C12. D11, R15 and C13 causing pin 4 to go high turning on TRI and energising RLA.

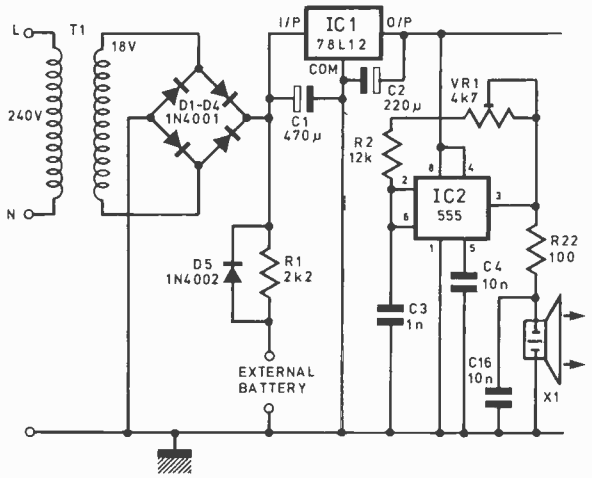


Fig. 1. Complete circuit diagram of the Intruder Alarm

COMPONENTS . . .

Resistors

R1, R18	2k2 (2 off)
R2	12k
R3	47k
R4, R5	220k (2 off)
R6, R12	1k (2 off)
R7	4k7
R8	100k
R9, R22	100 (2 off)
R10	470k
R11, R16, R20	4M7 (3 off)
R13, R17	22k (2 off)
R14, R15, R19	1M (3 off)
R21	680

All resistors ¼W 5% carbon

Potentiometers

VR1	4k7 min. hor.
VR2	100k min. hor.

Capacitors

C1	470µ 25V elect.
C2, C15	220µ 16V elect. (2 off)
C3	1n polyester
C4, C16	10n ceramic (2 off)
C5, C8, C11, C12, C13, C17	22µ 16V elect. (6 off)
C6, C7, C9, C10, C14	100n polyester (5 off)

Semiconductors

D1–D4	1N4001 (4 off)
D5	1N4002
D6, D7, D8, D10, D11, D12	1N4148 (6 off)
D9	Red l.e.d.
TR1	BC547
IC1	78L12
IC2	NE555
IC3	CA3140E
IC4, IC5	741 (2 off)
IC6	4001

Miscellaneous

T1	Mains transformer 18V sec
X1	MA40LIS
X2	MA40LIR

20mm grommets (2 off)
9mm grommets (2 off)
ABS box 115 × 95 × 45mm
Relay Omron LC1N-E
Piezo sounder ITT 250 RHA, p.c.b.
3-way terminal block p.c.b. type (2 off)

Constructor's Note

A complete kit of parts for the Intruder Alarm is available from **GJD Electronics, 105 Harper Fold Road, Radcliffe, Manchester M26 0RQ.**

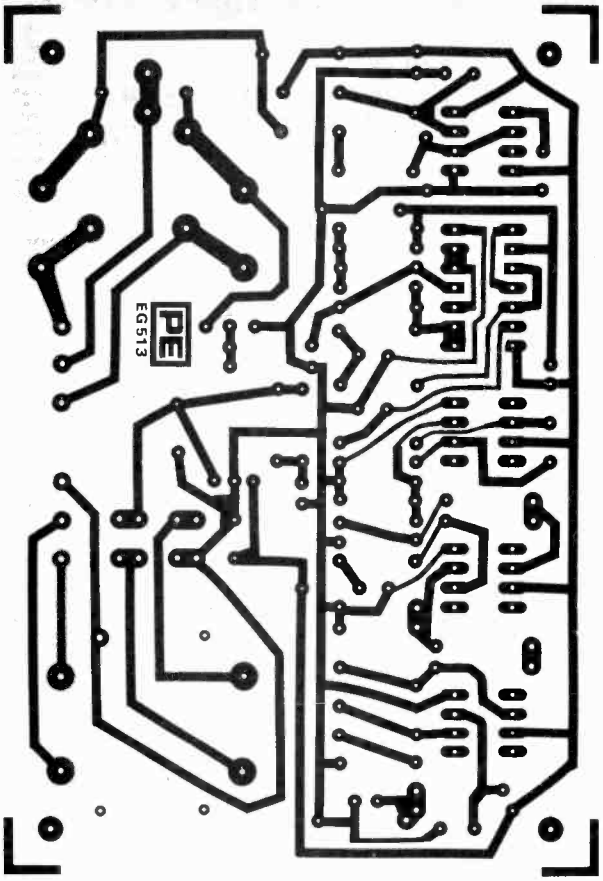


Fig. 2. P.c.b. design

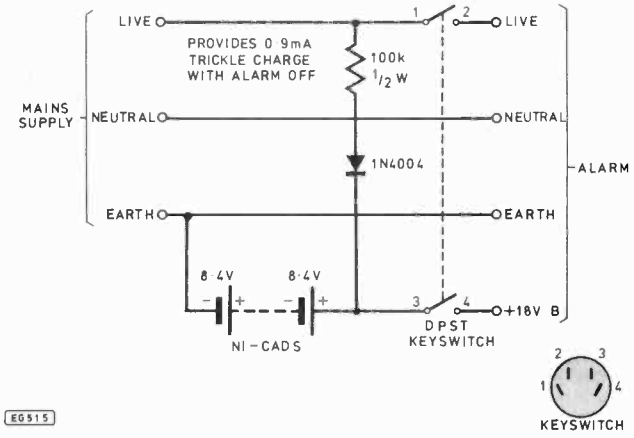
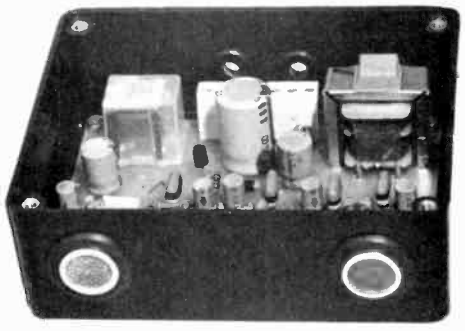


Fig. 4. Circuit for ni-cad conversion



Internal view of the alarm

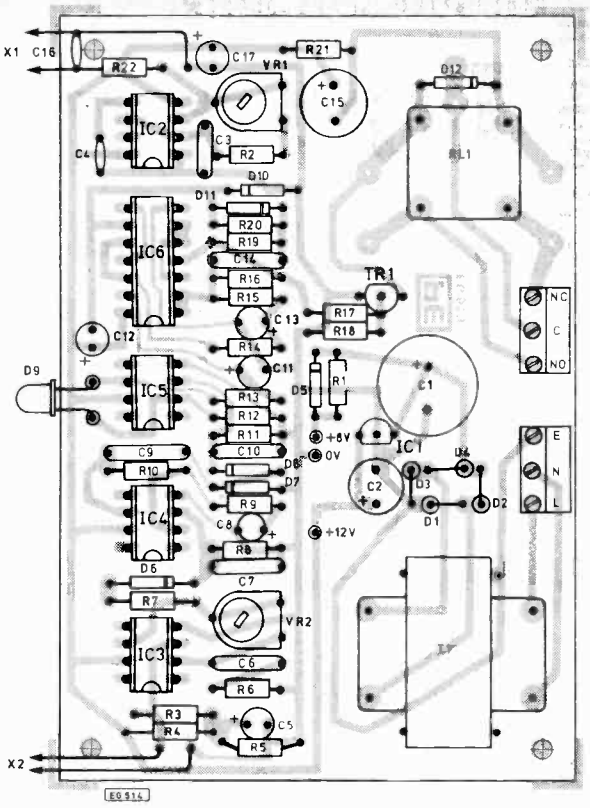


Fig. 3. Component layout

CONSTRUCTION

The p.c.b. design for the alarm unit is shown in Fig. 2 with the component layout shown in Fig. 3. After all the components have been soldered onto the p.c.b. and checked then the case can be drilled. On the prototype the two transducers were fitted into 20mm grommets. The front panel should also be drilled for the movement detector l.e.d. Grommets should also be fitted to the two holes at the rear of the case used for the mains lead and relay connections.

With the transducers fitted into the case and the p.c.b. mounted, then C16 and the other end of R22 should be soldered onto the ultrasonic transducer X1.

SETTING UP

Point the alarm into the room. Turn VR2 fully clockwise and measure the voltage at IC4 pin 3 which should be at around 5·5V d.c. Adjust VR1 until the maximum voltage is obtained, reduce this setting of VR2 for the required sensing range. It is always best to use the minimum range required to reduce the possibility of a false alarm.

INSTALLATION

The alarm is prone to both vibration and air currents therefore the points below should be observed to avoid false triggering of the alarm.

(1) Do not place the alarm on a vibrating surface.
(2) Close all doors and windows.
(3) Do not point the alarm at a radiator or convector heater.
(4) Cats, dogs and large insects should be considered.
(5) If more than one alarm is to be used ensure that the ultrasonic sound emitted by one alarm does not interact with the second alarm.
(6) Try to install away from telephones as some bells can produce high frequency sound similar to that of the alarm ★

Interfacing COMPUKIT

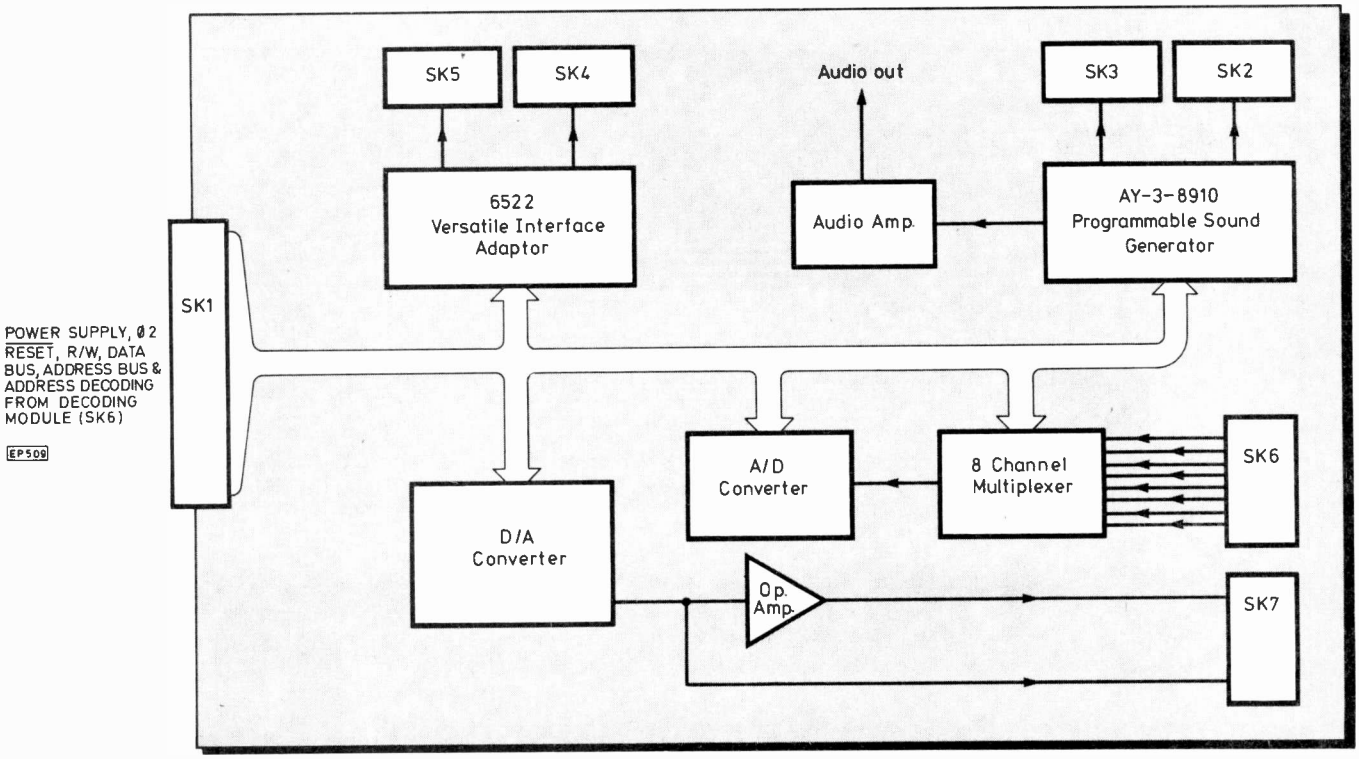
Part 4 D.E.Graham

THIS MONTH we introduce a second companion board to the Decoding Module, and examine the implementation of analogue output from the Compukit.

ANALOGUE, TIMING AND AUDIO BOARD

This is a double sided p.c.b. of the same dimensions as the Decoding Module, which connects directly to it via a single edge connector to provide the Compukit with a range of facilities. The board is powered by the Decoding Module's dual 5 volt power supply, and, as may be seen from Fig. 4.1, contains four separate sections: A D/A converter and operational amplifier taken out to SK7; an 8 channel A/D converter accessed through SK6; an AY-3-8910 Programmable Sound Generator and audio amplifier whose output is taken to a number of pads at the edge of the board, and whose two 8 bit ports are accessed through SK2 and 3; and a 6522 Versatile Interface Adaptor providing a number of counting and timing facilities, as well as a further 16 bits of parallel port. Connections to the 6522 are made via SK4 and 5. Sockets SK2, 3, 4, 5, 6 and 7 are all of the 16-pin d.i.l. variety.

4.1. Block diagram of Analogue Board



CONSTRUCTION

This should prove to be fairly straightforward. It is probably easiest to solder in i.c. sockets first, followed by discrete components, and finally the through-pins (as indicated on the component overlay in Fig. 4.4). Before inserting the i.c.s, test that the correct supply voltage appears at the appropriate pins of all i.c. sockets. The Analogue Board connects to the Decoding Module via a 2 × 25-pin 0·1 inch edge connector SK1. This is wired to SK6 on the Decoding Module as shown in Table 4.1. This wiring should be kept to a few inches in length. Precautions against static damage must be exercised when dealing with i.c.s 1, 2, 6, 8 and 10 since these devices may be easily damaged by static charges.

We will cover the testing of the four parts of the board in the particular sections dealing with each functional unit. Details of the PSG 6522 and A/D converter will be given in forthcoming issues. Now we deal with D/A conversion.

D/A TECHNIQUES

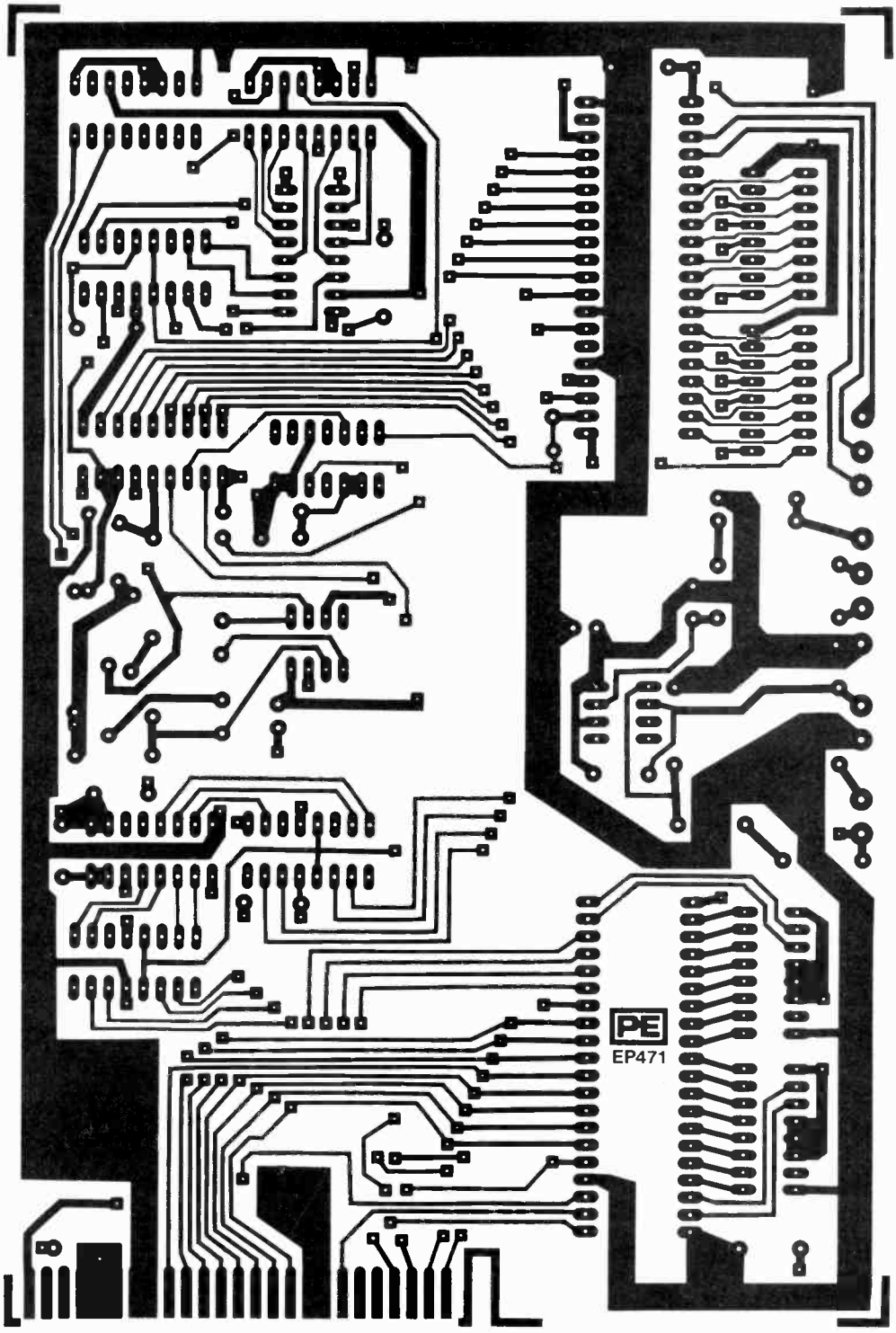
In its simplest form a D/A converter may consist of a chain of resistors joined to a parallel output port. Fig. 4.5 shows a 4 bit D/A converter that could be connected directly to the

outputs of a 7475 quad latch. The output voltage would range from a fraction of a volt for zero data to about 4 volts for the decimal value 15. The resistors would need to be one per cent tolerance types to avoid abrupt changes in voltage occurring when different sections of the chain are brought into play, as in the major transition which occurs from 7 to 8 for example.

The configuration could be doubled up to produce an 8 bit converter, but resistor tolerances would become more critical. Also, if a PIA port was to be used with such a converter, higher value resistors would be required because of the relatively low drive capability of its output. This would further necessitate the use of a d.c. amplifier to produce a usable analogue output.

ZN425 MONOLITHIC CONVERTER

It is of course possible to get around these problems, and particularly the problem of conversion accuracy, by using a



4.2. P.c.b. for Analogue Board (actual size)

Table 4.1 Connections Between SK1 of Analogue board and SK6 of Decoding Module.

SK1 pin number	Upper		Lower	
	SK6 pin number (upper)	Function	SK6 pin number (lower)	Function
1	1	Vgg(−5V)	1	RESET
2	2	Ø2	2	W7
3	3	1RQ	3	W8
4	4	BC1	4	R7
5	5	BDIR	—	NC
6	—	NC	—	NC
7	—	NC	7	R/W
8	—	NC	8	GND
9	—	NC	9	GND
10	—	NC	10	D7
11	11	W7	11	D6
12	—	NC	12	D5
13	13	A3	13	D4
14	14	A2	14	D0
15	15	A1	15	D1
16	16	A0	16	D2
17	17	GND	17	D3
18	18	GND	18	Vcc
19	19	GND	19	Vcc
20	—	NC	20	GND
21	—	NC	21	GND
22	—	NC	22	GND
23	—	NC	—	NC
24	—	NC	—	NC
25	25	NMI	25	BL2

monolithic D/A converter i.c. From the variety of such devices on the market we have chosen to use the Ferranti ZN425 for a number of reasons. In particular it is readily available at a reasonable price, and operates from a 5 volt supply.

Fig. 4.6 gives a block diagram of the sections of the 425 used in D/A conversion. Essentially it consists of 8 data switches which are activated by an external port or latches. These switch a precision R-2R network to an on-chip 2·5 volt reference source to produce an analogue output on pin 14. This is typically 2·555 volts for all bits on, and 3mV for all bits off.

PRACTICAL D/A CIRCUIT

Fig. 4.7 gives the full circuit of the D/A section of the Analogue Board. This consists of a pair of 74LS75s wired to form an 8 bit data latch. The latch enables are taken to the W line on the Decoding Module, which corresponds to an address of 61320. The 8 parallel outputs of the latch are connected directly to the ZN425, which performs the conversion of the latched data within 1μ sec. The analogue output (DA) appears at pin 14 of the 425, and is fed to the non-inverting input of IC11, a 741 operational amplifier. Both DA, and the output of the op. amp. (DAA) are taken out to SK7, which also carries both polarity supply connections and ground.

The op. amp. circuit has two associated variable resistors. VR1 is used for zeroing, and has been given an extended offset capability, and VR2, which controls the gain between about 1 and 2.

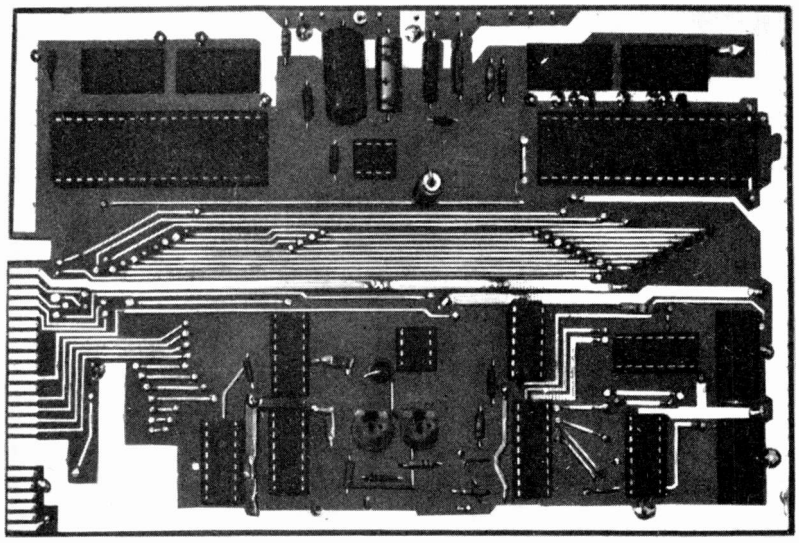
To test the converter, connect a voltmeter between pin 14 of SK7 and earth (pins 1, 5 or 6 of SK7). Execute the command **POKE 61320, 0,** and adjust VR1 to give zero volts on the meter. Now execute **POKE 61320, 255.** This should cause the meter to read somewhere between 2·5 and 4 volts, depending on the setting of VR2. The system is now operational, and POKEing intermediate values to 61320 should yield intermediate voltage readings with a linear correspondence (providing the gain has not been set too high).

If the voltage does not vary with differing data, a voltage check should be made on the DA output of the converter (pin 14 of IC6, or pin 16 of SK7). If this does not alter when data is POKEd to 61320, then checks should be made on the outputs of the two latches IC4 and 5. These should also change when different values are POKEd to 61320.

APPLICATIONS OF THE D/A CONVERTER

The DAA output of the converter unit at pin 14 of SK7 may be used in a wide variety of different applications. It could be used for example to feed a servo amplifier controlling a d.c. motor which could variously drive a graph plotter, a steering mechanism, or a robot's left leg.

More simply it may be used to drive power controllers of one kind or another. For low power d.c. operation, a simple current amplifier of the type shown in Fig. 4·8 may be connected to the DAA output of the converter unit. This will vary the brightness of a 2·5V lamp according to the data POKEd to 61320. To set this up, first execute POKE 61320, 0, and adjust the zero offset (VR1) so that the bulb is just extinguished. Then execute POKE 61320, 255. This should



CONSTRUCTOR'S NOTE: NEW MONITOR IN EPROM

During the development of this series the screen editor written by Nigel Climpson and published in PE was found to be extremely useful. This editor is now available as the CE1 monitor in a 2716 EPROM for £12·50 + VAT and p&p, from **Technomatic Ltd.** It replaces the UK101 2K monitor ROM, and also contains useful routines such as a rapid screen clear.

illuminate the lamp brightly, and VR2 may then be adjusted to achieve best control over the full range of data.

A program of the type listed below will be found useful in setting up the converter for the above, and for other applications:

```
80 REM TEST ROUTINE FOR A/D CONVERTER
100 A=61320
120 INPUTX
140 POKEA,X
160 GOTO100
```

It simply requests a number, which should be an integer between zero and 255, and POKEs this to the converter.

TRIAC CONTROLLER

If a.c. or pulsed d.c. control is required, then the converter may be used to drive a Triac or Thyristor. There are many ways in which this may be achieved, but perhaps the most straightforward is to use the DAA output of the converter to vary the brightness of a l.e.d. indicator, which itself illuminates a light dependent resistor placed at a strategic

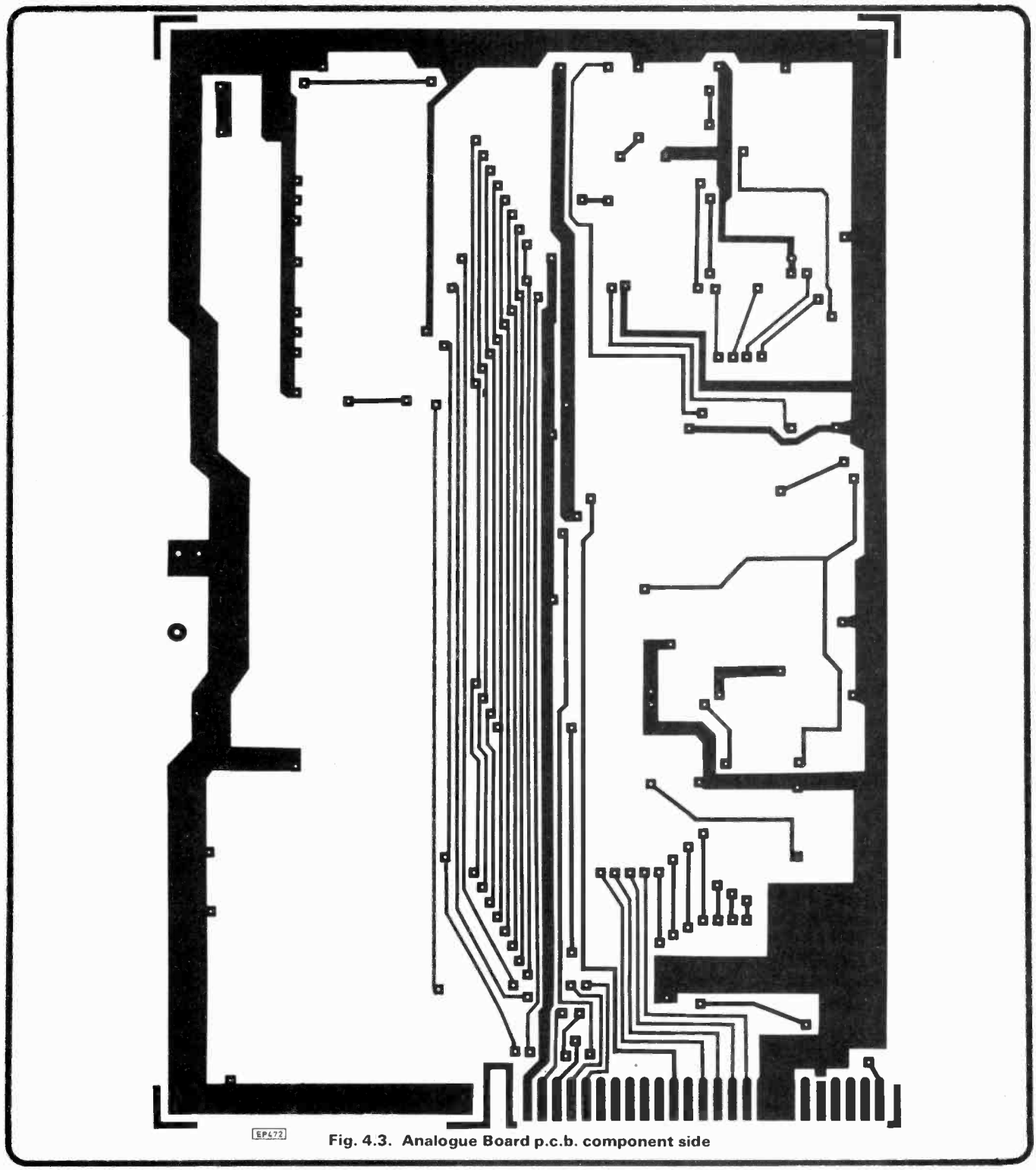


Fig. 4.3. Analogue Board p.c.b. component side

point in a triac or thyristor controller circuit. This has the great advantage of completely isolating the computer system from the mains. Alternatively, a patent opto-isolator such as the TIL112 may be used. In either case the l.e.d. may be directly driven by the DAA output of the converter as in Fig. 4.9.

Fig. 4.10 gives an experimental circuit for a power controller using the l.d.r. method. The phase shift for the triac is produced by the R1/C1 network, with the l.d.r. altering the charge time of C1. R2, R3, and C2 help to reduce hysteresis and flicker, common diseases of this type of controller, though the latter is *not* completely eliminated. L1 and L2 are inductors each formed by winding about 100 turns of wire of a half inch former. Perhaps the most vital part of the circuit is the R4/C3 network. This prevents spikes in the supply line from destroying the triac.

The l.e.d. and series resistor are connected between the DAA output of the converter and Vcc. The l.e.d. should be

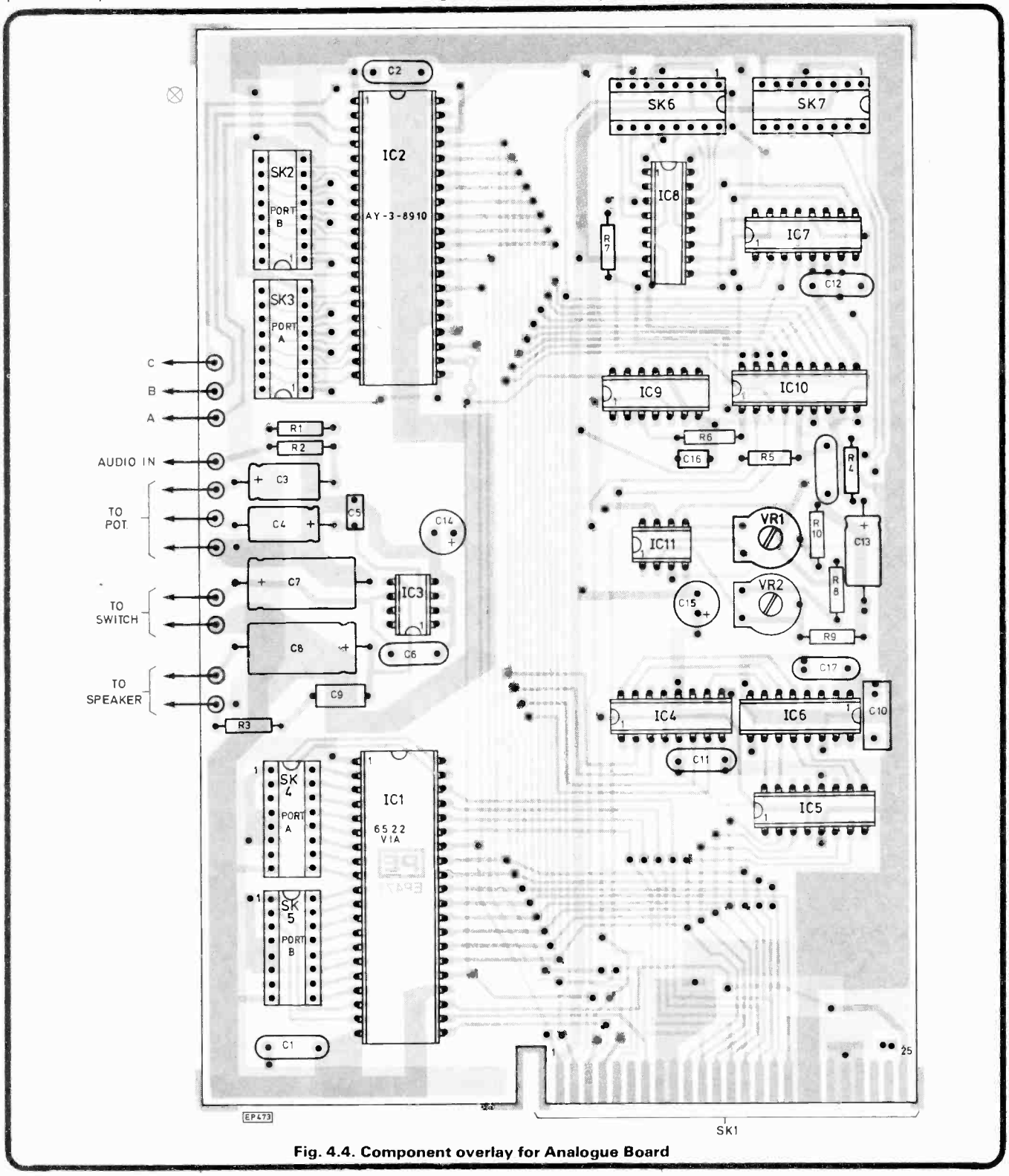


Fig. 4.4. Component overlay for Analogue Board

taped to the l.d.r., and the pair mounted in a *completely* light-tight container.

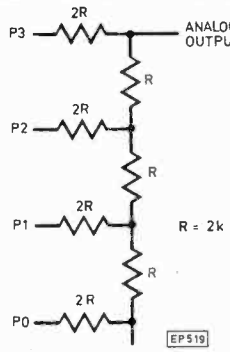
To set up the circuit, VR1 of the converter should be set to give zero volts between DAA and ground on execution of POKE 61320, 0. VR2 should then be adjusted to give a smooth range of control. Some adjustment of R1, 2 and 3 may be necessary to effect this.

THYRISTOR CONTROLLER

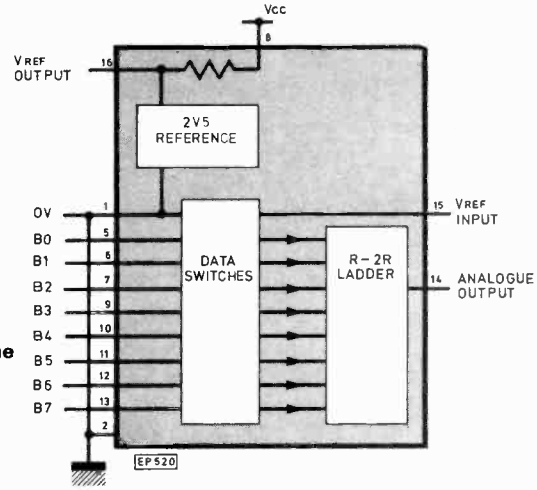
In the author's experience, far more satisfactory power control is achieved using thyristors rather than triacs. One advantage of the thyristor is the ease with which unijunction transistor delay circuits may be used with them; and secondly they cannot suffer from asynchronous firing in the two directions of current flow, as may occur with the triac, and which is indeed one of the factors causing flicker in the controller of Fig. 4.10.

Fig. 4.11 gives the circuit of a thyristor controller which may be used to vary the power to some 12 volt d.c. device for currents up to two or three amperes. Control using the 500k resistor is smooth and flicker-free. An l.d.r. driven by an l.e.d. from the D/A converter may be introduced in a number of ways into this circuit. About the simplest is to take the l.d.r. from point X to earth via a resistor in the range 20 to 100k. To obtain smooth control it will be necessary to adjust the 500k pot in conjunction with VR1 and VR2 on the Analogue Board. Again, however, it should be stressed that this is an experimental circuit, and some adjustment of values may be necessary to obtain the best performance.

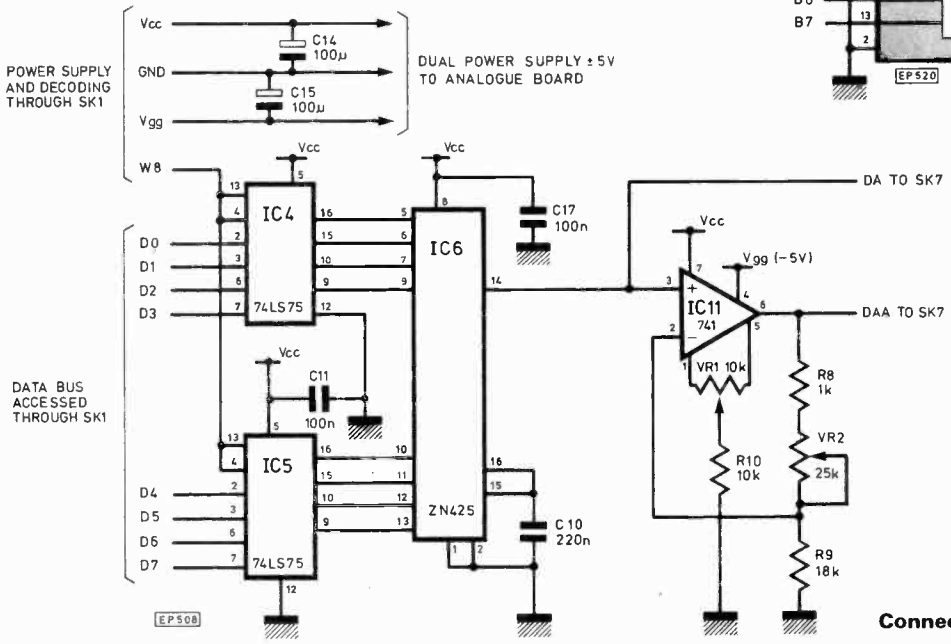
If it is desired to use this circuit for power control at a higher voltage, then it should be possible to increase the supply voltage, and adjust the Zener diode dropper resistor R1 accordingly. If a.c. control is required, then the load



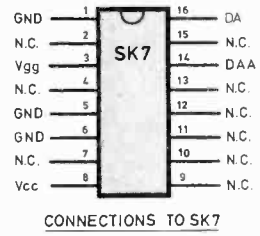
4.5. R/2R D/A converter



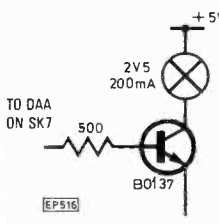
4.6. ZN425 block diagram



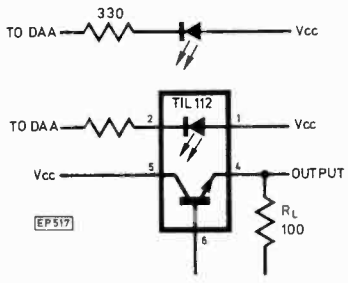
4.7. D/A Converter section of Analogue Board



Connection of l.e.d. to D/A converter

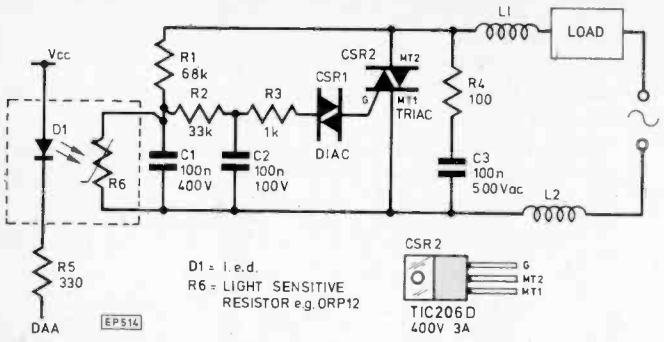


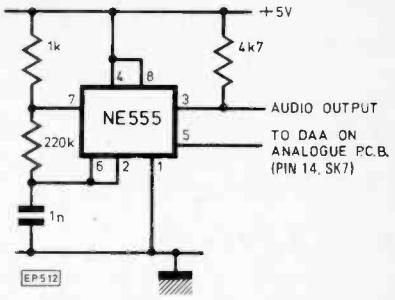
4.8. BD137 Current Amplifier



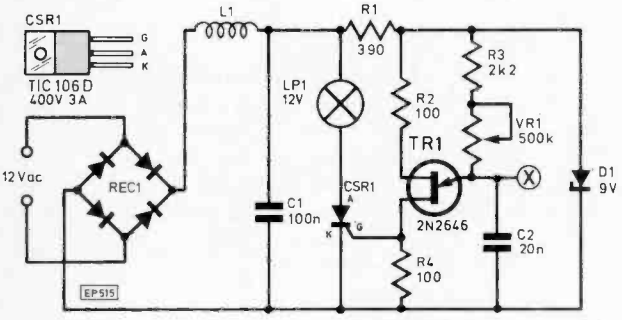
4.9. L.e.d. and Resistor (to opto-isolator)

4.10. Triac Power Controller. All resistors are 1 Watt

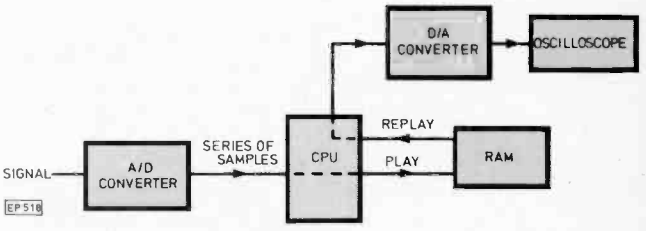




4.12. NE555 signal generator



4.11. Thyristor Power Controller



4.13. Block diagram of storage oscillocope

COMPONENTS . . .

Resistors

R1, R6, R8	1k (3 off)
R2	100k
R3	10
R4	390
R5	82k
R7	3k9
R9	18k
R10	10k

Potentiometers

VR1	10k preset
VR2	25k preset
VR3	100k log + switch

Capacitors

C1, C2, C6, C11, C12, C17	100n disc ceramic (6 off)
C3, C4, C13	10µ/10V (3 off)
C5	1n
C7, C14, C15	100µ/10V (3 off)
C8	200µ/10V
C9	47n mylar
C10	220n mylar
C16	50n mylar

Integrated Circuits

IC1	6522
IC2	AY-3-8910
IC3	LM386
IC4, IC5, IC7	74LS75 (3 off)
IC6	ZN425
IC8	4051
IC9	74LS90
IC10	ZN427
IC11	741

Miscellaneous

P.c.b.
SK1 2 x 25 0·1in. edge connector
SK2–SK7 16-pin d.i.l. sockets (6 off)
40-pin d.i.l. sockets (2 off)
16-pin d.i.l. sockets(5 off)
8-pin d.i.l. sockets (2 off)
14-pin d.i.l. sockets
14-pin d.i.l. sockets
length of 40 strand ribbon cable

Constructors' Note

A complete kit of parts, excluding loudspeaker, is obtainable from **Technomatic Ltd., 17 Burnley Road, London NW10**

should be placed in series with the a.c. supply feeding the bridge rectifier. Additionally the reader is referred to the many power control circuits that have appeared in *P.E.* in the past, and to the useful book on the subject by *D. Marsden*, entitled *110 Thyristor Projects*. The use of one of these with a controlling l.d.r. or opto-isolator should meet most individual requirements; though it should be noted that the recently published circuit for the *Slave Light Dimmer (P.E. Feb. 1981)* is not suitable for this purpose.

AUDIO OUTPUT

For some purposes it may be found useful to run an audio generator from the Analogue Board D/A converter, or from a R-2R converter running from an unused port, and buffered with an operational amplifier similar to that used on the Analogue Board. In either case the DAA output (or similar) may be used directly with i.c.s such as the NE566 function generator or the NE555 timer. Fig 4.12 gives a circuit for audio production using the 555. The DAA line from pin 14 of SK7 is used to directly drive the control pin (pin 5) of the 555. With the components specified this will give outputs in the range 5 to 10kHz. VR1 should be set to null output for zero data, and VR2 to maximum gain. This will result in outputs of about 10kHz for 255, and about 5kHz for data of around 80. If zero is POKEd to the converter, the generator ceases to oscillate, so providing a convenient means of switching off audio output.

FURTHER APPLICATIONS

The D/A converter on the Analogue Board may also be used for directly handling audio and other waveforms. It can, for example, be used in the direct generation of virtually any conceivable waveform. The program below produces a staircase output at the DA and DAA pins of the converter:

```
100 A=61320
110 INPUT "SAMPLE RATE: TRY 5"; C
120 FOR B=1 TO 255 STEP C
130 POKE A, B
140 NEXT
150 GOTO 120
```

Using BASIC for this purpose limits the output frequency of any waveform generated to a few Hz or so. For higher frequency outputs, the program would have to be executed in 6502 code. It would be a relatively simple matter to write a short routine in 6502 code that successively output the contents of a block of memory to the D/A converter. The block could then be filled beforehand, using a POKE routine in BASIC, with any desired waveform, e.g. sin, square, triangular step, etc. The short 6502 code program could then be accessed via the USR(X) call to output the data at any given speed.

Using similar techniques in conjunction with an A/D converter it would be possible to write software for a storage facility for an oscilloscope. The A/D converter would sample a given waveform, and store the data in a given block of RAM. The D/A converter could then be used to output the sequence repeatedly, and at any frequency and repetition rate, so as to provide a permanent display, with the option of recall facilities, etc. See Fig. 4.13.

Next month we will look at the use of the PSG on the Analogue Board, and discuss applications such as a 14-note organ operated from the UK101 keyboard. Details will also be given on the use of the Programmable Sound Generator as a 3-channel D to A converter

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Excellent Combination

Sir—I have recently constructed a *PE* Congress amplifier from a kit supplied by Wicca, as a re-introduction to electronics after a fifteen year break. Apart from bridging two tracks in the phono stage, the unit worked first time. I must congratulate the designer(s) on the performance of this design—it really is incredibly good to listen to, and is capable of 'demolishing' a number of commercial units with a higher 'paper' performance.

I have only two small points of criticism. Firstly, the effectiveness of the balance control can only be described as minimal. I can find no fault in the construction, so can you advise? The second problem (about which I intend to speak to Wicca) is transformer hum, which, in an amplifier that generates so little noise internally, is very noticeable. Perhaps a toroidal unit would have been worthwhile?

My second reason for writing is to give a pat on the back to a company which has given me superb service. Some six months ago, I purchased a pair of Videotone GB3 speakers through the *PE* Special Offer. These were used a few times on an old stereo record player which at best could be described as poor, but did play old records, so I took little notice of the poor sound. When I had completed the Congress, I connected the GB3 units, and with a decent input to them, it was immediately obvious that one tweeter was inoperative.

I telephoned Videotone and explained the problem, which they suggested may have been caused by clipping on the old amplifier (which I doubt as I treated the unit very carefully in deference to its meagre output), but they took my address and offered to supply a new tweeter under warranty. It duly arrived and was installed, and the speakers were connected. The performance of those tiny (and cheap) boxes is a revelation. There is ample bass during the day with a little boost, but the real beauty is at night. With the bass rolled off a little, the sound quality is retained without annoying the neighbours. Try doing that with the bus-sized speakers that so many people seem to think necessary. In any normal residence, the Congress and GB3 pairing will be found capable of generating excrutiating volume without distortion, even to those with 'disco-ears'.

To any reader who may have built a Congress, I would say without hesitation, "hang on a pair of GB3s, you will not believe your ears". I bought the GB3s on the strength of an earlier auditioning of the older 'Minimax', which was very good, but not, I believe, in the same class as the GB3. As for the service from Videotone, what can I say except "thank you".

S. G. West,
Northampton.

Noddy Radio

Sir—As a reader of your magazine I would be quite content if the sickeningly over-exposed letters "CB" appeared never again. I have no enthusiasm for citizens band radio, and I suspect that 99% of the population of this country is similarly disinterested.

What we have is a verbose minority creating a furore over what is, after all, Noddy radio. I am prepared to tolerate occasional breakthrough on my domestic equipment when it is the police going discreetly about their business—or even a local taxi firm.

However, I see no reason why I should endure prolonged breakdowns when I am trying to take in the news, just so that an immature "citizen" can tell the world he is called Rubber Duck and he doesn't like "bears".

I have no doubt that should this band be allowed, every ten years or so it will become involved in some small way with a murder hunt, and then we shall hear of the wonderful contribution CB makes to society. Why should a respectable magazine like *Practical Electronics* jump on this bandwagon?

As far as I'm concerned, CB should be allowed only on microwave at 1mW so that nobody can use it!

Peter Bleck,
London.

Sir—I see that you have published a CB converter in your March issue. I already have a converter and I see from your editorial in the February issue that I need a licence to listen to it. As I cannot obtain a licence to listen to CB, how can I be prosecuted for not having something I cannot obtain anyway?

It is also illegal to transmit on CB, so therefore there is nothing to listen to. So how can I be prosecuted for listening to something that is not there in the first place?

This seems to me to be a ridiculous situation and the sooner the government comes up with some *sensible* licensing ideas, the sooner it will be getting more money to help with the running of the country.

Little T,
Leicester.

Sir—Your editorial seeking views on listening to—for example—CB on 27 MHz raises a wider question. Has any government the moral right to forbid us to listen to any available radio transmission? There may be perfectly justifiable reasons for restricting *transmission* (e.g. CB) but it must surely be a fundamental right to *listen* to any broadcast information in an intelligible form.

The obvious exception is on security grounds, e.g. police radio—but the enterprising criminal is hardly likely to be deterred by the Wireless Telegraphy Acts more than, say, the Theft Act!

If the originator of a message chooses an inherently public medium such as radio the onus is on him to adopt a cryptic method of transmission. If an illicit broadcaster gets on the air it is the business of the authorities to stop him, not to tell us not to listen, as do totalitarian regimes. Even those who practice press censorship tend to go for the publisher rather than the reader!

D. B. Lyall,
Cheltenham.

Alive and Kicking

Sir—As the new chairman of the Amateur Computer Club I would like to clarify the current position of the ACC, and in particular its future. I feel that your readers, many of whom are interested in home computing will be interested to learn of the current position of the ACC.

I am pleased to announce that the ACC is now very much alive and kicking following a somewhat dormant period last year. The ACC is a national organisation to promote interest in amateur computers and computing, to facilitate the exchange of information and ideas, and to help members with their home computer systems. Annual membership is £4·50.

I would also like to mention a few other points. Firstly, last year the ACC year was extended to September '80. The new year started on October 1st and runs until 30th September '81. Secondly, it is hoped to set up regular contact with the journals and to keep them informed of the activities of the ACC.

Peter Whittle,
Chairman—ACC,
1 Blinco Road,
Urmston,
Manchester.

Micro Bus Error

Sir—Congratulations for your excellent 'Micro Bus' series, but why not every month? Having tried the *Draughts Board* game in *February 81* issue (for the ZX80) I would like to point out a couple of small (but very important) errors (probably printing errors!):

Line 30 should read: **PRINT "12345678"** *Space after the eight,* and Line 300 . . . **OR (X=13 AND TL$ (A$)="R") OR NOT...** *Bracket close after "R"*

Having just spent a Sunday afternoon finding the missing space, I hope this might save someone else the trouble. There has been some gain though, at least I now know how the program works, which I admit I wouldn't have if it had worked straight away!

P. Holton,
Upper Norwood,
London.

PE Microtune

Sir—I have read with interest your project Microtune, in the Dec-Jan editions of your magazine, and was impressed by the technical specifications and useful functions available on what is quite a reasonably priced machine.

It is good to note that your magazine is aware of the importance of the correct adjustments to the ignition system of the modern motor car and that this equipment makes such adjustments an easy task. Using this equipment carefully should enable the builder to recover the cost of it in improved fuel consumption and smoother running in a very short time.

On reading the section "USING THE MICROTUNE", I would like to comment on a few points that I feel may cause confusion with an operator who is not fully conversant with car electrical systems and I hope that my comments may be of use.

In the section "Battery Checking" the test that is suggested is a good test but I feel that the duration of the test should be limited to 15 seconds as the time of 30 seconds quoted I consider too long and could result in the premature condemning of a serviceable battery. An extra check that could be incorporated into this section is a check on coil SW voltage. On a 12 volt coil system the voltage at the SW terminal should be no more than 0·5 volt lower than the battery voltage. A higher volt loss could be due to a faulty ignition switch or connections in the coil feed. On a ballast system the voltage should be between 5 and 8 volts; a reading higher or lower could indicate a wrong coil fitted or a high resistance in ballast resistor or wiring. These checks are carried out with the contacts closed and ignition on. With the engine being cranked over, this voltage at the SW terminal should be a minimum of 9 volts. With a ballast system a voltage of, say, 5 volts would indicate a fault in the boost circuit between solenoid and coil.

Coil resistance tests are extremely useful, particularly when trying to find out if a car has the right coil fitted. The most usual figures are 3 to 3·5 ohms for a 12 volt coil and 1·5 ohms for a ballast coil. Most ballast resistors are 1·5 ohms and on some cars it is possible to check this also.

The section on points resistance is perhaps the most useful section, and it is important to get this figure down as low as possible. The figures quoted by distributor manufacturers vary between 0·1 volt and 0·4 volt. The Lucas figure of 0·2 volt can be considered as one to aim for. Good starting and coil output depend on a low volt loss here and to some extent condenser performance can also be affected. Things to look for are faults in plug-in connectors in the wiring, burnt or dirty contacts and distributor base plate earth faults.

Dwell angle on modern cars is around 50° and typical figures quoted are Motorcraft 48 to 52° on Ford vehicles, 46 to 56° by Lucas on most Leyland vehicles and 49 to 51° by Delco fitted to Vauxhall cars. These figures are all for 4 cylinder engines. Owing to the fact that altering the dwell angle by 5° alters the ignition timing by 5°, it is important to check and adjust the ignition timing after any distributor adjustments.

M. J. Stacey,
TI Transport,
PO Box 8,
High March,
Daventry,
Northants.

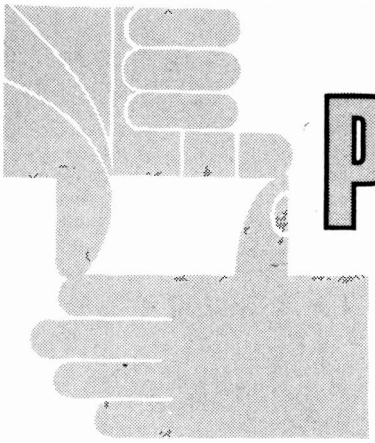
Going too far?

Sir—In view of the recent interest in CB, I think you may be interested to learn of an article which appeared in a recent issue of the medical newspaper *Doctor*.

The article concerns an incident in Preston, when a CB group donated £560 to the intensive care unit of a local hospital to buy some urgently needed equipment. The doctor who had accepted the donation was shocked when the hospital management refused the gift and ordered inquiries into the donors.

The article states: "An embarrassed Dr Saltpepper said 'After the DMT's final decision I was informed that it is not advisable for members of staff to associate with unlawful organisations.' He had not realised that the CB group—many of whom are ambulancemen—was unrecognised as a charitable body because CB radio is illegal."

D. M. Broughton,
Leeds.



PATENTS REVIEW...

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the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1·25 each.

FINGER ON THE PULSE

The national obsession with jogging, and the health risks involved, is producing a spate of patents for gadgets which monitor the wearer's pulse rate and heart beat. The latest, British patent application 2 039 434, from Patrick Wright of Woking, Surrey and Julian Lynn-Evans of Chichester, Sussex, describes a sophisticated monitor which is worn like a watch on the wrist to give a constant digital readout of heart beat and sound an alarm if a dangerously high rate is reached.

The unit shown in Figures 1 & 2 has a transducer 16 and pressure sensor 13 on the rear face which lies over the wrist pulse point. Normal pulse rate is around 72 pulses per minute and the inventors suggests that in general, exercise should be controlled to keep the rate down to below 120ppm.

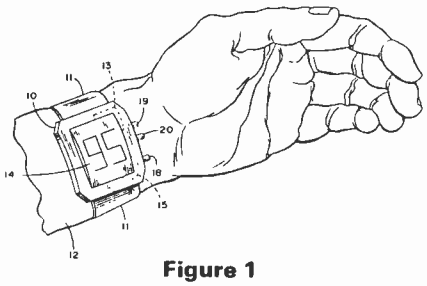


Figure 1

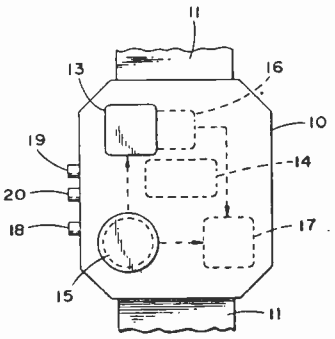


Figure 2

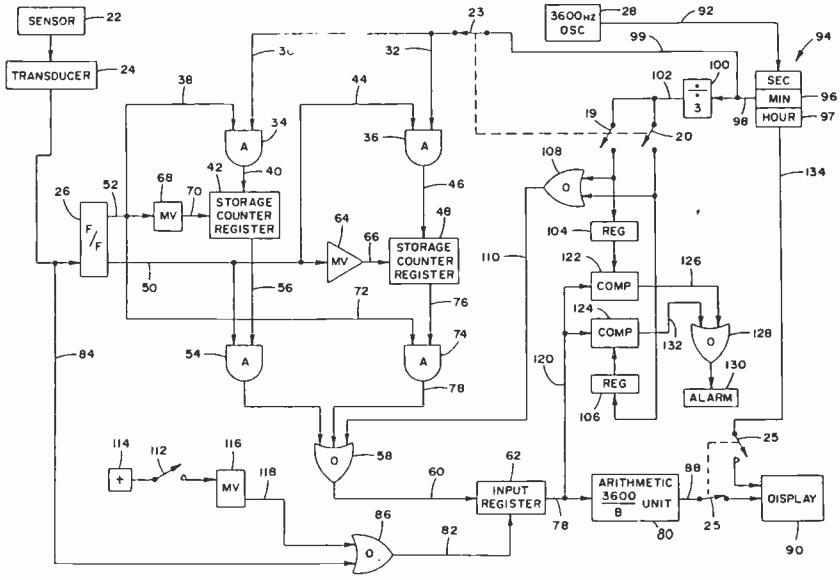


Figure 3

Figure 3 shows the basic circuit for utilising the pressure sensor output. Oscillator 28 produces a 3600Hz signal on line 92 coupled to clock 94. Heart beat rate is determined by the formula

$$H = \frac{3600}{8}$$

where H = heartbeat rate and 8 = the number of oscillator pulses stored between heart beats. So if 60 pulses are stored between heart beats, a rate H, of 60 beats per minute is represented and if 120 are stored between beats a rate H, of 30 beats per minute, is represented. Clock circuit 94 is a conventional second, minute, hour, clock and its 60 pulse per second output on line 98 is fed to AND gates 34, 36. These gates are enabled by a signal from flip-flop 26 which changes state each time a pulse is received from transducer 24. When the sensor 13 is in contact with the wearer's pulse pressure point it produces a pulse each time a heart beat is detected so flip-flop 26 changes state with the wearer's heart beat.

With the appearance of each heart beat one of two counters 42, 48 begins to store pulses from oscillator 28 until the next heart beat is sensed. At that instant the 60Hz pulses from clock 94 are transferred from the first counter to the second counter, while the output of the first counter is coupled to input register 62. So the number of pulses occurring between heart beats is stored alternately in counters 42, 48 and transferred alternately to input register 62. Arithmetic unit 80 is programmed to divide 3600 by whatever count is stored in register 62. The output of unit 80 is coupled to numerical display 90. So the wrist watch unit provides a constant monitor of heart beat rate.

To sound the alarm for an excessively high rate, a pre-set number of oscillator pulses is stored in a register for comparison with the sensed rate. Switches 19, 20 couple the output of divider circuit 100 to storage register 104 and 106. As these switches are held closed, pulses are fed into the registers at 20 pulses per second and until required upper and lower limit heart beat rates are stored. Switch 19 is depressed to store the upper rate and switch 20 is depressed to store the lower rate.

Comparators 122, 124 receive the same input signals as arithmetic unit 80 from input register 16. Comparator 122 produces an output for OR gate 128 if the monitored heart beat is greater than the number of pulses stored in register 104. Likewise if the monitored number of pulses is less than the number stored in register 106, comparator 124 produces an output for OR gate 128. In each case an alarm 130 is activated to warn the wearer.

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.

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

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.

'DAY TO REMEMBER' CLOCK

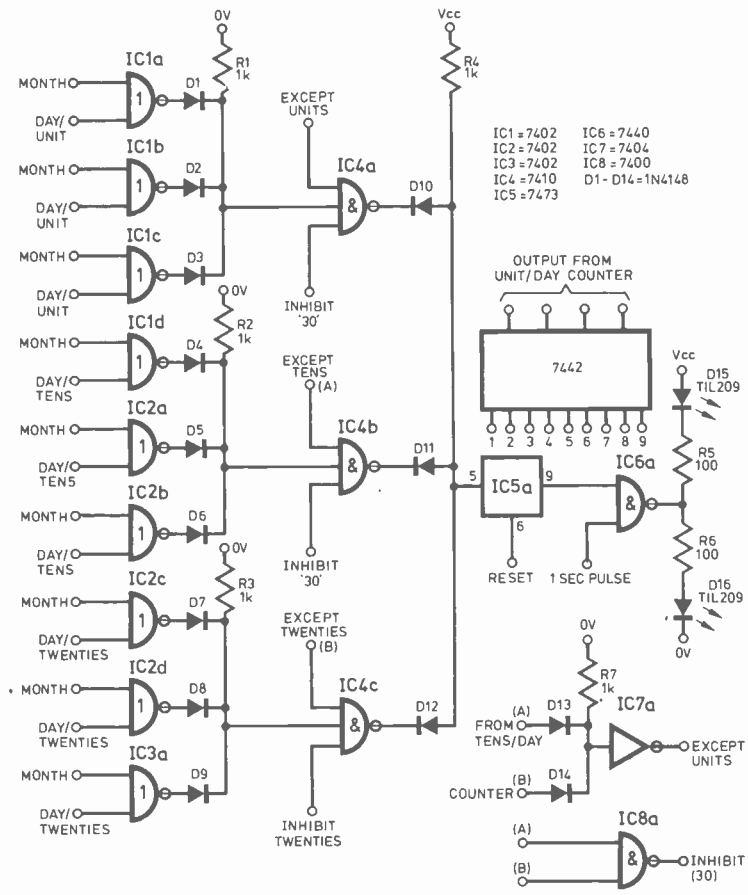
THIS circuit is an add on unit to D. E. Clarke's Digital Calendar published in *PE* June 1976. It provides a 'Day To Remember' alarm for birthdays, anniversaries, etc.

The NOR gates inputs are wired up to the required outputs from the 74154 on the digital calendar and the 7442. I have divided the unit up into three groups of three NOR gates, DAY/UNIT/MONTH, DAY/TENS/MONTH, DAY/TWENTIES/MONTH. If the day to remember is the 16th March, then the middle set of gates would have one of its inputs connected to the 3rd output on the 74154 and the other input connected to the 6 output on the 7442.

When the clock indicates this date both inputs would go to '0', feeding a '1' to the 7410 gate, as the date is the 16th, and not the 6th, or the 26th, 'except tens' will be at '1' and the 'inhibit 30' will also be at '1', then a '0' will be fed through and trigger the 7473. This will remove the inhibit from the 7440 and let the 1 sec. pulse through to switch the l.e.d.s on and off. The 7473 is reset by a '0' on pin 6; this will cause pin 9 to restore the inhibit and stop the l.e.d.s switch on and off.

Obviously it would be of no point in setting up the clock to indicate the day on which the birthday or anniversary falls, therefore I have set my clock up for the alarm to come on 5 days before the event.

C. T. Chantler,
Grimsby,
South Humberside.



BARGRAPH THERMOMETER

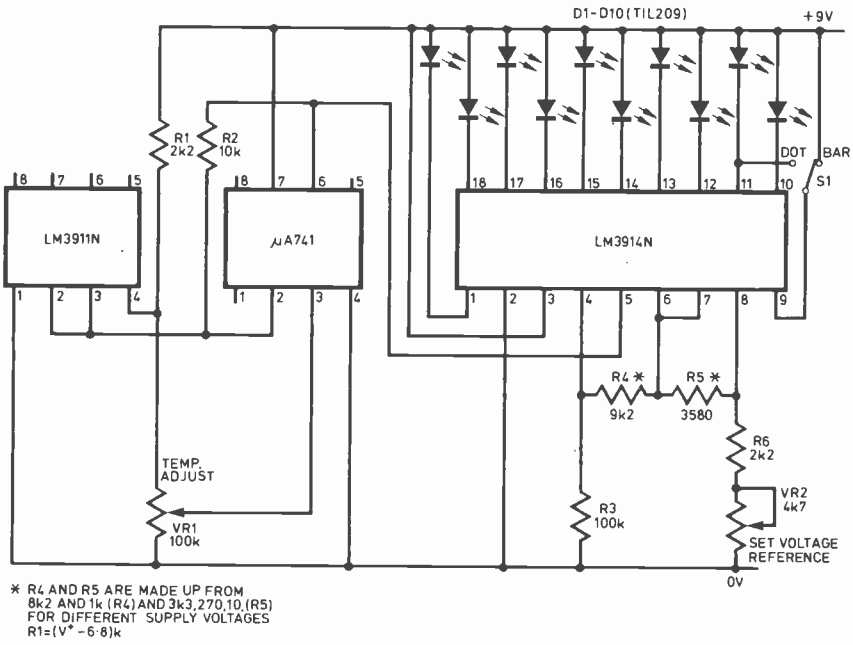
THE thermometer circuit shown will measure temperature in the range −25°C to +85°C. The LM3911 is used to sense the temperature and provides an output of 10mV/°k (10mV/°C). Therefore at −25°C (248°k) the output is 2·48V and at +85°C (358°k) 3·58V.

This output, though, goes negative on temperature increase, and is so inverted by the 741 op-amp. VR1 can be used to adjust the final reading on the display.

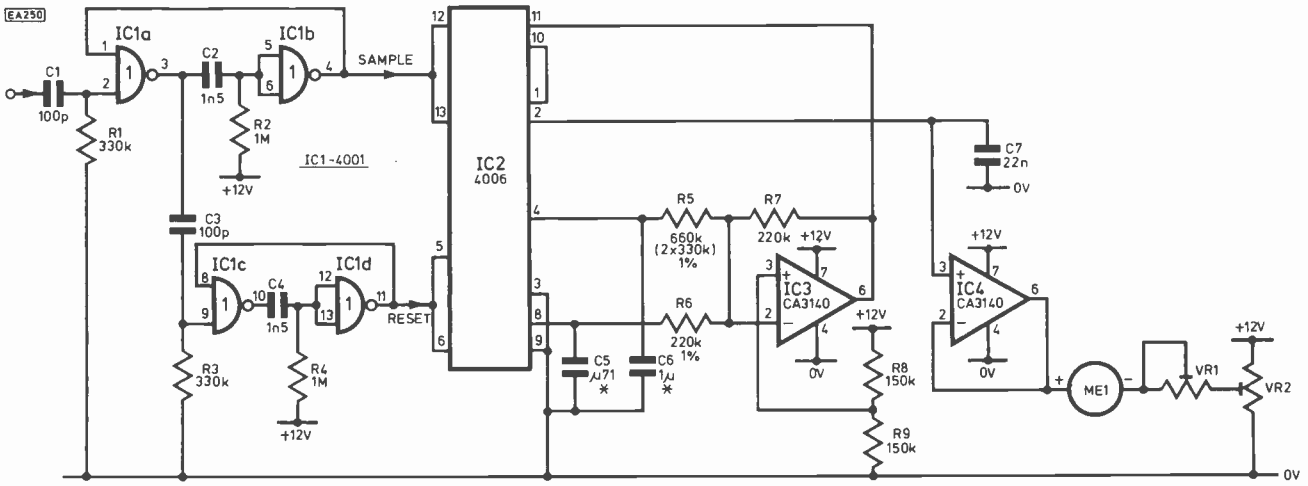
The LM3914 is an i.c. that senses analogue voltage levels and drives to l.e.d.s, providing a linear analogue display. The current for each l.e.d. is programmable and in this case is set at approximately 10mA. The i.c. uses a resistive divider network, one end of which is set to the high reference, the other end to the low reference. For this application they are set to 3·58V and 2·48V respectively. These being adjustable by VR2. The divider therefore has 1·1V across it which means that another l.e.d. will light for every 110mV input, which corresponds to an 11°C temp. rise. The first l.e.d. will switch on at −14°C, the second at −30°C and so on up to +85°C.

The mode switch selects whether previously lit l.e.d.s remain on as temp. increases, or whether only one l.e.d. remains on.

R. Eley,
Keynsham,
Bristol.



L.F. ANALOGUE MONITOR



MOST low frequency measurements, e.g. the human pulse rate, involve a compromise between a slow response and a pulsating output. This can be avoided by calculating the reciprocal of the interval between pulses. Done digitally, this is elegant, but costly enough in itself to increase the pulse rate!

My simple analogue circuit gives excellent linearity over a 4:1 or more frequency range. It relies on the fact that a CR charge will approximate a reciprocal. Combining two charge currents of different time constants in the right ratio gives a good approximation to linearity.

Here, R5 R6, C5 and C6 form the two RC networks, C5 and C6 charging towards an aiming potential $V_{DD} \times R9/(R8 + R9)$. .

IC3 produces an output voltage proportional to the sum of the currents in R5 and R6. This is sampled and held, to drive the meter via IC4, each time a positive going pulse appears at the input to IC1a. Each such input pulse develops, via IC1a to d, a sample pulse for this purpose, followed by a reset pulse to discharge C5 and C6 and recommence the cycle.

The 4 channel switch IC2 performs the discharge and sampling. Sampling is via two gates in series to maximise leakage resistance. C8, which provides a double integrator in the open gate condition via the gate leakage resistances, is not needed at pulse rates higher than 30 per minute.

VR1 and 2, which control sensitivity and zeroing, can with many meter scales be set up for a direct indication of frequency.

The ratios R5/R6 and R5C5/R6C6 should ideally to correct within about 1%.

The supply voltage is not critical but should be reasonably stable since it affects sensitivity to some extent.

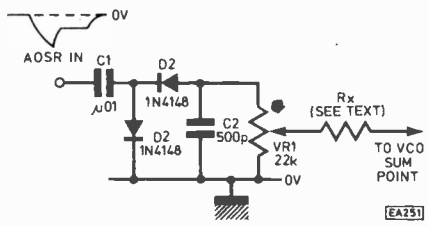
C. J. Collins,
Letchworth,
Herts.

ENVELOPE DIFFERENTIATOR

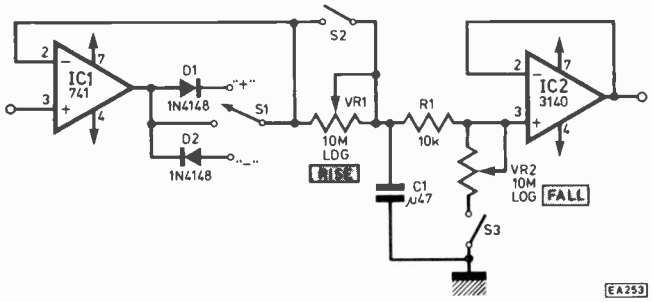
MOST monophonic lead line synthesisers have provision for modulation of the VCOs by other oscillators to give vibratos and trills, but few use the ADSR envelope output because of the difficulty in tuning caused by sustained portions of the envelope. The circuit described here converts an ADSR envelope into an AD envelope, giving a 'chirp' at the beginning of every new envelope.

Capacitor C1 'differentiates' the changing envelope voltages, whilst diodes D1 and D2 ensure that only negative going AD envelopes reach the VCOs. VR1 controls the depth of VCO modulation. Rx is a resistor chosen to give acceptable maximum levels of modulation. For use in the *PE* Minisonic suitable values range from 100k to 470k, depending on individual tastes.

Martin Russ,
Fallowfield,
Manchester.



SYNTH PROCESSOR



THIS circuit was originally designed for use in a voltage-controlled synthesiser as a multi-purpose voltage processor, but it can be applied to many other uses.

The circuit consists of a peak detector made up of IC1 and the associated components, and a memory circuit made up of IC2 and the associated components.

Switches S2 and S3 are used to control the operation mode of the circuit. Controls VR1 and VR2 control the rate of change of the output voltage. Switch S1 controls the direction in which the circuit holds the peaks of the input voltage.

With S2 open the rise time of the circuit is determined by VR1 and the circuit now behaves as 'lag' circuit or integrator. If S3 is closed the fall time of the circuit is determined by VR2, S3 is opened for a memory hold or peak detector function. If S2 and S3 are closed and VR2 is set to its minimum value, the circuit acts as a voltage follower.

There are many applications of this circuit. In a voltage-controlled synthesiser, the lag processor and voltage follower are useful control-voltage modifiers, using the peak hold with a keyboard voltage can give unusual effects such as unidirectional portamento, where the glide speed varies with the direction of playing on the keyboard. For low frequency a.c. applications the circuit can be used as a rectifier and filter unit with the output being proportional to the 'average' of the input in a similar manner to the operation of an envelope follower.

Martin Russ,
Fallowfield,
Manchester.

TVC FOR SYNTHS

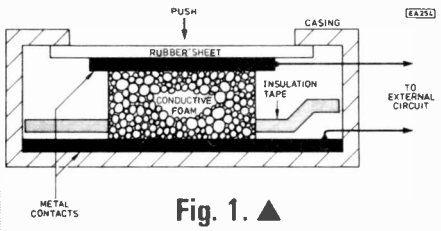


Fig. 1. ▲

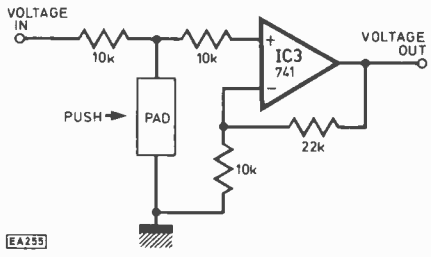


Fig. 2. ▲

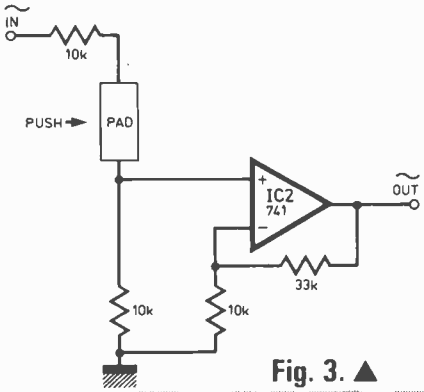


Fig. 3. ▲

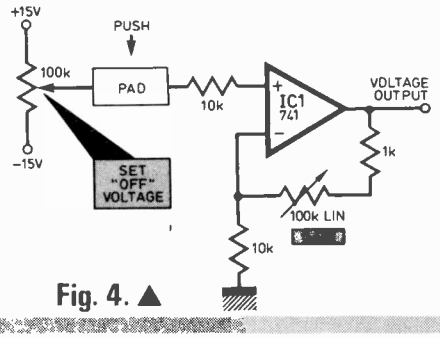


Fig. 4. ▲

COMMERCIAL performance synthesisers use many forms of man/machine interface. Of these, the pitch-pad is rarely seen on home produced synthesisers. The touch voltage control (TVC) described here enables the pitch pad idea to be applied to almost any synthesiser.

The basis of the circuit is the 'conductive' black foam used to pack CMOS i.c.s. By using a piece about 3 cms square, sandwiched between two metal sheets, it is possible to make a resistor whose value changes with pressure, from about 100k or more down to about 200 ohms.

Mechanical and electrical construction of the TVC pad is shown in Fig. 1. The prototype was constructed in a PP3 battery case from which the insides were removed and a rectangular hole cut in the side.

The pad can be used to replace any resistor in the control circuitry of the synthesiser, a few ideas are given in Figs. 2, 3 and 4. These are a voltage controller, volume control and attenuator respectively.

Martin Russ,
Manchester.

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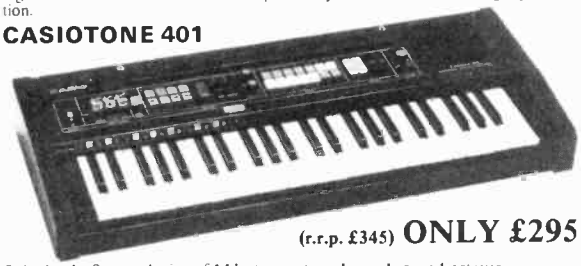

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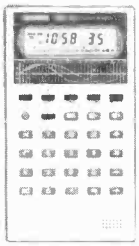

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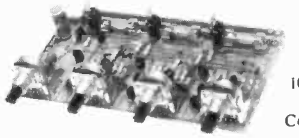

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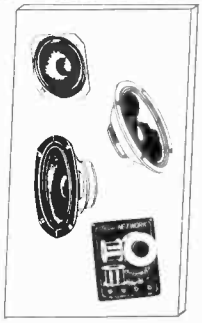

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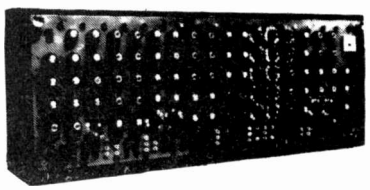

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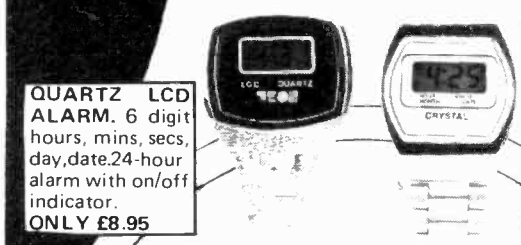

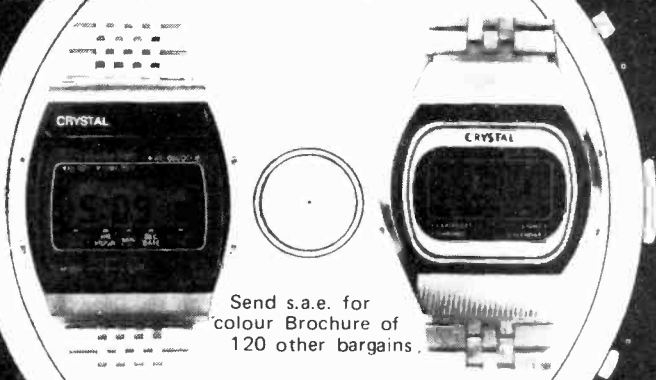

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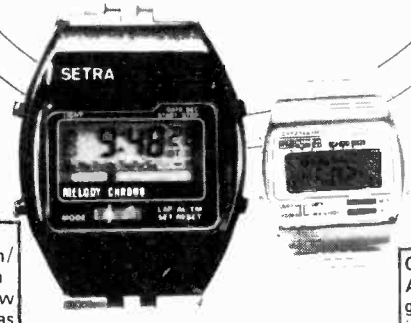

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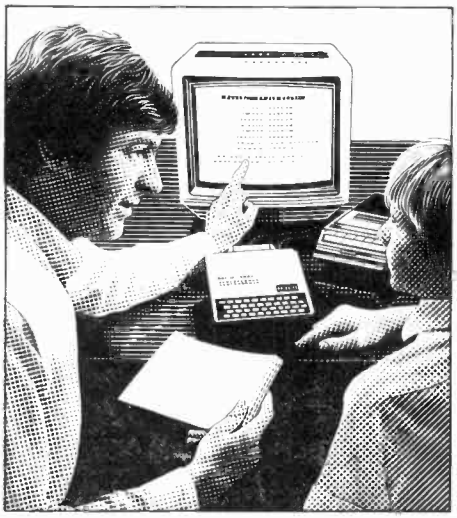

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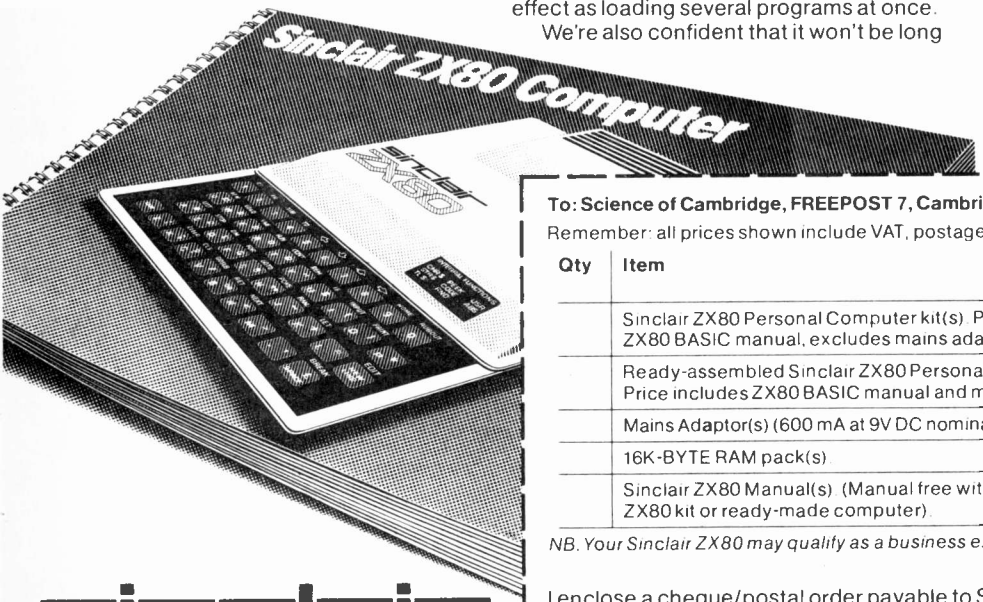

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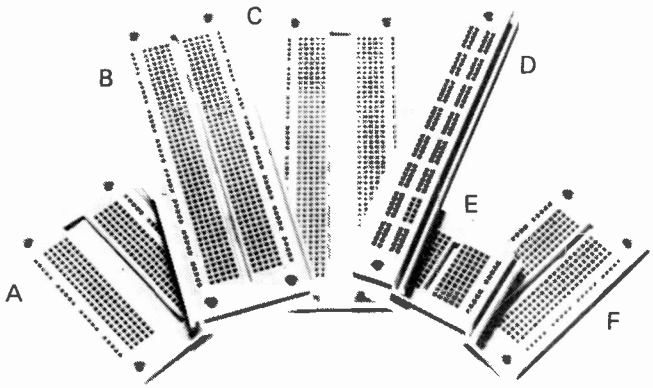

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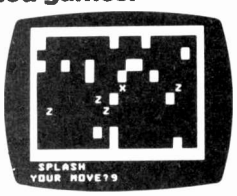

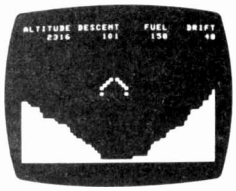

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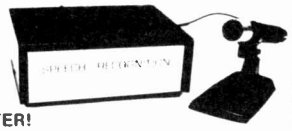

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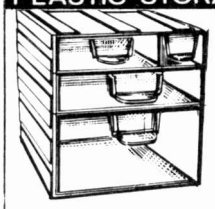

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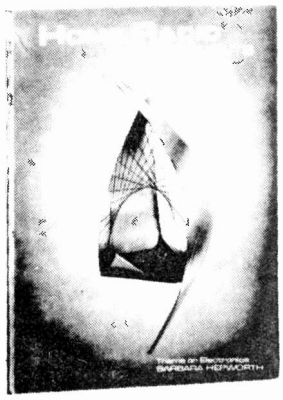

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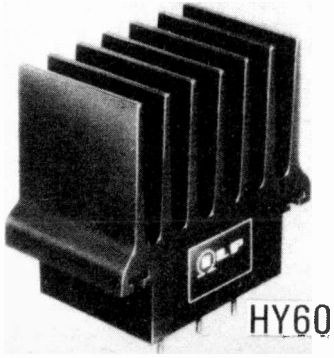

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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3 88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5 02

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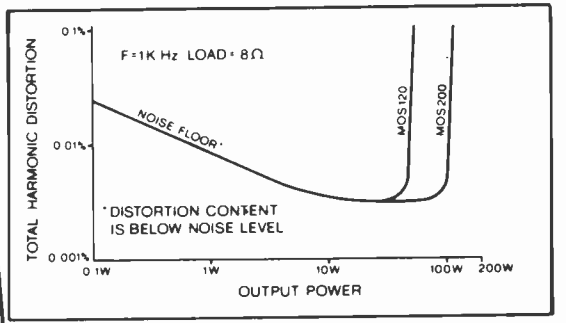

Load impedance both models 4Ω-∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB

BIPOLAR

STANDARD O/P TRANSISTORS

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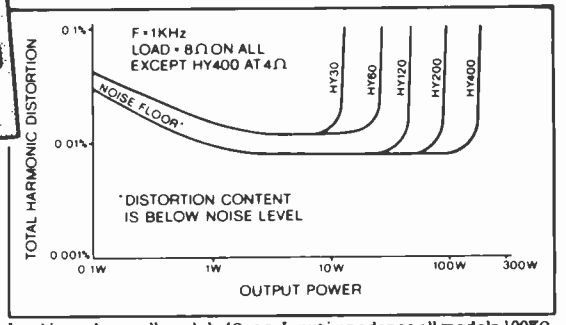
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77



Load impedance all models 4Ω-∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB

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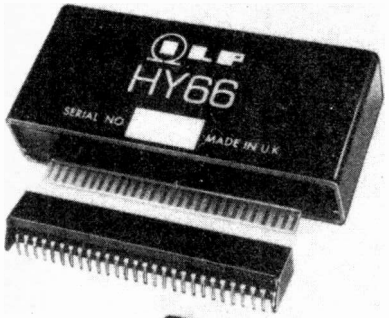
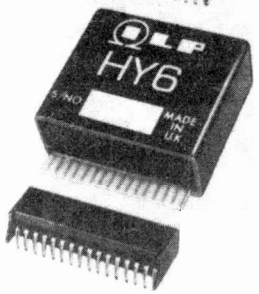
The introduction of standard heatsink extrusion for all I.L.P. power amplifiers achieves many advantages: – Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for higher thermal conductivity. Extrusions vary in size according to module number.

I L P PRE-AMPS



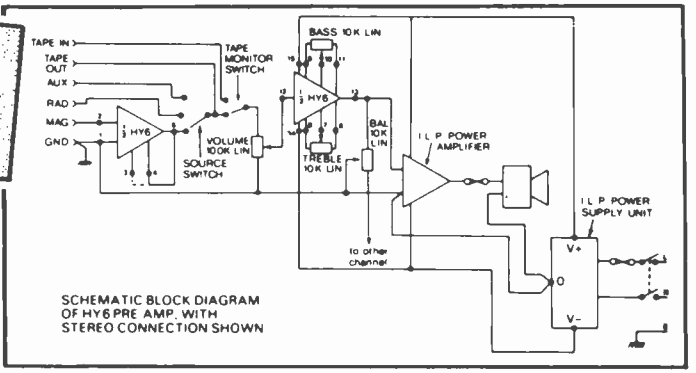


HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from yc ir equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.
Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm. Active Tone Control circuits provide ±12dB cut and boost. **Inputs Sensitivity** – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £6.44 + 97p VAT Connectors included
HY66 stereo £12.19 + £1.83 VAT Connectors included

B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE AMP. WITH STEREO CONNECTION SHOWN

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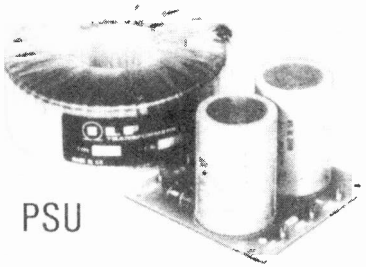
IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS



PSU

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

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PSU90	for use with 1 HY200	£16.20 + £2.43 VAT
PSU95	for use with 1 **MOS200**	£16.32 + £2.45 VAT
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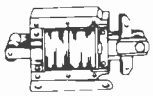

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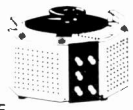

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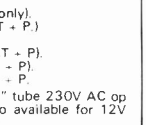

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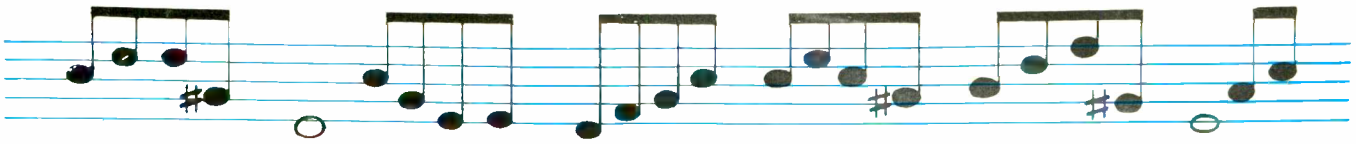

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